# E-Commerce and M-Commerce Technologies

P. Candace Deans

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**IRM Press**

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| Printed at: | Integrated Book Technology |

Published in the United States of America by
IRM Press (an imprint of Idea Group Inc.)
701 E. Chocolate Avenue, Suite 200
Hershey PA 17033-1240
Tel: 717-533-8845
Fax: 717-533-8661
E-mail: cust@idea-group.com
Web site: http://www.irm-press.com

and in the United Kingdom by
IRM Press (an imprint of Idea Group Inc.)
3 Henrietta Street
Covent Garden
London WC2E 8LU
Tel: 44 20 7240 0856
Fax: 44 20 7379 3313
Web site: http://www.eurospan.co.uk



Library of Congress Cataloging-in-Publication Data

E-commerce and M-commerce technologies / P. Candace Deans, editor.
p. cm.
Includes bibliographical references and index.
ISBN 1-59140-239-5 (pbk.) -- ISBN 1-59140-566-1 (hardcover) -- ISBN 1-59140-240-9 (ebook)
1. Electronic commerce--Technological innovations. 2. Mobile commerce--Technological innovations. I. Deans, P. Candace.
HF5548.32.E18298 2005
658.8'72--dc22

2004003774

British Cataloguing in Publication Data
A Cataloguing in Publication record for this book is available from the British Library.

# E-Commerce and M-Commerce Technologies

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# Preface

Electronic and wireless technologies have changed the way we do business forever. We have seen fast paced change in the last decade not only in information technology advancement but also in business model design and strategic direction. Technology has become central to company operations as well as strategy. Successful companies today recognize electronic technologies and the Internet as mainstream to business success. Wireless technology is becoming increasingly important for companies seeking a means for cost cutting, enhanced productivity and improved efficiency. The future for electronic and wireless technology applications will continue to be promising to companies seeking competitive advantage.

Keeping abreast of technological advancement has never been more difficult or more important for companies as they compete in an increasingly global economy. Change comes from every direction and competitive forces surface from nontraditional sources. The dot com era forced traditional companies to think in new ways in order to remain competitive in a newly emerging marketplace. Today, business is electronic and e-business is business. Just as in the PC revolution there is a point at which there is no turning back. Computers today are a given necessity for doing business. The digital transformation has, likewise, pushed companies to a new era of electronic business. That era is being pushed a step further with the advent of wireless technologies and mobile commerce initiatives. Tomorrow, business will be mobile. These transformations will not only impact the way business is transacted but it will impact the very fabric of society.

Electronic and wireless technologies continue to evolve. Technological innovation provides opportunities for new business applications and consumer products. Standards play a big role in the direction and eventual success of new products and applications. Currently a lack of international standards has made progress difficult as telecommunications companies move along differ-

ent standards paths. Competing standards and technologies have emerged that make decision making for companies more difficult as they plan for technology advancements. Europe and Asia (Japan) have advanced in wireless technology faster than the US and other parts of the world. Movement toward third generation (3G) technologies has been slower than expected due to the high cost of building out networks and the uncertainty in demand to recoup the costs. In the US, for example, the trend to move toward 2.5G was based on lower costs to implement than would be required for 3G. Japan and Europe have moved more quickly down the 3G path but not without tremendous cost in license agreements and network expense. Wi-Fi and the development of hot spots around the US have progressed with some success. Cost is a major consideration in these decisions but it is unclear how all these technologies will evolve in the future and which will eventually win out. Companies are taking fewer risks and testing the waters more cautiously in the wireless technology realm. Uncertain economic conditions have also contributed to the confusion and proliferation of standards and technologies. The consumer perspective has not helped, as the demand for wireless technologies and devices has not been as substantial as was expected. Worldwide trends and market conditions will continue to evolve and play a significant role in the future direction of electronic and wireless technology applications.

Currently, successful mobile commerce strategies have focused on applications and opportunities inside the organization. These applications have greater potential for return on investment than those directed toward consumer commerce. It is not difficult for companies to make the business case for wireless technology applications inside the company that meet objectives for cost savings, enhanced productivity, and increased efficiency. For example, sales force automation and field force automation are key areas for companies to target for return on investment. Wireless technology makes it possible for sales personnel to get critical information on clients and products while away from their desks. This saves time, improves customer relationships, and increases revenue and profitability. Field force personnel can get access to schedules, forms that need to be completed on the job, and product information from their handheld devices. This can cut labor costs and reduce the extra time and cost of inputting data more than once. Data can be captured at the point of access, which will also reduce error rates. Wireless technology is also being used in the warehouse to keep inventory current and to improve accuracy. This translates into happier customers. Wireless LANs have also been implemented to improve efficiency in the workplace. In addition, companies can now wirelessly track their assets through Radio Frequency Identification (RDID) technology.

This technology is expected to replace bar codes when the price point reaches an affordable level. Product information can be stored on these tags that track the product along the supply chain and keep track of important information that was not before possible. Combined with location technology, company assets can be located at any point in time. Telemetrics allows companies to wirelessly access information and monitor status levels at all times. For example, electricity meters can be read through wireless technology, eliminating the need for a person to read each meter manually. Layers of labor may be eliminated with some applications providing additional cost savings. Machines can be monitored at a distance and alerted when there are problems detected. For example, the toner in a printer can be monitored and the company's suppliers notified to place an order without the intervention of a human. Wireless Customer Relationship Management (CRM) is still another avenue for companies to exploit. Wireless technology provides another channel to interact with the customer. There are challenges from the marketing perspective but the potential is real if implemented correctly.

From a consumer perspective, wireless technology has not taken off to the degree expected, especially in the United States. In Europe, short message system (SMS) was the driver for wireless devices. In Japan, entertainment, ring tones, and wireless icons pushed mobile consumer commerce forward. In the US market, consumers are still waiting for the killer application. The demand for wireless has been slow to gain momentum because consumers do not see a pressing need. Mobile payments are expected to be one means for pushing mobile business forward. Currently, security is an issue for many applications and privacy issues play a role in acceptance of applications such as location-based services. Consumers are skeptical about technologies that can track their location at all times. Applications that provide for safety such as e-911 and information availability that is timely such as local directions will be most likely to succeed in the US consumer market. The consumer market has experienced an increase in wireless access through laptops, personal digital assistants (PDAs), and cell phones. There has also been an increase in households that have wireless networks. As these trends continue, acceptance of mobile commerce applications will increase as well.

Currently, worldwide trends indicate a period of transition from mainstream electronic business to mainstream mobile business. It is unclear how long this transition will take. The eventual movement to 3G and 4G networks will provide the infrastructure for companies to move forward with wireless technology applications. As will be discussed in the chapters that follow, many issues remain to be addressed that have surfaced as a result of these techno-

logical advancements. The enabling technologies will also undergo improvements that will further enhance their usefulness. New technologies will continue to proliferate and further complicate the existing platforms and infrastructure. Voice integration, for example, will emerge to play a role in future mobile technology applications. Technology can be expected to continue to change and evolve as well as play an increasingly significant role in the strategic direction of companies.

## Organization of the Book

The book is organized into four sections with 11 chapters. Section I addresses the role of Customer Relationship Management (CRM) in the context of Internet and mobile commerce channels. CRM has become increasingly important for companies as electronic and wireless technologies have provided new opportunities to interact with customers. The evolution of CRM from traditional systems to e-CRM to wireless CRM has provided companies with both new challenges and new opportunities for developing innovative customer strategies. Companies in the digital era have been forced to reinvent their companies from the customer perspective. Chapter 1 addresses a broad array of issues related to evolving CRM systems and potential research directions.

Section II addresses specific issues related to wireless technologies and mobile commerce. Specifically, Chapter 2 addresses the issues of information presentation on handheld devices. This issue has been significant from the consumer perspective. Information must be packaged in ways that limit the amount of information that must be read by the end user but at the same time provide value in timely information. The authors address the issues of human interface and interaction in this context. Chapter 3 addresses the critical issue of making payments on mobile devices. Many believe solutions to mobile payments may be a driving force behind mobile commerce. In this chapter the authors examine the various options for mobile payments and resulting challenges. Standards, security and consumer acceptance are discussed in this context. Chapter 4 examines the issues associated with 3G multimedia services specifically from the perspective of the Italian market. Conclusions from the study can be compared and applied to other markets. Lessons learned may be relevant for other markets. Finally, Chapter 5 addresses a broad perspective on wireless technology and mobile commerce for developing countries. Developing countries have found it advantageous to leapfrog traditional

technologies through the use of wireless applications. The authors provide specific examples of how these technologies are being implemented and the development of new business opportunities afforded by these technological advancements.

Section III takes a more focused look at specific technologies and issues relevant to the digital age in general. Chapter 6 examines digital watermarking technology in the context of specific applications and potential problems. The authors explain the specifics of the technology and its potential benefits. Chapter 7 addresses digital rights management and the issues related to the protection of intellectual property in digital format. The authors develop a domain model to provide insights on issues and future trends. Chapter 8 looks at the dynamic nature and role of ad hoc networks. Change rates are examined in the context of these networks that form, change and dissolve in an ad hoc way routinely. The authors examine the impact of these networks on network functionality.

In Section IV, the focus shifts to specific issues relevant to electronic business. In Chapter 9 the authors report results of an empirical study that measures the loyalty of Internet shoppers to online companies. Based on the findings, the authors provide recommendations for online companies. In Chapter 10, findings of a study on managers' perceptions of the benefits and difficulties of Internet use in hotels is discussed. Finally, a case study is presented in Chapter 11 that addresses the pros and cons and other issues relevant to reverse auctions.

A strength of the book is its international flavor. Authors of the chapters are from a variety of countries all over the world. This gives the reader perspectives on the issues from different world viewpoints. Culture, the role of government, legal environments and other differences among countries may play a key role in the direction countries take on various technologies and the significance of security, privacy, ethics and other related issues. It has become increasingly important to look at the direction of technological advancement, trends, and specific applications from a global perspective.

# Acknowledgments

I would like to thank all the authors who made contributions to this book. Without their dedication and interest the book would not have been possible. I would also like to acknowledge all those involved in the review process. Their constructive and comprehensive reviews were valuable to the overall process and quality of the final product.

Special thanks go to the publishing team at Idea Group Inc. Mehdi Khosrow-Pour and Jan Travers always provide encouragement and professional support. It has been a pleasure to work with the editorial team led by Jennifer Wetzel. This project went smoothly because of the support and organization from all those involved at Idea Group.

***Candace Deans***
***January 2004***

# Section I

# Customer Relationship Management: Internet and Wireless Channels

## Chapter I

# Customer Relationship Management on Internet and Mobile Channels: An Analytical Framework and Research Directions

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## Abstract

*The Internet has served as an effective channel for companies to build and manage relationships with customers. The mobile channel, emerging from the convergence of wireless communications and the mobile Web, promises to deliver additional support to meet consumer needs. This chapter examines features of customer relationship management (CRM) as implemented on the Internet (eCRM) and the mobile channel (mCRM) from the customer's perspective. It further explores how companies can*

*better coordinate their CRM strategies between these two channels to support e-commerce customers. We propose an analytical framework to examine the current eCRM and mCRM practice in terms of customer loyalty, branding, customer satisfaction, customization, and trust. These five factors affect customer acquisition, sales and services, and customer retention. A checklist was developed to guide the evaluation of CRM practice for e-commerce sites. Several examples and research directions are discussed in the chapter.*

## Introduction

Customer relationship management (CRM) involves the deployment of strategies, processes, and technologies to strengthen a firm's relationship with customers throughout their lifecycle – from marketing and sales, to post-sales service. The motivation for CRM stems from companies' desire to increase their revenues and profitability through improved customer satisfaction and retention (Reichheld, 1996; Reichheld & Sassar, 1990; Winer, 2001). Internet technology has transformed CRM into electronic CRM (eCRM), because companies can use Internet technologies to capture new customers, track their preferences and online behaviors, and customize support and services. Furthermore, the convergence of wireless communication and mobile Internet provides companies with opportunities to interact with their customers through a new mobile channel.

Despite the potential growth of mobile commerce for location-aware and customer-aware services (Varshney, 2003), recent research points out that most mobile sites were designed primarily for supporting existing e-commerce customers (Chan et al., 2002). Customers who are already familiar with the interface and services provided on a company's Web site are likely to benefit more from its mobile site. Therefore, out of a wide range of mobile services (Varshney, 2003; Varshney & Vetter, 2001), it is logical to consider the mobile channel as appropriate for building and retaining relationships with existing customers. Because of current technology and usability barriers (Chan & Fang, 2003; Ernst & Young, 2001; Shim et al., 2002), businesses and consumers are hesitant to adopt the mobile channel. Research is needed to examine how the mobile channel can be effectively leveraged to attract and retain e-commerce customers.

The main purpose of this chapter is to provide an analytical framework for examining how companies can build and manage relationships with their e-commerce customers by leveraging the Internet and the mobile channels. We take a customer's perspective in examining the firm-customer interactions through these two channels. The chapter focuses on the features of content and services presented on companies' Web and mobile sites. Our intent is to identify (a) how CRM can be effectively coordinated between these two channels, and (b) key research questions pertinent to the eCRM and mCRM coordination. Our proposed framework examines CRM implementation across three phases of an e-commerce site's interactions with its customers – acquisition, sales/service, and retention. Interactions in each phase are also examined along five factors that are essential to Internet-based CRM solutions: (1) customer loyalty, (2) branding, (3) customer satisfaction, (4) customization, and (5) trust. We apply this framework to several e-commerce sites and their corresponding mobile sites to explore how CRM features are currently incorporated into these sites. A checklist, derived from the framework, was used for the site analysis. From this exploratory work, we identify commonalities between eCRM and mCRM, and the respective roles played by each channel. Furthermore, we propose a set of research questions for future investigation. This chapter contributes to a better understanding of mobile commerce technology and strategies. In particular, it addresses how organizations can optimize CRM by leveraging the unique characteristics of Internet and wireless technologies.

# CRM and E-Commerce

## CRM Research

CRM is a strategy for companies to build and manage long-term relationships with their customers. Researchers have shown that CRM implementation can provide better customer service, as well as improvement and management of customer expectations and loyalty (Cho et al., 2001; Reichheld, 1996; Reichheld & Sassar, 1990; Romano, 2001; Winer, 2001). CRM also complements a firm's capability to present products, quality, and services to its customers (Chen & Sukpani, 1998). By implementing CRM solutions, many

firms expect to improve profitability by gaining customer loyalty, customizing offerings, and lowering costs.

The increasing pressure on profitability has motivated companies across different industry sectors to invest in CRM solutions. An Internet impact study shows that CRM applications are the most widely adopted e-business solutions (Varian et al., 2002). On the average, 71% of companies in this study have adopted Internet-based solutions for customer service and support, 68% adopted e-marketing for customer development, and 52% adopted e-commerce for sales and transactions. Generally, an investment in retaining repeat customers contributes more to a company's profitability than do marketing expenditures for attracting new customers. Reichheld and Sassar (1990) have demonstrated that the overall profit generated by existing customers over seven years exceeded those generated by new customers. For e-commerce companies, the need to expand customer base and attract repeat customers may be equally important for their sustainability. Forrester Research (2003) has projected online retail sales to grow to $96 billion in 2003, a 26% increase from 2002. However, this growth only represents 4.5% of total retail sales in 2003. E-commerce still has potential for further growth. Therefore, a dual emphasis on customer acquisition and retention is important to achieve profitability for e-commerce companies.

CRM approaches are built on the concept of relationship marketing, which emphasizes building a long-term relationship with individual customers. In contrast, traditional transaction marketing maintains a short-term focus on the transaction of products. Relationship marketing embraces strategies of personal and ongoing exchanges with customers for brand management, feedback, knowledge acquisition, and customer differentiation (Moon, 2002). Knowledge acquisition enables companies to gather better information about their customers through some type of self-disclosure. Customer differentiation allows companies to offer services that match different customer needs and customer values. Essential to relationship marketing is the strategy of customizing the marketing mix – products, services, communications, channels, and price. Thus, "the relationship marketing process involves an iterative cycle of knowledge acquisition, customer differentiation, and customization of the entire marketing mix" (Moon, 2002).

Researchers and industry practice tend to adopt a *suppliers'* (or firms') perspective of relationship marketing by emphasizing the goal of customer retention and profitability (Hennig-Thurau & Hansen, 2000; Hennig-Thurau & Klee, 1997). Most of the relationship and loyalty programs tend to focus on the

company's drive for transforming relationships into profit (Winer, 2001). In contrast, less attention has been devoted to understanding *customers'* motives and wishes regarding their relationships with the companies.

The IT approach to CRM stems from early research on customer resource life cycle (CRLC). Different life cycle modes have been used for analyzing how a company can strengthen its relationship with customers through the application of information technology (Burnstine, 1980; Ives, 1984). Ives (1984) expands IBM's four-stage model into 13 steps to: (1) establish customer requirements, (2) specify requirements, (3) select sources, (4) order products or services, (5) authorize and pay for product/services, (6) acquire products/services, (7) test and accept products/services, (8) integrate products/services into existing processes, (9) monitor product/service performance, (10) upgrade products/services, (11) maintain the condition of products/services, (12) transfer or dispose of products/services, and (13) account for the products/services. In practice, this CRLC model may be simplified into three broad phases of interactions between a firm and its customers – acquisition, sales/service, and retention.

For e-commerce, the acquisition phase emphasizes marketing activities that are based on personalization technology to facilitate the customer decision process in the pre-sales phase. During the sales phase, creating customized transactions makes a customer's shopping and purchasing experience more efficient and satisfactory (Lee & Shu, 2001). An e-commerce site can enhance customer retention by building customer trust and loyalty through a variety of online features (Hoffman et al., 1999; Lee & Shu, 2001; Papadopoulou et al., 2001). These features enable customers to check the status of transactions, shipments and orders, and to work collaboratively with the sales force. Incentives for repeat visits through push e-mails and other loyalty programs can also enhance customer trust and loyalty.

## Electronic CRM

Internet technology enables companies to capture new customers, track their preferences and online behaviors, and customize communications, products, services, and price. The mass customization concept, or the one-to-one approach, promoted by writers such as Peppers and Rogers (1993), has become the "mantra" of eCRM (Winer, 2001). A company's e-commerce Web site integrates marketing, sales/service, and post-sales support as a

seamless front-end to meet customer needs. Therefore, e-commerce Web sites have become viable channels for customer acquisition, sales/service, and retention.

The Internet plays an active role in customer acquisition via e-marketing, which emphasizes proactive and interactive communications between companies and their customers. Companies can provide information on products and services on their Web sites for prospective customers. Advanced searching capability and functions for product and service inquiry can attract new and repeat customers to visit, compare products and prices, and reach decisions for purchase. Companies also create online communities to facilitate social groups among existing and prospective customers. Online product discussions and reviews encourage *customer-initiated communications* between firms and customers and among fellow customers (Strauss, 2000). These online communities improve customer loyalty, branding, and trust, which can lead to increased sales and improved customer relationships (Lee & Shu, 2001).

## The Mobile Channel

The convergence of mobile Internet and wireless communication technology has promised users "anytime anywhere" access to information for their work and personal communication. Mobile services support m-commerce transactions and improved management of personal activities, mobile office, and mobile operations (Alanen & Autio, 2003). Among many mobile applications proposed by wireless researchers (e.g., Kannan et al., 2001; Mannecke & Strader, 2001; Varshney & Vetter, 2002), mobile financial applications, location-aware and context-aware advertising, and location-based services seem to hold special promise (Varshney, 2003). These mobile services may provide customized support for individual users.

Many researchers point to four reasons that the mobile channel could be used to build relationships with customers. The mobile channel and wireless technology enable companies to: (1) personalize content and services; (2) track consumers or users across media and over time; (3) provide content and service at the point of need; and (4) provide content with highly engaging characteristics (Kannan et al., 2001). Anckar and D'Incau (2002) point out that consumers are most interested in services with high mobile values that meet spontaneous and time critical needs, such as checking stock quotes, driving directions, and short messages.

A recent study indicates that, at present, most of the available mobile sites tend to share similar interfaces with their corresponding Web sites and primarily support existing customers (Chan et al., 2002). For example, Amazon only offers the 1-click order option for purchasing from its wireless site. This feature does not allow customers to review order details before submitting the order. Once an order is submitted, it is difficult for customers to navigate to the right screen on the handheld device to cancel the order. Therefore, only experienced mobile customers who have already built trust in Amazon and the interface of the 1-click order option would find it efficient to order products from the mobile Amazon site. In comparison, new customers would be hesitant to use the mobile channel. In the case of accessing eBay by a wireless PDA device, users often encounter a large number of results from a product search. The high volume of transferred data can result in connection errors and frustrate new customers. Only seasoned eBay customers are more likely to benefit from using a handheld device to monitor a bid in progress.

These findings imply that current mobile sites have been designed primarily to support existing e-commerce users. The inherent difficulties using the wireless technology may discourage prospective customers from exploring a new mobile site. These barriers include limited bandwidth and poor connectivity, small screen display, and difficulty in input formats of wireless handheld devices (Chan & Fang, 2003). The study by Anckar and D'Incaur (2002) indicates that e-commerce users are more likely to adopt m-commerce services. Their finding further confirms the proposition that the mobile channel is more relevant to customer support and retention than acquisition.

## An Analytical Framework

Based on the above review, we propose an analytical framework for examining how e-commerce sites implement CRM strategies online and on the mobile channel. This framework views eCRM and mCRM across three phases of customer interactions with an e-commerce site — acquisition, sales/service, and post-sales retention. In each phase, the framework also examines CRM implementation according to five inter-related factors — customer loyalty, branding, customer satisfaction, customization, and trust. These five factors represent the salient characteristics of relationship marketing, as emphasized by Winer's (2001) customer relationship model, Lee and Shu's (2001)

framework of American Customer Satisfaction Index (ACSI), and Andaleeb's (1992) research on trust in relationship marketing. Winer's model (2001) identifies customer satisfaction as the key to establishing customer relationships. Customer loyalty, customization, community building, and unique services with branding contribute to high customer satisfaction and retention. Winer further emphasizes that delivering a high level of customer satisfaction that exceeds customer expectation increases profitability – a key objective of relationship management strategy. Lee and Shu's (2001) ACSI framework explains the importance of customization and brand building to raise customer perception of quality and value of products and services. A higher level of perceived quality and value of products and services contributes to customer satisfaction and customer loyalty in a multi-layer fashion. Andaleeb and Anwar (1996) point out that trust is one of the most widely confirmed factors in

*Table 1. An analytical framework for CRM*

| Factors\ Phases | **Acquisition** | **Sales & Service** | **Retention** |
|---|---|---|---|
| **Customer Loyalty** | Loyalty program details<br>Loyalty program enrollment<br>Loyalty program status display<br>Loyalty program reward<br>Custom status customer display | Custom service for member and status customer<br>Capability to redeem reward<br>Membership convenience service | Delivery options<br>Order tracking<br>Help desk service<br>Product review and discussion group<br>Customer feedback/survey<br>Return policy |
| **Branding** | Large customer community<br>Unique branding product/service<br>Exclusive product | Exclusive interface for transaction support | Exclusive product |
| **Customer Satisfaction** | Information consistency<br>Product variety<br>Product and price comparison<br>Attractive graphic interface<br>Self-management capability<br>Company details<br>Efficient and accurate search engine<br>Product review | Easy to use transaction interface<br>Alternate product and pricing recommendations<br>Payment options | Delivery options<br>Order tracking<br>Help desk service<br>Product review and discussion group<br>Customer feedback/survey<br>Return policy |
| **Customization** | Profile and preference self-manage capability<br>Self-help, FAQ<br>Personal custom display<br>Preference product suggestion | Question posting/ inquiry capability<br>Use customer profile information to complete product transaction<br>Fast check-out service | Profile and preference self-manage capability<br>Self-help, FAQ<br>Customer purchase history, detail billing, delivery history, and status<br>Delivery tracking<br>Custom incentive<br>Custom services. E.g., personal reminder<br>E-mail promotion notification |
| **Trust** | Information consistency<br>Privacy statement for customer profile<br>Authentication mechanism<br>Authorization mechanism<br>Third party signature | Payment options<br>Order confirmation<br>Security measurements, digital certification, SSL transmission, encryption, non-repudiation<br>Authentication mechanism | E-mail order notification<br>Help desk support |

relationship marketing. Table 1 provides an overview of the five CRM factors and their roles in the three phases of firm-customer interactions. The ensuing sections discuss the proposed framework in greater detail.

## Customer Loyalty

Dick and Basu (1994) conceptualize customer loyalty as the strength of the relationship between an individual's relative attitude towards an entity (brand, service, store, or vendor) and repeat patronage. The work of Lowenstein (1997) further introduces the concept of commitment into the relational paradigm through the identification of what he termed "commitment-based" companies. These are firms that adopt a proactive approach to creating customer value and loyalty management by constantly anticipating and responding to latent customer needs (Lowenstein, 1997). According to Aakar (1991, 1996), customers who exhibit the highest level of commitment to a brand will also demonstrate a high level of loyalty. Dekimpe et al. (1997) emphasize that companies should treat their loyal customers as a competitive asset. Indeed, customer loyalty represents a basis for charging price premiums and a barrier to competitive entry (Aaker, 1996). Accordingly, companies can provide unique customer benefits that are difficult for competitors to match in order to achieve a higher level of customer loyalty (Evans & Laskin, 1994).

Relationship marketing strategy includes introducing customer loyalty programs, like frequent flyer and reward programs, membership, and online community. For example, American Airlines offers the AAdvantage program for its frequent travelers. This program encourages customers to accumulate mileage from traveling with American Airlines to redeem free plane tickets for future trips. Similarly, Starwood Hotel Group has implemented the Starwood Preferred Guest program for repeat customers to accumulate hotel points with Starwood-chain hotels and redeem these points for automatic upgrades and free vacations.

E-commerce players can achieve customer loyalty by providing the following CRM features:

- Detailed information about the loyalty program;
- Incentives for joining the loyalty program;
- Instructions for creating a personal account;

- Detailed information about a personal account with purchase history and loyalty status information;
- Personalized services for repeat customers;
- Frequent buyer incentives such as discounts or personal upgrade services;
- A status page on customer loyalty status, upgrade options, redeem procedures, and special discounts/promotions;
- Special services for frequent buyers—no cost delivery, priority seating, and/or 1-click checkout; and
- Online mechanisms to actively collect feedback from frequent customers.

Companies have used loyalty programs for marketing and attracting new customers. These programs are also important for repeat customers who value the effectiveness and convenience for registered members to redeem rewards and updates. An e-commerce site can also enhance customer loyalty through retention efforts such as customer feedback, status information about loyalty programs, and help desk services. Therefore, loyalty programs are important for all three phases of firm-customer interactions.

## Branding

The efficient use of branding can increase product differentiation (Aaker, 1991, 1996) and build customer relationships by influencing a customer's attitude towards the brand. A customer's perception of the functional, experiential, and symbolic aspects of the product can strengthen customer loyalty to the company. Good branding tactics include selling exclusive products and services and having a large e-community of customer participants.

In an e-commerce environment, branding involves a number of strategies:

- Building a large customer community through online chat rooms, discussion sessions, and product reviews (e.g., online chat rooms on MSN.com and Amazon's community of online reviewers) to accentuate the customer's experience with the brand;
- Providing unique branding products or services (e.g., eBay's auction trading) to differentiate a site from its competitors;

- Providing exclusive brand name products, such as Gap.com and JCrew.com;
- Providing supplementary services to enhance the main business and raise the barrier to entry, such as Citibank's online personal banking services through citi.com; and
- Providing unique interfaces to support customer shopping experiences (e.g., Amazon's one-click ordering interface and Peapod's grocery shopping interface).

Large customer communities, unique branding of products and services, and exclusive brands help to attract new customers. Exclusive products and services help to build long-term customer loyalty and retention. Internet technology has also enabled companies to create brand recognition through their unique user interface design for transaction support.

## Customer Satisfaction

Customer satisfaction is a major factor in retaining long-term customers and can indirectly attract new customers through referral. Researchers have used the confirmation/disconfirmation (C/D) paradigm to explain customer perception of performance and quality (Anderson & Sullivan, 1993; Fournier & Mick, 1999). The C/D paradigm states that customer satisfaction stems from a customer's comparison of post-purchase and post-usage evaluation of a product with the expectation prior to purchase (Achim et al., 2001). Oliver and Swan (1989) suggest that customer satisfaction occurs when the purchasing experience and after-sales service meet the customer's expectation. Customer satisfaction is often viewed as a cumulative experience, measured as the general level of satisfaction based on the overall experience with the firm (e.g., Garbarino & Johnson, 1999). So CRM tactics, implemented across multiple channels, can form a cumulative customer experience.

Silk and Kalwani (1982) suggest that fairness and ease in the ordering process affect consumer satisfaction after purchase. If customers feel they are being treated fairly and feel easy with the ordering process, they are more likely to be satisfied with the products. Extending this finding to the e-commerce context, one can suggest that user interface and usability are factors that contribute to good customer satisfaction. There exists a high correlation between perceived

convenience and customer satisfaction with the products and services sold on the Internet (Lee & Ahn, 1999). For e-commerce, low price, low asset specificity, and clear description are important product and service characteristics that attract online shoppers.

Therefore, an e-commerce site should incorporate the following features to build customer satisfaction:

- Wide variety and lower price products;
- Useful descriptions and price comparison for products and services;
- Self-service capability;
- Self-help, FAQ, and help contact services;
- Easy-to-use transaction interface;
- Easy-to-understand text, images, and animation to communicate with the customers;
- Accurate information about products and services to support pre-purchase services;
- Company details;
- Search engines for information searching;
- Product reviews and discussion;
- Different payment and delivery options;
- Recommendations for alternate product and services;
- Comparable products and services with lower prices;
- Purchase and delivery confirmation;
- Follow-up e-mail notification for product and service status;
- An order tracking method;
- Follow-up surveys for customer feedback; and
- Easy options for product return.

The quality of information and interface design for information search on an e-commerce site helps to draw new customers. For transaction and service support, good interface design and usability of the shopping cart are critical to a customer's shopping or service experience. Availability of timely post-sales

support, such as order tracking and response to customer inquiry, contributes to customer satisfaction and retention.

## Customization

Customization in CRM refers to the entire marketing mix – communications, products, services, processes, prices, and channels. Lee and Shu (2001) emphasize that the level of customization helps to shape customers' perception of quality in products and services. By tailoring products and services to meet individual customers' needs and preferences, a company can fulfill and exceed customer expectations and increase their perception of product quality. By using the ACSI model, Lee and Shu (2001) demonstrate how the perceived quality and perceived value of a product contribute to customer satisfaction in a multi-layer fashion.

Mass customization tactics, such as personalized direct e-mails and product recommendations, are essential to eCRM. As acquiring information about customers is essential to relationship marketing, the Internet technology has made it easier for companies to collect data about customer profiles and online activities. Winer (2001) emphasizes that building a customer database is the first step towards an eCRM solution. His model involves the following steps: (1) build a database of customer activities, (2) analyze customer activities, (3) determine the target customers, (4) develop tool to target these customers, (5) implement privacy issues, and (6) define metrics for measuring the success of CRM program. After understanding the customer activities and selecting target customers, the company can proceed to creating products and services. Companies should characterize their customers as product makers rather than product takers.

Personalization techniques can be used to customize online interactions with e-commerce customers. Common techniques involve collaborative filtering, rule-based, and intelligent agent-based methods. Amazon.com has applied these techniques not only for pre-sales product recommendations, but also for one of their loyalty programs in the form of Gold Box special promotions. A registered customer has opportunities to receive discount promotions in a timed presentation, but only once. The Gold Box service remembers what items have already been shown to the same customer. Customers can also configure products and services that they are interested in purchasing. For example, Peapod.com allows customers to create personalized shopping lists, which, in

turn, enables customers to tailor their shopping experiences and product choices. These forms of customization allow companies to capitalize on *customer-initiated* communications and interactions. In the long run, both firm-based and customer-initiated customization approaches can lead to cumulative positive customer experience with the products, services, and the Web site.

An e-commerce site can customize its content, products, and services by providing the following features:

- A personal page display, such as "my bookstore" and "my news box";
- Self profile and preference update with self-management capability;
- Self-help, FAQ, and question posting capability;
- Recommendations for products and services based on the customer's personal profile;
- Customer purchase history, delivery history, and account status;
- Incentives according to customer preference; and
- Personal services – remembering the customer's delivery address, personal reminders, previous search results, contact lists of friends and families, and so forth.

Customization features can be implemented in all three phases of CRM. To support pre-sales activities, customization can be applied by providing customers with product recommendations and the capabilities to create their own profiles and preferences. Customized order transaction processes facilitate the sales phase. Features that help to customize post-purchase support, such as e-mail promotion notifications, delivery tracking, and self-management capability for updating profiles and preferences are important for customer retention.

## Trust

Trust is one of the most widely examined and confirmed constructs in relationship marketing research. There is the notion that trust constitutes the belief, attitude, or expectation of a party that the relationship partner's behavior or its outcomes will benefit the trusting party itself (Andaleeb & Anwar, 1996). Trust is built on the level of risk, which can be determined by network infrastructure,

Web and mobile applications, customer privacy issues, security of data transfer, and system authentication (Lee & Ahn, 1999). On one hand, easy-to-use system interfaces, consistent and complete information, reliable connectivity, and sufficient customer support ensure customer trust. On the other hand, a high level of perceived risk associated with these system features may result in customer hesitation for performing transactions via the mobile channel (Chan & Fang, 2003).

Online trust is based on the user's Internet experience. Reputation contributes to "trust belief" and "trust intention". Thus, third-party endorsement and icons placed on e-commerce sites can affect consumer trust (McKnight, Choudhury & Kacmar, 2000). Trust is "the willingness of a party to be vulnerable to the actions of another party based on the expectations that the other will perform a particular action important to the trustor, irrespective of the ability to monitor or control the other party" (Mayer, Davis & Schooman, 1995, p. 712). This definition accentuates vulnerability, which is not just risk-taking but the willingness to take risks. Ambrose and Johnson (1999) have applied this definition to the online retailing environment. In this environment, the absence of face-to-face interaction between the buyer and the seller increases the buyer's vulnerability. Customer perceptions of a site's assurance of privacy and security influence trust. Thus, a high level of perceived risk affects a customer's intention to carry out the transactions online.

Trust also affects customer satisfaction and customer loyalty, and it directly influences the effectiveness of the eCRM strategy. Therefore, an e-commerce site needs to build customer trust by incorporating the following features:

- Consistent product and service information;
- Product information that embodies brand equity, transience, quality, variety, availability, as well as competitiveness and options for customization;
- Price information and payment options;
- A privacy statement to guarantee that customer information is kept confidential;
- Security measurement such as a digital certificate, public-key cryptography, authenticity, integrity, confidentiality, non-repudiation, and third-party verify signature, and SSL;
- Proper authentication mechanism;

- Secure payment and transmission; and
- Help desk support.

Trust features are important to all three phases of CRM. Privacy statements should be thorough, and authentication mechanisms as well as third-party signatures should be prominently demonstrated for new customers. Secure transactions are essential for bringing back repeat customers.

## Applying the Framework

To explore the applicability of the proposed framework, we conducted a cognitive walkthrough of e-commerce sites and their corresponding mobile sites for the Palm OS platform. We also developed a checklist (in Appendix) based on the framework to guide the cognitive walkthrough. The choice of Palm

*Table 2. Summary of eCRM and mCRM – Amazon.com (books)*

| Factors\ Phases | **Acquisition** | **Sales/Service** | **Retention** |
|---|---|---|---|
| **Customer Loyalty** | (**W**) Online book community | (**C**) Coupon available for redeem | (**W**) Gold box<br>(**C**) E-mail for purchase discount and promotional free shipping |
| **Branding** | (**W**) Online community for review and discussion<br>(**W**) Purchase certificate | (**W**) Used books and price info to facilitate other buying options<br>(**C**) One-click order | (**M**) Simple product browsing access anywhere anytime<br>(**W**) Amazon credit card |
| **Customer Satisfaction** | (**C**) A Variety of products are available.<br>(**W**) Promotion product - books, music, special deals, electronic, games<br>(**W**) Price comparison | (**C**) Book search<br>(**W**) New hard copy, paper back and used books are available with price comparison.<br>(**C**) Book review<br>(**C**) Cross sales - customer also buy items) | (**C**) E-mail confirmation<br>(**W**) Purchase tracking<br>(**W**) Full online support, FAQ and contact number<br>(**M**)Simple FAQ |
| **Customization** | (**W**) News, preferences, and personal recommendation display on the first page<br>(**W**) Personal wish list<br>(**W**) Provide baby and wedding registry services | (**C**) Require sign on for purchase<br>(**C**) Access profile from the web<br>(**C**) Able to modify delivery information | (**W**) Provide friend and family occasion reminder<br>(**W**) Personal order and personal recommendation available at sign in<br>(**M**) Simple book purchase link on top of the first page |
| **Trust** | (**C**) Security guarantee on personal profile | (**C**) Sign on required for purchase<br>(**C**) Security indication | (**C**) Profile is saved on the Web<br>(**C**) Address and purchase information can be modified<br>(**W**) Preference can only be modified on the Web |

*(C) Common Feature (W) Web Feature Only (M) Mobile Feature Only*

*Table 3. Summary of eCRM and mCRM – United Airline (Flight)*

| Factors\ Phases | **Acquisition** | **Sales/Service** | **Retention** |
|---|---|---|---|
| **Customer Loyalty** | | (**C**) Mileage plus program is associated with the customer purchase<br>(**W**) Redeem award | (**C**) Mileage Plus summary<br>(**C**) Award availability<br>(**C**) Upgrade status |
| **Branding** | (**C**) Flight schedule and arrival/departure detail<br>(**W**) About United, united product and service, contact United | | (**M**) Upgrade, travel awards, and red carpet club are on the first page |
| **Customer Satisfaction** | (**W**) Promotion travel packages, special deals, and cruise<br>(**W**) Price comparison<br>(**W**) Spanish version support<br>(**W**) Service information<br>(W) Company details | (**C**) Book/purchase a flight<br>(**C**) Flight availability<br>(**W**) Seat selection<br>(**W**) Detailed price comparison<br>(**W**) Electronic and non-electronic tickets<br>(**M**) Only electronic tickets | (**C**) My itinerary<br>(**C**) Flight status<br>(**C**) Flight paging request registration |
| **Customization** | (**W**) After sign on, preference page display with personal preference of price alert | (**C**) Sign on or fill in mileage plus member number is necessary for both platforms. | (**W**) E-mail promotion registration and preference change<br>(**M**)Book a flight, flight status, my itinerary, travel awards are on the first page |
| **Trust** | (**W**) Sign up can only perform on Web site | (**W**) Customer address, profile and form of payment can only be changed on Web site<br>(**C**) Both platforms indicate secure transaction | (**C**) Profile is saved on the Web<br>(**M**) Required to be mileage plus customer with current profile for access |

*(C) Common Feature (W) Web Feature Only (M) Mobile Feature Only*

OS version of mobile sites allowed us to evaluate a wider range of CRM features, because Palm handheld devices have relatively larger screens and support more interface features than WAP phones do. On the Palm.Net site, we downloaded the wireless applications for selected sites onto the Palm VII device prior to the evaluation.

For illustration purpose, this chapter includes three examples — Amazon.com, United Airlines (*united.com*), and USA Today (*usatoday.com*). These three sites represent the retail, travel, and news portal industries. Tables 2, 3, and 4 summarize observations generated from the three cognitive walkthrough studies. Common features appearing on both the Web and the mobile channels are noted as "C". Features only available on the Web channel or the mobile channel are noted as "W" or "M" respectively.

From these three examples, we observe that eCRM supports all three phases of firm-customer interactions — acquisition of new customers, sales/services,

*Table 4. Summary of eCRM and mCRM – USA Today*

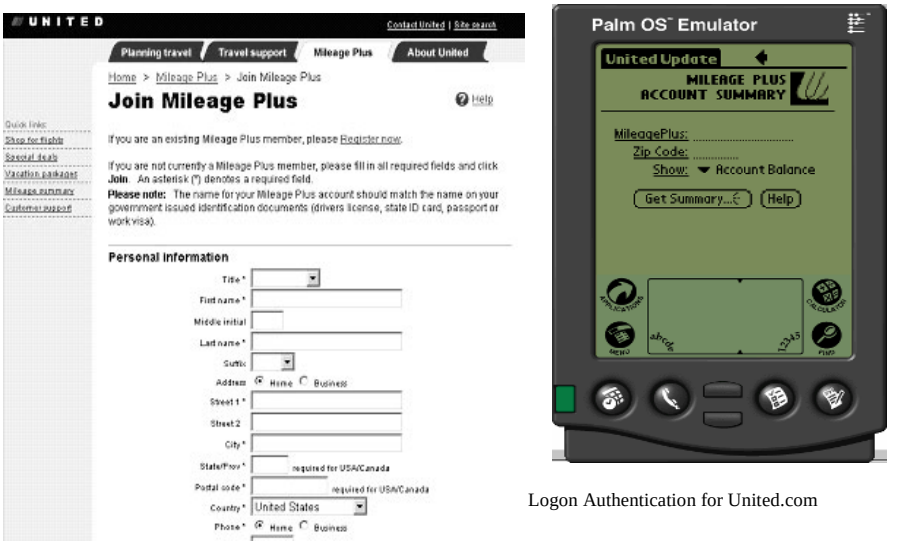
| Factors\ Phases | **Acquisition** | **Sales/Service** | **Retention** |
|---|---|---|---|
| **Customer Loyalty** | (**W**) Provide incentive for online subscriber<br>(**W**) Online subscribe with American Express, earn member reward | (**W**) With sign on id, the Web site recognizes subscriber | |
| **Branding** | (**C**) Well known and reputation newspaper<br>(**W**) Online archive search | (**W**) Can online purchase full archive USAToday article or get free version of the brief highlight | |
| **Customer Satisfaction** | (**W**) Attractive front screen design<br>**(C)** One click to the latest news (highlights)<br>(**W**) Search engine available<br>**(C)** About USAToday<br>(**W**) Provide quick tour and sample complete online paper for new customer | (**W**) Search engine available<br>(**C**) News display by category<br>(**W**) Online stock quote inquiry<br>(**W**) More real time news update<br>(**W**) Provide online subscription process | (**W**) FAQ and feedback are available<br>(**W**) Provide electronic version of USAToday complete copy online (with subscription)<br>(**W**) Online report with delivery problem<br>(**W**) Confirmation to subscription |
| **Customization** | (**W**) Customize to favorite columnist<br>(**W**) Customize local weather display | (**W**) Can subscribe as a gift to someone else | (**W**) Online profile and preference management<br>(**W**) Online address and password maintenance<br>(**W**) Current subscriber can retrieve past issues of paper online<br>(**W**) Online and e-mail reminder for when subscription is up |
| **Trust** | (**W**) Provide quick tour and sample complete online paper for new customer<br>(**W**) Subscriber is provided with decure login authentication<br>(**W**) Partner with American Express | (**W**) Provide multiple payment options<br>(**W**) Online bill pay services<br>(**W**) Confirmation to subscription | (**W**) E-mail notification for subscription |

*(C) Common Feature (W) Web Feature Only (M) Mobile Feature Only*

and retention of existing customers through cross-sell, sales promotion, and loyalty programs. In contrast, mCRM focuses primarily on supporting and retaining existing e-commerce customers; little attention is focused on acquisition of new customers.

Mobile sites require customers or subscribers to register online first, particularly for sites involving transactions (Figure 1). It is not easy for new customers to initiate relationships with a company on the mobile site. However, news sites,

*Figure 1. Web customer registration interface and mobile logon authentication for United.com*



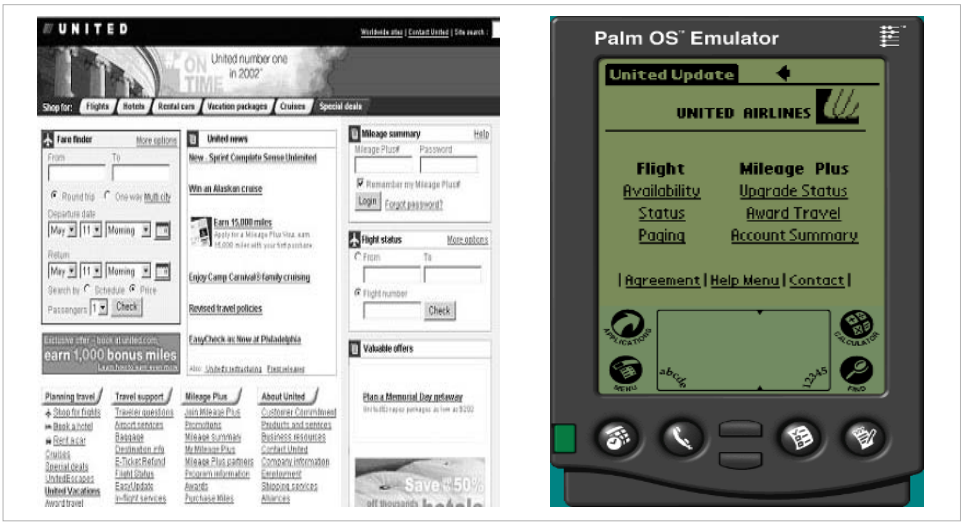

Logon Authentication for United.com

like USA Today, due to the time-sensitive nature of their services, seem better positioned to attract new customers. For all three sites, the mobile channel provides limited customer support. Other than limited product and service information, customer self-help and self-configuration delivery are not available on the mobile site. Mobile customers need to refer problems or questions back to the Web site.

In general, the mobile site emphasizes information delivery. Transaction and registration functions are carried out on the Web sites. Among the three sites illustrated in this chapter, the mobile site of *USA Today*, because of its focus on content, offers the least amount of services for retention purpose. In comparison, the mobile sites for Amazon and United Airlines include more mobile services for sales transaction and post-sales support. United Airlines provides a more complete range of mobile services to meet the needs of its mobile customers.

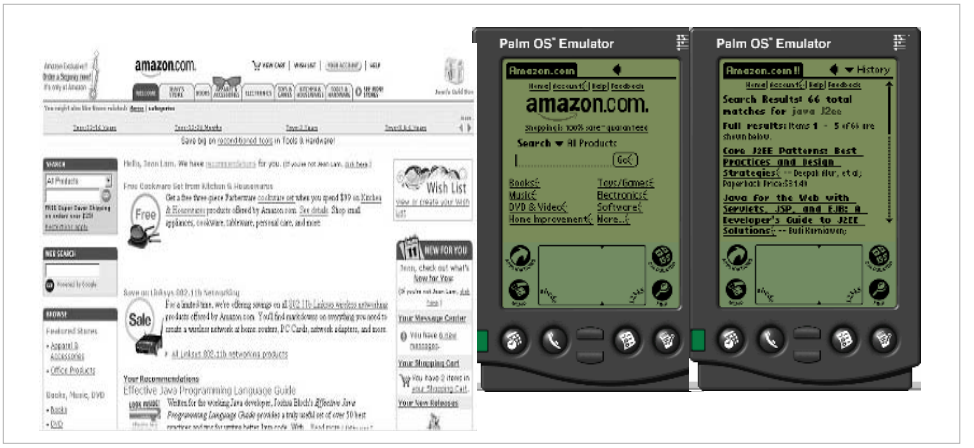
Therefore, the mobile channel supplements, rather than substitutes, the Internet channel for supporting and retaining existing e-commerce customers. mCRM targets existing customers who are: (a) frequent users with a high purchase rate

*Figure 2. Web and mobile front screen for United.com*




and strong brand loyalty, and (b) in need of "on the move" services and spontaneous shopping. As illustrated in Figure 2, United Airlines' mobile site contains the essential information and features for a frequent traveler who is already a registered Mileage Plus member. Figure 3 shows that customers who chose to access Amazon's mobile site must overcome many interface barriers to access the mobile services. These customers may already have a strong commitment to the brand of Amazon.

*Figure 3. Web and mobile book search and book matching display for Amazon.com*



# Research Directions

Drawing from the literature review and the analysis of eCRM and mCRM presented in this chapter, we identify several implications and issues for future research.

## The Relationship between eCRM and mCRM

A company's e-commerce Web site serves as the primary channel for building and managing relationships with e-customers. The current state of wireless communication technology limits the role of the mobile channel in supporting customer needs. It seems more effective to use the mobile channel for retention of a small number of frequent and loyal customers who have mobile needs. For e-commerce sites that emphasize complex transactions and interactions, a simpler version of these interactions and information delivery should be provided for mobile users. Companies should use the profile and preference data from registered frequent users in designing appropriate mobile services. Further research is needed to validate the relationship between eCRM and mCRM in several areas:

- How are eCRM and mCRM features implemented in other sectors of online retailing, service, and content portals? How are these features implemented across three CRM phases?
- What services are provided on both channels? How consistently are these services implemented on both channels?
- What are characteristics of best practice for eCRM and mCRM?
- Are mCRM features most often implemented for retention purpose?
- How do companies map their mCRM to different wireless technology platforms?

## Coordination of CRM across Multiple Channels

Beyond the Internet and the mobile channels, companies should develop a synergistic approach to coordinating CRM strategies across multiple channels in order to optimize customer satisfaction. For example, a hotel could provide

a Web site for guests to conduct product and service search, compare prices and services, and make reservations. Registered guests can use their mobile devices to check and update reservations, and for advance room check-in when they are on the road. The hotel could send e-mail alerts and location-based information according to the guest's profile and preference. These interactions could be coordinated with the traditional in-hotel services to offer the frequent guests an integrated experience. Further research should examine multi-channel CRM in several areas:

- How should the firm-customer interactions be mapped across the entire process of customer life cycle to identify touch points for interactions?
- What criteria should be considered to guide the process mapping and requirement analysis?
- How could the information gathered from different channels be integrated to form a comprehensive customer profile?

## The Tradeoff among CRM Factors

The five CRM factors emphasized in the proposed framework seem to play different roles in eCRM and mCRM; each factor also affects the firm-customer interactions differently. Our limited examples show that customer loyalty, customer satisfaction, and customization factors are more prominently presented on transaction-based mobile sites than branding and trust factors. These five CRM factors are inter-related. Future research should empirically examine their individual and collective impact of these factors on eCRM and mCRM. Researchers should construct and test the underlying model in the mobile environment to examine which factors are most important to mobile customers. Findings on specific mCRM features for transaction support and retention will improve the understanding of specific CRM tactics.

- How do the five CRM factors relate to one another in supporting customer acquisition, shopping experience, and customer retention?
- Which factors are most important for mCRM?
- Which factors are most important for eCRM?

- Are loyalty, customization, and customer satisfaction factors more important than trust and branding factors for mobile customers?
- What kind of trade-offs among CRM factors should be considered to strengthen long-term customer relationship?

## mCRM and Customer Acquisition

Our analysis reveals that the mobile channel currently plays a limited role in customer acquisition. Advantages of location- and context-based marketing and mobile commerce remain conceptually sound but are not substantiated. Location-aware advertising is primarily text based. However, the introduction of third-generation mobile network and multimedia-enabled mobile devices may change the mobile commerce environment. A recent study (Oh & Xu, 2003), an exploratory simulation, shows that multimedia location-aware advertising messages led to favorable attitudes and increased intention to reuse the mobile advertising service. More creative mobile services for attracting new customers will emerge. In the meantime, researchers will need to address:

- How could location-aware and context-aware technology be effectively used to attract new customers?
- What are key concerns of new customers in selecting mobile commerce sites?
- How can multimedia technology and short text messages be best designed to attract new mobile customers?

## Usability and Personalization Issues for mCRM

As technology advances, a wider range of wireless applications may be introduced. Future research on usability for wireless applications (Chan et al., 2002; Chan & Fang, 2003) and personalized content adaptation (Zhang, 2003; Zhou & Chan, 2003) may contribute to more effective use of the mobile Web for relationship building with customers. Unique mobile features appear to be implemented mostly by content adaptation so the mobile users can access essential services and information more efficiently on their handheld devices. Future research will need to address:

- How could content and services be personalized for CRM on the mobile platform? To what extent are current personalization techniques useful to mCRM?
- Would personalization be more important for mCRM in terms of information content, transaction support, or services?
- How does the flow of shopping experience using wireless devices differ from the online experience? What are the implications of such differences on interface design?

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# Appendix

## CRM Feature Checklist

| | | |
|---|---|---|
| **Customer Loyalty** | | |
| ❑ | L1 | Does the site provide enough information about the loyalty program? |
| ❑ | L2 | Does the site provide ways to join the loyalty program? |
| ❑ | L3 | Does the site provide a personal account? |
| ❑ | L4 | Does the site provide information about purchase history and shipping status? |
| ❑ | L5 | Does the site provide personalized services for repeat customers? |
| ❑ | L6 | Does the site provide frequent buyer incentives (discount or personal upgrade services)? |
| ❑ | L7 | Does the site provide a special page for status customers – Status page, upgrade options, redeem procedures, and special discount / promotion? |
| ❑ | L8 | Does the site provide special services for frequent buyers – no cost delivery, priority seating, or 2 clicks checkout? |
| ❑ | L9 | Does the site actively collect feedback from frequent customers? |
| **Branding** | | |
| ❑ | B1 | Does the site have large customer community and provide chat room, discussion sessions, and product reviews? |
| ❑ | B2 | Does the site provide special service that differentiates it from other sites? |
| ❑ | B3 | Does the site provide exclusive brand name products? |
| ❑ | B4 | Does this site include exclusive interfaces to support order processing? |
| ❑ | B5 | Does the site provide supplementary services, which are associated with the traditional business services and high barrier of entry: Banking, Ameritrade, and American Express Credit Card? |
| **Customer Satisfaction:** | | |
| ❑ | S1 | Does the site provide good variety and lower price products? |
| ❑ | S2 | Does the site provide good descriptions and price comparison for product and services (extensive feature description and product performance)? |
| ❑ | S3 | Does the site provide self-management capability? |
| ❑ | S4 | Is the transaction interface design easy to understand? |
| ❑ | S5 | Does the site provide good text, images, and animation to communicate with their customers? |
| ❑ | S6 | Does the site provide pre-sale services – accuracy product and services information? |
| ❑ | S7 | Does the site provide company detail? |
| ❑ | S8 | Does the site provide search engine for information searching? |
| ❑ | S9 | Does the site provide product review or discussion groups? |
| ❑ | S10 | Does the site provide different payment options? |
| ❑ | S11 | Does the site provide different delivery options? |
| ❑ | S12 | Does the site provide alternate product and services suggestions? |
| ❑ | S13 | Does the site provide comparable product and services with lower price? |
| ❑ | S14 | Does the site provide confirmation with purchase and delivery? |
| ❑ | S15 | Does the site provide self-help, FAQ, and help contact services? |
| ❑ | S16 | Does the site provide follow-up email notification for product and services status? |
| ❑ | S17 | Does the site provide order-tracking method? |
| ❑ | S18 | Does the site provide follow-up survey for customer feedback? |
| ❑ | S19 | Does the site provide easy way for product defective or unwanted return? |

| | | |
|---|---|---|
| **Customization** | | |
| ❑ | C1 | Does the site provide personal page display? |
| ❑ | C2 | Does the site provide self-profile and preference update (self-management capability)? |
| ❑ | C3 | Does the site provide self-help, FAQ, and question posting capability? |
| ❑ | C4 | Does the site provide recommendations for product and services based on personal profile? |
| ❑ | C5 | Does the site provide customer purchase history, delivery history, and account status? |
| ❑ | C6 | Does the site provide incentives according to customer preference? |
| ❑ | C7 | Does the site provide personal services – remembering delivery address, personal remainder, previous search result, friends and family contact list, etc? |
| **Trust** | | |
| ❑ | T1 | Does the site present consistent information? |
| ❑ | T2 | Does the site present product information with brand equity, transience, quality, variety, customization, competitiveness and availability? |
| ❑ | T3 | Are the price and payment options available? |
| ❑ | T4 | Does the site present a privacy statement to guarantee that customer information confidential? |
| ❑ | T5 | Does the site present security measurements such as: digital certificate, public-key cryptography, authenticity, integrity, confidentiality, non-repudiation, attributes of the system (benevolence, competency, predictability), third party verifies signature, and SSL? |
| ❑ | T6 | Does the site present the proper authentication mechanism? |
| ❑ | T7 | Is secure payment (payment gateway, firewalls and encryption) and transmission available? |
| ❑ | T8 | Does the site provide help desk support? |

# Section II

# Wireless Technologies and Mobile Commerce

## Chapter II

# Presenting Large and Complex Information Sets on Mobile Handhelds

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## Abstract

*The opportunity to access information at any time and any place caused a boom in the development of small mobile devices in recent years. Due to their application, these handhelds become smaller and handier, which leads to new challenges in human-computer interaction. Due to limited resources of these devices new paradigms for information presentation and interaction facilities are needed. We take this into account by applying concepts for interaction and display of information from the field of information visualization to mobile pocket-sized devices. We focus*

*on concrete problems caused by presenting huge images and large hierarchies in such environments. Moreover, we introduce an effective technique for browsing the World Wide Web via mobile handhelds. The presented techniques offer an improved support in navigation, orientation and interaction that enables the user to browse, interpret and handle presented information much more easily.*

## Introduction

Small mobile devices have become more powerful and popular in recent years, and are used in different application areas. Typical examples are personal mobile navigation systems. However, in the future, the wireless and mobile access of data and information via little handhelds will become as popular as browsing the World Wide Web. Since mobile handhelds suffer from limited resources, like screen space, interaction facilities and computational power, new paradigms for presenting and exploring complex information on such devices are needed.

On the other hand, in recent years the visualization of complex information spaces has evolved to an important and innovative area in computer graphics. A variety of novel visualization approaches and frameworks have been developed and proposed. Nevertheless, these approaches were designed for stationary devices, and using them for mobile handhelds leads to unsolved problems.

This chapter focuses on the presentation of complex information on pocket-sized devices. Information can be represented graphically or by abstract data sets. Due to the reason that both types require different treatment for presentation purposes, we want to discuss them separately.

Graphical information can be described in many ways, for example by text, images, video, or combinations of them. To discuss typical problems, we limit our considerations to one main and frequently used class: still images. Here, we focus on raster graphics and show how special presentation techniques can be used to solve the problem of exploring large images on small displays (third section).

Non-graphical, for example, abstract information, can also be described by a wide range of representations. However, the main challenge for representation is to support the navigation and orientation in often complex information

spaces. This can be done by presenting the basic structures of these information spaces. We discuss this topic by two typical examples in the fourth section.

We bring these both basic approaches together by considering one typical, well-known and widely used application: browsing the Web via mobile devices (the fifth section). Future work and conclusions close our contribution in the last section.

To give the interested reader an overview of existing and basal work in this area, we briefly describe the basics in the following section.

## Current Problems and State-of-the-Art

Although hardware of mobile devices is steadily improved, the main limitations are still the same and can be stated as lack of

- Screen size/resolution and
- Processing power.

Moreover, due to the size of mobile devices, which might become even smaller in the future, these two limitations seem unlikely to decrease during the next few years. On the other hand, available information sets are increasing from day to day. Therefore, new strategies for data access, presentation, and interaction must be developed in order to present such complex information on mobile handhelds.

One possible strategy is the use of advanced information visualization techniques. Although the approaches in the field of information visualization have mostly been designed for stationary devices, they focus on the same problem: presentation of huge amounts of information on limited screen areas. Mainly three concepts are applied to solve the problem:

- Efficient use of screen space by special presentation techniques.

  So-called FOCUS & CONTEXT-TECHNIQUES are a popular example of this approach (see Keahey, 1998; Leung & Apperley, 1994). These techniques combine a focus view, which shows a part of the layout at a high

degree of detail, and a context view, which presents the whole information in lower detail to provide an overview. Depending on the distance from the focus, the context is distorted in respect of space requirements. These concepts can be used for information presentation on mobile handhelds as well (Björk et al., 1999; Buyukokten et al., 2000; Fishers et al., 1997). To avoid distortion, focus and context can be displayed in two different images. This method is called OVERVIEW & DETAIL (Card et al., 1999). We apply these principles in the third section.

- Visualizing the structure of huge information sets to support navigation and orientation.

  The visualization of an underlying information structure is interesting, especially for mobile environments. Since the screen space of mobile handhelds is very limited, we can present relatively small parts of information only. Thus, it is necessary to support the search for special information to avoid extensive scrolling and panning. This can be done by showing the relationships between information objects. A number of customized methods to visualize the information structure have been developed. We can distinguish between methods presenting hierarchical structures and methods for more general classes of networks. Hierarchical methods are well capable for mobile handhelds, since the number of presented nodes (or information, generally spoken) can be controlled effectively (see the fourth section).

- Reducing the amount of presented information in an appropriate way by using information hiding.

  A basic approach of information hiding is the FILTER FISHEYE VIEW (Furnas, 1981), where information is hidden based on the distance to a point of interest. Another example is the interesting approach of Taivalsaari (1999), which can be considered as an abstraction of a certain set of information objects. Thus, the visibility of information is controlled by a radial movement of the objects into or out of the EVENT HORIZON. Further examples for information hiding are, for example, SECTION OUTLINING based on text filtering and generation of abstracts (Brown & Weihl, 1996), or POWER BROWSER (Buyukokten et al., 2000) with image removal or scaling. However, information hiding also requires suitable interaction mechanisms to explore the hidden information. In the fifth section we describe how these concepts can be used, extended, and combined with interaction techniques to browse the World Wide Web.

We use these concepts to display complex information on mobile handhelds as follows:

- For large images, we apply certain presentation techniques,
- for abstract data, we apply methods from structure visualization, and
- information hiding is used to enable an appropriate Web browsing.

The introduced techniques, now discussed in more detail, offer a powerful approach for information presentation and can be used to display complex information sets on mobile devices.

## Presenting Graphical Information – Displaying Large Images

In mobile environments, the size of large images often exceeds the display area of the user's output device. There are too many pixels that have to be displayed eligibly. This problem is related to hitches in information visualization, where the content of hundreds of thousands of different values has to be represented suitably. In this section, we want to describe how certain presentation techniques from information visualization can be used to display large images.

The basis of every presentation technique is the transformation of the image from a logical to a display coordinate system. The transformation function depends on the used presentation technique and the available display space. The 2D-logical coordinate system contains the undistorted pixel representation of the image to display. These image data are mapped into a 2D-display coordinate system, which represents the available display area of the mobile device.

### Zoom & Pan

The way often used to overcome the limitation of a limited screen size is to pan the undistorted image depending on the viewer's current interests. This way of view and interaction is done in every windows-like GUI, for example, the

Windows© operating system family, where the actual content is displayed on the screen in separate windows. Due to the limited size of a single window, a user has to choose an image area he or she wants to see by adjusting a vertical and a horizontal slider, which indicate the relative position of the displayed area to the whole image. By using sliders, the user selects an area in the logical coordinate system, which has nearly the same size as the available display space in the display coordinate system. Hence, the transformation function simply consists in a pixel mapping from one area to another. If panning is used exclusively, the user has no information about other areas of the image until he or she pans to these specific regions. Furthermore, after the user leaves his or her current view, all information about this position is discarded and will be no longer displayed. So, if the user needs this information any longer, he or she has to bear this in mind, maybe even together with the current position. This demands a viewer's complete attention and is rather complicated, especially on mobile handhelds. Sometimes this technique is combined with zooming. By doing so, the selected area in the logical coordinate system has another size than the display area and the transformation function has to scale the image information to the available display space. Its actual size depends on the zoom factor. Zooming allows a hierarchical view of the image and gives the user a better understanding of the whole image information. Like ordinary panning, it is easy to implement, but needs more processing power since and additional scaling must be executed. Furthermore, if the user wants to see an image detail together with the context this technique cannot be applied.

## The Rectangular FishEye-View

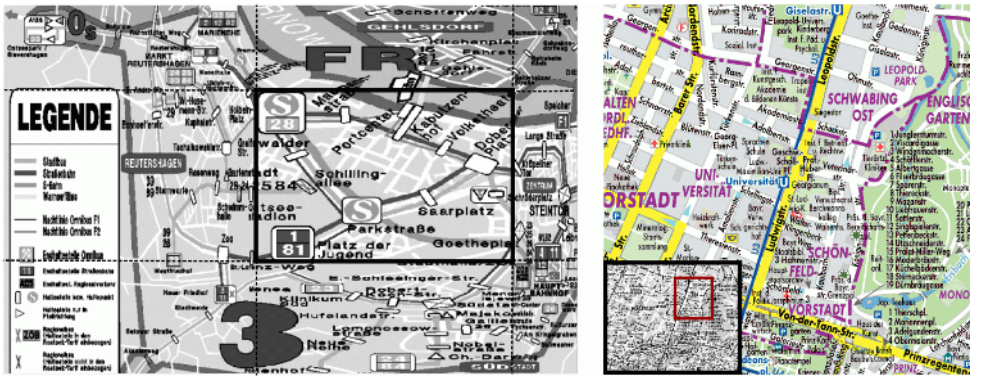
One of the techniques that can be used in mobile devices to combine the display of image details with additional context information is the Rectangular FishEye-View (Rauschenbach, 1999). This kind of view belongs to the class of Focus & Context techniques, which embed the detailed information directly into the context. To be able to display large parts of the image as context information, they have to be distorted. Focus & Context techniques are generally based on the reasonable assumption that the interest of the user for a specific image region decreases with the distance from the detail. This is used by the Rectangle FishEye-View by applying different distortions to different parts of the image, starting with less distortion near the focus to strong distortion near the borders of the available display size (Figure 1a). Based on

Rauschenbach et al. 2001), we suggest three different implementations of the transformation function with respect to the distortion of the context:

- **uniform context scaling:** the complete image in the logical coordinate system is divided into a focus and a surrounding context belt. To map the context on the display coordinate system, the context belt is divided into non-overlapping areas, each of them reaching from the focus to one of the displays borders. To every context area a uniform scaling is applied, depending on its size in the logical and display coordinate system. The uniform scaling is a straightforward and, because of application of the scaling to large areas, computationally inexpensive way of mapping the context to the display area. A disadvantage of this method is aroused by the scaling, which causes a visible discontinuity on the transitions between focus and context.
- **belt-based context scaling:** this more complex implementation of the transformation function uses more than one context belt to allow a more adapted scaling of the content. Every belt is created in the same way as in uniform scaling, apart from the fact that belts near the focus are less scaled than belts on the displays borders. The use of more than one belt leads to decreased visual discontinuities, but they cannot be fully removed. Furthermore, it needs more computational power than the uniform scaling, which cannot be neglected for mobile devices.
- **non-uniform context scaling:** With this method the requirement of a smooth transition from the focus to the context can be achieved. The belt layout is the same as in the uniform case – a single context belt is used. Unlike the former case, the context scaling factor is continually decreasing with increasing distance from the focus. Conceptually, this scaling mode can be seen as composing the context of a very large number of narrow context belts, which causes a considerable amount of computational power and a slow screen refresh if the focus is moved during interaction. This method leads to the best visual results, but can be inapplicable to mobile devices with very limited processing power.

As in panning, the focus area is created by a simple pixel mapping, besides the fact of a conspicuous smaller focus compared to the available display area. The focus itself obtains its size and relative position in both coordinate systems, which makes it rather easy to navigate within the image.

*Figure 1. Examples of image display on small devices (I)*




*1a) Rectangular FishEye-View* *1b) Large Focus-Display*

The RECTANGULAR FISHEYE-VIEW uses most of the available space for the context display, but in many applications the user is rather interested in a specific detail than in the context. In such cases other solutions must be found.

## The LARGE FOCUS-DISPLAY

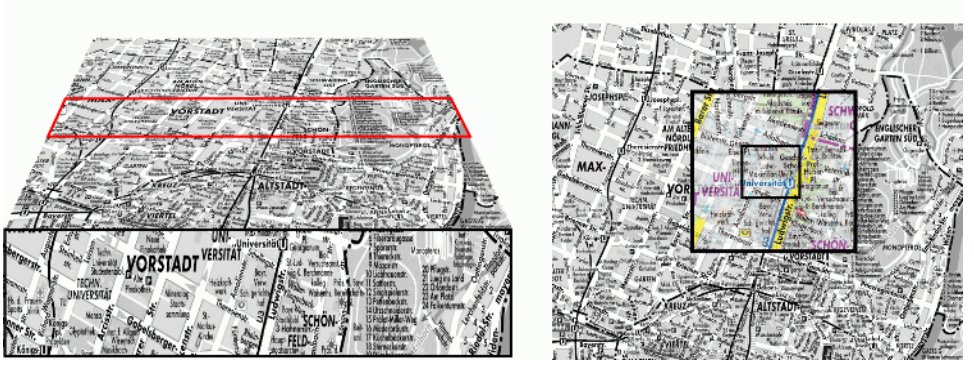
Instead of embedding the focus in the context, DETAIL & OVERVIEW – techniques (Card et al., 1999) display them separately. We introduce this concept to display large images and make use of more than one distinct region to display focus and context. Figure 1b shows the LARGE FOCUS-DISPLAY (Karstens, Rosenbaum & Schumann, 2003) as an example of such a technique. Here, most of the space available at the screen area is used to view the detailed region of current interest. Only a small part of the representation of the image in the display coordinate system is used for a context overview. The overview is a downscaled version of the image, where the currently displayed focus region is highlighted. This allows a panning-like appearance in combination with an additional view of the whole content and compensates most of the disadvantages of ordinary panning. Nevertheless, the content region hides some of the focus area, and this is one of the disadvantages of this method. To overcome this, the placement of the overview can be chosen interactively, which allows the complete exploration of the focus region. The transformation function is quite similar to panning and zooming, which makes it rather fast during

interaction. Therefore, it is useful especially for mobile palm-size devices. The focus area is created as during panning, except the area that is occupied by the content. This area contains a downscaled version of the whole image in the logical coordinate system, which is mapped, as during zooming, to a smaller area in the display coordinate system.

## The Perspective Overview-Display

The Perspective Overview-Display is another example of a Detail & Overview – technique (Figure 2a). Here, two completely distinct areas are used to display the overview (top) and detail (bottom) of an image. To save valuable screen space while displaying the overview, the image has been perspectively warped. The human recognition is quite familiar with the perspective distortion and can handle it very well, which was the reason for the choice of such a distortion. Nevertheless, this makes it necessary to enhance the transformation function to this mapping. The detail is displayed in its original resolution using the described panning-transformation. This technique enables the user to look at details of an image area and use the marked detail area on the overview to navigate through the image. Despite these advantages, there are two disadvantages: the increased processing effort to compute the perspectively distorted overview, and the unused display space that appears by using such a distortion.

*Figure 2. Examples of image display on small devices (II)*




*2a) Perspective Overview-Display* *2b) Transparent Focus-Display*

## The TRANSPARENT FOCUS-DISPLAY

Lastly, we want to propose a technique that makes use of properties from FOCUS & CONTEXT – as well as DETAIL & OVERVIEW – techniques, the TRANSPARENT-FOCUS-DISPLAY (Fig. 2b). To display the focus/detail and context/overview two different images are used. These images are created by the transformation function. To display the context, the whole image in the logical coordinate system is scaled to the available display size. The focus is created as during panning, but using an equal or smaller size than the available display size. Afterwards the images are combined by the transformation function by applying a fixed or time-variant $\alpha$-blending. This blending can vary from the solid display to the complete vanishing of the focus and can be adjusted by the user or periodically by the system. This allows a simultaneous display of two distinct images, each as large as the available display size. To change the focus currently displayed, the user can move an area marked on the context view, which allows an easy and fast interaction. The main disadvantage of this technique is the increased processing power necessary to compute the $\alpha$-blending between the overlapping regions of focus and context. Nevertheless, to create the initial images for the focus and context only a few transformation steps are necessary.

## Implementation Issues

All techniques described apply already known concepts of information visualization to solve the problem of displaying large images on small screens. The implementation of these techniques has shown that they also can be used in mobile environments. However, since mobile handhelds are still limited in their capabilities, like computing power or memory, a concrete implementation must use the available resources appropriately. Due to the different ways to present and to interact with image data on screen, every one of the introduced techniques uses the resources differently. Especially in environments where image handling exceeds the available capabilities of the device, this might cause a long response time during interaction or other unpleasant effects, which constrain the exploration of the image content. Thus, we want to give some basic statements for the effective implementation and application of the proposed display techniques, based on Rosenbaum and Tominski (2003).

1. Panning is faster than scaling:

   This statement implies that display techniques that apply mostly panning to display image areas of interest (e.g., the large focus-display) provide a faster response time than techniques that scale the displayed image content to a large extent (e.g., the rectangular fisheye-view).

2. A simple scaling of raster data is fast but leads to low quality presentations:

   There are a number of different methods to scale image content. Nevertheless, there is a correlation between the computation speed and the quality of the scaled content. If more sophisticated scaling approaches, like filtered scaling, are applied, the processing speed is in general slower but leads to more appealing presentations. This conclusion might be used to provide a fast scaling during interaction and a high quality scaling during idle time.

3. Additional manipulation of the image content needs additional time:

   Besides scaling, some presentation techniques (e.g., the perspective overview- or the transparent focus-display) call for additional manipulation of the image content to be displayed. Depending on the kind of manipulation (e.g., perspective distortion or blending), this also needs additional processing power to produce the presentation. Such techniques are not useful if mobile devices with very limited processing power, for example Palm handhelds, are used.

4. Handling of raster data is faster than of vector data:

   We also compared the handling of raster data with vector data and found that it is in most cases reasonable to work with raster data (Rosenbaum & Tominski, 2003). This kind of data can be loaded, processed and displayed very fast. Only if a high quality output is required or the number of primitives used to describe the image content does not exceed a certain number, using vector data is the better choice.

Based on these statements, a certain display technique might have an advantage over others in specific environments and circumstances, and a developer must carefully select the right approach. Nevertheless, besides the given technical statements, there are a number of points, like user preferences or a concrete application, that also influence the choice of an appropriate presentation technique to display large graphical contents on small screens.

# Presenting Abstract Information – Visualization of Hierarchies

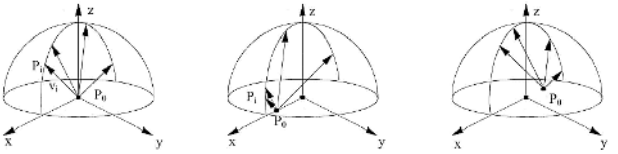
Due to the limited screen space of mobile handhelds, we can only present small parts of an abstract information set at once. Therefore, we need a special treatment to connect different parts of the information set to support navigation and orientation. One way in doing so is the visualization of relationships between these different parts of the information content.

This structure can be expressed as a graph, where the nodes represent several parts of the information, and the edges the relations between them. Several graph drawing methods have been proposed in the past (Di Battista et al., 1999). However, it can be difficult to keep the orientation if we cannot assure that all nodes can be drawn. On the other hand, hierarchical structures allow an efficient control of the number of nodes to be presented. Many information structures are hierarchical, for example file systems. Moreover, graphs can be decomposed into hierarchical structures (Abello & Korn, 2000). Therefore, hierarchical methods can be applied to show information structures on mobile handhelds. A number of customized methods for visualizing hierarchical structures have been developed (Keim et al., 2002). In the following, we want to discuss two examples for visualizing structures on mobile hardware. First, we adapt an effective approach for visualizing hierarchies, the MAGIC EYE VIEW (Kreuseler et al., 2000), for our purposes. Secondly, we introduce the RECTANGLE VIEW, a method that combines the visualization of a basic hierarchy with the drawing of general graph structures.

## MAGIC EYE VIEW

The original MAGIC EYE VIEW was designed for regular PCs or workstations. The technique is based on a 2D hierarchy layout, which is mapped onto a

*Figure 3. Projection rays before and after moving* $\boldsymbol{p}_0$

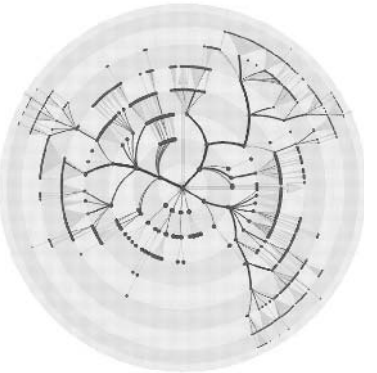


hemisphere such that each hierarchy node is located at the hemisphere's surface after the mapping. Furthermore, a projection is introduced in order to achieve a FOCUS & CONTEXT display. Applying this projection allows smooth transitions between focus area and context regions. For this projection, rays are computed from the center of projection $\mathbf{p}_0$, which is initially located at the hemisphere's origin through each node on the hemisphere; that is, the directions of the rays are determined by the nodes' initial positions at the hemisphere. For changing focus, the center of projection $\mathbf{p}_0$ can be moved arbitrarily, whereby the directions of the rays are retained. New positions of the hierarchy nodes are obtained by computing the new intersection points of the rays with the hemisphere. Thus the distances between nodes are increased or decreased depending on the position of $\mathbf{p}_0$. By increasing the distance between nodes we obtain more space for showing details (focus) while maintaining context information (see Figure 3).

Furthermore, coloured rings are introduced for minimizing the amount of confusion that may be caused by applying the projection. Based on different colours, hierarchy levels can be distinguished very easily (Figure 4).

Since real interactive 3D FOCUS & CONTEXT visualization exceeds the capabilities of pocket-sized devices this technique must be customized in order to use it on mobile handhelds. Thus, the following three adaptations have been applied (Karstens, Kreuseler & Schumann, 2003):

*Figure 4. An orthogonal view of the MAGIC EYE VIEW with about 1,000 nodes*



*1. Reducing the number of elements to be displayed*

Due to the limited screen size, the number of represented elements must be reduced. A simple but intuitive way is restricting the number of displayed hierarchy levels. The EVENT HORIZON introduced by Taivalsaari (1999) is an interesting technique to solve this problem. The key idea is the compression and expansion of the graphical representation by a radial movement of objects, which aligns every object with a certain distance to the so-called event horizon in the middle of the screen. The event horizon can be considered as a virtual container (sink) in which objects are stored and, thus, as a graphical abstraction of a certain set of nodes according to the interaction of a user. If the set of nodes in the event horizon is large, we can explore nodes on high levels of the hierarchy, and if this set is relatively small we can consider nodes near the root node.

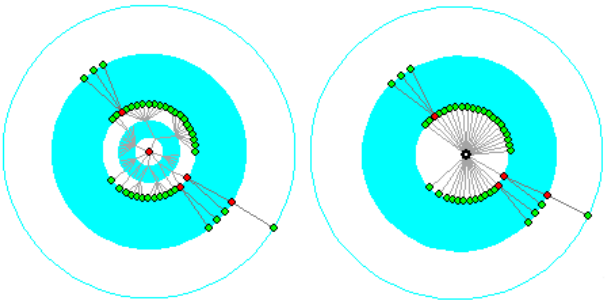
We applied the concept of the EVENT HORIZON based on the following considerations:

- The user must specify the maximum number of levels that can be displayed out of the event horizon. This is done due to the variety of mobile handhelds, applications and requirements.
- The amount of nodes inside an event horizon is given by three different graphic styles:
    - Minigraph: The structure inside the event horizon is abstracted by an iconographic view. Only little edges are used to create a minimized representation of the level structure inside the sink.
    - Circlets (concentric circles): The sink is represented by small concentric circles. Each circle represents one hierarchy level inside the sink.
    - Symbol: One little colour-coded circle is drawn where the colour reflects the number of nodes in the sink.

The three alternatives try to provide a tradeoff between minimum loss of information (minigraph) and minimum space requirements in the display (symbol). Figure 5 illustrates the drawing styles.

Furthermore, subtrees can be folded and unfolded to reduce the complexity of the hierarchy. Arbitrary nodes of the structure can be selected and the entire

*Figure 5. Different views of the event horizon: Minigraph with circlets (left) and symbols (right)*



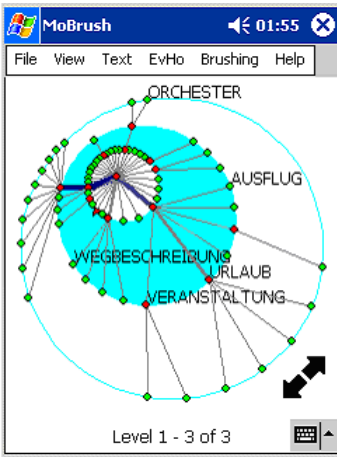
subtrees below will be folded (hidden). Only the root node of a folded tree (i.e., the previously selected node) remains visible and is marked as folded. The reverse operation is applied when selecting a folded node; that is, the entire subtree below will be unfolded and displayed.

## *2. Reducing the complexity of the graphical output*

Instead of 3D, a 2D representation of the Magic Eye View is used. This is done by an orthogonal projection of the hierarchy onto a circular 2D display region. Furthermore, simple graphical primitives such as circles, triangles and straight lines are used instead of 3D primitives and curves. Replacing curves with straight lines for edge drawing curves may cause overlapping problems. Therefore, curve drawing is still offered as an option at the cost of slowing down display performance.

Moreover, we are using a simplified FOCUS & CONTEXT-approach by moving nodes in 2D either towards (moving into focus) or away (moving into context) from the center of the circular display region, instead of using a center of projection in 3D. Figure 6 gives an example for the MAGIC EYE VIEW on a mobile handheld.

*Figure 6. Visualization of hierarchical structures: The MAGIC EYE VIEW on a mobile device*




## 3. Simplifying interaction functionality

The original MAGIC EYE VIEW provides rich interaction functionality such as 3D transformations (zoom, rotation or translation), focusing areas, folding and unfolding subtrees (Herman et al., 1998), changing parameter values, annotations and so forth. While 3D functions are not needed for mobile handhelds the remaining operations are implemented based on the available input mechanisms. Nearly all interactions can be done via the input pen; in particular, pointing with the pen (for annotation or folding) or moving the pen for focusing should be mentioned.

Using theses adaptations, we can state that it is possible to use the MAGIC EYE VIEW on mobile handhelds for up to 300 nodes in interactive time. Among other things we have used the original Magic Eye View as a visual interface to represent a huge ontology in the field of tourism industry. Now, we can provide this functionality at mobile handhelds as well. For example, a mobile user can click at a node on his or her handheld, representing relevant topics from tourism industry, to be informed, for example, about hotels, restaurants or cultural events in the user's direct environment.

## The RECTANGULAR VIEW for Mobile Handhelds

The RECTANGULAR VIEW was developed for displaying and interacting with large networks on mobile handhelds (Karstens, Kreuseler & Schumann, 2003). The scenario to use these technique is: a user can browse on a network of nodes and edges in a level of detail and select nodes that represent other levels or pieces of information. New levels or underlying information can be provided in conjunction with a server if necessary. First of all, one might ask - what kind of graph is easy to compute and to display on a mobile handheld with a small display area and a 33 MHz CPU? Hierarchical structures containing a root node and nodes arranged in levels offer advantageous preconditions to compute effective layouts for mobile handhelds, as we have shown for the MAGIC EYE VIEW. This is not the case with more general networks. In our example we want to display a large graph with 3,389 nodes and 7,311 edges. Moreover, we restrict the considerations on a Palm environment. We have to find appropriate layouts, which should be easy to compute and should not produce edge crossings or unnecessary holes. Most layout algorithms for networks are very expensive to compute, such as force directed methods, which compute optimal layouts based on the physical analogy of spring forces. Another common problem with existing graph layouts is undesired global layout changes, when nodes or subgraphs are inserted or deleted from the graph. Thus we use a hierarchical layer based algorithm for graph display on mobile handhelds: the original method presented by Sugijama, Tawa and Toda (1981). Improvements of the algorithm are introduced and published in Battista et al. (1999). The algorithm contains three steps:

- Layer Assignment:

  The nodes of the graph are assigned to layers. Dummy nodes are inserted if nodes are more than one layer apart.
- Crossing reduction:

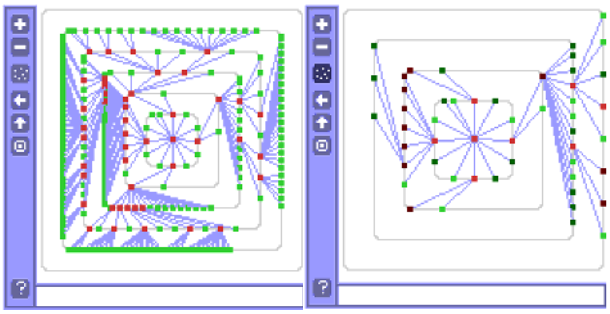
  The nodes and subgraphs are permuted to minimize the number of edge crossing.
- Alignment:

  The nodes in a layer are aligned horizontally.

Classical horizontal layouts can only display about 100 nodes. In order to extend the number of displayable nodes we apply a radial layout, but arrange the levels as squares, and not as circles around the root in the center of the screen. Thus, we exploit the rectangular screen space more efficiently. Moreover, this approach is very fast since node alignments require one incremental integer addition per node only. However, a disadvantage of this method is the necessary decision of at which side of the square a node must be placed. If one node is mapped onto one side of the square, the subtree below must be placed at the same side. Thus, arranging the children of the root along the four sides of the square influences the appearance of the layout tremendously. This arrangement is done by exploring the complexity of the substructures. However, placing a node and its entire subtree at the same side of a square (as it is done by the layout algorithm) has another major advantage — user orientation after folding subtrees is much better supported than in a circle based layout.

The introduced approach exceeds the computation power of a Palm-device. Therefore we have to decide which parts of the algorithm have to be computed on a PC and which on the mobile handheld. One suitable way is computing layer assignment and crossing reduction on the PC, and transferring a hierarchical graph to the mobile handheld. Each transferred node is associated with a level of the hierarchy and a side of the square. The mobile handheld provides the following functions: Specifying the number of levels to be displayed, computation of the exact position in the RECTANGLE VIEW, and interaction facilities with the graph.

*Figure 7. Visualization of a graph with the RECTANGULAR VIEW (Left: Full hierarchy with 332 nodes. Right: Zoomed hierarchy with many folded subgraphs - nodes with underlying graphs are black)*



Since computing and drawing hierarchies of large graphs is time consuming and complex, we restrict the dimension of the hierarchy to be computed. Our solution uses the Coffmann-Graham-Layering to find layers with a minimum width (number of nodes without dummy nodes per layer). Nodes that were not assigned by this procedure are stored in separate substructures. In our example the graph with 3,389 nodes was transformed into a hierarchy with 332 nodes and several substructures. The hierarchy and the subgraphs are converted into separate databases and transferred to the Palm. As by customizing the radial MAGIC EYE VIEW to PDA environments, we applied different adaptations:

1. Reducing the number of elements to be displayed:

   Not all nodes of the original graph are inserted into the hierarchy. The hierarchy is limited to 400 nodes. This is because we have found that it is impossible to display more nodes at the same time on mobile handhelds. The number of displayed layers can be adjusted by zooming. Moreover, subgraphs can be folded in order to provide more space for the remaining nodes.

2. Reducing the complexity of graphical output:

   The RECTANGULAR VIEW is a 2D-technique. Only simple primitives such as lines and points are used. The calculations of node positions only require incremental integer addition. Therefore, changes of the layout are fast and easy to compute. Furthermore, colour-coding of nodes is restricted to a very few colours. Leaf nodes are green, nodes with children are red and folded nodes are brownish. Thus it is easy to distinguish "root nodes" of folded subtrees from real leafs. An extra colour is used to mark all nodes with underlying graphs (see Figure 7).

3. Simplifying interaction functionality:

   The presentation starts with the full hierarchy. The layout can be changed by selecting nodes and folding its subgraphs. An alternative for changing the presentation is using toolbar buttons. The buttons (at the left hand side) can be used for zooming in and out, showing the mark of a node, drawing the underlying graph or showing a history. Textual information can be presented at the status bar at the bottom of the window.

Considering these adaptations, we can state that it is possible to work with the RECTANGULAR VIEW in real time even if mobile hardware with little processing

power is used. We can handle structures around 3,400 nodes at once. We found this is a good number to show relevant parts of complex information spaces.

## Presenting Compound Information – Browsing the World Wide Web

In this section we consider a special application for the information presentation on mobile handhelds, the browsing of Web contents. In particular, this covers the adaptation of Web pages, which have not been sketched for such devices. This requires a special treatment to ensure the information of the whole Web can be used.

There are several approaches for the adaptation of Web pages:

- Device based adaptation:

  For different types of devices, special Web pages are available. Examples are Web pages made with WML. The advantage of these techniques is the optimal usage of device dependent properties. A drawback is the little availability of such special pages.
- Layout based adaptation:

  Here, different layout classes are defined based on criteria like degree of abstraction. These classes can be applied to Web pages. For example, layouts can be specified for different output media by using cascading style sheets (CSS). However, a problem is the need for a special preparation of the Web pages.
- Client based adaptation:

  This approach uses the original information and changes the presentation on the output device only. Appropriate adaptation can be done by applying special algorithms or rules to a Web browser. Some examples that use FOCUS & CONTEXT (FLIP ZOOMING: Björk et al., 1999; CZWeb: Fishers et al., 1997) or OVERVIEW & DETAIL (Power Browser: Buyukokten et al., 2000; WebThumb: Wobbrock et al., 2002) are well known. The necessary information must be quickly generated from the original document.

- Document based adaptation:

  Any Web page is transformed with their presentation on the display in mind. It is possible to change the structure or content of elements of a Web page. Examples are section outlining, the replacement from text parts by hyperlinks (Zippers: Brown & Weihl, 1996), the removal or scaling of pictures (Power Browser), or the text filtering and generation of a text summary (West: Björk et al., 1999).

We have developed a client-based adaptation in connection with techniques from the document based adaptation to present Web pages on mobile handhelds. That means we avoid a document adaptation on the server. Our design criteria have been as follows:

- provide the same information,
- allow the accessibility of all information, and
- use the same presentation as on PC-oriented HTML sites as far as possible.

Additionally, overview representations have to be presented. We restrict ourselves on documents containing frames, tables and HTML elements, especially used in scientific articles.

The base of the technology is a data structure called WEBGRAPH, which records the layout of a Web page. The WEBGRAPH is a tree with nodes and edges. Leaf nodes represent single Web elements like text, illustration, link, and heading. Interior nodes contain at least one child node. These are frames, tables, table contents and paragraphs. Furthermore, a set of possible edges must be defined to specify the relationships between the nodes. An example is the edges of a paragraph node. Children of a paragraph could be paragraph nodes, tables, text, illustrations, links, and headings. That means the possible edges from a paragraph are edges to one or more of those elements. For a clear specification of the Web document some further definitions and rules must be made:

- The root of the WEBGRAPH is a frame-node or paragraph-nodes representing the whole document.
- Child nodes are aligned.

- Heading-nodes are assigned to position 0.
- On table-nodes, the table-content-nodes are ordered regarding row and column number and the table node is a single node in a paragraph node.

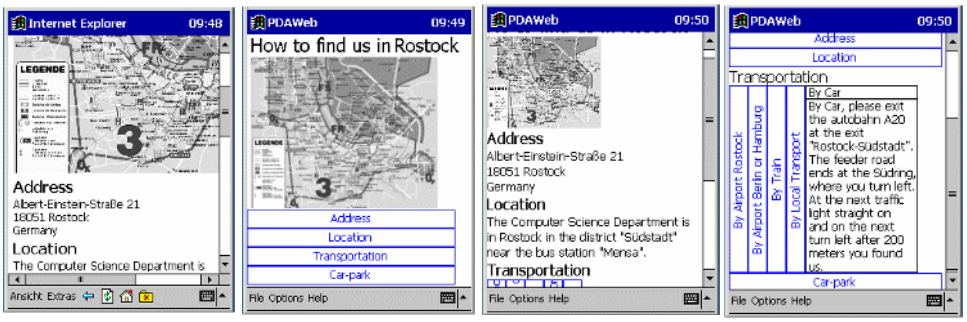
Based on the WEBGRAPH, three concepts (SECTION FOLDING, RELATIVE SIZE and KEYWORD OVERVIEW) have been developed for the presentation of HTML documents.

We introduced SECTION FOLDING as the concept of information hiding to reduce the amount of information to be displayed. For this purpose, an enhancement of section outlining (Brown & Weihl, 1996) that replaces textual parts of a document by hyperlinks is used. Section folding operates on a WEBGRAPH, so every node or subgraph can be replaced or hidden in the presentation. Because there are several classes of nodes, it is possible to process them differently to achieve an efficient treatment. For example, to generate the textual information for hypertext, we can use the name of the table in a table node or the first sentence in a text node. In order to use section folding optimally, an automatic computation of the starting situation is necessary. Moreover, for information filtering using a tree, the Filter-FishEye-View (Furnas, 1981) can be applied. A degree of interest (DOI) is determined starting from the current point of interest (POI) with a distance function and the certain level of detail (LOD). Uninteresting information can be hidden by a threshold value.

With the concept RELATIVE SIZE, the extent of elements of a Web page is adapted to the display of a mobile device, so it is possible to handle node types like text, structural components and illustrations differently. Textual elements can use fonts and font size of the handhelds. The size for structural components can be processed by absolute size, by the relative size compared to parent- or sister nodes or as a collection of child nodes. For structural elements like tables, the optimal column width can be determined from the presentation window, so it is possible to avoid horizontal scrollbars. On the handheld, images can be displayed in its original size, scaled or also with an implementation of the RECTANGULAR FISHEYE-VIEW to make use of its advantages described in the third section.

The approach KEYWORD OVERVIEW uses techniques from text filtering for the fast navigation on Web sites. Key-words are listed in an additional window, so it is possible to jump to the appropriate regions of the presentation window. The keywords are arranged either according to the object types or the position in

*Figure 8. Section folding on columns and table items*




the Web document. Thus, the keyword overview eases the orientation and navigation, especially in unstructured sides.

Apart from the presented possibilities it is also possible to choose a full size view with the assistance of scrollbars. In a section folding view a user can reach all information of the original document by an info-bar as place holder. By interaction in the section folding window or in the keyword overview, the current point of interest can be changed. Subtrees can be folded and unfolded manually, so beside automatic section folding an interactive section folding is also possible.

All the presented techniques have been implemented and integrated into a Web browser. Figure 8 shows an ordinary Web site, displayed using the Internet explorer (left) and three different presentations of this site, using our proposed concepts. In the second picture all information is folded and the picture is scaled. The third picture shows an unfolded paragraph of interest and its local environment, whereas the last picture shows a table with one unfolded table row.

# Conclusions

Information presentation on mobile handhelds requires a special treatment to consider the limited resources of these devices like screen space, interaction facilities and computational power. Nevertheless, basic techniques from the field of information visualization can be adapted for these purposes.

We have introduced methods for the display of graphical as well as abstract information. For presenting large images on small screens, one existing technique has been adapted and three new presentation techniques have been proposed. For presentation of abstract data, we introduced two techniques to visualize hierarchical structures of large information spaces. Therefore, we adapted the MAGIC EYE VIEW to mobile handhelds and developed the RECTANGULAR VIEW for Palms. Lastly, we made use of these concepts and suggested different approaches to browse the Web via mobile devices.

All these examples showed the feasibility of information presentation on handhelds. Further work will concentrate on the combination of the proposed approaches in a general framework and usability tests. This includes the visualization of the Web graph described in the fourth section. Moreover, we want to adapt and integrate more techniques like special graph drawing algorithms, and evaluate our work by several application cases.

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## Chapter III

# Mobile Payments (M-Payments) – An Exploratory Study of Emerging Issues and Future Trends

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## Abstract

*With the growing momentum of wireless revolution and m-commerce explosion, it is evident that mobile devices are becoming a critical component of the new digital economy. As mobile markets continue to mature, being able to pay using the mobile handset may perhaps be the key to the development of next generation services. The current market penetration of mobile phones in conjunction with the optimism on the growth of m-commerce offers high potential for m-payment surge over the next few years. When mobile phones are equipped with a device to protect personal information, the security level of an entire service,*

*including the network, improves considerably. However, the mobile payments market today is typical of an emergent one, encumbered with an abundance of approaches and concepts that may not interoperate. In this chapter, we have explored the broad range of available m-payment methods, emerging issues in standardization, security, and some proposed and existing solutions.*

## Introduction

With the creation of the new freedom economy driven by deregulation, new sources of global competition and ICT revolution (Keen & Mackintosh, 2001), commercial transactions are rapidly transitioning from fixed locations, to anytime, anywhere and anyone. New forms of mobile technologies are rapidly transforming the marketplace. Optimists are of the opinion that the new world economy will witness the transition of mobile devices from a simple communication device to a payments mechanism, because the sole ownership characteristics of the mobile phone supports non-repudiation of transactions by customers and enables secure certificates to be stored inside the device to support security of mobile commerce (Ding & Unnithan, 2002). Mobile phones have become devices for paying merchandise, receiving time sensitive information such as stock quotes, or for dissemination of critical business processes in the value chain (Paavalainen, 2001) in many countries. Mobile phones surpass fixed lines in many economies, and in fact, some accession countries or developing nations have made mobile network a choice over the fixed line networks (Unnithan & Swatman, 2002). The number of mobile phone subscribers worldwide was 946,297,000 (ITU, 2002) and is expected to reach 1 billion by 2002. With the rise in the number of Internet enabled mobile devices, the number of subscriptions will rise and perhaps, the wireless Internet users will outnumber the fixed line Internet users (Krueger, 2001). The market for m-commerce in Europe alone is estimated to be worth Euro 3 billion by 2003 (KPMG, 2000; Muller-Veerse, 1999). Bucci (2001) highlighted that Italy – a country with the highest mobile phone penetration rates (63.6 million for 57.5 million people), has more than half of the population participating in m-commerce and 61% of the mobile phones are Internet enabled. Mobile payments will gain significant foothold in coming years.

Many authors (Keen & Mackintosh, 2001; Paavalainen, 2001) are of the view that the growth potential of m-commerce is difficult to overestimate. Within the next 3 years, millions of people will access the Net via their PDAs (Personal Digital Assistants) – more than will do so via a PC (KPMG 2000). Wireless World Forum (2002) highlighted that Japan, USA, Germany and UK will represent four of the largest mobile payment markets in the world by 2006 and forecasted that there will be more than 200 million regular mobile payment users spending a total of 47.2 billion euros. The European Committee for Banking Standards (ECBS) and the European Telecommunications Standards Institute expects m-commerce to be one of the key drivers in developing the global information society, with applications emerging in numerous areas including banking, financial services, security services and shopping (m-Travel.com, 2002). As mobile markets continue to mature, being able to pay using the mobile handset will be key to the development of next generation services (Baschnonga, 2002). An important aspect in this sense is the expected convergence between mobile phones and the Internet (Bucci, 2001).

However, a major inhibitor of m-commerce is the lack of a suitable payment system (Heijden, 2002; Krueger, 2001; ZDNet, 2001;). If mass-market m-commerce diffusion has to be achieved, a successful m-payment system needs to be developed (Henkel & Zimmermann, 2001; KPMG, 2000; Krueger, 2001). Towergroup (2001) agrees that m-payments will begin to show significant adoption globally as wireless industry hurdles are overcome and consumer demand rises. According to their new research, by 2005 the number of US based m-payment users are expected to become 3.5 million, making the m-payment system a critical hub in the bank/consumer relationship (TowerGroup, 2001). Forrester Research claims that mobile payment market will be worth $22 billion by 2005, making it the fastest growing part of global payments scenario (Baschnonga, 2002). Compared to other payment systems, mobile payments have the particular advantage that they can be used at the real point-of-sale, as well as in e-commerce and in m-commerce (Dahlström, 2001; Krueger, 2001b).

The spread of mobile phones also bodes well for the future of m-commerce. Similar to e-purses, most mobile phones have an embedded chip that can be used to store value or provide secure authorization and identification. In addition, the fact that the mobile phone provides communication services means that it does not have to rely on a card reader, PC and modem combination or a POS terminal. Therefore, it is not surprising that some experts

believe that the mobile phone will replace even smart cards as a means of payment (Bucci, 2001; Henkel & Zimmermann, 2001; Krueger, 2001b).

There has been great optimism as well as hype surrounding mobile payments (m-payment) since 2000. Many market experts, vendors and mobile operators had expected rapid, widespread adoption by consumers. Their optimism was based on the increasing popularity of mobile phones and the positive attitude consumers exhibited when using the devices. The vision of the handset as a mobile transaction device is widely shared. According to Celent, a financial services research and consulting firm, there will be 60 million mobile payment users generating sales of $50 billion by 2004 (Mobile Payment Forum, 2002). Towergroup (2002) further added that the number of consumers using mobile devices to make payments would rise dramatically between 2002 and 2005. Towergroup undertook a study that predicts that 118 million Western Europeans and 145 million users in the Asia-Pacific region will purchase low-cost mobile premium content by 2005. That far exceeds the reports' estimate of 22 million such users in North America. M-payments are likely to become an important segment of the retail payment market. Also, according to the report, to a large extent the reason lies in immediate payment fulfillment and thus reduced risk and transaction cost. The largest portion of those mobile payments will be for content-related services that cost less than 10 • each. These are called micropayments and include things such as ring-tones for phones or other premium content. An approximate value of 10 • is seen as the dividing line between micro- and macro-payments.

This chapter attempts to provide an insight into the progress of m-payments, some current initiatives and emerging issues.

## Defining Mobile Payments

Krueger (2001) defined m-payments as payments via the mobile phone. Mobile payment is a point-of-sale (POS) payment made through a mobile device, such as a cellular telephone, a smart phone, or a personal digital assistant (PDA). Using the m-payment method, a person with a wireless device could pay for items in a store or settle a restaurant bill without interacting with any staff member. This ability makes it a potential e-commerce and m-commerce application (Krueger, 2001).

Heijden (2002) identified it as any conventional or new payment system that enables financial transactions to be made securely from one organization or individual over a mobile network.

Mobile payments are used to pay not only for merchandise purchased via mobile channel but also for transactions in the physical world such as vending machines, passport photo machines, car wash machines and so forth (Paavalainen, 2001).

Some experts believe that the mobile phone will even replace smart cards as a means of payment (Bucci, 2001; Henkel & Zimmermann, 2001; Krueger, 2001), as they have an embedded chip that may be used to store value or secure authorization.

The m-payment vision is to transform the mobile phone into a personal mobile wallet (m-wallet), holding credit cards, debit account information and mobile "cash" for small transactions.

## Mobile Payments – Current Scenario

M-payment is already in use in many parts of the world, including Europe and Asia. There are several providers offering the m-payment systems services, although the predominant players are Telcos and the financial institutions (Bucci, 2001; KPMG, 2000; Krueger, 2001b; MeT, 2001; what-is.com).

Table 1 provides some examples of m-payment systems as of December 2001 (Krueger, 2001). The highlights are where mobile operators are participating in the m-payment ventures.

In March 2002, Korea's Seongnam City, south of Seoul, piloted a mobile payment system, "Zoop," which connects the city's stores to a central payment system via broadband links. The mobile payment system runs on infrared technology and will be used for transit payments, for goods and services at retail locations and in restaurants around the city. Because the credit card-equipped phones interact with cash registers, and link to a central payment system, users only have to enter a PIN on their phone handset to initiate a payment anywhere in the city. The system, which applies infrared rays to link handsets with cash registers, will come in handy for any kind of transaction (Korean Herald, 2002).

The Finnish carrier, Sonera, is running a mobile payment trial in Helsinki, with Visa and Euro cards complementing its prepaid Shopper service, to which

*Table 1. M-payment ventures*

| SUPPLIER | TYPE OF TRANSACTION |
|---|---|
| **Banko.max** (Austria) | Virtual POS |
| Bibit (Holland, international) | M-commerce (WAP-enabled) |
| Cellonet (Sweden, Netherlands) | Parking |
| **Cingular DirectBill** (USA) | Virtual POS |
| **EMT** (Estonia) | Parking |
| **GiSMo** (Sweden, UK, Germany) | Virtual POS |
| Metax (Denmark) | Real POS (filling stations) |
| Mint (Sweden) | Real POS |
| **NTT DoCoMo** (Japan) | M-commerce (subscription) |
| **Omnitel Onphone** (Italy) | Virtual POS |
| **Orange Mobile Payment** (Denmark) | Purchase of mobile air time |
| **Oskar** (Czech Republic) | Payment for prepaid and invoice |
| **Paiement CB sur mobile** (France) | Mail order and virtual POS |
| Paybox (Germany, international) | Real and virtual POS |
| PayDirect (USA) | Virtual POS, P2P |
| Payitmobile (Germany) | Virtual POS |
| Payline (France) | Virtual POS |
| PayPal (USA) | Virtual POS, P2P |
| Phonepaid (UK) | Virtual POS, P2P |
| **Sonera Mobile Pay** (Finland, Sweden) | Real POS (including vending machines) |
| StreetCash (Germany) | Real and virtual POS |
| **Telenor Mobil** (Norway) | Tickets |
| **Telia Payit** (Sweden) | Virtual POS |
| VisaMóvil (Spain) | Real and virtual POS |

funds are transferred from users' bank accounts. Payments in the pilot are added to the customer's credit card invoice, or debited to a Shopper account (Cnet, 2002).

In Australia, Telstra Mobile along with city councils of Bronte in Sydney and CBD in Melbourne commenced a three-month m-commerce parking meter trial in September 2002, where customers were able to pay for their parking via their eligible mobile phone or using coin slot machines (Telstra, 2002). As of December 2002, following the trials, motorists in Melbourne and Sydney are able to pay for some parking spaces using their Telstra mobile phones (Cauchi, 2002). To pay by the mobile phone, drivers call a 1-900 number listed on the meter. The transaction is confirmed by a voice message, and the meter displays an expiry time and parking fee. Drivers cannot top up the meter by mobile and must pay 55 cents to use the service. All charges appear on their next Telstra phone bill. If a driver pays for more than 10 minutes, they get a free SMS reminder of the expiry time (Cauchi, 2002). However, motorists are still reluctant to use the phone payment system as it seems a lot easier to use coin slots – as opposed to spending 55 cents extra, which equates 15 minutes of parking time. Vodafone and Optus mobile phone subscribers are also unhappy that they cannot use their mobile phones to pay for parking.

At the same time, Coca-Cola and Telstra have partnered to bring in the Dial-a-Coke service. The mobile phone users in Australia can now use the phone to buy a drink from specially marked Coca-Cola vending machines distributed across Central Station, Sydney. The new Dial-a-Coke service allows consumers to purchase a 600ml Buddy without the hassles of loose change. Customers have to call the number displayed on the vending machine, make the selection and the bottle will appear as if customers had used coins. The cost of the bottle of soft drink will appear on the customer's next mobile phone bill, and there is no charge for the call. Dial-a-Coke is only available for Telstra post-paid GSM customers (Telstra, 2002).

Bucci (2001) highlighted that the Italian banking institutions believe that providing mobile payment services to their customers is their first priority and are now starting to integrate e-banking services with the mobile services, including mobile phone payments. However, the main m-payment initiatives are currently coming from the telcos due to the technology push. An example of this is TIM (Telecom Italia Mobile), who has jointly developed a system with Oberthur Card Systems and Societa' per i Servizi Bancari (SSB) that allows the mobile phone user to carry out banking functions and m-payments. Additionally, TIM and Banca Popolare di Milano (BPM) have jointly launched

We@TIM, a set of services for online trading, mobile banking and generalized access to e-commerce. Others telcos that have provided similar mobile payments initiatives include Omnitel, who has launched a trading service along with Self Trade, a French broker on the Net. On "Omnitel 2000" to buy and sell shares online, Blu and Nokia have signed a turnkey contract for the supply and rollout of network solutions for their GSM network. Blu will probably adopt the Nokia EMPS (Electronic Mobile Payment Services) technology. The EMPS is a joint project between Nokia, MeritaNordbanken and Visa to enable secure mobile payments using dual slot mobile phones with chip cards. The first slot is for the SIM card that identifies the caller, and the second slot is for a tiny credit card. Combined with BlueTooth, EMPS can be used to facilitate a wide array of mobile transactions from vending machines to supermarket purchases (Paavalainen, 2001).

Forrester Research reported in 2001 that mobile content payment for ring tones and vending machines dominated the market with a total spending of •51 million. Forester Research also forecasted that low-value payments such as those at vending machine payments would continue to increase by 2003, although higher value payments such as supermarket payments will dominate by 2005 (Jüptner, 2001). Mobile users in Austria, Ireland, Italy, the Netherlands, Portugal, Switzerland, and the UK are more likely to spend an average of EUR 6.77 per mobile user per month in 2005, while Belgium, France, Greece, Luxembourg, and Spain will only spend an average EUR 3.47 per mobile user per month in 2005.

However, the promised technological outcomes did not live up to prevailing expectation. Despite the high level of expectation that prevailed in 2000 and 2001, no m-payment platform has as yet gained significant market acceptance, at least in Europe. Paybox (2003) announced in January 2003 that it was withdrawing its mobile payment services from all countries except Austria, where Mobilkom will take on its business. Also in July 2003 they informed all their customers and merchants that moxmo.com will take over business and services for Germany and will commence activities by September 1, 2003. According to Jones (2003), Paybox was ahead of its time in its ability to offer person-to-person and person-to-business payment services using mobile phones. Although the Paybox system works well in a technical sense, consumers and potential partners such as mobile operators and banks did not create enough demand to make the payments processing business profitable. There are other similar examples of past micro- payment ventures that have had similar endings (e.g., Cybercash, Digicash, Flooz, Beenz.com, etc.) that had

been implemented for payments via the Internet as well as the evolution of m-payment services (e.g., Paybox), but these are also gradually disappearing.

However, the areas in which mobile payments have proven to be successful are niche applications such as parking or payments for specialized deliverables such as games and ring tones, which do not need a general-purpose payment system. Mobile payments as yet do not offer a sufficient advantage over conventional systems such as credit cards to attract large numbers of consumers or merchants. Despite the repeated stated willingness of customers to use alternative payment solutions in the digital environment, only 1% of users actually do so. In Germany, for example, alternative payment systems make up only 3% of online transactions, while the remaining 97% are processed through direct debit, invoicing and credit card payments (Cornelissen, 2003).

## Mobile Payment Transaction Environments

Consumers currently use mobile payments for transactions in three different environments: remote, local and personal. Remote environments are typified by services accessed over digital public mobile networks. Remote payments generally use a browser-based transport infrastructure or an SMS/MMS-based system. Although there are technical differences between IP and messaging-based communications, payment protocols can operate similarly across both. Local environment is characterized by services in the proximity and involve the use of short range messaging protocols such as Bluetooth, infrared, RFID and a contactless chip to pay for goods and services over short distances (Met, 2003; Mobile Payment Forum, 2002; Visa, 2003). Personal environment is the communication between multiple devices controlled by the user such as mobile phone and PC or set-top box. In this chapter, we have discussed remote and local payments.

A majority of mobile payment transactions today are in the area of remote micro-payment and are usually handled via operator billing. Mobile remote micro-payment started with the introduction of value-added SMS services such as downloadable ringing tones. This market has grown to the size of over 1 Billion Euro for Europe alone and is still growing fast due to the introduction of new personalization elements and digital content consumed in the mobile

phone. Some of the present digital content consumption also involves bigger transactions, including subscriptions and service packages. Thus, there are expectations for growth of remote macro-payments. This growth will be substantially higher if topping prepaid accounts for mobile services predominantly occurs utilizing a mobile phone instead of scratch cards.

However, local mobile payment, also known as *proximity payments* and *contactless payment* (terms used interchangeably throughout the document), is in the phase of rapid development. Proximity payments are expected to be particularly popular when time is short or when it may be physically difficult to swipe a payment card in a payment terminal (Visa, 2003). In the United States, most major cities are implementing or planning to implement contactless smart card-based automatic fare collection (AFC) systems. In 2002, MasterCard, VISA and JCB also announced the availability of contactless payment options for traditional cash-only environments where speed is essential, in places such as quick serve and casual restaurants, gas stations, convenience stores and movie theaters. Proximity payment devices come in a variety of shapes and sizes, ranging from traditional plastic cards to key fobs, watches and cellular phones: for example, Smart Card Alliance (2003), Visa International (2003), and Mastercard (2003). According to Smart Card Alliance (2003), there is an increased interest shown by the financial, retail, and transportation industries over this latest payment trend.

MET (2003) suggests that there is a large potential for growth in the emerging local mobile payment environment, with continuing growth in remote micro-payments and some potential for remote macro-payments. Other research analysts in support of this stated that projected values of proximity micro-payments are expected to grow from 423 million Euros in 2002 to 5005 million Euros in 2005. Similar growth is projected for proximity macro-payments: 314 million Euros in 2002 to 12,674 million Euros in 2005 (Trintech, 2002). However, whilst the forecast is for a major growth in proximity mobile payments, others have suggested that it will take some time to build wide acceptance for m-payments in general and results will not be seen until 2006 (Fife, 2002; Towergroup, 2002; Trintech, 2002). Clarke (2003) quoted Tower Group Senior Analyst for Emerging Technologies, Edward Kountz, as being positive about the success of radio-frequency (RF) technology for low-value, non-remote, impulse-driven purchases. Kountz highlighted examples of proximity payment solutions like Speedpass (US) and Korea (Octopus) and further predicted that eventually RF payment devices would be included in mobile phone covers and then phone chipsets. The ability of global card issuers

to leverage existing user habits with contactless convenience will drive the rise of contactless retail and transit payment cards at a rapid growth rate between 2002 and 2007 (TowerGroup, 2003).

Some examples of current implementation of proximity cards, their technology and device formats are summarized in Table 2 (SmartCard Alliance, 2003).

In September 2002, Visa International developed a new global payment specification that removes the need to physically insert a smart card into a reader. Based on an international standard, ISO 14443, the new specification uses a chip embedded in a plastic card or an electronic device such as a mobile phone. According to Visa International (2003), the device is held in front of a terminal and a wireless interface transits the payment information, which removes the need to insert or swipe a payment card, making it easier to pay in places where speed and convenience are important. These technologies will facilitate the move closer to the company's goal of displacing cash. Visa contactless payment was trialed in South Korea in conjunction with Harex Technology and the mobile network providers in April 2002. It was commercialized for the first time in the world as a wireless mobile proximity payment service called ZOOP, using infrared communication. ZOOP is presently being used in some 4,000 places including major department stores, coffee shops, and restaurants in Seoul and Sungnam City (Mochizuki & Atsushi, 2003).

A pilot program was launched in April 2003 to test infrared credit card payment service between Visa International, Nippon Shinpan, OMC Card, AEON Credit and NTT DoCoMo Inc. The credit card data are downloaded and then stored in the DoCoMo 504i and 504iS mobile phones, which are equipped with

*Table 2. Featured applications and corresponding technology*

| Featured Application | # of Cards Issued | Technology | Form Factor |
|---|---|---|---|
| Hong Kong Octopus Card | 9+ million | Non-standard 13.56 MHz (FeliCa) | Plastic card |
| ExxonMobil Speedpass | 6+ million | Low-frequency RF (TI) | Key fob, wrist watch, window transponder |
| Visa Contactless Payment | 7+ million | ISO/IEC 14443 13.56 MHz, Infrared | Plastic card, mobile phone |
| MasterCard PayPass | Pilot phase | ISO/IEC 14443 13.56 MHz | Plastic card |

infrared transmission (IrDA) ports. The pilot leverages a DoCoMo "i-±ppliTM" application for payments based on the "Visa Proximity Payments Messaging Specification". Every DoCoMo 504i and 504iS phone is standard-equipped with an IrDA port to exchange information with other IrDA-equipped devices via an infrared signal (Visa International, 2003).

In May 2003, Nokia and MasterCard launched a similar trial for "contactless" payment initiative using Nokia phones as credit cards. The Nokia phone SmartCover™ is embedded with a contactless chip and a radio frequency (RF) circuit. The chip has been specially programmed with pre-registered MasterCard payment account information and is compliant with the MasterCard PayPass specification. When consumers tap or wave their Nokia phones on the specially equipped PayPass readers at the point-of-sale, payment account information is transmitted to the terminal. The transaction is then processed through MasterCard's highly trusted payment network in the normal way. A system provided by JP Morgan Chase processes the payment account information. Just a few seconds after consumers tap or wave their phone, payment confirmation is received and the transaction is complete (Mastercard, 2003).

The key challenge in increasing the acceptability of mobile payments is to replace cash payments with electronic cash, as the former still accounts globally for about half of all transactions. Ajay et al. (2002) point out that payment methods today are dominated by cards and cash simply because there is often no better alternative despite their lack of security and lack of convenience. Cash has an additional benefit of providing anonymity, which is not present in any other forms of payment (Ajay et al., 2002).

Smart Card Alliance (2003) highlighted that contactless payment allows issuers to penetrate the cash payment market, enjoy increased customer transaction volume and improve customer retention and loyalty. At the same time, consumers enjoy the convenience of hands-free payment, the ability to pay for multiple services using one device and the security of not having to display a card for payment (Smart Card Alliance, 2003).

Birch (2003) points out that the public wants a simple m-payment service where they can point their phone at the payment register and the payment is completed without the complexity of having to do all the things like registering for the service, remembering credit card numbers and/or passwords or be with a particular operator and so on.

## Many Dimensions of M-Payments

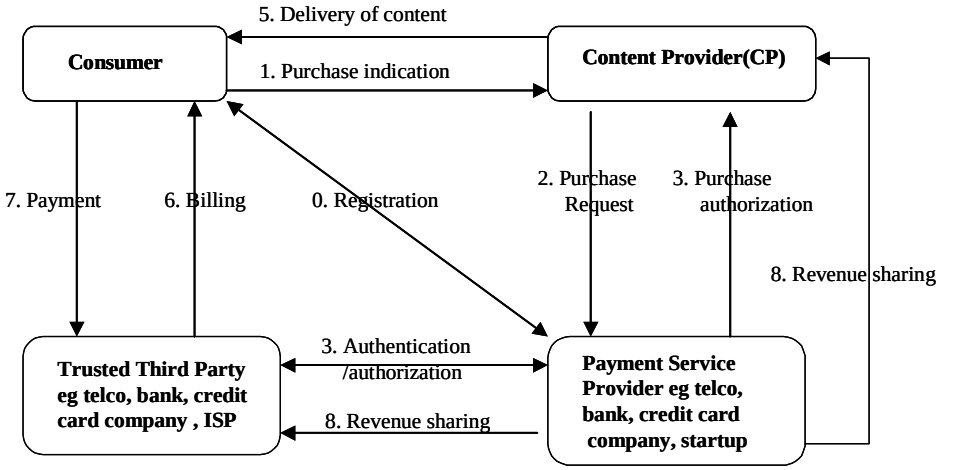
The many phases involved in an m-payment transaction, despite the environment, are illustrated in Figure 1 (Telecom Media Networks, 2002).

In the mobile environment, transaction dynamics are similar although the form factor that contains the transaction credentials is different. In addition, in the case of remote payments, the transport of payment details will involve a mobile network operator and use either a browser-based protocol such as WAP or HTML, or a messaging system, such as SMS or Unstructured Supplementary Service Data (USSD). Alternatively, the transport of payment details could be via Bluetooth, infrared, RFID or contactless chip in the case of proximity payments.

To-date, m-payment transactions based on different strategies has been implemented. They involve different combination of key players in the role of Trusted Third Parties (TTP) and Payment Service Providers (PSP).

A trusted third party (TTP) is the company who performs the authentication and the authorization of transaction parties and the settlement. It could be a telco, bank, or credit card (pre-paid account, consumer bill, bank account, etc.). The payment service provider (PSP) is the central entity responsible for the payment process. It enables the payment message initiated from the mobile device to be routed to and cleared by the TTP. This service generally includes

*Figure 1. Phases in mobile payments transaction*



an "e-wallet" application that enables payers to store their payment details such as credit card account numbers and shipping addresses on a provider's secure server so that they do not need to type in all the pertinent information required for each sale on small and difficult-to-use mobile keypad devices. The PSP may also act as a clearinghouse to share the revenues between all the partners involved in the payment process. It could be a telco, a bank, a credit card company, or a start-up.

Several models of collaboration as well as architecture have been implemented to date in the m-payment transaction process: for example, a Full Payment Service Provider, where the key player is acting both as the payment services provider as well as the trusted third party between consumers and merchants. Fees from these transactions together with basic hosting fees generate the revenue for the full payment service provider. Some authors suggested that the mobile network provider could fulfill this model if they have the technology to handle the end-to-end.

Another model is the Mobile Wallet Provider, who offers mobile payment processing without clearing. The provider stores and maintains consumer account information and establishes secure communication with merchants for user payment and order information. All communication between consumers and merchants will be handled via the mobile wallet provider. The mobile wallet provider provides customizable authentication methods that fulfill the consumer's needs for security. Transaction fees are the main source of revenue, which is supplemented by hosting service fees. Other models include revenue sharing models where separate key players undertake the roles of TTP and PSP respectively.

In the above examples of m-payment models, the role of the customer and the merchants remain consistent.

Many new initiatives that include various combinations of different types of players already exist in the m-payment market. According to Northstream (2002), the future m-payments market is one where players act together, each taking a fair piece of the pie. New players will enter the market and will take some of the profits that could otherwise remain with existing players; mobile operators could possibly have a share of a market they have not been a part of before; credit card companies could potentially have reduced profits due to the entrance of mobile operators (Durlacher Research, 2001; Northstream, 2002). A key advantage of the independent players is that they enable every mobile user to use the service upon registration regardless of their mobile service provider. For a specific merchant intending to use an m-payment solution,

teaming up with such a player is more efficient than teaming up with three or more separate mobile operators.

On the other hand, an independent player will need to build a user base, usually from scratch. A mobile operator or a bank will already have millions of customers who are potential m-payment users (Northstream, 2002). The m-payment value chain is complex and it will take some time before the different roles are assigned to the best actors. It will, however, require expertise from a variety of players in a carefully coordinated manner if mobile data services are to be provided successfully (Fife, 2002). Cooperation between players is desirable to achieve synergy, especially between banks and operators. According to Birch (2003), Paypal is an example that shows clearly how synergy between a marketplace and an effective transaction system will by itself generate and refine business models.

# Emerging Issues in M-Payments

With some of the initiatives highlighted in the previous section, we found that there are pertinent issues in the area that may be classified under two headings: standardization and security. In the following sections, we have explored the issues and current emerging solutions to these issues.

## Standardization

MeT (2001) highlighted that the mobile commerce market today is typical of an emergent one, encumbered with an abundance of approaches and concepts that may not interoperate. Currently, there are several proprietary approaches to formulating a functioning framework for mobile e-commerce and this lack of a coherent roadmap for the future may lead to market fragmentation and delay the growth phase. A standard interface is necessary because ease of use and commonality of experience is key to driving adoption of new technology. Having standards and a standards body will help jump-start the mobile commerce market (Costello, 2002). Mobile commerce requires mobile payments. The payment, transactions and authorization component of mobile commerce is currently being held back due to lack of standards and disparity of systems that do not necessarily work together (Costello, 2002). The

adoption of m-payments, and the accompanying spread of m-commerce, may be slowed down without standardization (Henkel & Zimmermann, 2001). A host of different solutions have been proposed to enable mobile payments, leading to a need for standardization, which may be reached by regulation, voluntary agreements, or market forces (Henkel & Zimmermann, 2001; Krueger, 2001b). Interoperability is central to the move towards next-generation networks and the effective functioning of mobile payments will require cooperation and interoperability (Krueger, 2001b; MeT, 2001). The usefulness of payment systems increases with the number of users. As users have a high preference for ubiquity, Krueger (2001) argues that the demand for ubiquity will require interoperability and a certain amount of standardization.

Several initiatives are underway to provide ubiquity of services either by a centralized solution or by cooperative solution. Early this year, two existing bodies, the WAP Forum and the Open Mobile Architecture, have been dissolved to form the Open Mobile Alliance (OMA) as the first steps towards wireless technology unification in its bid to devise the open, interoperable standards industry needs to bridge the gaps among all the players (Open Mobile Alliance, 2002). OMA aims to deliver responsive and high-quality open standards and specifications for market and customer requirements, to create a common architecture and to consolidate standards (Yahoo News, 2002). A consortium of companies called PayCircle, including Sun Microsystems Inc., Hewlett-Packard Co., Oracle Corp., Lucent Technologies, Siemens AG and several other smaller companies have teamed to create standards for the way transactions originating on mobile devices are handled, a move that the companies hope will remove some barriers to widespread mobile commerce (Costello, 2002). PayCircle will attempt to correct non-standardization by creating standard interfaces by which payment systems, wireless networks and vendors will be able to communicate (Costello, 2002). In Europe, the European Committee for Banking Standards (ECBS) and the European Telecommunications Standards Institute (ETSI) have signed a co-operation agreement to increase the effectiveness of their efforts towards the development of standards for the security of telecommunications and m-commerce (m-Travel.com, 2002).

RichSolutions is offering a mobile applications suite, RichPayments For Mobile Devices, to render PDAs and mobile phones as mobile credit card terminals that support signature capture and receipt retrieval. Card-present payments on mass-market mobile devices such as Palm, Handspring, iPaq, Jornada, Sony, and Kyocera smart phones, are possible given that the suite supports the Palm,

Microsoft Windows CE and Symbian OS. The suite also works with industry standard card readers, receipt printers and wireless carriers to give merchants card-present services when used with card readers from Semtek or Verices. The m-payment solution utilizes the connectivity options of mobile devices, such as Palm.Net, CDPD, or 802.11b, to access the Internet for the processing of SSL-secured payments (ePaynews.com, 2002). Nokia and Sony have joined wireless carriers and manufacturers, such as AT&T, Cingular, NTT DoCoMo, Vodafone, Samsung, Siemens and Ericsson, in an open initiative to boost mobile Internet services. With the objective of establishing an "open mobile architecture," the venture aims to promote non-proprietary technology to stimulate wireless innovation and competition (Total Telecom, 2001).

## Security

The lack of security has been a major obstacle for the success of business-to-consumer e-commerce in the fixed line Internet environment (Baschnonga, 2002; KPMG, 2000; MeT, 2001). Baschnonga (2002) highlighted that the evolution of payment services has been hampered by the absence of a ubiquitous security standard. KPMG (2000) and MeT (2001) add that secure payment standards are essential if m-commerce has to become a mass-market pheonomenon. According to Kikuchi and Tanokura (2000), mobile commerce began with the appearance of mobile phones equipped with smart cards, because they offer security functions not available through other methods of e-commerce. When mobile phones are equipped with a device to protect personal information, the security level of an entire service, including the network, improves considerably. Data on a smart card are said to be relatively secure because it is difficult to extract encrypted data from the outside and difficult to alter them. The mobile phone with its integrated SIM card is an ideal bearer for the private key digital signature of a PKI system. Thus, the mobile device can become a security tool, for example for secure payment in e-commerce and m-commerce. The mobile phone will eventually become an electronic wallet where payment will be made through electronic funds transfer via the mobile phone network and the Internet or paid via the telephone bill (Kikuchi & Tanokura, 2000).

Smart cards will be the preferred way of gaining access to a secure system. The smart cards in third-generation (3G) mobile phones will include a processor for encryption and other processing, an electrically-erasable programmable read-

only memory (EEPROM) to store user information, a program ROM, and random access memory (RAM) work space. The EEPROM in the smart card stores a variety of information that requires protection, including the terminal information needed during communication, the electronic authentication certificate issued by the certifying authority to verify the identity of the user and the encryption program itself. It can also store other confidential information such as credit card numbers and personal identification details (Kikuchi & Tanokura, 2000).

Visa International announced a new global specification that ensures the security of Internet payments made over mobile phones. The Mobile 3-D Secure specification is based on existing payment technologies and extends payment authentication initiatives into mobile commerce, enabling Visa card issuers to validate the identity of their cardholders in real time. The Mobile 3-D secure specification supports global interoperability, enabling consumers to have a consistent and seamless experience regardless of the method or device being used to access the Internet. It minimizes the impact on merchants and requires no changes to backend payment systems. A number of Visa m-commerce programs are currently underway worldwide to test the viability of m-commerce payment solutions and raise consumer awareness. In Asia, Visa has partnered with Hutchison Telecommunications and Dao Heng Bank to develop a mobile payment service using Mobile 3-D Secure. In Europe, Visa has signed a strategic alliance with Omnitel Vodafone, while in the US, Visa and Sprint are working together to help facilitate secure mobile payments and create opportunities to purchase goods and services over the Sprint PCS nationwide wireless network (Visa, 2002).

## Conclusions

It is evident that m-payment methods are here to stay, with m-commerce gaining momentum. Lack of standards and security within devices as well as networks may be pertinent issues for the future of m-payments. A range of solutions involving financial institutions and mobile service providers seem to be in progress, and perhaps is the key to addressing these issues. The lack of standards across economies may be addressed through various consortiums, involving many economic forums, mobile operators and also financial institutions, if m-commerce has to be diffused into the mass market. The research

direction remains optimistic that m-payments will progress and become a standard for future business.

## Future Trends

As mobile commerce continues to evolve and new mobile devices emerge, m-payment vendors will be compelled to evolve their solutions continually to keep up with the changing technological and business landscapes. Eventually, successful payment methods will be those that can allow increasingly sophisticated client applications to be used on mobile handsets.

The need for secure, reliable payment methods to be made available to consumers cannot be understated. Otherwise, consumers are potentially at the risk of losing out in the long run. In this context, it is crucial to define standards so as to guarantee real mobility, enabling seamless m-commerce and independent from the current mobile infrastructure.

In addition, there are necessary amendments to be made in other areas such as banking laws and retail traditions. Partnerships among mobile operators, financial institutions and other businesses continue to emerge to provide dynamic, secure mobile payment solutions. The development of this area would be of interest to academics and industry consortiums involved in the dynamic world of mobile business.

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## Chapter IV

# Motivations and Barriers to the Adoption of 3G Mobile Multimedia Services: An End User Perspective in the Italian Market

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## Abstract

*This chapter provides an end-user perspective on mobile multimedia services that are likely to emerge with the roll out of Third Generation Mobile Services (3G). More specifically, the objectives of the study are:*

- *to provide an insight into current behavior in terms of attitudes towards, access and usage of multimedia mobile services by current end users;*

- *to establish main clusters of mobile users;*
- *to investigate the possible motivations and barriers of usage of new mobile multimedia services as viewed by current users.*

*The remainder of this chapter is organized into the following four sections. The first section provides a brief review of the literature on the technology acceptance model. Next we present our research model based on a qualitative exploratory survey conducted in six markets. Then we test the proposed model on the Italian market and present the analysis and results of our study. Finally we make conclusions by discussing the implications of our study, followed by presenting future research directions.*

## Introduction

As telecommunications move into an era where the distinction between voice, video and data will be blurred, convergence of communications, information, entertainment, commerce and computing will lay the foundation for the development of an Information Society.

Over the last five years there have been a number of significant developments in multimedia computing power, CD-ROM technology, digital television, the Internet/Intranet, IP-based services, and terrestrial and satellite mobile communications, which could have a profound impact on our society. These technologies and systems may enable dramatic changes to take place in working practices, entertainment, education and health care.

Many organizations within the computing, entertainment, and communications industries are now looking to identify and capitalize on the promise of new market opportunities in multimedia created by these developments.

However, demand for multimedia services, should they be successful, is unlikely to be constrained to the fixed network. Greater pressure on time, and the need for flexibility and responsiveness in business, will lead to a growing demand for access to these services anytime, anywhere.

In order to meet the evolving needs of customers, and to capture the opportunity which this evolution represents, the mobile industry is looking to define

and develop a third generation of mobile technology that will take the personal communications user into the Information Society by delivering voice, graphics, video and other broadband information direct to the user, regardless of location, network or terminal.

The purpose of the chapter is to provide an end-user perspective on mobile multimedia services that are likely to emerge with the roll out of Third Generation Mobile Services (3G).

The remainder of this chapter is organized into the following four sections. The first section provides a brief review of the literature on the technology acceptance model. Next we present our research model based on a qualitative exploratory survey conducted in six markets. Then we test the proposed model on the Italian market and present the analysis and results of our study. Finally we make conclusions by discussing the implications of our study, followed by presenting future research directions.

## Technology Acceptance Model (TAM): The Theoretical Background

Information Systems (IS) researchers have made significant efforts in building theories to examine and predict the determinant factors of information technology (IT) acceptance (Agarwal & Prasad, 1998, 1999). Existing models of IT acceptance have their foundations from several diverse theories, most noticeably innovation diffusion theory, where individuals' perceptions about using an innovation are considered to affect their adoption behaviors (Agarwal & Prasad, 1998; Moore & Benbasat, 1991; Rogers, 1995). Other important theoretical models that attempt to explain the relationship between user beliefs, attitudes, intentions, and actual system use include the theory of reasoned action (TRA) (Ajzen & Fishbein, 1980), the theory of planned behavior (TPB) (Ajzen, 1991), and the technology acceptance model (TAM) (Davis, 1989; Davis et al., 1989). Although there are numerous studies in the field of adoption and diffusion of marketing-enabling technology (Daghfous, Petrof & Pons, 1999; Holak & Lehman, 1990; Labay & Kinnear, 1981; Plouffe, Vandenbosch & Hulland, 2001; Rogers, 1995), previous work has mainly focused on the adoption of products and technology (Au & Enderwick, 2000; Davis, 1989; Eastlick & Lotz, 1999; Verhoef & Langerak, 2001). In contrast, the perspec-

tive on services and service-enabling technologies is considerably less pronounced. Despite the fact that several trend studies have been conducted regarding the potential of wireless technology and 3G services (Durlacher, 2001; UMTS Forum, 2001), there exists a need for more substantive, theory-based research, creating a more in-depth understanding of consumer behavior with regard to m-commerce. In the information system literature on IT adoption, researchers have conducted several studies to examine the relationship between perceived ease of use, perceived usefulness, and the usage of other information technologies (Adams et al., 1992; Chau, 1997; Davis, 1989; Davis et al., 1989, Hendrickson & Collins, 1996; Mathieson, 1991; Szajna, 1996). Their researches have supported the Technology Acceptance Model (TAM) proposed by Davis (1989), which posits that perceived ease of use and perceived usefulness can predict the usage of technology.

TAM was derived from the Theory of Reasoned Action (TRA). According to Davis (1989), perceived usefulness and perceived ease of use are the two determinants that influence people's attitude toward IT usage intention and actual IT usage. Perceived usefulness is defined as "the degree to which a person believes that using a particular system would enhance his or her job performance" and perceived ease of use is defined as "the degree to which a person believes that using a particular system would be free of effort" (Davis, 1989, p. 320). Davis and his colleagues (Davis, 1989; Davis et al., 1989, 1992) demonstrated that perceived ease of use affected usage intention indirectly via perceived usefulness.

In an extension to TAM, Davis and his colleagues examined the impact of enjoyment on usage intention (Davis et al., 1992). They reported two studies concerning the relative effects of usefulness and enjoyment on intention to use and usage of computers. As expected, they found enjoyment had a significant effect on intention. A positive interaction between usefulness and enjoyment was also observed.

Several recent empirical studies have validated adoption theory in relation to a wide range of products (Holak & Lehman, 1990; Labay & Kinnear, 1981; Ostlund, 1973; Rogers, 1995) and technology (Beatty, Shim & Jones, 2001; Plouffe et al., 2001). A large number of studies have investigated the use of electronic commerce, but the field of mobile commerce has been left virtually unexplored. In this research our goal is to extend the TAM model to study motivations and barriers to the adoption of 3G mobile multimedia services. In the following sections the research is divided into two stages: an exploratory qualitative stage followed by a quantitative stage focused on the Italian market.

# Research Framework

## Methodology

Many factors positively or negatively influence users' adoption of multimedia mobile services. In this section we identify several variables that influence adoption of 3G mobile multimedia services. The variables are derived from two preliminary pilot studies realized on a sample of young people in Italy and USA followed by an exploratory qualitative study conducted by Nokia through 24 focus groups in six markets (Brazil, Germany, Italy, Singapore, UH, USA).

The second stage of the analysis concentrates specifically on a quantitative marketing research. Data were gathered by means of a questionnaire. The population consists of 1,000 Italian users of mobile services. It tries to describe behaviors, roles and test variables influencing adoption of mobile computing. We consider Italy because it is the European country with the higher penetration of mobile phones and profitability, and it is also prone to market innovation.

The main goal of this research is to identify a hierarchy of importance concerning the critical factors influencing the adoption of mobile services. To realize this research objective, conjoint analysis was seen as the appropriate statistical tool.

### *Conjoint Analysis*

Conjoint analysis is a technique that allows a set of overall responses to factorially designed stimuli to be decomposed so that the utility of each stimulus attribute can be inferred from the respondent's overall evaluations of the stimuli (Green, Helsen & Shandler, 1988). A number of (hypothetical) combinations of service elements can be formulated that will be presented to a sample of customers. According to Lilien and Rangaswamy (1997), the analysis comprises three stages.

The first stage is concerned with the design of the study, where the attributes and levels relevant to the product or service category will be selected. In the second stage customers rate the attractiveness of a number of possible combinations of customer service elements. Finally, in the third stage, ratings are used to estimate part-worth utilities, that is, the utility that is attached to the

individual levels of each service element included in the research design. Consequently, an accurate estimate of customer trade-offs between services elements can be obtained.

The dependent variable in our study was the intention to make use of mobile services.

## Exploratory Qualitative Stage

The fieldwork has been carried out face to face in the first and second quarters of 2001 through 24 focus groups conducted by Nokia Networks in six markets (Brazil, Germany, Italy, Singapore, UK, USA). The interviews focused in on the core target for the 3G offering, namely, teenagers, young adults and family adults, all currently using mobile phones for personal usage. The sample was segmented by age, 16-19, 20-29 and 30-45, and by life stage.

The research looked primarily at the following mobile multimedia services: photo messaging, mobile e-mail, video messaging and postcard messaging. However, the research also briefly touched on rich text messaging, and on video calling.

Of utmost importance in the study was to ensure that the respondents concentrated on the messaging format, and did not allow previous misconceptions about service or delivery of the service. They were therefore told to

*Table 1. Fieldwork details*

| Country | Sample | Field times |
|---|---|---|
| Brazil | Nationally representative of adults aged 18-64 who are economically active | 6th – 20th March 2001 |
| Germany | Nationally representative of adults aged 14+ | 23rd March – 5th April 2001 |
| Italy | Nationally representative of adults aged 15+ | 23rd March – 5th April 2001 |
| Singapore | Nationally representative of adults aged 15-64 | 13th – 26th April 2001 |
| UK | Nationally representative of adults aged 15+ | 23rd March – 5th April 2001 |
| USA | Nationally representative of adults aged 18+ | 21st – 30th March 2001 |

*Table 2. Motivation segmentation*

| | |
|---|---|
| ***1.*** | ***Business*** |
| | - for business purposes |
| ***2.*** | ***Formality*** |
| | - When I want to send a formal message |
| ***3.*** | ***Urgency*** |
| | - When I need to know the message has arrived |
| | - When I want to send urgent communication |
| | - As a rapid way to stay in touch |
| ***4.*** | ***Function*** |
| | - To send a long piece of text |
| | - To send an attachment |
| | - When I don't feel like talking |
| | - Practical reason (like to show something I want to buy) |
| ***5.*** | ***Price*** |
| | - When I want to communicate cheaply |
| ***6.*** | ***Discretion*** |
| | - Need to be discreet and quiet |
| | - When talking would disturb people around me |
| | - Might disturb the person I'm trying to contact |
| ***7.*** | ***Personal contact*** |
| | - To keep in touch with friends/family abroad |
| | - To send an intimate message |
| | - To contact people I don't see very often |
| | - As a personalized way to send a message |
| | - To increase the feeling of contact |
| | - To share an experience |
| | - Nice for people to see me if they haven't done so for a while |
| | - For longer greetings |
| | - When I don't want to talk, but need to communicate |
| ***8.*** | ***Fun*** |
| | - Joke or chit-chat with friends |
| | - As a novel way to message |
| | - To share an experience |
| | - As it is just great fun |
| | - To send pictures from my holiday |
| | - To show something like a view |
| | - To express creativity |

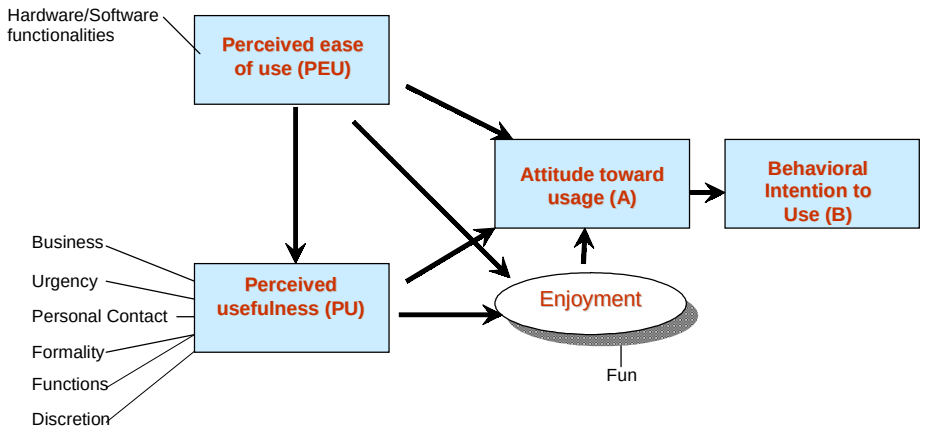
imagine that there would be no network problems, and not to concentrate on pricing.

The prompted statements offered to the sample as motivations for usage of the future multimedia mobile services can be classified to form eight broad segments of usage (Table 2):

1. Business
2. Formality
3. Urgency
4. Function
5. Price
6. Discretion
7. Personal Contact
8. Fun

The research model to be empirically tested in the Italian market is illustrated in Figure 1. The model is derived from the theories and hypothesis described in the preceding section. The relationship constituting the model also has support from prior theoretical and empirical work in the exploratory qualitative stage.

*Figure 1. Adapted TAM model on the adoption of multimedia mobile services*



## Exploratory Quantitative Stage

A following stage of analysis concentrates specifically on a quantitative marketing research conducted in the second quarter of 2002 through questionnaires on a sample of 1,000 Italian users of mobile (sampled among over 18 Italians).

One thousand interviews provide a sampling error (at 50%) of 3.1% (with a probability level of 95%).

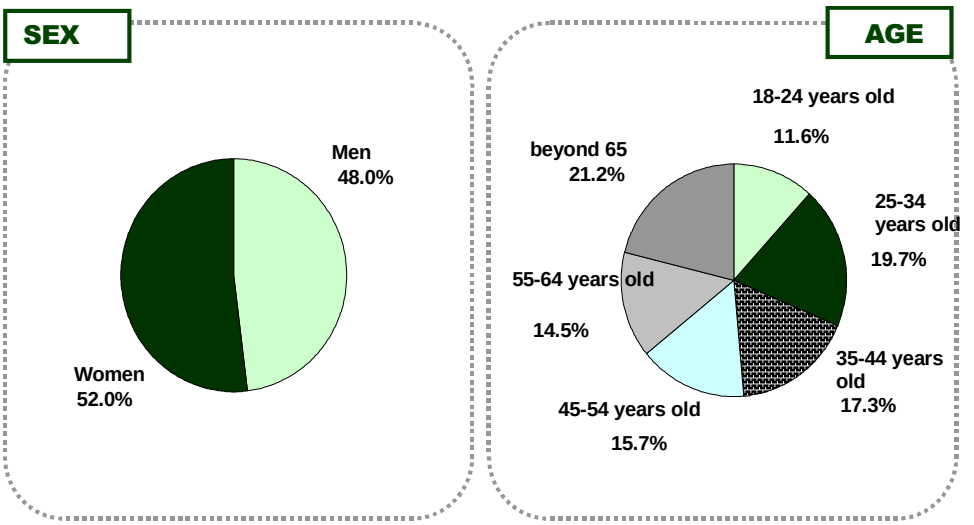
The research, managed through telephone calls, tries to describe behaviors, roles and variables influencing adoption of mobile computing.

The results of the quantitative marketing research are now summarized. This research was structured in order to deepen the motivations and barriers towards the innovative services delivered through 3G mobile services, the eventual levels of demand and usage and the content types and formats that consumers express opinion for.

Key items in the questionnaire used for analyzing the survey are as follows:

1. **Degree of service innovation** perceived by consumers. Respondents selected their answers from a list of innovative services categories;
2. **Interest** for the services categories under scrutiny;

*Figure 2. Composition of the sample*



3. **Preference** for means/platforms through which selected services can be accessed (portables, phone and/or TV);
4. **Analysis** of key features of services (ease of use, speed, cost and usefulness);
5. **Ranking** of services features.

The services considered in the questionnaire are the following:

- interactive and real-time entertainment;
- data exchange among people and between people and various electronic devices;
- contextual and real-time shopping;
- portfolio and personal funds management;
- safety-related services;
- location-based services.

All the services have been considered rather innovative (the average is 7.1 on 1 minimum -9 maximum scale).

In terms of the interest expressed towards these services, the sample distributes are shown (see Figure 3).

*Figure 3. Interest expressed towards multimedia mobile services*

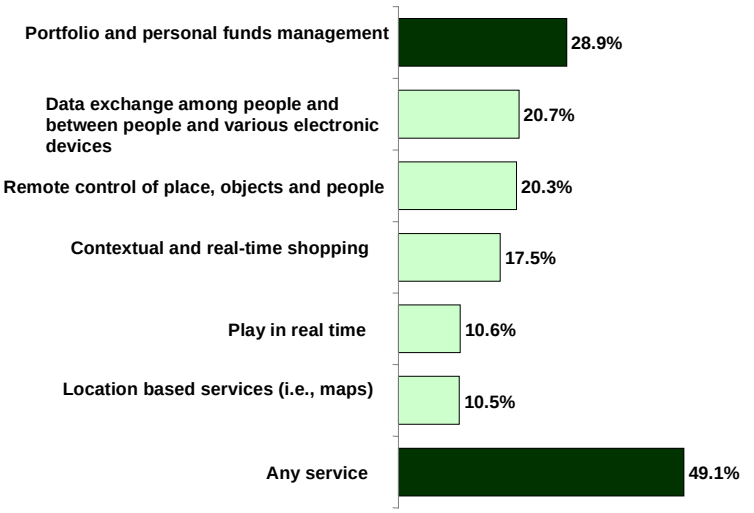


*Table 3. Features preferred*

| | IMPORTANCE | |
|---|---|---|
| | Ranking | % |
| **Usefulness** | **1°** | 31.3% |
| **Ease of use** | **2°** | 26.7% |
| **Price** | **3°** | 23.8% |
| **Speed of use** | **4°** | 18.2% |

Table 3 shows the main features preferred by the people to be attracted to use these services.

"Usefulness" and ease of use are considered the most important variables in order to access the segments of population and, as shown in Figures 4 and 5, there are different meanings assigned to these words.

The final objective of the research was to identify the key descriptive elements of homogeneous segments of the population. This is relevant in order to define the right strategies to offer the new services in the proper and differentiated way.

*Figure 4. Meaning of usefulness*

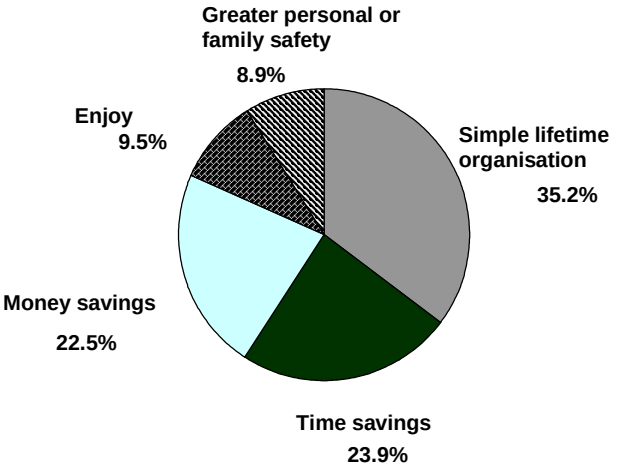
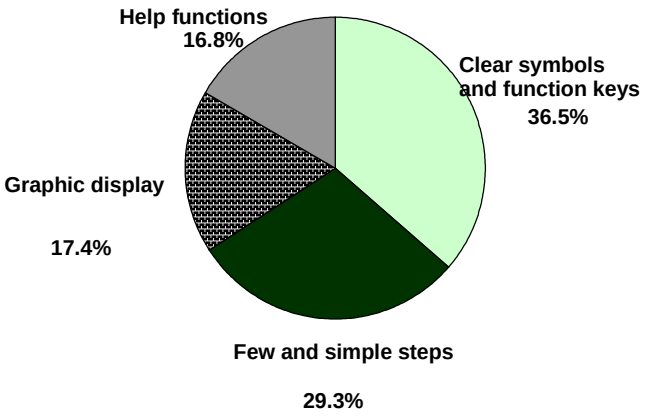


*Figure 5. Meaning of ease of use*




The most statistically powerful variable in order to distinguish the behaviors of people is the degree of interest towards the innovative services.

If we then clusterize the sample using this variable, and cross it with the socio-demo data, it turns out that the kind of activities performed in life by the consumers is the strong predictor of their future use of the new services.

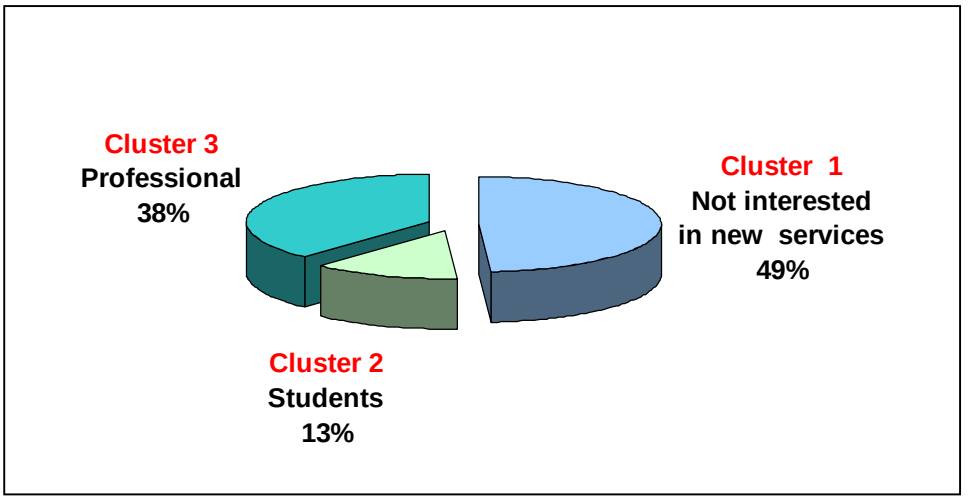
In particular, it is possible to describe two different segments as indicated in the following figure:

- cluster 1 is composed of people who declared they are not interested in the new services;
- the remaining 51% can be divided in two groups that are different in terms of the way firms should approach them to sell the new services.

The two segments are:

- the "professionals," that is, people who mainly are managers or entrepreneurs in life, who are 38% of the interviewed base;
- the "students," who account for the remaining 13%.

*Figure 6. Main clusters of mobile users in the Italian market (base 1,000 Italian mobile users)*




The purpose is now to identify the variables network operators can use to access the identified clusters. This is an essential piece of information for crafting the right strategies in order to "catch" the segments.

The "professional" segment is made of people who look for *usefulness* as the almost exclusive variable in order to access and pay for the service.

The "students" segment is made of people who look mainly for *low-cost* and *convenience*.

For the entire interviewed base, an interesting relationship emerges: the degree of interest is inversely related to the degree of knowledge of the service. In particular it has been noticed that people who declare a low level of interest in these services are those who actually know least the main features and potential outcomes of these services, even though the interviewer deeply explained the meaning of each service.

## Conclusion

In this research, we attempt to identify valid factors that predict a user's adoption of 3G mobile multimedia services.

The findings show key characteristics and factors playing decisive roles in the development of strategies for the launch of multimedia mobile services.

The findings of this study have significant implications also in the perspective of research on mobile consumer behavior. Our study provides further evidence on the appropriateness of using the TAM model to measure the different dimensions of actual multimedia mobile usage and it provides empirical evidence that PEU (perceived ease of use) and PU (perceived usefulness) are important factors that influence the user's adoption of 3G multimedia mobile services.

The findings of the study suggest important practical implications for businesses currently providing mobile multimedia services as well as those that are planning to do so. It is evident from this study that in order to influence adoption of 3G multimedia services, perceived ease of use (PEU) and perceived usefulness (PU) must be enhanced.

## Acknowledgment

The authors wish to acknowledge Massimo Farioli for his cooperation in the data processing phase.

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## Chapter V

# Impact of Mobile and Wireless Technologies on Developing Countries

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## Abstract

*This chapter discusses the impact of mobile and wireless technologies on developing countries. The new technological advances and capabilities allow developing countries the opportunity to "leapfrog" years of wired technology and infrastructure development. Based on this study, it appears that mobile and wireless technologies will not be enough to truly advance developing countries. In order to truly "leapfrog" and make up for years of technological advancements, developing countries must consider dealing with government corruption, violation of human rights and extremely low literacy rates. These factors may derail the effort to "leapfrog" and gain economic benefits from technological advancements. The Village Cell*

*Phone Program is presented as an example of how mobile technology can be used to create a business opportunity along with changing the role of women in society. Any implementation of mobile and wireless technology must be complimented with social and political reform in order to be successful.*

## Introduction

Today there are more mobile phones than fixed-line telephone access throughout the world, and the industry still shows a strong growth momentum. Wireless subscription is expected to grow to 1.3 billion by 2004. The mobile technologies industry experiences rapid transformation with the evolution of new standards and business strategies. In developing countries there is hope that the digital divide, the gap in technology and infrastructure, will be history once access to communication and the Internet is established and available to every citizen. Current studies and literature on the advancement of digital technology and its impact on developing countries allow us to witness just the beginning of this digital revolution (Aronson). The impact this revolution is imposing on developing countries is multidimensional:

- Traditional businesses such as telecommunication carriers will have to revise their business model and incorporate innovation as a core competency in order to succeed and survive this revolution.
- Governments will need to adjust their approach for taxation and revenue stream in order to compensate for the tidal wave of privatization and dealing with the freedom and evolution of the Internet.
- Dealing with illiteracy will become one of the main focuses, as it poses a barrier for success of this revolution.
- New laws and legal infrastructure will become a key necessity in order to lead and manage rather than control and suppress the digital revolution.
- Society will be transformed by changes in both social framework and inherently changes in social structure, status and norms.

These are a few of the key elements surfacing in response to the digital revolution and the fast paced evolution of mobile technologies. Many organi-

zations are set up to help developing countries narrow the digital divide and deal with the changes detailed above. There is visible evidence of successful business models such as the "Village Cell Phone" programs. Developing countries will continue to "leapfrog" years of wired technology and infrastructure, but they will not be able to "leapfrog" the social and political changes that will result from this digital revolution and the adoption of innovative technologies and business models.

# Mobile Technology Development

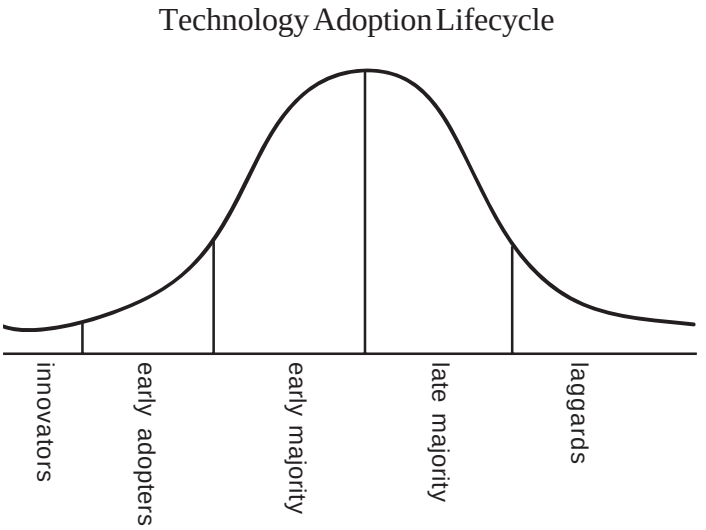
The concept of "leapfrog" refers to developing countries making a conscious decision not to replicate the evolutionary cycle for infrastructure and business models as based on developed countries. The concept refers to developing countries bypassing years of historical development of wired infrastructure and instead adopting newer standards, business models and change. According to Gavin Jeffery of the Afghan Wireless Communications Company, "What we will have is state of the art technology, straight from the beginning." His quote captured the essence of "leapfrog" during an interview with the BBC (BBC News Online, 2002).

## Technology Adoption Lifecycle

In his book "Crossing the Chasm," Geoffrey Moore discusses the evolution of technology and how we as a society adopt and mature along with the technological advance. He introduces the "Technology Adoption Lifecycle" as a representation of the population grouped by psychological profile and demographics (Moore, 2002). The bell curve also signifies the lifecycle and the point that each group is willing to accept the technology (see following page).

The groups are divided into Innovators, Early Adopters, Early Majority, Late Majority, and Laggards. For many years, developing countries were classified as either a Late Majority or Laggards from the perspective of technology adoptions. There are many reasons why they were classified as such:

- **Education** – Adopting new technology heavily depends on education, skill, and the resources needed for support. In some countries up to 170




local languages are spoken, which presents a challenge when delivering content. These developing countries are dealing with a high rate of illiteracy as well as several failed attempts at standardizing the language. Another language barrier is the use of non-Latin alphabets, which are harder to adapt to computers and cell phones.

- **Cost** – As wired infrastructure is maturing, the cost of implementation has decreased, but is still relatively high. A study done by the *Canadian National Broadband Taskforce and InfoAmericas* (see Appendix A) organization reveals that it costs over 40,000 dollars to install one mile of optical fiber, not including the cost of support infrastructure. This is a tremendous undertaking for many of the underdeveloped countries, who are still struggling to offer basic necessities for their citizens. Much of the current infrastructure (electricity, running water) is not offered throughout developing countries due to the challenges of funding, regulation, governance, and harsh topology such as mountains, wet and swampy ground, and deserts.
- **Government** – Local government still own and manage many of the companies providing telecommunication services. Landlines are heavily taxed and governments are reluctant to change the business model and lose much of that revenue stream. Many developing countries are faced

with political instability, bureaucracy, and corruption, which slow down the adoption of change and the passing of reforms.

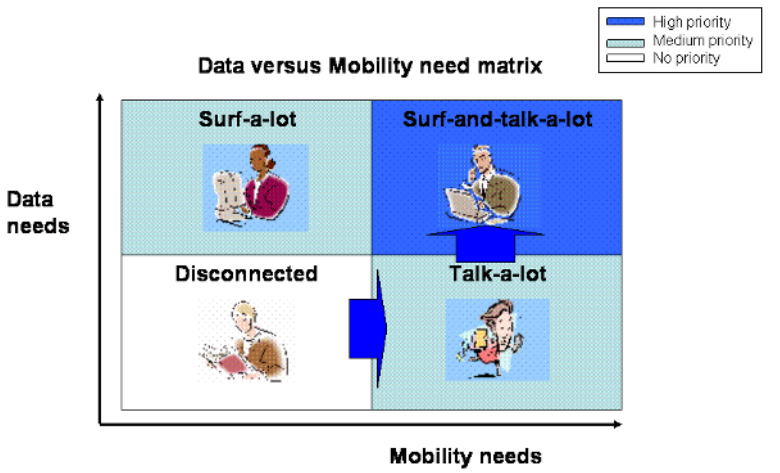
This list is not all-inclusive, but does illustrate why for many years developing counties have been late to adopt technology and are classified as Late Majority or Laggards (Moore, 2002).

As a witness to the changes brought on by the evolution of the Internet in the late 1990s, developing countries have made a conscious decision to "leapfrog" generations of technology and move to early stages of the technology adoption lifecycle and become innovators and early adaptors of mobile technologies.

## Convergence

Prior to further discussion about the industry trends and details about the prevailing technologies, it is important to understand the nature of the demand for mobile technologies. Many use the terms "wireless" and "mobile" interchangeably and to some extent that is correct; but as technology evolves the

*Figure 1.*




*Source: DiamondCluster International*

lines will become even blurrier. "Wireless" refers to transmitting and accessing data through a device without being hooked to a fixed phone line or cable. "Mobile" in the traditional sense refers to the ability to transmit voice over a phone without being connected to a landline. Figure 1 shows the relationship between and the demand for voice and data to converge to one common platform.

There is a tremendous growth and a push for the "surf-and-talk-a-lot" services. In recent years, mobile manufacturers have responded by providing data services through the use of a cell phone through services such as SMS (Short Messaging Service) and Internet access though the use of portals (Nguyen, 2002). This trend will continue with the adoption of technologies such as Voice Over Internet Protocol (VOIP) and the eventual adoption of 4G (Fourth Generation) network standards (further details in the next section).

## The Wireless Hype Cycle

In order to better illustrate the roadmap from past to present and future perspective of mobile technologies, Gartner Group (a research organization) presents another cycle to complement the technology adoption lifecycle. Much of the technology evolution is dictated by the innovation and adoption of standards throughout the industries. Each standard represents a way of transmission, which can include data, voice or video. Standards are researched and certified by standard bodies such as IEEE (Institute of Electrical and Electronic Engineers). Once they are accepted, they are utilized throughout the industry. Gartner Group presents the "Wireless Hype Cycle" (see Appendix B), which illustrates the marketing hype or visibility of a technology versus its maturity stage and the timeline for the technology to reach plateau of acceptance. The cycle goes through the following stages: Technology Trigger, Peak of Inflated Expectations, Trough of Disillusionment, Slope of Enlightenment, and Plateau of Productivity. Each technology is marked to indicate its position and the time to plateau or adoption speed.

The United States is considered to be behind the rest of the developed world in infrastructure and standards adoption. Asian and European countries have made significant investment into 3G (third generation) networks (see Appendix C). The heavy investment into 3G networks promised higher speed and larger capacity for multimedia transmission. European countries sold licenses in the sum of over 100 billion dollars, but most companies have found the technology

to be extremely difficult to implement and are rethinking their strategies. Advances in technology since the standardization of 3G have also contributed to companies refocusing their research and development. Wi-Fi – Hotspots are currently at the height of the hype curve. Wi-Fi Hotspots provide high-speed Internet access to equipped devices within approximately 50 meters of a small base-station. This newer technology is much cheaper to implement and has taken the industry in a new direction. The growing popularity of Wi-Fi Hotspots has brought on new business models such as the Starbucks and T-Mobile. The hype and the successful business models forced companies to rethink their 3G strategies and start looking toward the future for 4G (Fourth Generation) (Gartner, 2003).

Europe and Asia are considered to be early adopters of technology, while America is considered part of the early majority. Some might even classify the United States as laggards based on the technology adoption lifecycle. Companies in America have not bought into the idea behind 3G, and therefore are still supporting 2 and 2.5G. American companies have spent the last couple of years maturing their infrastructure and providing incremental improvements.

In recent years, developing countries have been more influenced by Europe and Asia and have started to invest directly in 3G networks, therefore bypassing generations of infrastructure built up. European and Asian companies have been willing to pay premium prices for 3G licenses and the right to sell wireless services in those countries. The governments of developing countries are still holding on to the state-run telecommunication firms, focusing strictly on traditional wired services such as fixed phone and low-speed Internet provider. With the privatization of the wireless market and the large support of European and Asian firms, new business models are forming within those countries based on the newer technologies. The cost of implementing a wireless network could be as much as 90% cheaper than the traditional implementation fixed and wired access (see Appendix A). Local shop owners throughout rural areas in the developing countries are setting up local area networks (LAN) and providing complimentary services to those residing within a radius of a few miles of the shops. In addition to Internet access, the shop owners can offer wireless Internet access, wireless devices and mobile phones (Gartner, 2003).

Experts have predicted that 4G (Fourth Generation) networks will not be actualized within the next five years, but in recent months the markets and technology advances have accelerated the timeline. Gartner Group classifies 4G as a technology trigger in the Wireless Hype Cycle. Europe, Asia and America are focusing on the development of 4G standards through research

and prototyping (Appendix D). The potential 4G standards bring promise to developing countries in their attempt to narrow the digital divide. The newer standard promises wider coverage area, supported by fewer base stations, and will help developing countries provide services even in remote rural areas, regardless of topology (Gartner, 2003).

# Business Models for Mobile Technology

Mobile technologies are significantly changing current business models, even with the fast pace evolution of e-commerce. The principles guiding the evolution of m-commerce are anytime, anywhere, by/for anyone, with anything. Many in the industry like to think of the *m* as representing: multilingual, multicultural, multimodal, multidevice, and so forth. The telecommunication industry has traditionally been about managing cost. Companies invest a tremendous amount of resources in infrastructure and for the rest of the lifecycle, they focus on driving down support and maintenance costs. One of the barriers for change is the high investment or commitment in current infrastructure. Many companies are forced to write off losses in order to refocus their resources on newer standards. The new paradigm will force telecommunication companies to change their business models and focus on innovation and value added services.

## Value Chain Analysis

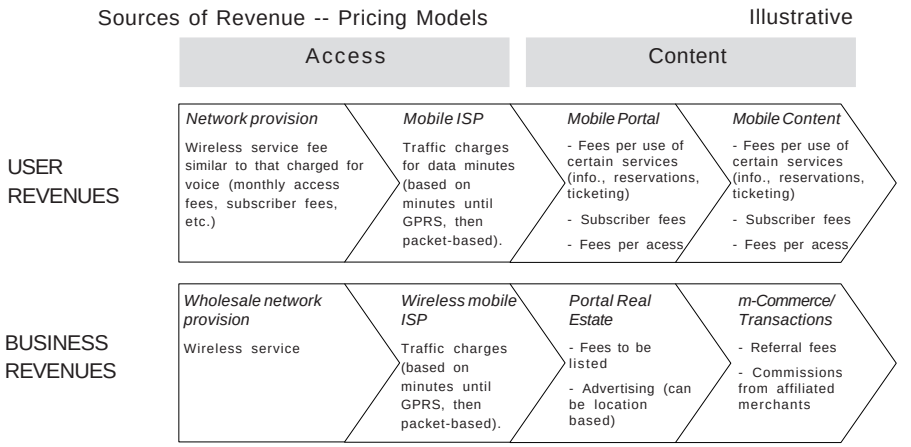
Regina Wong, in her presentation to the GSM Congress Asia Pacific 2000 in Singapore, presented a picture comparing the traditional versus the new mobile technologies value chain (see Appendix E). In her view, mobile service providers will simply replace the traditional services throughout the value chain. In her model, application providers become the enablers while the mobile service providers are responsible for aggregating content and providing functionality. Regina Wong's value chain representation is linear and does not take into account the new value creation by way of new services or the need for mobile service providers to provide content and transactional services. The newer models promote collaboration and seamless integration as key services as well as enhancement of the end-user experience (Wong, 2000). In August

of 2002, Bror Salmelin presented in a European Union forum about the "Challenges and Opportunities in the E-economy - the Single European E-Business Space". In his presentation, he depicts a newer business model that focuses on the empowerment, creativity and value creation based on interoperability and open systems (see Appendix F). In the new m-commerce business model only several of the key market players will provide vertical integration, meaning they will have control throughout the value chain. Open systems will provide for the involvement of many new players in the market; some focusing on horizontal services, most focusing on niche markets. Traditional telecommunication companies once considered utilities will adopt new business models and transform themselves to value add service providers (Salmelin, 2002).

DiamondCluster International presented an illustration to better explain the new value chain and the sources of revenue (see Figure 2). As countries adopt more of the mobile technologies standards and go through deregulation and privatization, more of these revenues will be realized. Developing countries "leapfrog" many of the traditional business models we have created in the developed countries and through small-scale developments they are transforming their industries through the use of mobile technologies

In developing countries many of the governments still manage and control the entire value chain. Keys to success include market reforms, deregulation and

*Figure 2.*




*Source: DiamondCluster International*

privatization of many of the industries. This will allow outside and local firms to compete and meet the future demand for m-commerce. The following section provides an example of newly formed enterprises within developing countries that utilize the lower cost and effectiveness of m-commerce (Nguyen, 2002).

## The "Village Cell Phone" Program

The per capita income of a Bangladesh worker is one hundredth of that of a US worker. Meaning, you would need 100 Bangladeshis to provide the buying power of one American. This statistic was on the mind of Dr. Iqbal Z. Quadir when he was looking for investors for his idea of a mobile network in Bangladesh. He is now the founder of Grameen Phone, which is built upon the vision to transform poor countries by establishing a wireless network that will be used for production rather then consumption. Dr. Quadir's company is the sponsor of the "Village Cell Phone" program, which provides wireless and banking services to over 50,000 Grameen Phone women (Grameen Phone, 2003).

In this program, women living in rural areas of developing countries that lack developed infrastructure, such as fixed line telephones, are buying cell phones financed by bank loans and are selling "talk time," much like a pay phone. This phenomenon is enabled by the development of mobile technology and entrepreneurs who have a vision of transforming isolated and undeveloped areas into emerging markets. Advances made in mobile technologies in the last few years have made it possible for the realization and formation of business models similar to the scenario of the "Village Cell Phone". Developing countries and the service providers are claiming to "leapfrog" the rest of the developed world by offering advanced mobile technologies. "Leapfrog" refers to the fact that the developing countries are bypassing the wired generation and are directing their attention and resources to wireless infrastructure and the newer advanced technologies. Mobile technologies have significantly changed the lives of those living in the rural villages described in this article; but they also have other effects on the social and economic development of those countries. The growth of the "Village Cell Phone" program has transformed the role of women in their local society as well as their economic status and their contribution to the welfare of the village (BBC News Online, 2002).

Bangladesh has the lowest number of phones in South Asia, which is why the "Village Cell Phone" program was a key in the transformation of the country.

Grameen Bank, a subsidiary of Grameen Phone, provides a low cost bank loan that is used to set up a mobile phone exchange. The bank only lends money to women, which challenges the status quo of the culture. One of the conditions of the loans requires the husband to transfer the deed of his property to his wife; this is done to reduce the chances of abandonment. The bank sees women as less of a credit risk and therefore targets them for their programs. Once the mobile phone exchange is established, the women provide communication services to their village, which in many cases has few to no telephone connections (Grameen Phone, 2003).

This business strategy started out in the late nineties and has grown through the years. The Grameen Phone women have expended their enterprises and are selling other services related to mobile technologies. The cost of the cell phone has deceased significantly, becoming a viable replacement for landlines or pay phones. Companies have created low cost or even disposable cell phones with a prepaid function built into the system. The Grameen Phone women are able to sell those newer phones without having to establish accounts or set up a billing system. This allows the villagers to control their spending and provides an alternative to either establishing a line of credit or meeting the requirements of other mobile service providers. Many of the Grameen Phone women have established their business inside a local coffee shop at the centers of their villages. These relationships led to the creation of the "small-scale telecentres" throughout the developing countries (CNN Specials, 2001).

## Telecentres and Community Access

Starbucks wants their customers to access the Internet while sipping on their premium coffee beverages. This is a new value added service that has rapidly expended beyond the coffee shop. Wi-Fi is one of the key enabling technologies that allows mobile service provider to set up "hotspots" in highly dense areas, therefore covering a greater customer base within a few mile radius. Even Central Park within New York City now offers a free hotspot for the use of the park's visitors. While this has become a recent phenomenon in the United States, this concept has been on the top agenda of many developing countries as a way to link up rural areas and provide communication capability that is otherwise not available.

Using a low cost tower, shop owners in many developing countries are setting up local area networks (LAN) and are providing complimentary services within

their community. In the late nineties the focus was on communication between the local villager and those village members who left for a job abroad. In the last few years, those businesses have transformed themselves and are now providing newer service such as Internet access, billing service, and commerce. There are several cited examples of farmers looking for a better location to sell their products based on pricing information they receive through the Internet via PC and cell phones. In the past they were forced to sell for rather cheap to the local companies since they lacked the knowledge about the ongoing rate of their crops. Many of the fishing villages utilize the Internet and mobile technology to improve their fishing efficiency by accessing information about weather, movement of fish, GPS based devices and overall security as they go out early every morning (Cowhey, 2003).

## Worker Migration

Many of the villages were losing their population due to lack of jobs and opportunities. This trend alarmed many of the village leaders and the government of those developing countries. In order to provide opportunity and maintain connectivity with rural areas, many of the villages have set up training centers for the locals to learn more about the use of personal computer, mobile devices and the application and services that they enable. This approach creates a way for companies to offer more services to the villages and help the villages maintain their infrastructure for developing new capabilities (Charny, 2003).

The above scenarios have gotten the most attention in recent years due to their success. Many organizations and developing countries that have adopted these business models are utilizing the new mobile technologies to connect all rural areas and provide new services where they were not previously available before. The cost of implementing the infrastructure has declined, and many new business models have formed, providing new value added services that were previously not available for the majority of the population in the developing countries. In order to be successful the local markets must go through further reform and privatization of their businesses. The government should focus on social, health and economic issues as they prepare their countries for the changes the mobile industry will bring about.

## Social and Political Development due to Introduction of New Technology

The evolution of the Grameen Phone women has not just created a change in the business strategies, but also a social change. Many of the developing countries are still years behind in social advances. They are faced not only with poverty but also with illiteracy, health concerns, political instability and personal security. Mobile technology is not the panacea to solve all the issues currently facing developing countries, but it does provide the means to empower individuals and communities. Vanessa Gray and Michael Minges of the International Telecommunication Union (ITU) discuss the other variables in the effort to narrow the digital divide (see Appendix G). They focus on human skills and the affordability of infrastructure as the other variables critical to the success of any change in those countries. Human skills refer to literacy, language, and learning as keys to the success of the mobile revolution.

Much of the success of the mobile phone is the fact that it serves a more basic need of communication. Many of the breadwinners in these villages end up going abroad to earn more money to support their families. The only mode of communication is letters and packages, which are slow to arrive and are an unprotected mode of transferring money to the families. Mobile phone satisfied the need to connect with family members and maintain the close community ties so ingrained in those cultures. Once mobile phone services were in place, it was easy to build on the momentum and engage the population. Mobile phone presents an easier learning curve than a personal computer. It is much easier to learn the 10 key numbers versus learning how to use a keyboard regardless of the language used, be it English or the commonly used local language. Many of the newer devices are providing much-improved graphical interface with multimedia capabilities; this allows many to avoid learning the use of the traditional keyboard altogether (BBC News Online, 2002).

## Education

Developing countries, with the help of world organizations, are setting up training centers, many based on the Telecentres and Community Access concepts. This provides a location for classes as well as a way to generate revenue to further finance current and future expansion of the programs. This helps elevate computer literacy within rural areas and furthers technology

awareness. In more urban areas, the government is relying on universities and private companies to offer training and education opportunities to all citizens. World organizations are monitoring the growth of class enrollment as a measure of progress but there are still many obstacles to overcome (M-Business Daily, 2002).

## Local Languages Going Digital

Many of the developing countries face the issues of localization and spoken languages. According to studies by Ethnologue, many countries have over 100 local languages spoken; Malaysia and the Philippines both have 139 and 169 spoken languages respectively. This proves to be a challenge for providing content since they cannot achieve economies of scale or apply same level of resources for each language.

Representation of digital characters is one of the biggest challenges facing content providers and application providers in localizing digital displays. UNDP (United Nations Development Programs) cites examples describing the difficulties in adjusting technology standards to serve developing countries. For example, Thai language is not based on the Latin alphabet, has "some 44 Thai consonants and around 30 vowels requiring almost 90 different letters on the keyboard (compared to 66 for English)" according to UNDP (Gray, 2002).

## Impact on Social Structure

Grameen Phone women are gaining status by owning businesses and are becoming the breadwinners of their households; this trend is contrary to the traditional cultural norms practiced in those countries. There are many questions and concerns about the role of women within the technology revolution. Several organizations were established to address the many issues facing women in the developing countries and the narrowing of the gender divide (among many others):

- Office of Women in Development Bureau for Global Programs, Field Support and Research United States Agency for International Development

- Women's Learning Partnership (WLP)
- Women in Global Science and Technology (WIGSAT)

Regardless of technology advancement these women are dealing with basic human rights and equality. Many believe that thanks to programs such as the "Village Cell Phone," women will be empowered and be in a better position to overcome cultural and political norms. In June 2001, Nancy Hafkin and Nancy Taggart of the Academy for Educational Development (AED) released their study on the topic of "Gender, Information Technology, and Developing Countries: An Analytic Study". The study deals with the role of women in developing countries and the impact of new technology on their lives. Cultural and social progress starts with the freedom to make choices; this is not a reality for many of the women in developing countries. Many women lack the basic human rights such as walking in public venues, owning properties, having a job, personal security from physical and mental abuses and many other rights commonplace in the developed countries (Hafkin, 2001).

In order to address not only the digital divide, but also the gender divide, organizations such as Grameen Phone are taking the counter-culture approach. Grameen Phone made a conscious decision to make the "Village Cell Phone" program available only to women. In order to ensure the education of women, many institutions have started to hold "women-only days". Many women complained that they were feeling uncomfortable attending classes or cyber-cafés frequented predominantly by men. This is attributed to the physical presence and the public interaction with men, which is prohibited in many countries. This would prove to be an issue when organizations were looking for instructors and support personnel. Women were uncomfortable asking for help or support from a man (Hafkin, 2001).

## Changes in the Political Landscape

Developing countries have not done enough reform to open up their markets and enable the growth of small business and the entry of outside firms into the market. State-run companies, health care systems, and farms are slow to adapt to the changes needed to benefit from the new advances in technology. This stagnation is due to the potential loss of revenue from the traditional stream, for example, phone line usage fees, taxes, tariffs, and lack of competition. Much of that fear is unwarranted and is an inhibiting process.

Governments of developing countries must reform in order to spur market growth; not only to bridge the digital divide, but also to reduce the extremely high levels of poverty and health concerns. The governments are not keeping up with the change of technology and are late to adopt new governing approaches. There is a missed opportunity to manage and generate growth within the developing countries. In the late 1990s European governments auctioned off licenses for 3G networks. The auction produced revenues amounting to tens of billion of dollars. Developing countries have the opportunity to invite outside investors and local companies to bid for licenses and generate revenue. This is also an opportunity for the government to let someone else manage the network and provide better quality of products and services (Fink, 2002).

All over the world, there are new initiatives with the goal of redefining the way people interact with the government through the e-government efforts. This is done for the purpose of eliminating bottlenecks within the systems and making the government more efficient. This is just one of the newer collaboration business models that have evolved by the enablement of e-commerce. Mobile technologies extend the business model toward other applications such as billing for a variety of services from phone bills, movie tickets, grocery stores, vending machines, and so forth. The mobile phone serves as a virtual purse and based on a well-developed security model, a user can pay for any type of service. The success of mobile technology is due to its shorter learning curve versus learning to access the Internet via the traditional keyboard.

Mobile technology applications are already a reality, but in order for developing countries to partake there must be reform in the banking systems. Many of the citizens in developing countries, especially in rural areas, do not hold a bank account. This is a barrier for the growth of mobile services since they rely on established accounts to solidify relationships with their customers. One of the alternatives has been the growth of the prepaid calling plans; but those users do not benefit from the same security and legal protection as those with an established relationship with a bank and a service provider (Hermida, 2002).

## Regulation

Companies entering into the developing countries' markets lobby for the formation of an independent regulatory body rather than government regulation. Many of the countries have yet to relinquish control of the governing

bodies regulating the telecommunication industry. Without the knowledge of how to regulate under the new standards any progress made economically could be diminished. With government deregulation and the privatization of industries, the legal systems must be updated to deal with anti-competitive practices, copyright infringement regarding digital content, technology patents and many other related laws. The development of a new legal system, privatization and independent regulation would create a free market where competition would lead to better pricing and quality mobile services for the citizens (Hermida, 2002).

## Implementing Change

Developing countries have bolstered their ability to "leapfrog" years of technological advances straight into the wireless age. Many have heavily depended on outside firms and organizations for assistance in implementing and managing the programs. In order to maintain the momentum, developing countries must aspire to "leapfrog" years of social and political development. Implementing mobile technology without the development of human capital and organizational infrastructure would derail the effort of world organizations and private companies entering the new markets. Without the readiness for new technological advances, only a few would benefit and the gap between developed and developing countries would widen. The willingness to "leapfrog" years of technological advances has many benefits as detailed so far, but there are also risks such as implementing standards that have not fully matured and might fall out of favor. Developing countries adopting 3G networks are at risk of investing large sums of resources while the rest of the world adopts more promising 4G networks or Wi-Fi standards.

Investments in mobile and wireless technologies must be complemented with investments in education and health. Issues such as illiteracy, lack of health care services and other basic human services must be addressed in order to improve the lives of those living in developing countries. Mobile and wireless technologies are not the panacea for all those issues, but rather the enablers for developing countries to narrow the gap and improve the lives of their citizens.

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Wireless Week – www.wirelessweek.com - updates on wireless news

Mbusiness – www.mbizcentral.com - company news and industry trends

Mobile Commerce World – www.mobilecommerceworld.com - company trends around the world

## International Business Sources

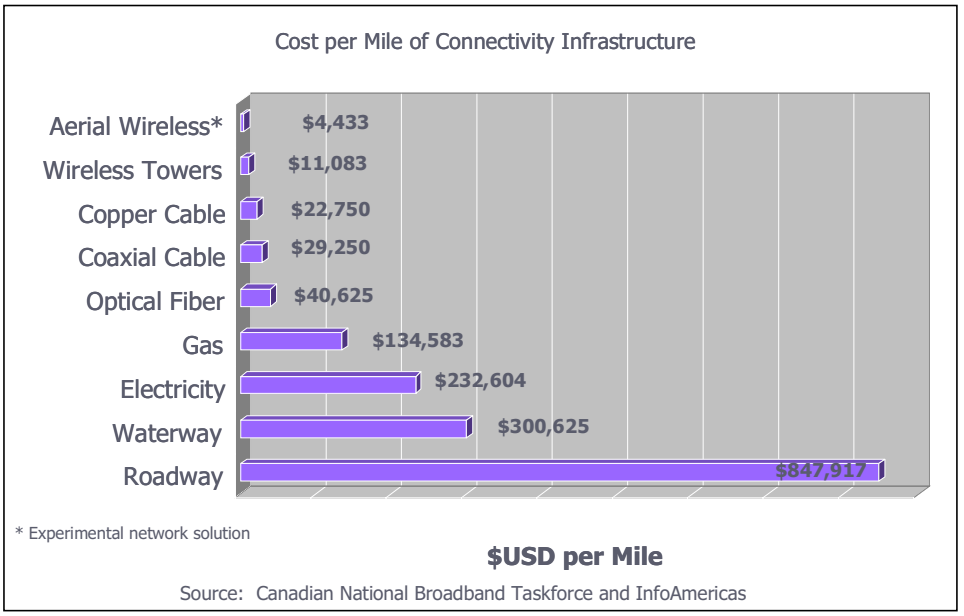
Countrywatch - www.countrywatch.com

Country Research - www.ebusinessforum.com

Ethnologue.com - research of the world's languages - http://www.ethnologue.com

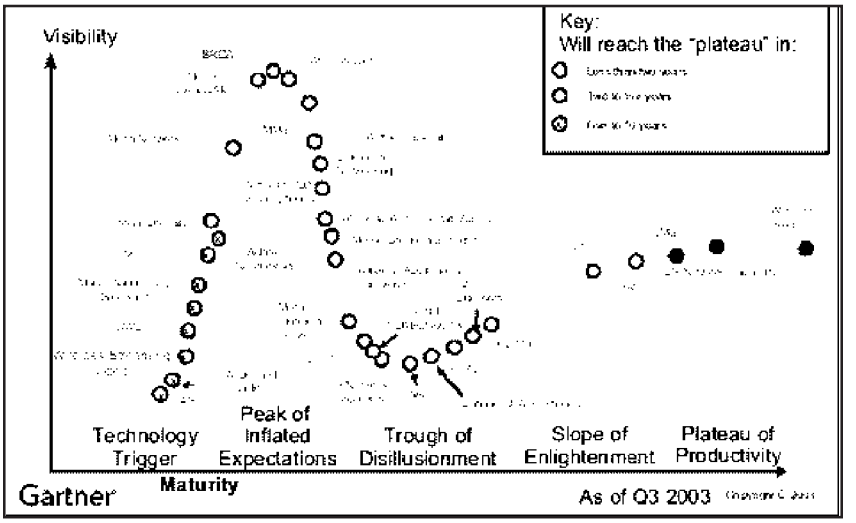
# Appendix A

*"The New Networks and New Economic Opportunities" by Peter F. Cowhey, January, 2003*



# Appendix B

*Mobile Technology and Business Scenario, Phil Redman, Gartner Group, U.S. Symposium/ITxpo*




**Technology Trigger:** A breakthrough, public demonstration, product launch or other event generates significant press and industry interest.

**Peak of Inflated Expectations:** During this phase of over-enthusiasm and unrealistic projections, a flurry of well-publicized activity by technology leaders results in some successes, but more failures, as the technology is pushed to its limits. The only enterprises making money are conference organizers and magazine publishers.

**Trough of Disillusionment:** Because the technology does not live up to its over-inflated expectations, it rapidly becomes unfashionable. Media interest wanes, except for a few cautionary tales.

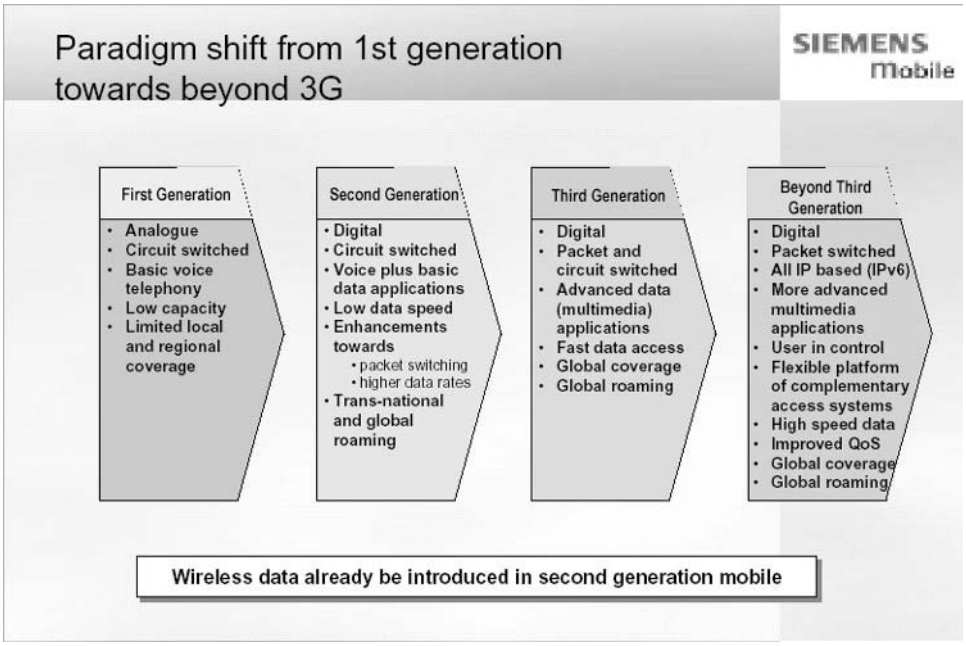
**Slope of Enlightenment:** Focused experimentation and solid hard work by an increasingly diverse range of organizations leads to a true understanding of the technology's applicability, risks and benefits. Commercial, off-the-shelf methodologies and tools ease the development process.

**Plateau of Productivity:** The real-world benefits of the technology are demonstrated and accepted. Tools and methodologies are increasingly stable as they enter their second and third generations. The final height of the plateau varies according to whether the technology is broadly applicable or benefits only a niche market. Approximately 30% of the technology's target audience has or is adopting the technology as it enters the Plateau.

**Time to Plateau/Adoption Speed:** The time required for the technology to reach the plateau of productivity.

# Appendix C

*Mobile Communications Beyond 3G in the Global Context by Werner Mohr of Siemens Mobile, Munich, Germany*




| | |
|---|---|
| *1G* | *Analogue* |
| *2G* | *Digital (GSM, CDMA, PCS)* |
| *2.5G* | *GPRS* |
| *3G* | *Broadband* |
| *4G* | *Intelligent networks* |

# Appendix D

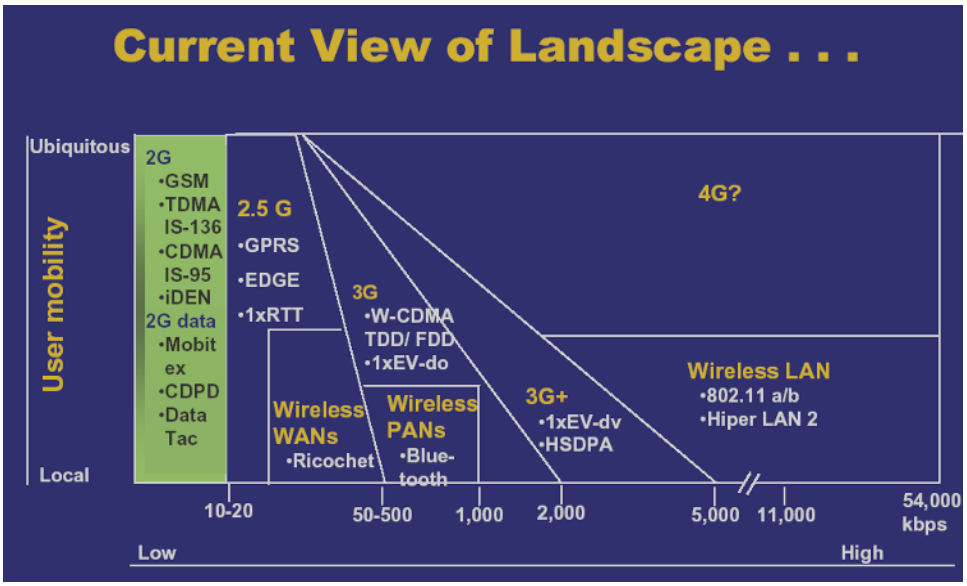
*Comparing Key Parameters of 4G with 3G*

| | **3G (including 2.5G, sub3G)** | **4G** |
|---|---|---|
| Major Requirement Driving Architecture | Predominantly voice driven - data were always add on | Converged data and voice over IP |
| Network Architecture | Wide area cell-based | Hybrid - Integration of Wireless LAN (WiFi, Bluetooth) and wide area |
| Speeds | 384 Kbps to 2 Mbps | 20 to 100 Mbps in mobile mode |
| Frequency Band | Dependent on country or continent (1800-2400 MHz) | Higher frequency bands (2-8 GHz) |
| Bandwidth | 5-20 MHz | 100 MHz (or more) |
| Switching Design Basis | Circuit and Packet | All digital with packetized voice |
| Access Technologies | W-CDMA, 1xRTT, Edge | OFDM and MC-CDMA (Multi Carrier CDMA) |
| Forward Error Correction | Convolutional rate 1/2, 1/3 | Concatenated coding scheme |
| Component Design | Optimized antenna design, multi-band adapters | Smarter antennas, software multiband and wideband radios |
| IP | A number of air link protocols, including IP 5.0 | All IP (IP6.0) |

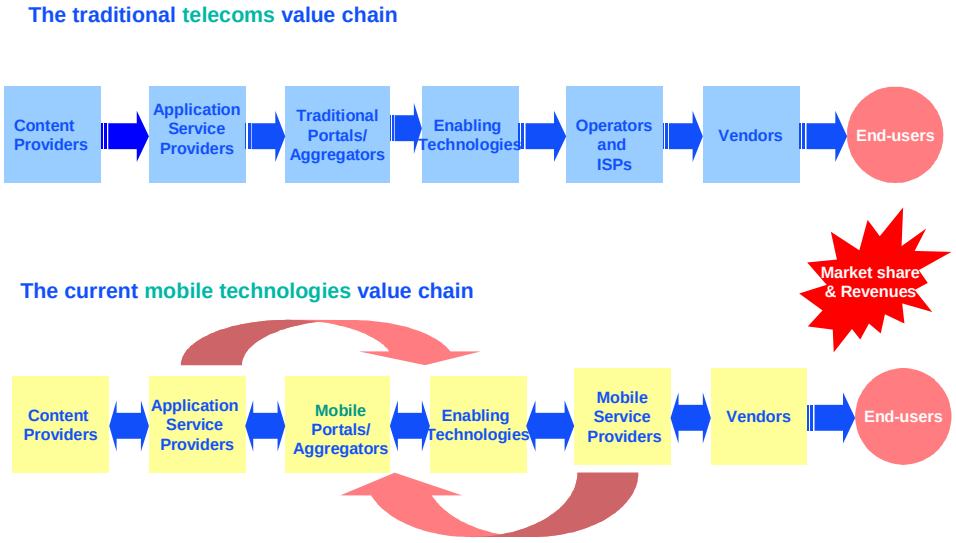
*4G - Beyond 2.5G and 3G Wireless Networks*

*"Mobile and WirelessGlobal Trends and Strategies Strategies" by Jonathan Aronson*

*USC GLOCOM, Tokyo Forum on "Socio-Economic Impacts of Mobile/ Wireless Technologies: Strategies and Policies" November 21, 2002*

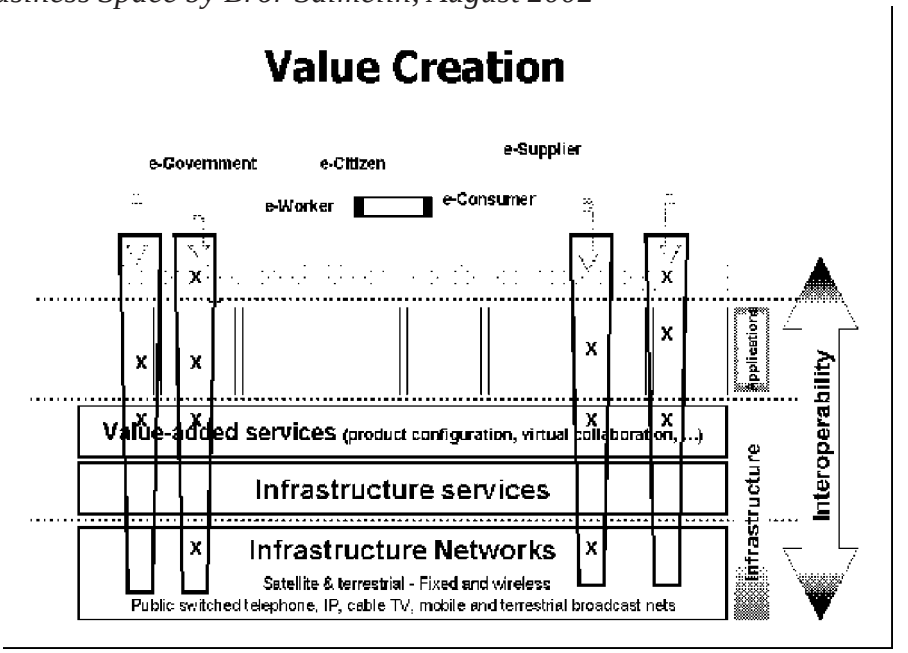


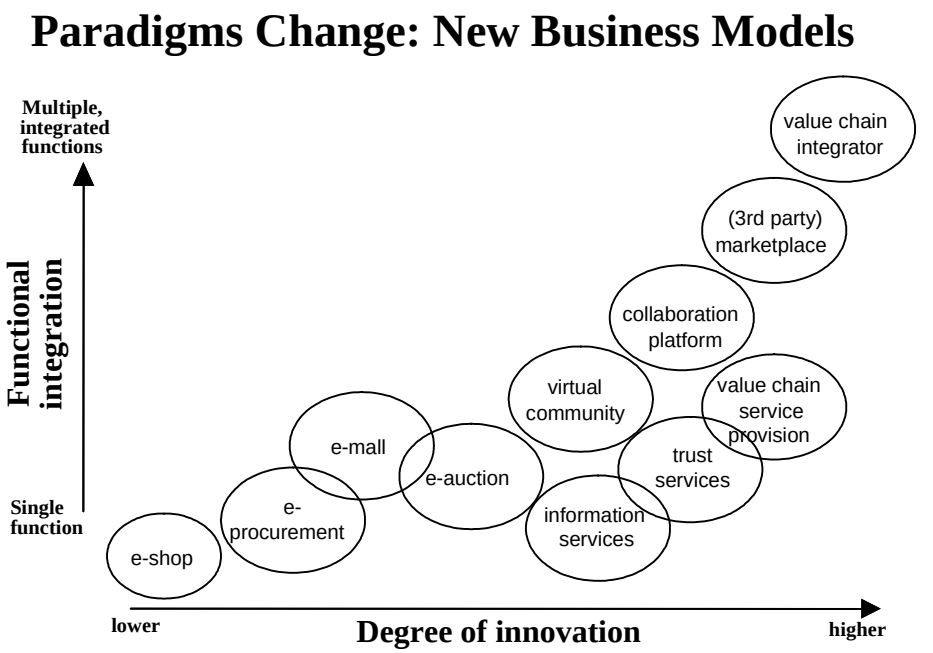

# Appendix E



# Appendix F

*Challenges and opportunities in the e-economy - the Single European E-Business Space by Bror Salmelin, August 2002*

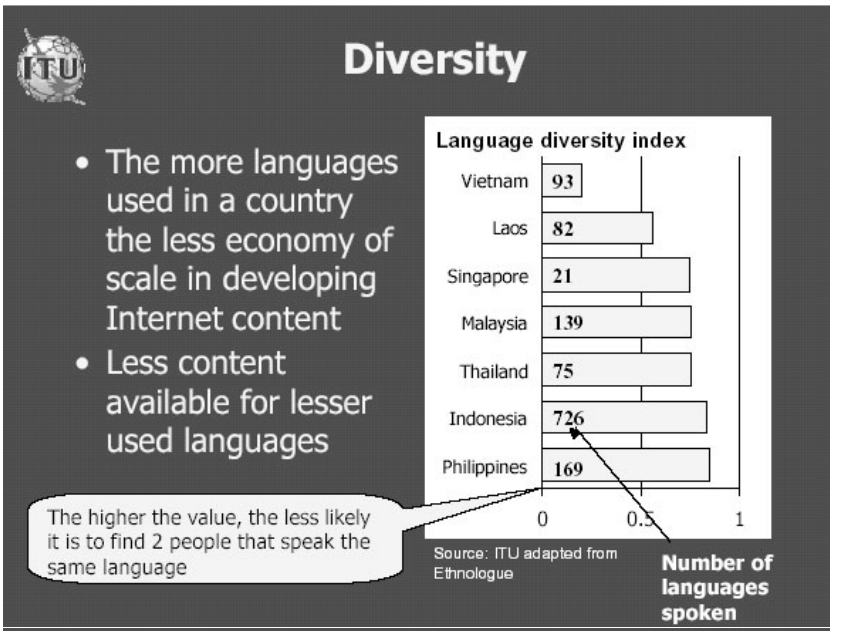


# Appendix G

*3rd World Telecommunication/ICT Indicators Meeting, Geneva, January 2003,*

*Vanessa Gray ITU (International Telecommunication Union)*




# Section III

# Technologies and Applications for Digital Business

## Chapter VI

# An Introduction in Digital Watermarking: Applications, Principles, and Problems

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Juergen Seitz,
University of Cooperative Education Heidenheim, Germany

## Abstract

*In order to solve intellectual property problems of the digital age, two basic procedures are used: "Buy and drop," linked to the destruction of various peer-to-peer solutions and "subpoena and fear," as the creation of non-natural social fear by specific legislations. Although customers around the world are willing to buy digital products over networks, the industry is still using conventional procedures to push such a decisive customer impulse back into existing and conventional markets. Digital watermarking is described as a possibility to interface and close the gap between copyright and digital distribution. It is based on steganographic techniques and enables useful right protection mechanisms. Digital watermarks are mostly inserted as a plain bit sample or a transformed*

*digital signal into the source data using a key based embedding algorithm and a pseudo-noise pattern. The embedded information is hidden in low-value bits or least significant bits of picture pixels, frequency or other value domains, and linked inseparably with the source of the data structure. For the optimal application of watermarking technology a trade-off has to be made between competing criteria like robustness, non-perceptibility, non-delectability, and security. Most watermarking algorithms are resistant against selected and application-specific attacks. Therefore, even friendly attacks in the form of usual file and data modifications can destroy easily the watermark or falsify it. This chapter gives an overview in watermarking technologies, classification, methodology, applications and problems.*

## Limitations, Threads, and Impacts on the Digital Age

At this decade, the Internet and especially the World Wide Web, a global working network with worldwide broadcasting potential, has been successfully integrated into public and business domains. Recent surveys and public opinion polls have accented the value of the Internet. Traditional television and the Internet converge (Merz, 1999, p. 209). In addition, the growth and integration of broadband access points, wireless and mobile technologies and the progress towards one-in-a-box device proves the significance of developing a legitimate marketplace for entertainment and business activities. Today, digital networks and libraries, Internet services and the disposition of non-branded digital products within a global accessible network support and lead to illegal copying, modification and redistribution. Particularly, the music and entertainment industry has struggled against the illegal distribution over peer-to-peer and other networks for years. The Recording Industry Association (RIAA), the leading music industry consortium, estimates the annual revenue for recorded music in the USA to $14 billion and worldwide $38 billion and claims $5 billion loss due to piracy in the year 2000 and millions $US to all forms of piracy per day (Tadjer, 2000). Although the industry positively evaluates the Internet and its distribution and economical quality, technologies, frameworks and support were blocked for a long time. On the other hand, the most significant barrier for online shopping – the trust of the customer – begins to fall. The increasing

popularity of streaming media technologies and other types of distribution methods of digital content will support and eventually boost the acceptance of the Internet to become the most popular distribution channel in the future. Decisive business activities, like *Amazon.com, apple.com* and *yahoo.com,* who are selling entertainment products, like video and audio, clarify the progress of these progressive distribution channels. But, as audio, video, and any digital source can be straightforwardly copied and illegally distributed over various channels, the capital loss prevents decisive business activities and investments until a working juristic and technical protection mechanism would be available. These concerns are supported by the facts that digital mass recording devices for digital media have effectively entered the market (Hanjalic et al., 2000). The importance and the supposed economical thread for copyright holders are clarified by initiatives of the entertainment industry, like VIVA and SDMI - Secure Digital Music Initiative. Although distributors and artists have already recognized the advantages in making their material available online, they will not go further into the online business until their content can be protected by technical and by wide law regulations. As new intellectual property changes became new European law in 2003 and started to fit more towards the proposals of the World Intellectual Property Organization (WIPO) political signals, that proves the importance was set. Therefore, the features of the digital world lead to economical chances, but also to serious problems in simplifying unauthorized copying and distribution. In order to solve these problems, digital watermarking together with a working law framework can be used and eventually close the gap between usability of goods and the security level of protection.

## Steganography, Data Hiding and Historical Watermarking

The core principles of watermarking and data hiding can be traced back approximately 4,000 years to Egypt and Greece. At this time, hidden packets of information were transferred by special character adjustments or mutations (Hanjalic et al., 2000). Herodotus, the great Greek storyteller, often refers to the hidden information methodology transferred on wax-tablets or smuggling secret messages tattooed on the skull of human messengers (Cox et al., 2002).

*Figure 1. Tattoo messages on Roman slaves (Bail)*

> "In Roman times a slave would have his head shaved, then tattooed with an important message, and as the hair began growing, he made his way as instructed through enemy lines and indifferent countries, across water and inhospitable terrain, sleep and snow, mountain ranges, etc., finally reaching the reader who immediately had the head shaved, and eagerly scanned the message."

The most famous method is to mark the document with invisible secret ink, like the juice of a lemon, and hide information. Another method is to mark selected characters within a document by pinholes and to generate a pattern or signature (Schneider, 1998). Such techniques are often referred to *steganography*. Steganography is a sub-discipline of data hiding and a part of cryptology. While the art of cryptography is about protecting the content of messages, steganography is about covering their existence. Steganography means secret writing and consists of the Greek words "steganos" and "graphia". The main security of a steganographic system is based on a simple procedure. Because the steganographic message is integrated invisibly and covered inside other harmless sources, it is very difficult to detect the message without knowing the existence and the appropriate encoding scheme.

Plain watermarking instead is strongly related to the invention of papermaking in China. It was intensively used in the eighteenth century in America and Europe as a trademark and a method against counterfeiting books and money (Cox et al., 2002; Schneier, 1998). Such watermarks are archived by the "International Association of Paper Historians" electronically and clarify mainly the historical meaning (Dittmann, 2000). Over recent years, simple, skillful and aesthetic watermarks have been developed to prove authenticity, originality and authorship, and to complicate the illegal redistribution process. The most famous watermark can be detected holding a bank note against the light. Its digital pendant, the "digital watermark," considers the main principles and practices of its steganographic approach.

## Digital Watermarking Methodology

*Digital watermarking* means embedding information into digital material in such a way that it is imperceptible to a human observer, but easily to detect by computer algorithms. A digital watermark is a transparent, invisible information pattern that is inserted into a suitable component of the data source by using a specific computer algorithm (Dittmann, 2000). Digital watermarks are signals added to digital data (audio, video, or still images) that can be detected or extracted later to make an assertion about the data.

The digital watermarking research field is well demarcated and the first "noteworthy" publications can be tracked back to 1982. Since 1995 the interest on digital watermarking has notably increased. This movement was supported by the first SPIE "Information Hiding Workshop" in 1996 and various upcoming conferences about digital watermarking and multimedia security. At the same time, organisations like *Copy Protection Technical Working Group* (CPTWG) and *Secure Digital Music Initiative* (SDMI) were founded in order to industrialize, standardize, and evaluate the digital watermarking field. Supported projects, like *Visual Identity Verification Auditor (*VIVA) and *The Tracing Authors Right Labelling Image Services and Monitoring Access Network* (TALISMAN), are examples for working watermarking applications for monitoring broadcasting material. Since MPEG is an accepted standard, the International Organisation of Standardization has adopted digital watermarking in its specification draft. Such activities can be measured as proof for its technical and industrial relevance.

## Digital Watermarking Associations

In order to protect copyrighted material from illegal duplication, two typical technologies have been developed. One approach uses key-based cryptographic methods and procedures to control the process of copying, manipulating, and distributing media assets. Cryptography and encryption techniques enable the appropriate security during the transmission process, but once the encrypted data are decoded, the control of re-distribution and its spread falls. To address the limitations of encryption the main idea is to label a digital material with specific marks, which are called digital watermarks. Such technology can

be used as ownership proof for distribution channel tracking and other applications in business and public domains. Furthermore, watermarking technology enables the owner to obtain the copyright status of certain documents, and distributors can be made accountable for the content. Additionally, compatible media player technology, such as DivX and DVD players, can detect distorted marks and refuse to play, display, or execute the media asset files. The lack of such technologies has enforced the establishment of research in information science disciplines and the foundation of different organisations. Such initiatives especially focus on the development and progress of the watermarking technology for applications. In the future, portable consumer devices may be equipped with specific hardware detectors to protect business models and the rights of the owners of media assets.

## Digital Watermarking Initiatives, Companies and Projects

In recent years, various activities in the digital watermarking field can be detected. A powerful and significant non-profit organization, the SDMI-Secure Music Initiative, was established in 1999 and consists of 161 companies in the music, entertainment and computer area. SDMI develops specifications that enable the protection of the playing, storing, and distributing of digital music and points out that a new market for digital music may emerge that is led by the Recording Industry Association of America (RIAA). The strategy of SDMI is to mark music data in such way that the data are permanently attached and recognized by all specified devices (Sherman). Actually they are reacting to the popularity of MP3 and the introduction of portable consumer electronic devices that play unprotected files. The SDMI consortium wanted to have SDMI compliant devices available for Christmas 1999 (Lacy et al., 1997), but its major plan was impaired by technological and political limitations.

CPTWG, the Copy Protection Technical Working Group, researches effective protection mechanisms for DVD-Video. Additional state supported projects have brought out industrialized results, for example, TALISMAN – The Tracing Authors Right Labelling Image Services and Monitoring Access Network, and VIVA, engaging the development of watermarking technology for broadcasting monitoring. Additionally, commercial products, like MusiCode for audio material, VEIL II and MediaTraxx for video, exist in the high-end

consumer market. Digimarc, one of the first established watermarking companies, has successfully integrated its third party "plug-in" into Adobe's Photoshop Suite and other graphic software. Furthermore, a Mediasec cooperation has developed a fragile watermarking framework used at major airplane industries to prevent terrorists attacks and to enable an authenticity mechanism for marked plane designs and technical instructions.

## Other Activities

In June 1989, the music industry initiatives RIAA and IFIPA, and producers, for example, Mitsubishi, Grundig, Phillips, and Sony, agreed on the integration of a copy control mechanism for the digital audio tape named SCMS (Serial Copy Management System). Since 1989, consumer DAT-devices have been equipped with a copy mechanism that prohibits copying a copy. The DVD, the standard storage medium for video, was kept back from the market because of its copy control limitations. In all, approximately 10 safety techniques have been integrated in DVD devices. The famous ones are CSS (Content Scramble System), Macro vision, CGMS (Content Generation Management System), Regional Code Playback Control, and digital watermarking. The Content Scrambling System was integrated into DVD devices by patent activities around 1996 and is based on an encryption and authenticity system. CSS video streams are encrypted and can be decoded by a CSS-compliant MPEG-decoder. In 1999, the CSS procedure was hacked and software tools (DeCSS) were available for download in the Internet. The Copy Generation Management System embeds information in the source document enabling a mechanism to control if video stream can be copied or not. One of the most effective copy control mechanisms is the regional code. It is integrated into the DVD disk and DVD device. It disables the playback possibilities in specific geographic regions (Bechtold, 2002).

## Watermarking Applications

Digital watermarking is described as a viable method for the protection of ownership rights of digital audio, image, video and other data types. It can be

applied to different applications including digital signatures, fingerprinting, broadcast and publication monitoring, authentication, copy control and secret communication (Cox et al., 1997, 2000, 2002). As a signature, the watermark identifies the owner of the content and can be used as a fingerprint to identify content consumers. For example, a specific watermarking technique is planned to be used to secure passports against counterfeiting in the United States. Broadcast and publication monitoring describe the area of computer systems that automatically monitor television and radio broadcast to track the appearance of distributed material. Watermarking technology can also be used to provide authenticity of several types of content. It is designed that any alteration either destroys the watermark or creates a mismatch between content and watermark that can easily be detected. Furthermore, watermarking enables designing copy control applications within the embedded information and contains rules of usage and copying. By integrating watermarking techniques in copying devices by law or patent, the widespread occurrence of illegal copying and distribution could be controlled. Digital watermarking can also be used to transmit such secret information in images, audio streams, or any type of digital data and it is reported that some communication activities of people or groups linked to the 911 tragedy were based on such data hiding approaches.

## Copyright Protection and Authentication

Digital watermarks are often used for copyright and intellectual property protection (Cox et al., 2002; Friedrich, 1998). In this case, the author or originator integrates a watermark containing his or her own intellectual property signature into the original document and delivers it as usual. By doing this, he or she can prove his or her intellectual creation later on, for instance in a legal proceeding, and has the possibility to assert entitlement to the restricted use.

*Figure 2. The "Lena-Image"*

The "Lena-Image" in Figure 2 is one of the standard reference pictures used in the scientific digital imaging area and was used in the first digital watermarking publications without real permission of the owner (Cox et al., 2002).

## Fingerprinting and Digital "Signatures"

In order to explain fingerprinting with digital watermarking, the pay-per-view scenario in Friedrich (1998) is used. Customers are buying different media types, like images, video and audio over the Internet. Within a real-time watermarking framework, the digital goods are individually marked with the fingerprint of the customer. This could be a generated OEM number or another useful pattern. In this case, cryptographic methods could increase the data security and can be combined with digital signatures. Although there seems to be a conflict between digital signature and digital watermarking, because watermarking differs from the idea of a public key encryption, it could be interesting to combine both techniques. To identify those that make illegal copies or re-distribute them, an automated agent scanning system can be used to trace down the traitor. According to the popularity of DivX and screened copies of brand new movies, "Screeners," the cinema and film projectionist could be traced, enabling such illegal action. Because of the analogues techniques used in worldwide cinemas, the digital watermark has to survive the change of the analogue to the digital domain. However, such watermarks could be easily integrated with more security and reliability by using digital projectors and digital devices.

## Copy Protection and Device Control

Digital watermarks can be used to enable copy control devices. In this combination, the recording device scans the digital data stream for an existing watermark and enables or disables the recording action for a specific movie or stream. Such technology could extend the pay-per-view concepts and close the gap between the applied cryptographic approach and its usability. However, the implementation in consumer devices seems to be possible in using the same procedures applied when inserting the "Macro Vision" and "CSS" DVD copy mechanisms. By limiting the available DVDs to CSS compliant DVD-player, manufacturers had to integrate new encoders that are secured by patent law regulations in their devices to maintain the position in the market.

## Broadcast Monitoring

The production cost of broadcasting material, like news, shows, and movies, are enormous and can raise up to 100.000 US$ per hour and more. Therefore, it is important for the productions companies, for example, Warner Bros., Miramax, and Universal Pictures, to secure their intellectual property and permit illegal re-broadcasting activities. In this case, digital watermarking can enable technical frameworks, like TALISMAN, which automatically monitor broadcasting streams at satellite nodes all over the world and identify illegally broadcasted material. Furthermore, TV stations can be monitored and the unlawful use could be tracked and debited individually. In 1997, two Asian broadcasting stations had been identified that intentionally overbooked their advertising time and customers paid for un-played broadcasting time (Cox et al., 2002). Such computer systems can be used for tracking and monitoring advertisement activities on broadcasting channels and to examine advertisement deals. Nielsen Media Research and Competitive Media Reporting are offering such computer systems.

## Data Authentication

Digital watermarking is often used to prove the authenticity of a specific digital document. The digital watermark contains information that can be used to prove that the content has not been changed before. Any operation on the file destroys or changes the integrated watermark. If the watermark information can be extracted without errors, the authenticity can be proven. In order to design an effective watermarking algorithm the watermarking data or procedure can be linked to the content of the digital document. Such watermarks are called fragile watermarks or "vapormarks" (Cox et al., 1999).

## Further Applications

Though the main application of digital watermarking is to secure the intellectual property, it can also be used in the medical field. In using digital watermarks as containers for information about patients and their diagnosis, medical images, for example, X-ray or nuclear magnetic resonance tomography, could be automatically associated to the patient (Peticolas et al., 1999). Furthermore,

digital watermarking could be used to save context or meta-information in source documents. In using special watermarking agents, generic search machines are enabled to retrieve such information and can offer time-based media documents as a result.

## Classification and Requirements

Digital watermarks can be classified and measured on the basis of certain characteristics and properties that depend on the type of application. These characteristics and properties include the difficulties of notice, the surviving of common distortions, and resistance of malicious attacks, the capacity of bit information, the coexistence with other watermarks, and the complexity of the watermarking method. In generally, they are described as fidelity, robustness, fragility, tamper resistance, data payload, complexity and other restrictions. Digital watermarks must fulfill the following often contradictory requirements (Kutter & Hartung, 2000).

- **Robustness:** It may not be possible without knowledge of the procedure and the secret key to remove the watermark or to make it illegible. Robustness also means the resistance ability of the watermark information brought in a data material opposite changes and modifications of the original file. Modifications will be particularly considered resizing, file compression, rotation, and common operations. Especially commonly used operations like lossy compression (JPEG, MPEG) should not destroy the digital watermark (Hanjalic et al., 2000). Further examples are linear and non-linear filters, lossy compression, contrast adjustment, gamma correction, re-coloring, re-sampling, scaling, rotation, small non-linear deformations, noise adding, pixel permutations, and so forth. Robustness does not include attacks on the embedding scheme based on the knowledge of the algorithm or on the availability of the detector function. It means resistance to common operations applied in the imaging, motion picture or audio field (Friedrich, 1998).
- **Non-perceptibility:** It is important to recognize whether the brought bit sample of the watermark produces perceptible changes acoustically or optically. A perfect non-perceptible bit sample is present if it cannot be

distinguished between data material marked with watermark and the original. This classifier is based on the idea and properties of the human visual system (HVS) and human audio system (HAS). The watermark is non-perceptible or invisible if a normal human being is unable to distinguish between original and carrier.

- **Non-detectable:** The data material with the brought watermark information are not detectable if they are consistent with the original data. In this case, an embedding algorithm could use, for example, steganographically, the noise components of the data source of a picture to hide the watermark information. Non-detectability cannot be directly linked to non-perceptibility, which is based on the concepts of human perceptions. Non-detectability is related to the data source and its components. It describes the consistency with the original data (Friedrich, 1998).
- **Security:** It is assumed that the attackers have full knowledge about the applied watermark procedure; however, no secret key would be known. Therefore, an attacker will try to manipulate the data material to destroy the watermark, or again print and scan to win the original material without a copyright-protection note. The complexity is also connected with the security; that is, the algorithm for the bringing in and reading of watermark information should work with enough long keys to discourage the search for the appropriate secret key. However, for certain applications and persons the watermark must be also detectable. The problem of secure key exchange emerges.
- **Complexity:** The complexity describes the expenditure to detect and encode the watermark information. A measurement technique could be the amount of time (Dittmann, 2000). It is recommended to design the watermarking procedure and algorithm as complex so that different watermarks can be integrated. By that, "trial and error" attacks can be avoided (Voyatzis et al., 1998).
- **Capacity:** Capacity is referred to amount of information that can be stored in a data source. In using digital watermarking for simple copy control applications, a capacity of one bit (one=allow/zero=deny) seems to be sufficient. On the other hand, intellectual property applications require about 60- to 70-bit information capacity to store data about copyright, author, limitations, or ISBN, ISRC, or OEM numbers.

For the optimal watermarking application a trade-off has to be accepted between the mentioned criteria. Robustness means, for example, that much

information of a watermark must be embedded that is, however, then in case of an attack better visibly or detectable. On the other hand, if a watermark consists only of a minimal bit sample that covers only a small part of the picture, such a watermark is quickly lost as a result of the modifications of the data (Woda & Seitz, 2002). Finally the amount of watermarking information and the robustness could have significant effects on the quality of the data source and influences the requirements. Therefore, a decision has to be made for the right application.

## Digital Watermark Types

In the previous section we classified watermarks on the basis of their requirements. However, digital watermarks and their techniques can be subdivided and segmented into various categories; for example, they can be classified according to the application, source type (image watermarks, video watermarks, audio watermarks, text watermarks), human perception and used technique. As watermarks can be applied in the spatial or frequency domain, different concepts, like discrete Fourier (DFT), discrete cosine (DCT) and wavelet transformation, or additionally, manipulations in the color domain and noise adding can be mentioned. Furthermore, digital watermarks can be subdivided on the basis of human perception. Digital watermarks can be invisible or visible. We see visible watermarks everyday watching television as station logo. They can be robust against operations or even fragile for use in copy control or authenticity applications. At least, digital watermarks can be subdivided in blind and non-blind detection techniques, which are strongly related to the decoding process.

## Blind and Non-Blind Techniques

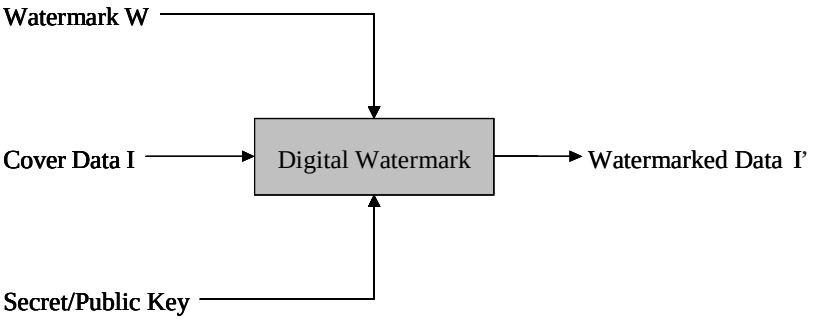
In order to detect the watermark information, blind and non-blind techniques are used. If the detection of the digital watermark can be done without the original data, such techniques are called blind. Here, the source document is scanned and the watermark information is extracted. On the other hand, non-blind techniques use the original source to extract the watermark by simple comparison and correlation procedures. However, it turned out that blind techniques are more insecure than non-blind methods.

# A General Watermarking Framework

In contrast to common techniques, including copyright information inside data headers or visible areas, digital watermarks are weaved into the core structure of the digital document in an invisible and unrecognizable way. The main goal of the watermarking research is to develop digital watermarking methods that survive all known format and common transformations, D/A and A/D conversions, and any other kind of data operations used in image and audio processing. The basic digital watermark method integrating information packages in digital data is based on steganographic methods. Figure 3 explains this generic and its steganographically derived watermarking scheme. Digital watermarks are inserted into pictures, video and audio files with different embedding schemes, concepts and algorithms. Almost all watermarking procedures are based on the use of secret keys, which are applied in the integration and detection process to extract the watermark information properly and enable basic security (Kutter & Hartung, 2000). In general, any watermarking scheme consists of the watermark, the encoder that inserts the information, and the detector.

In contrast to traditional cryptographic methods, the watermark set does not change the main functionality of the file. Therefore, the watermark must be inserted into the data structure imperceptibly. Depending on the given data type, it should neither be visible, audible, and so forth, nor detectable for strangers or observers. Each watermark method consists of an embedding algorithm and an extracting algorithm. The embedding, encoding algorithm inserts the watermark information in the data and the extracting algorithm

*Figure 3. Generic digital watermarking scheme (encoder) (Kutter & Hartung, 2000)*

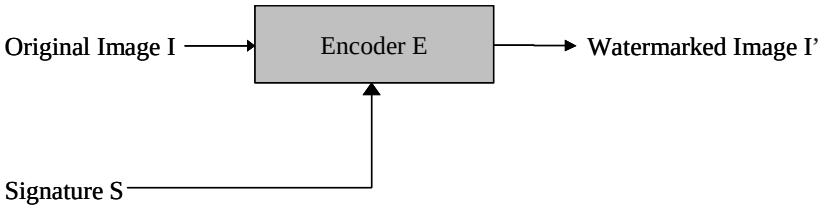


decodes the watermark information. However, some methods extract the whole watermark information and others only determine their existence. Such methods can be either used as ownership proof or verification.

## Watermark Encoding

In order to combine a watermark with a digital document, for example, images, you need an image (I), a signature ($S = s_1, s_2, s_n$) that contains the watermarking information and an encoding algorithm (E) to create a watermarked image (I'). The encoder takes the signature and the cover document, and generates the watermarked image, which is described as a function: **E(I, S) = I'**. In this case, secret or public keys, and other parameters can be used to extend the watermarking encoder.

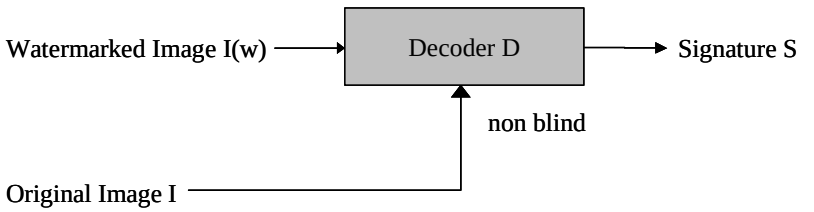
*Figure 4. Watermark encoding example*




## Watermark Decoding

The watermark is extracted using a decoder function (see Figure 5). In this case, the decoder **D** loads the watermarked, normal or corrupted image I(w) and extracts the hidden signature **S**. Using non-blind watermarking techniques

*Figure 5. Watermark decoding example*



the decoder **D** loads an additional image I, which is often the original image, to extract the watermarking information by correlation. Such methods are more robust against counterfeit attacks. The process can be described as: **D(I, I (w)) = S.**

## Watermarking Techniques

> *"Why is it so difficult to find a needle in a haystack? Because of the size of the needle relative to the size of the haystack. Also, because once the needle falls out of your hand, it is not predictable where it will land in the haystack. Both principles — inconspicuousness and randomness — help conceal information in digital watermarks to protect intellectual property of multimedia documents."* (Zhao, 1997)

Zhao clarifies the main principles to hide information in digital documents. In using randomness and inconspicuousness to hide information, a reliable security level could be reached. Noise pattern, either Gaussian or normal distributed, are excellent carrier signals for information brackets. Noise patterns are existent elements of life and often not predictable by human beings. Since natural noise patterns are linked to source material, it is not recognized in the most cases. Therefore, we have to pay attention to the source material when designing the noise generator in order to integrate watermark information. Further techniques consider the transformation of the image and its specific domains. Most watermark techniques use the frequency or spatial domain in order to integrate the watermark information (Dittmann, 2000). Such algorithms are based on, for example, discrete Fourier, cosine, and wavelet transformations, or fractal approaches for digital images. On the other hand, time-variant materials, like audio files or video streams offer, sometimes in combination with DCT and DFT, other technical possibilities, for example, psychoacoustic transformations, phase modulations, echo-adding and spread spectrum methods.

### LSB Watermarking Technique

LSB watermarking describes a straightforward and basic way to integrate watermark information in digital documents. Considering a basic greyscale

image the pixel and its values can be sliced up into significant and irrelevant levels. Because the significant levels merely represent a digital noise pattern, it could be easily used for digital watermarking. In changing selected pixel values of the noise pattern using a special or key-based algorithm, the watermarking information can be easily integrated (Hanjalic et al., 2000). However, such a technique is very insecure because the watermark could be easily destroyed. On the other hand, such a technique could be useful in copy control and authenticity applications.

## Spatial Domain Watermarking

Digital watermarking techniques in the spatial domain use the values of the color channels, luminance or brightness signals of a digital image (Dittmann, 2000). One straightforward and rapid technique is based on the principle to generate a pseudo-generated noise pattern and integrates it into specific chrominance or luminance pixel values (Darmstaedter et al., 1998). Such pseudo-random noise patterns consist of black (1), white (-1) and neutral values (0). The pseudo-noise is generated with a "secret" key and algorithm. Additionally, the process could be adjusted to the image components or feature vectors to achieve a higher level of invisibility. In general, the watermark W(x, y) is integrated into the image components I(x, y) by a factor that allows the amplification of the watermarking values in order to obtain the best results.

$$I_W(x, y) = I(x, y) + k * W(x, y)$$

The detection of the watermark is based on the principles of correlation. In this case, a specific detector compares the watermarked image $I_W(x, y)$ with the original image and automatically decides, based on a specific correlation level, whether a watermark exists or not (Hanjalic et al., 2000). Such techniques especially enable the integration of one-bit watermark information. In integrating more information, various techniques have been invented. Such methods have the possibility to save up to 500 bits in one 512x512 image (Hanjalic et al., 2000). In order to clarify this main procedure, the original image will be subdivided into small blocks. Now, the selected blocks are watermarked or not and produce a bit sequence in the detection process. In this case, the watermarking detector scans the image and generates the bit sequence accord-

ing to a specified correlation level. Using the CRC method could improve the error-prone level.

## Frequency Domain Watermarking

The basic principles adding or changing components of digital images and other digital documents can be transferred to other value domains. In order to integrate watermark information into frequency components, the document has to be transformed into its frequency components using discrete cosine, discrete Fourier, or Hadamard transformations (Dittmann, 2000; Hanjalic et al., 2000). As such transformations are used in lossy compression techniques, for example, MPEG and JPEG, the watermark appears to be very resistant against usual attacks. Furthermore, in integrating watermarks in the most important frequency components improve security and resistance, because every change reduces the quality of the image significantly (Hanjalic et al., 2000). Therefore, it is important to identify the coefficients of the transformation that are less infected by the attack method. In most cases digital watermarks are integrated into the mid-band frequencies. Research has determined a specific sensibility of high-band frequencies against filter operations, lossy compression and noise insertion, whereas manipulating low frequencies seems to produce visible artifacts anytime (Hanjalic et al., 2000).

## Spread Spectrum Watermarking

Spread spectrum techniques used in digital watermarking are borrowed from the communication field. The basic idea of spread spectrum is to spread the data across a large frequency band. In the case of audio, it is the entire audible spectrum; in the case of images, it is the whole visible spectrum. Spread spectrum is a military technology and designed to handle interferences and disturbances. In most cases, signals that represent the information are modulated at low intensity across the source bandwidth. Spread spectrum communication is used in radar, navigation and communication applications. The information is weaved in the source material using a secret key or an embedding procedure (Hanjalic et al., 2000).

## Other Approaches

Further relevant watermarking methods for images use fractal transformation to integrate bit information into the structure of the document (Jacquin, 1992). Nevertheless, various procedures have been invented and used for diverse watermarking applications in the image, audio, or video field. Especially, watermarking for video data can profit by scientific findings of audio and image watermarking. Audio watermarking in its place is based on psychoacoustic theories, amplitude modification, dithering techniques, echo integration, phase distortion and spread spectrum techniques (Bassia & Pitas, 1999; Bender et al., 1996; Chen & Wornell, 1999; Cox et al., 1996; Gruhl et al., 1996 ). Such techniques are usually based on the same concepts. In this case, watermarking using amplitude modification means embedding a pseudo-noise pattern in the least-significant bit audio data by replacing or modification (Bassia & Pitas, 1999). Other approaches, like using echo signals to save the bit information, add a repeated adaptation of component with a small offset (delay time), initial amplitude and decay rate to make it imperceptible (Chen & Wornell, 1999). Other applications, like watermarking software code on the area of text watermarking and watermarking of notes in music scores complete the digital watermarking area.

# Attacks on Digital Watermarks

The watermarking research area has produced a wide range of watermarking techniques that can be subdivided into various methodical complexity levels. Each of these methods tries to reduce vulnerability on various attack scenarios. Attacks on digital watermarks can principally be classified into two main groups: friendly and malicious attacks. Conventional image or data operations applied in the normal use of computer technology can destroy the watermark information. Different operation of the classical image processing field, like scaling, colour and gamma corrections and so forth can be mentioned at this point. Today, compression techniques can be also placed in the field of classical operations, but often separated as a single element in the watermarking research. Friendly attacks have two common features: They are generally described as an unintentional event, and the user has no knowledge of the watermark and its embedded procedure. The second type of attack, the

malicious attack on watermarks, occurs with the intention to eliminate the information. In order to test the robustness of watermarks some applications have been developed. The powerful StirMark attack has been designed by a research group at the University of Cambridge (Andersson, Petitcolas & Kuhn). The attack simulates image distortions that commonly occur when a picture is printed, photocopied, and re-scanned. The image is slightly stretched and compressed by random amounts, and a small amount of noise is added (Friedrich, 1998). Comparable applications are the mosaic and histogram attacks. The mosaic attack assembles and reassembles the watermarked image. The histogram attack describes an attack on simple watermark methods. Finally, it is important to consider that a partial knowledge of the watermark or the process of watermarking enables pirates to remove the entire watermark or to disturb it. A good model to classify such attacks is given by Hartung et al. (1999).

## Simple Attacks

Simple watermark attacks try to wipe out the watermark information in manipulating the whole image and its components. The attack does not isolate or identify the specific watermark information. The attack has been successful when the watermarking information cannot be extracted or recognized anymore and the usability has not been affected (Hanjalic et al., 2000). Examples are common signal processing operations like linear filtering, such as high pass or low pass filtering, non-linear filtering, such as media filtering, colour reduction, D/A, A/D conversions, re-sampling, re-quantization, and dithering distorting.

## Detection Disabling Attacks

Detection disabling attacks directly destroy the watermarking information, for example, in disturbing the correlation process. Such a watermark attack usually bases on geometrical pixels or blocks shifting or direct modifications. Examples are scaling, rotation, cropping and inserting. One of the most famous attacks is based in the StirMark simulator, which destroys the watermark information in using randomly selected spatial modifications or a combination of other attacks.

### Ambiguity and Removal Attacks

Ambiguity attacks disable the watermark by inserting a new, overlapping watermark in the source document. In inserting multiple watermarks, the use as mechanism for intellectual property applications can be hindered. Let's consider a document marked which Bob's and later on with Alice's watermark information. In this case, it is impossible to determine the originator of the document. Such attacks are related to the use of intellectual property application. Removal attacks analyze the watermark, estimate the technique or watermark and try to extract the watermark in order to delete it. In this case, statistical applications are used to analyze the source material.

## Problems of Digital Watermarking

Digital watermarking techniques are already effectively used in associated copy control applications and broadcast monitoring systems. In combination with digital rights management frameworks they can solve the limitation of the intellectual property dilemma in audio and image related business areas. However, the main intellectual property problems cannot be solved by all existing watermarking methods. Watermarking techniques behave differently on attack operations or applications. Simple non-complex methods described in Kutter et al. (1997) are not very resistant to JPEG and JPEG 2000 compression, but resist against normal image operations. Complex and difficult watermarking techniques based on discrete, fast Fourier or wavelet transformations are in contrast very robust against compression techniques, but have a lack of resistance in normal image operations. Today, most watermarking methods cannot reach the main approach. It is still a wide and attractive field for further research, in which innovative methods and techniques may be established.

## Conclusions

As a result, we summarize that the watermark technology is still at the beginning of its development. Most watermark algorithms cannot tackle the attacks. Even

the friendly attacks in the form of usual file modifications can easily destroy the watermarks or falsify them. Therefore, a desirable watermarking algorithm should not rely on a certain method, but it could insert watermarks repeatedly in different ways (using least significant bits, frequencies or colour and contrast relations), so that at least one of them survives an attack. After embedding in an image has taken place, a watermark should be refreshed automatically. The jurisdiction has to accept a digital watermark as permissible evidence for copyright infringement. Besides, organizational frameworks are necessary to be able to put through the author's claim. Corresponding to the law and authorization problems, infrastructures are also demanded for the key management and time stamp services.

Meanwhile, several European projects work on copyright protection and its realization in the digital world: CITED (Copyright in Transmitted Electronic Documents), a part of the ESPRIT program, encloses access and user control (CITED, 1993). The system is put on exceptional flexibility; it accepts all widespread operating systems and can be applied for access over computer networks. COPEARMS provides a uniform standard to guarantee the copyright of digital documents (COPEARMS, n.d.). COPEARMS cooperates closely with another EU project, named IMPRIMATUR (IMPRIMATUR, 1999). The project takes care of the secure transmission and payment of documents, including authentication. Especially this year a significant increase of activities can be determined. Microsoft is planning to develop its Palladium operation system, apple.com is successfully operating its music download platform, yahoo.com is trying to complement the same area with audio and video streams, and real.com and Microsoft (Windows Media Environment) establish digital rights management extensions partly based on digital watermark technology in their products. Such activities clarify the importance of digital watermarking, especially in combination with digital rights management, and offer opportunities for further research activities. However, although the main argument for digital watermarking is linked to enable and secure business activities, like distribution of goods over networks, in the public and middle class domain, it seems that digital watermarking is primarily supported by mighty, international interest groups. Therefore, we suppose that digital watermarking is dominated by such initiatives and running applications will be supported by them, before the public domain can use the benefits of such technology.

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## Chapter VII

# Integrated Domain Model for Digital Rights Management

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## Abstract

*Digital Rights Management (DRM) is an issue of controlling and managing digital rights over intellectual property. It has recently broadened its scope from being merely a content protection concern to description, identification, trading, protection, monitoring and tracking of rights over tangible or intangible assets. In our study we found out an essential problem of the domain: lack of models on an appropriate level of abstraction needed to support research and system development. Modelling, identifying and describing the core entities enable the rights management functionalities. This chapter contributes in recognizing the principal entities and providing detailed description on current identification and*

*description matters and solutions. Our analysis results in the remark of distinguishing the evolution stages of digital content and separating the different offers and agreements through which the rights are traded between the value chain participants. Based on the depiction of the domain model, this chapter additionally gives insight into the future trends and issues on the DRM domain.*

## Introduction

Manual methods of managing intellectual property rights over organizations' assets are well established, although somewhat inefficient. Digital environment creates new challenges by disabling the inherent control over physical objects that organizations had with legacy media and, thus, the conventional management and securing of assets no longer applies. On the other hand, creation and distribution of digital media – for example, documents, audio, video and multimedia in digital format – offers opportunities for increased efficiency and additional revenues in certain industries (National Research Council (U.S.), 2000; Rosenblatt, Trippe & Mooney, 2002). At this time, creation and management of digital content itself has become uncomplicated. However, efficient and effective management of intellectual property rights in a digital environment is to date a complicated issue.

The worst scenario for those involved in digital content creation and commercial utilization is that the copyrights and rights to those assets can be infringed upon on a large scale. Misuses of digital products or confidential information may occur:

- as individual consumers are distributing content in peer-to-peer networks or in a business-to-business environment, within client company and/or between two companies;
- within a company, where a department uses copyrighted content from shared databases, being unaware of the restrictions of content usage;
- on the creators' side, for example, creator company operating in several business networks utilizes the assets or knowledge created in one network throughout other networks or similar exploitation in case of individual creators.

Altogether, losing control over digital assets and their intellectual property rights proposes an enormous risk. Besides the threats that the digital environment has brought about, also control may fail, as information management, workflow and operations relating to management of intellectual property rights in business and in technical environments are inadequately organized and cumbersome. Taking the perspective of an individual (either on the creators' or consumers' side or within the company), the easier it is to violate the honouring of rights and the more valuable misused content is, the more typical are the abuses of content.

Traditional management of intellectual property rights in a digital environment is based on prohibiting access to the content in case a customer does not comply with requirements, for example, payments or registration and logging in. This is facilitated by various encryption and security methods (see e.g., Erickson, 2003; Molva, 1999; Trusted Computing Platform Alliance (TCPA) specifications at *http://www.trustedcomputing.org/* [July 2003]), which force content providers and media distributors to select business models according to the available technology (Rosenblatt et al., 2002). Since success in electronic commerce seems to depend on the business model companies select, a common conclusion is that the balance of technology and the way of doing business should be the other way around. Additionally, current DRM methods can considerably reduce customers' ease of use; in other words the usability of products, particularly in cases where cumbersome procedures to obtain access to content are required or there are several incompatible standards and software.

Given the opportunities, threats and disadvantages, the research domain, currently associated under the term *Digital Rights Management* (DRM), has developed from an immature consideration of digital products' protection to identification, description, trading, protection, monitoring and tracking of digital rights over assorted assets, either tangible or intangible (Iannella, 2001). Moreover, in addition to legal and technical issues, digital rights management thus incorporates, for example, sociological, business and organizational matters (Guth, 2002). Given the variety of different perspectives and novelty of the domain, the research still is focused on specifying more complete business requirements from which the technical requirements may be derived.

However, fulfilling such tasks with the intention of providing a comprehensive solution sets high requirements to the development of an effective holistic DRM system, which is to be integrated with current operational systems. Conceptu-

alizing and formalizing the management in order to support organizational change and information system development is needed. Moreover, the assignment of the requirements to the system is challenging, as the domain lacks sufficient overall picture with a desired level of abstraction applicable to various situations and to describe the definitive characteristics of the domain elements. We therefore provide a depiction of an integrated domain model in relation to the current separate research and the standard development activities. Additionally, we make available a model for examining the digital rights management domain in terms of information management. Our scope to the rights management issues is on assets in electronic form, which is to say, on the content that is easily created, managed and traded in the digital environment.

Traditionally, copyrights have protected organizational assets against those parties out of the asset owners' reach. However, in the digital world rights and obligations related to asset usage can be negotiated and agreed upon in a comparatively straightforward manner, even with an individual consumer. In addition, the honouring of rights and obligations described in the agreements may be monitored and enforced more effectively. Thus, the following presentation should be read keeping in mind that in the digital environment the value of agreements (or contracts) assigned between parties will be emphasized. Consequently, below a particular importance is given to a novel way of describing agreements, rights and obligations through *digital rights expressions* (Rosenblatt, 2003). These expressions consist of information concerning copyrights and usage rights, and parties involved in creation, trading, distributing and utilizing assets. The expressions define which, how, by whom, where and when the assets may be utilized.

We start by defining the central information elements in digital rights management. For this purpose, we make use of the depiction of a profound framework to describe a domain from a commercial perspective and framework to define different dimensions for assets. Then, the following sections introduce the integrated domain model for digital rights management, and its essential entities in detail with their relationships and attributes. Along with the illustration of the model, various data schemes and standards are introduced, providing directions for those studying DRM. Finally, we conclude our discussion on the implications of the domain model and on the future trends and issues for the digital rights management domain.

# Existing Frameworks for DRM

Renato Iannella has pioneered the DRM domain and proposed a functional architecture for DRM that identifies three groups of digital rights management activities (Iannella, 2001). In the first category, intellectual property asset creation and capture, the underlying question is how to manage the creation of content and rights so they can easily be traded. This category is further segregated into tasks, which are applied to ascertain the confirmation of rights to re-use the existing content, to assign rights to owner(s) and rights to new content and which allow processing of content through workflow steps for review and approval of rights. Basically, the latter implies rights expressions to be stored and managed in a way that they may be efficiently used later.

Intellectual property asset management group includes repository and trading functions. Repository functions are applied to authorize access and retrieval of content and their relating metadata and rights descriptions in databases. In the upstream processes, content is accepted from the creators and added into content management system. On the other hand, trading functions enable the assignment of licenses or selling outright by agreements for rights over content. These functions moreover comprise management of payment data flows and, if required, content may need to undergo specific fulfilment operations to satisfy agreement provisions - for example, content is packaged and protected for particular usage. The third activity group according to the Iannella's functional architecture is the intellectual asset usage. It consists of permission management enabling the usage environment, for example, rendering applications, to enforce and honour the rights for utilizing the content according to the provided rights specifications and of tracking management responsible for monitoring the usage of content in case tracking is required in license conditions. This task also involves tracking and recording of trading transactions.

The introduced activities of the functional architecture may be reflected to the digital media management value chain and divided among value chain participants. Such analysis concludes in separation of intermediaries' roles and establishment of three broad categories of processes concerning digital rights management (Pagani, 2003):

- Content processes that shall enable the creation, capture, formatting, packaging, protection and storage of assets and that shall provide control over when and how content is utilized.

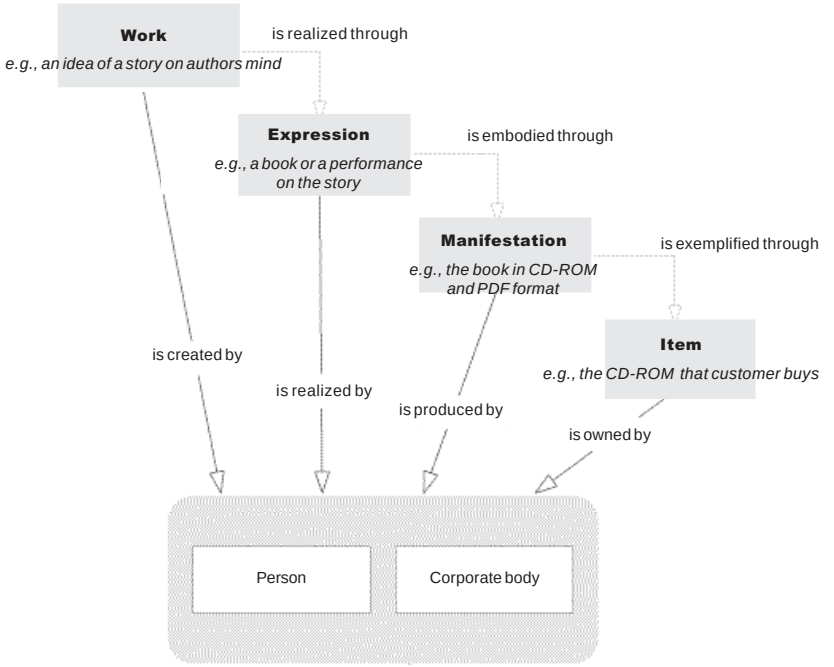
- Finance processes that shall enable players along the value chain to receive return for their investments, for example, through a financial clearinghouse.
- Rights management processes that shall enable authorization of utilization for distributors and customers, for example, through a content clearinghouse.

An existing work describing DRM entities and their relations is presented in the framework of the <indecs> project (Rust & Bide, 2000). Their contribution is based on the assumption that the complexity of intellectual property rights information could be handled through generic models identifying fundamental concepts with high-level attributes. The generic framework divides and identifies the principal entities, which include parties, rights and content. As these entities are examined from a commercial point of view, their relationships are described as follows: *parties* hold and trade *rights* over the *content* and *parties* create and use *content.* The very same central entities for DRM may also be found from existing agreement documents. Basically, an agreement document consists of the subject of the contract that corresponds to the content, of the parties entering the contract, of the agreement terms (i.e., rights expressions) and of an indication of parties' approval on the terms of the contract.

This presentation, despite of its abstract nature, provides a basis for the following discussion. With reference to Iannella's DRM functionalities above, definition of entities clarifies the needs of what is to be identified and described (parties, rights and content itself), what is traded in the domain (content and rights related to it), what we should protect (content and rights for infringements), and what is necessary for monitoring and tracking (usage of content and honouring the rights). Rust and Bide stress the importance of identification mechanisms and descriptive metadata and the reason for this is obvious. Identifying and describing the entities with proper metadata enable DRM functionalities.

The International Federation of Library Associations (IFLA) has made available a valuable framework to observe and model contents' development throughout its evolution stages from an abstraction to a realization (Plassard, 1998). The framework depicted in Figure 1 enables the properties of creation to be identified through four stages of the lifecycle, beginning from the most abstract: work, expression, manifestation, and item dimensions.

*Figure 1. Four dimensions for the creations and their relationships*




These stages are situated on a scale "idea – experience". The idea is the intellectual, creative process and simultaneously the abstraction, which is the foundation for all the creations. The other end of the axis, the experience, represents the view of the customers over the creation. Work corresponds to the most abstract level of a creation; thus, a work is not an identifiable entity and it can be caught only throughout its expressions. An expression together with a specific media and format embodies a manifestation of that particular creation. An item is the entity, which finally ends up into the consumers' hands. Each of the items is individual even if they would exemplify the same manifestation.

The notion of these different lifecycle stages offers some valuable viewpoints for considerations in terms of content identification, description and trading. Within its lifecycle, a creation serves several purposes, at first being a realization of its creator's intellectual effort, a content entity. Then the content entity or several entities are transformed into a product available for exploitation and use, and in the end, the copy of the product is offered to the customers

as something concrete and an experience worth paying for. Therefore, associated with the creation, we find a need for separate identification and description schemes for different dimensions. Moreover, at different stages of evolution, diverse rights holders can be distinguished.

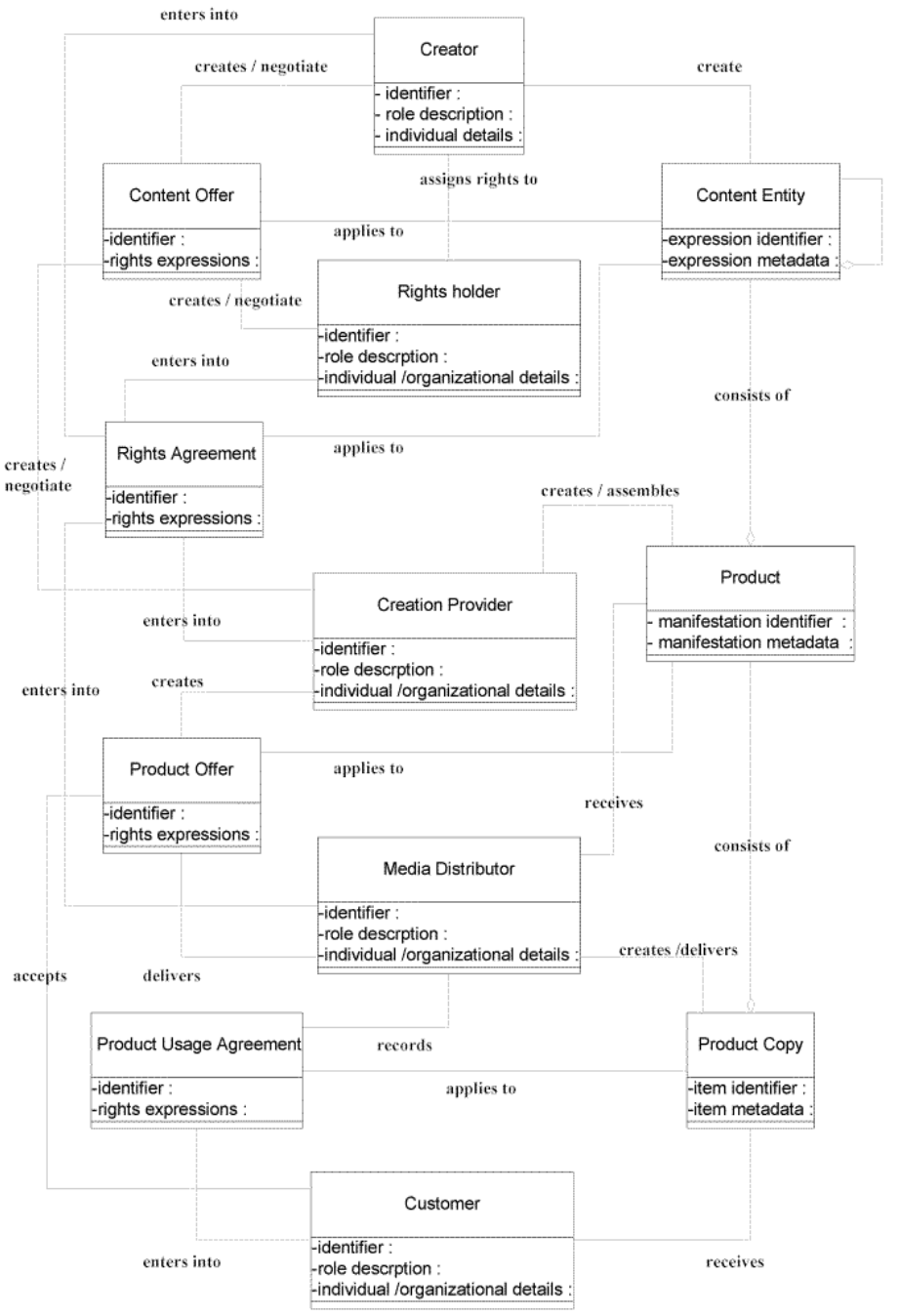
## The Integrated Domain Model for Digital Rights Management

Despite the acknowledged contribution of <indecs> and IFLA's frameworks, they by definition cannot be used to capture and analyze the requirements of the development of a DRM system. Data collection, processing and management needs for DRM may be elaborated as the commercial view is considered with the evolution aspect and the definitive characteristics of the domain's entities.

To demonstrate our integrated domain model, we make use of the basic notions in the object-oriented discipline. Constructing a domain model is one of the fundamental tasks of object-oriented analysis methods. Moreover, we see similarities in the basic principles of object-orientation and the needs for identification and description of entities in DRM as discussed above. The unified modeling language reference model (Jacobson, Booch & Rumbaugh, 1999) defines an object to be an entity with a well-defined identity assigned by the system. This recognition mechanism enables an access to the properties. In addition, the reference model suggests that an object's structure is to be described through its attributes. We do not suggest object-orientation to be the most suitable for the implementation of DRM systems. Rather, it provides a valuable tool for illustrating and visualizing the substance of the domain. In the domain model (see Figure 2), we use a notation of UML class diagram and deploy introduced DRM frameworks in the context of a business model (a basic value-chain).

Entities in the domain model represent the basic actors in the content production value chain, different realizations of a creation through its lifecycle, and rights descriptions evolving from offers to agreements describing permissions and obligations of the content usage. In Figure 2, presenting the integrated domain model, different categories are organized in a horizontal axis. The leftmost column characterizes a category of essential offers and agreements for digital rights management. Basically, these refer to documents that embody the

*Figure 2. The integrated domain model for digital rights management*



negotiation and confirmation of the copyrights and usage rights transfer. The model accordingly divides agreements into those assigning:

- copyrights, for example, rights to make copies of the content, to modify and aggregate several pieces of content, to perform required content management functionalities, to distribute copies and sell them in order to commercially exploit content;
- usage rights, for example, rights to display the content on end-user device, to render multimedia, to print a document, and rights to re-use the content that is common in academic communities.

Entities in the rightmost column represent the evolution stages of digital content processed and used by the value chain participant that are placed in the middle. The evolution of content in a value chain leads us to the finding that different type of descriptive data must be applied for each of the stages. Additionally, we classify the subjects to different agreements reflecting the right level of abstraction for the creations. As an example, the creation provider may generate different products from one content entity according to the rights acquired from the rights holder. Or, the content provider assembles content entities into one product having multiple rights descriptions relating to it.

The entity characteristics are represented in the domain model as attributes consisting of the metadata describing the content, the details and the roles of organizations and individuals, as well as the details of offers and agreements described in digital rights expression language. The different dimensions of the creation are taken into account in the description of the material metadata. Also, the identifiers are seen as attributes of the entity. When applying the model, one should be keep in mind that identification schemes may vary according to the nature of the entity. The complicated issue is not the selection of metadata standard or scheme to apply. If anything, it is an issue on how the scheme should by applied with different dimensions of the creation. On the expression level the creation may have general metadata associated with it, while the product manifestation will have more data attached to it – metadata describing the media and format used – and on the product copy characteristics of the single item shall be appended. Again, as the creation consists of several individual parts, different metadata on expression and manifestation levels exist.

Associations between entities follow the straightforward rules of the <indecs> framework. Accordingly, there are always parties holding and trading rights over content, which is created and used by the parties. However, the model provides a more detailed view to the DRM domain as it considers the evolution aspect of both content and agreements in context of the business model. Further, associations point out the DRM processes performed to create the introduced entities – negotiations and assignment of rights and obligations. There are minimal associations between the parties, since the parties are connected to each other by the means of offers and agreements. Further, this implies that the content metadata have references to the rights descriptions and vice versa.

# A Detailed View to Identification and Description Needs

## Identification and Description of Content

*Metadata,* generally known as data about data (Gardner, 1998), are regarded as a necessity in organizing, searching, retrieval, representation and utilization of information as it has been prior to computerization (Gilliland-Swetland, 2000). Research issues on DRM have various linkages to the general field of metadata research. This is due to the close relationship between content and rights expressions, as presented in the framework of the <indecs> project. Traditional research and practice on the identification and description as well as the management of metadata have naturally concerned the actual content. Thus, there are several established identifier and metadata standards for particular purposes.

However, techniques used for identification in the traditional environments cannot necessarily be transferred directly to the digital world. One downside of traditional identifiers is that they consider creations at the manifestation level – an identifier is assigned to content as it is transformed into products. Nevertheless, in the digital environment we need to identify creations also both at the expression level as well as at the item level, in order to enable monitoring and tracking functionalities. Further, we need means for uniquely identifying individual parts in complex composites consisting of several unique content

*Table 1. Existing metadata standards and schemes*

| |
|---|
| **The Dublin Core** scheme provides a metadata set that is intended to facilitate the discovery of digital documents and images and support interoperability amongst heterogeneous metadata systems. The Dublin Core standard includes 15 attributes, which are commonly agreed to be the most essential metadata standards. Moreover, the attributes have several qualifiers greatly extending the possibilities (Weibel, 1998). |
| **MARC** standards make up the foundation of most library catalogues used today by providing the mechanism by which computers exchange, use and interpret bibliographic information and its data elements (Furrie, 2000). |
| EDItEUR is developing **ONIX** Product Information Standard (2001) to homogenize the product information of books mainly for the needs of the publishing industry and e-commerce. |
| The Learning Object Metadata (**LOM**) standard is being developed by IEEE's Leaning Technology Standards Committee (2001). The standard aims to define the minimal set of attributes needed to manage, locate and evaluate learning objects. |
| National Information Standards Organization (NISO) and AIIM International are currently working on a data dictionary (**NISO Z39.87-2002 AIIM 20-2002**) that is to define a standard set of metadata elements for digital images (National Information Standards Organization, 2002). The specification makes reference to TIFF/EP (ISO/DIS 12234-2), and the **DIG35** Working Group's Metadata for Digital Images, which focuses on providing digital image metadata standard to support efficient management of individual images. Please refer to *http://www.i3a.org/i_dig35.html* |

entities, or even further, parts of content entities (see Erickson, 2001). Open standards, including Uniform Resource Identifiers (Berners-Lee et al., 1998) and Digital Object Identifiers (Paskin, 2001) aim at tackling some of these issues. For our purposes, recognition of identifiers applicable to digital material is a necessity for each dimension and for parts of composites.

In accordance to the development and applications of metadata, the objectives and motivations differ greatly between different interest groups. Currently, for several vertical industries, there exists an appropriate metadata scheme or development activity. These may describe the same subject, for example, educational material, with a different set of information. The following Table 1 introduces some widely used schemes and for referencing purposes.

## Identification and Description of Parties

The users of a DRM system have to be identified and their roles recognized in order to approve both the individuals and those representing the organizations involved in the content provision and in order to perform their role specific

operations. At present, a few recognized standards for such purposes prevail – for example, vCard, X.500, ONIX and MARC standards include proper mechanisms (Dawson & Howes, 1998; ONIX Product Information Standards: Release 2.0, 2001; Weider, 1992).

In rights management, roles represent the basic activities in the trading of intellectual property rights by initiating or facilitating the flow of rights, payments or other information (IMPRIMATUR, 1999). To legitimate the individuals and agents to perform their role- specific operations, actors of the system have to be identified and their roles have to be recognized.

A creator wishes to circulate her creation and, as a result, assigns her rights to exploit the creation to the creation provider with an agreement. Optionally, the creator may have assigned her rights to some other legal entity; thus, the agreement will be made between the third party rights holder and the content provider. Although a creator is the initial intellectual property rights holder, here the roles of the creator and the rights holder are differentiated, as their aims are either to create or protect intellectual property. Rights holders' main activity is therefore to license the use of the creations as well as to grant permissions related to the usage of the creations. IMPRIMATUR suggests that the defining characteristic of the creation provider is responsible for making a creation available for exploitation or use, in other words, making products. Additionally, the creation provider operates in various functions concerning the control and management of the creation, payments and intellectual property rights.

A media distributor's task is to establish the trade of creations on behalf of the creation providers in order to meet the needs of the customers. The media distributor's role may take responsibilities in packaging the product for distribution and delivery, in facilitating and reporting on sales and payment transactions and in providing marketing functions for the customers. However, the basic responsibility of the media distributor is to deliver product copies to the customer. Therefore, media distributors also enter into rights agreements, which declare their rights and obligations concerning the distribution of content. Finally, value to the chain is returned as customers acquire the product copies.

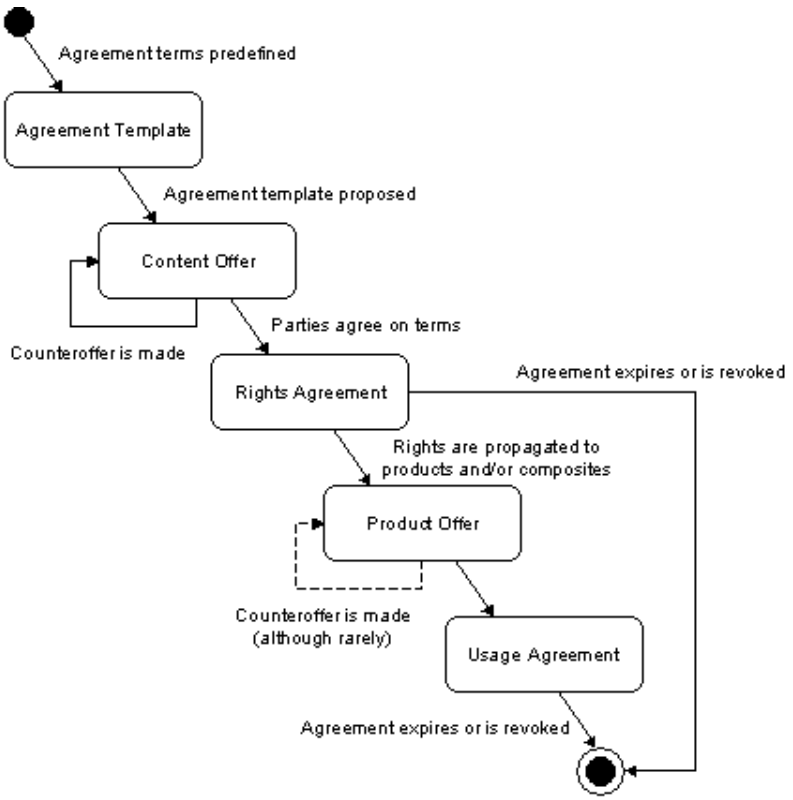
Considering description of parties, a brief analysis revealed that there are numerous schemes in use and available in variety of frameworks. For that reason, we recommend focusing on the issues of identification and authorization of parties for DRM functions and selecting (or maintaining) the descriptive scheme according to organization's data gathering needs.

## Identification and Description of Rights

Once the fundamental roles with their attributes relating to identification and description are recognized and the type of digital content these roles produce clarified, we may discuss their effect on rights expressions. Negotiation on the terms of the trade will be carried out as parties choose to circulate and acquire the content – offers between parties are created and possibly modified. Once parties accept the terms of the offering, they enter an agreement specifying who (party) acquires what (content) on which terms (rights expressions).

Agreement terms, rights and obligations concerning the content undergo a certain lifecycle as they are distributed and handled through the value chain. Basically, the current rights management processes involve predefined agreement terms that are stated in the agreement template (Milosevic, 1995); thus,

*Figure 3. Lifecycle of agreement terms as a state diagram*



the negotiations relating to assignment of creators' copyrights are handled as in Figure 3, employing agreement templates. An agreement template is considered as the initial content offer to the creator or other rights holders and the rights agreement is usually formed with minor modifications and selection of options given in template. In current DRM processes the idea of templates is adopted into downstream trading of content and rights. Several product offers with different rights expressions may be formed having a single piece of content as the actual product. Corporate parties may consequently select a proper business model – for example, subscription, paid downloads or usage metering – for their digital products. However, proper mechanisms to adopt the common real-world way of transferring rights are currently missing. Further, as corporate parties are only allowed to operate according to the rights they have managed to acquire, it should be taken into account that rights and obligations must be propagated from the rights agreement to products, possibly consisting of several content entities.

Rights expressions, considered to describe the agreement terms, consist of permissions, constraints and requirements of material utilization. Permissions are connected to the usage of the material (e.g., permissions to display or print the material), to downstream transfer of the material (e.g., permissions to sell or give material forward), to content management (e.g., permissions to save a copy or make a duplicate of the material), and to the reuse of the material (e.g., permissions to modify or aggregate the material). Permissions can have constraints. The rights holder may wish to assign the material to a single group of individuals, constrain the usage to some IP address space, constrain the maximum period of time that the material will be accessible and so on. Moreover, the rights holder may desire some consideration concerning the utilization of her material; that is, the payments that may occur for example per-use or before utilization of the material. Since corporate parties may only operate according to the rights they have acquired, the agreement terms product offer are propagated from rights agreement made earlier. As the digital rights are transferred and traded between parties in a given business model, the permissions tend to decrease, while the constraints and requirements tend to increase.

Table 2's terms reflect the possibilities of a currently evolving rights description language, Open Digital Rights Language (Iannella, 2002). One similar development activity is in progress: eXtensible Rights Markup Language (ContentGuard, 2001). Like its competitor for the standard, XrML attempts to provide "a general-purpose language in XML used to describe the rights and

*Table 2. Structure and basic elements of rights expression language (Iannella, 2002)*

| | |
|---|---|
| **Rights** and obligations are expressed as **Agreements** and **Offers** that further contain **Permissions** | |
| **Permissions** divide into four categories | |
| Usage Permissions | Permissions to display, print, play, execute content |
| Transfer Permissions | Permissions to sell, lend, give, lease content |
| Asset Mgmt. Permissions | Permissions to move, duplicate, backup, save, content |
| Reuse Permissions | Permissions to modify, excerpt, aggregate, annotate content |
| Permissions may have **Constraints** which divide into following categories | |
| User Constraints | Constraints permission to specific individual or group |
| Device Constraints | Constraints permission to specific CPU, network, storage |
| Bound Constraints | Constraints permission to specific count, range |
| Temporal Constraints | Constraints permission to specific date & time, interval |
| Aspect Constraints | Constraints permission to specific format, unit, quality |
| Target Constraints | Constraints permission to specific purpose, industry |
| Rights Constraints | Constraints for the downstream transfer of content |
| Permissions may have **Requirements** which include the following: | |
| Payment Requirements | Requirements describing an amount of the payment, currency and if the amount is due prior to, after or for each the granting/use of the rights |
| Interactions Requirements | User is required to agree to textual information or must register their details with the party providing content |
| Usage Requirements | Includes requirements of attribution of content owners and whether a party will be tracked for the content usage |
| Permissions may have **Conditions** that, if become true (or occur), revoke the Permissions | |
| Permissions | Indicates the set of permissions that will trigger the revoking |
| Constraint | Indicates the set of constraints that will trigger the revoking |

conditions for using digital resources". Moreover, the semantics of the core elements in these two are vastly similar. Digital rights data in the delivery channel confine or enable, depending on the point of view, consumers to use the material in the way defined in the rights descriptions. Such enforcement and possible tracking of digital rights through special technologies strives to govern digital rights data in a reasonable way.

Although the above depiction of the basic value chain suggests that the customer will eventually pay for both the product and the value created in the chain, also a notion of business-to-business trading of products and rights is valuable, since the creation providers and media distributors both license and sell rights to the content in order to provide them to the customers. These so-called syndication processes involve providing an access to the content for some authorized intermediaries. Here, rights descriptions provide intermediar-

ies with directions from which content they may choose from and what the rights are they have approved to redistribute. The Information and Content Exchange (The Information and Content Exchange, 2002) is a known protocol sustaining syndication relationships.

Although the description of rights relating to the content has become one of the single most attractive research areas, the issue of identification should not be neglected here. The unique identification of rights descriptions enables mechanisms to build an association between the content, whether transformed into products or product copies, and the rights regarding that particular content. An inherent association between usage agreements and product copies should be kept in mind here. Possibilities of such reference mechanisms include the insertion of rights description into a package along with the actual content for interpretation of rights in the terminal device, and the search for the rights descriptions through content describing metadata with association to rights descriptions, in addition to the administrate functions. In case product copies are uniquely identified, the operations the customer performs to the content may be monitored and tracked.

## Conclusion and Future Issues for DRM

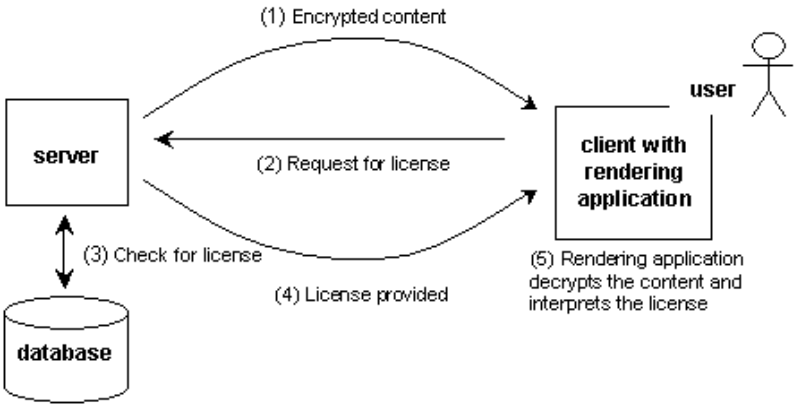
As elaborated in the introduction, creating and managing agreements in digital format is vastly attractive in certain industries where digital agreement details are to be distributed and handled between several organizations. In order to serve the rights holders, publishers and distributors, the DRM system should support and enhance processes generating and maintaining individual and organizational data, metadata describing the content and digital rights expressions, which stand for different offers and agreements between stakeholders. The domain model constructed here presents data collection, processing and management needs for digital rights management. It is therefore a valuable tool in specifying requirements for a comprehensive management system and in conceptualizing the domain for those influenced by the organization change that managing of intellectual property rights in a digital environment requires. Additionally, the model clarifies the need for a separate identification and characteristics description of offers, agreements, value chain participants and content through its lifecycle. Such data in digital form supported with suitable processes will improve rights clearances and trading of rights over content as

they occur in various different situations. Moreover, improvements may be gained in the control of access and use of material, and in rights tracking and monitoring.

The domain of digital rights management systems is in a phase where early adopters of the technology have implemented information systems supporting distribution of digital content over the Internet by using a variety of software tools intended for protecting content from unauthorized use. Figure 4 presents a typical DRM application workflow at delivery channel, where before presenting the digital content, the customer is first required to have permission to use the content. Then, rendering applications interpret the specified digital agreement terms, for example, in licenses, indicating whether and how the user of the application is allowed to access and utilize the content.

A large variety of software tool providers have offered systems focusing on content packaging using encryption techniques with many of them withdrawing from the business. So far the tool vendors have mostly been using in-house schemes for identification of content units and description of rights associated with the product package, but are paying *increasing attention to standardization*. At this stage it is fully feasible to implement business models based on digital distribution of content, but it requires careful matching of the business requirements, the processes, roles of parties in the business chain, and the

*Figure 4 . DRM application workflow*



technologies available. The domain model presented here provides a framework for splitting up the field into roles of the parties, the processes to be implemented, and for choosing the schemes used for each interface needed.

From the business perspective the contemporary research is emphasizing the business models to be used and harmonization process of the constraints set by national regulation and international treaties. Both legal and social factors need to be considered in this research. *Finding out the business models* the *consumers* are willing to adopt will have major impact on the technical side, on the content protection means and on the *core features of digital rights description languages* to be implemented uniformly in content packaging and delivery systems. These vary from the physical form factor of the devices to be used for consuming the content, varying from PDA, i-mode mobile handsets in Japan, and other mobile devices to personal video devices (PVD) used with digital TV equipment. Thus it seems likely that either one of the description languages used for rights descriptions will gain a position of a de-facto standard or a common subset of features used across a wide variety of platforms will emerge.

The development of standard business models for e-commerce on digital content will also be needed to *find a standard set of role descriptions* to be used in technical implementations and system components of information systems supporting content business models. Out of the variety of schemes for role description elaborated in this chapter, none has so far gained wide acceptance to the extent needed to establish itself as a mainstream de-facto standard. Further research effort will be seen for example in the area of *defining standard business process descriptions* for content trade in the form of Business Process Specification Schemes (BPSS) of the ebXML language (ebXML Core Components, 2001).

So far the commercial tools supporting use of DRM technologies has emphasized content packaging and protection while little tools are available for *trading content in between organizations* and for *acquiring rights descriptions from the content producers*. Trading content relates with the management of large volumes of rights descriptions possessed by an organization with the associated content and metadata. The content management systems implemented so far do provide features on managing the content with metadata and associated workflows, while they generally lack functionality needed for exchanging offers and agreements with associated rights descriptions and metadata in a standard format. This is much due to the lack of commonly adopted standards for representing these. In the area of *content identifiers* the

trend seems to be going from a vide variety of identity schemes towards use of URI as the interchange format. Dublin Core is probably the most common interchange format for metadata. However, in role descriptions and rights descriptions the situation is still much more open.

Along with the *standardization of schemes* to be used in *managing volumes of data related to the content*, more research and tools are needed for solving *transformations* of content descriptions, right descriptions, and metadata from one format to another. For example, the content described using metadata in MARC format will contain elements not present as such in Dublin Core metadata scheme. Or when an element with similar semantics exists, the cardinality, domain or encoding of the value or values may be incompatible, requiring use of mappings in between enumerated value domains or similar approaches related to research on integration of federated databases and enterprise application integration. In these cases also research and practical techniques are needed for mapping identifier schemes, resolution of identifiers, and certification of participants.

Assuming that an organization has the means to manage a uniform or a heterogeneous database containing the data needed for rights management of the content under possession of the organization, the next question is on *protocols for providing access to the data for external parties*. This includes concerns on business processes to be supported, technical aspects on implementing the processes and on publishing the process to other parties, for example in the form of ebXML BPSS business process descriptions published in a registry or UDDI, technical concerns on processing queries on metadata and right descriptions on the content another party desires to use, as well as concerns on security. All these aspects need to be considered in each case by each organization, while the standardization process is still under way. They also provide fruitful starting points for further research.

In case agreement terms are to be distributed and handled digitally, it is useful to *capture them into digital expressions* once they are assigned to corporate parties. This will enable automation of rights transfer processes in the following lifecycle phases as the terms of agreements can be retrieved, transferred, and manipulated by computers instead of elaborate manual processes. Besides the advantages gained through digitalization and automation of information management, digitalized agreement terms will be utilized with the content in digital delivery channel.

Currently, there are simple approaches to *produce digital expressions*. However, the current approaches reflect the way those languages express

rights rather than actual agreement templates and agreement. Selection of terms is carried out with selection elements having values directly from the expression scheme. In contrast, creating agreement templates and agreements for the exchange of assets requires both legal expertise and an understanding of business models and agreement documents that must conform to the legal foundations and reflect the corporation's or organization's way of operating. Thus, a need to use formal natural language still exists. On the other hand, the representatives of parties call for straightforward creation of agreements through selecting from available, predefined agreement terms and through minor modifications to the terms, if necessary. This applies for both the initial assignment of creators' rights to corporate parties and for the distribution of rights to utilize the content between corporate parties and customers.

The problem domain of *creating digital agreements* can be elaborated further. A need exists for providing a DRM applications and a method that allows the creation of agreements in digital environment that conform to the requirements set by legal and business matters of contracting. Further, a need exists also for a solution that allows creation of digital agreement templates that include possible agreement elements and parts, and from which the agreements may be created in a straightforward manner through simple selections and minor modifications. Additionally, we are required to capture the terms of agreements to digital expressions in order to enable the digitalization and even automation of distribution and handling of the agreement terms. Such capturing must produce a set of digital rights expressions according to a standardized schema, which may be interpreted by information processing systems and on the digital delivery channel by rendering applications enforcing rights and obligations. Moreover, a need exists for efficient means to distribute and handle evolving agreement terms between numerous parties.

Altogether, the contemporary domain of DRM provides business opportunities for early adopters as well as a multiplicity of interesting research questions. The domain model presented in this chapter enables elaborating the areas to be covered by projects implementing operational systems. It also draws attention to specific research questions.

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## Chapter VIII

# Rates of Change in Ad hoc Networks

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## Abstract

*Ad hoc networks are inherently dynamic, with nodes entering, moving around, and leaving the network, often for short duration membership. This property of dynamic restructuring limits functionality and greatly complicates security. Here, we establish a foundation for analyzing ad hoc network functionality or security properties relative to their dynamic nature. The essential structure in any network is the links between nodes. Thus, our approach turns on measures of link availability to define network properties that govern functionality. In this chapter, we systematically address issues associated with changes that occur in ad hoc networks. We consider the functionality impact of change and address bounds on optimization that exist when change rates are high and provide definitions that allow reasoning about limits on functionality resulting from increasingly dynamic link activity.*

# Introduction: Dynamics of Ad hoc Networks

Networks come in all shapes and sizes, with a wide variety of characteristics. We are concerned with networks that have no permanent structure; essentially, all nodes are not only mobile, but they characteristically regularly move about. These networks are comprised of nodes with limited transmission ranges and depend on other nodes to relay traffic in order to expand their broadcast domain. We commonly term these *ad hoc networks* because networks form, change, and dissolve in an ad hoc way, often and quickly, and as a matter of routine. The networks that they form are often highly dynamic.

This chapter addresses questions about functional limitations that high and fluctuating rates of change cause in ad hoc networks. Others have studied this question empirically (Obraczka, Viswanath & Tsudik, 2001), but there is little theoretical foundation for predicting or analyzing network functionality as a factor of network rate of change. The focus of this chapter is to identify and analyze the theoretical limitations on functionality in highly dynamic ad hoc networks.

In the rest of this section, we systematically set up the discussion by defining key terms and follow with an argument about the important metrics and the bounds that apply given assumptions about these metrics.

## Nodes, Links, Networks and Notation

Ad hoc networks are collections of nodes that intercommunicate by relaying messages across peer-to-peer links. We label our nodes in capital letters, while links are pairs using the lower case letters that correspond to the nodes that the link connects. Thus, a link between nodes A and C is represented as (a, c), or equivalently as (c, a) since, with no loss of generality, we assume all links are bidirectional.

A network consists of a collection, or set, of interconnected nodes. We label networks with upper case letters from the end of the alphabet, so we may say that nodes A and B are elements of network X:

$$\{A, B\} \in X$$

and that if bi-directional link (a, b) exists, it is also an element of X.

$$(a, b) \in X$$

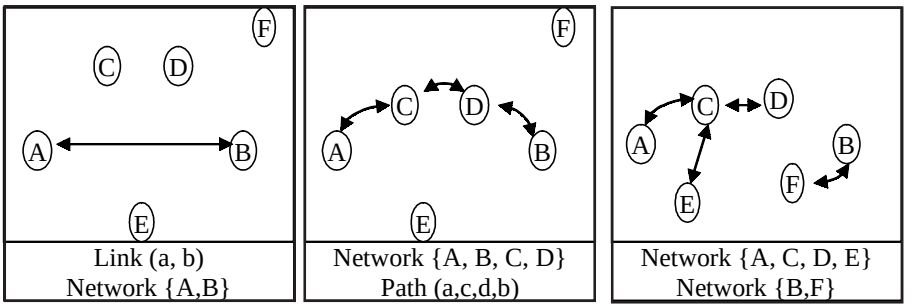
We define a path as a set of interconnected links that connect two nodes. Paths are represented as ordered tuples, with the number of entries dependent on the number of links that must be crossed. Thus, a path from A to B that must go through C and D (in that order) would be labeled (a, c, d, b), or equivalently (b, d, c, a). These relationships are casually illustrated in Figure 1.

## Network Structure Rate of Change

The ad hoc nature that is a primary characteristic of the networks we consider results in dynamic networks. As the rate of change increases, the nature of these networks becomes progressively more complex. For example, when a link forms, it may join a node to a network, establish a cycle in an existing network, or merge two networks. Conversely, dissolving a single link can have the opposite effects.

We consider the specific types of network structure change in order to better understand the nature of networks with high rates of change. We note that there is presently no existing set of measures to reflect these notions.

*Figure 1.*



## Discrete Structures in High Rate of Change Networks

One way to think about network changes is to consider the network structure during static periods, as addressed in Obraczka, Viswanath and Tsudik (2001). If we define change to occur instantaneously, then we can theoretically identify the network structure at any instant and leverage the static interval between changes. In such a network, answers to the following questions are Boolean (though the answer may not be available):

- Is node A connected to network X?
- Does a link exist between nodes A and B?
- Does a path exist between nodes A and D?

Practically, network structure change does not occur instantaneously, but rather injects a "change interval" where the system neither has the previous structure, nor the next structure. These change intervals result in an additional, fuzzy variable, and thus, an additional level of complexity into systematic analysis of dynamic network functionality. In networks where the change interval can be as long as link lifetimes, it may be impossible to reason about functionality, at least in sparse networks.

Conversely, if the change interval is small, the impact on network functionality is minimal. For simplicity, we consider networks with change intervals that are small enough that we can consider them to be instantaneous, thus with little impact on our results.

Most attempts to manage ad hoc networks are based on two assumptions regarding the rate of change:

(1) The change interval is insignificant and

(2) There are long network structure static intervals that have a significant interval between relevant changes in the network structure.

The impact of the former depends on the accuracy of the latter. Functions on ad hoc networks assume that the network is static for relevant changes for a period longer than is required to complete the function. For example, a node

count function may not succeed if it cannot expect that the number of connected nodes will not change between the time that the function begins and completes.

While it seems obvious that a network function cannot work if the links are not alive long enough to do their part, classic networks were constructed under a paradigm where long link lifetimes were the norm. In networks with low rates of change and long static intervals, the change interval is less significant, since network changes occur quickly in ad hoc networks. Adding or deleting a link in a network routinely takes a few seconds at most. If the network structure is routinely static for hours at a time, the few seconds it takes to make a structural change is insignificant relative to the network structure static intervals. However, if the network structure intervals are short, the few seconds that it takes to make changes have a larger impact.

## Population Density in Ad hoc Networks

Considering the rate of change in network structure necessarily requires scope. We now consider some subtleties of how changes affect sparse versus dense networks. In general, large networks will have more changes than will smaller networks. Thus, again generally speaking, larger networks require more management effort because of the larger number of changes and the shorter static intervals. On the other hand, each link in a smaller network tends to be more important to the traffic in that network, so a larger percentage of changes are significant relative to more network functions.

Some networks will have few nodes and few links. Others will have numerous nodes, but are sparsely connected, while still others will have few nodes that are highly connected. We posit that the rate at which changes take place has different impacts in each situation. In a sparsely populated network, dissolution of a node is more likely to split the network into two or more disconnected networks than is loss of a single node in a densely populated network. Similarly, loss of a single link is more likely to separate a node from the network if the network is lightly connected (few links per node) than a more highly connected network.

Conversely, in a densely populated network, rather than experiencing network partitioning with loss of links, channels can quickly become saturated with change information. Consider a network where there are 10% node changes (add, loss, or move) every hour. In a sparse network of 10 nodes, there will be only one change per hour. A denser network of 1,000 nodes will experience

100 changes per hour. If the interval change is 10% per minute, low power, bandwidth, and other such devices may not be able to keep up with the change maintenance process in a dense network.

For the rest of this chapter, we employ the somewhat uncomfortable use of the phrase "more dynamic" to address the network rate of change. We say that a network that is more dynamic than another has a higher rate of network structural change and shorter static intervals on average. We offer a series of metrics that categorize the dynamic nature of ad hoc networks in the next section.

# Rate of Change Metrics

We now define measures of the dynamic nature of ad hoc networks. With little background to build on in this area, our metrics are simple by design, leaving rigorous definition and proof techniques to later work. Rather, we introduce building blocks that we use to make intuitive arguments about bounds on operational efficiency. We partition the metrics into the categories of architectural and application oriented metrics.

## Architectural Rate of Change Metrics

### *Link Lifetime*

The first metric that we introduce is the network average link lifetime. Links in ad hoc networks may be formed or dissolved for many reasons, but we limit the scope of the problem by recognizing only four causes of link changes in an ad hoc network.

- A node enters the network
- A node leaves the network
- A node moves, allowing a new network link to form
- A node moves, causing an existing network link to dissolve.

Changes may occur concurrently; for example, when a node moves, it may cause one link to dissolve and another distinct link to form. However, if we assume that changes are instantaneous, we can distinguish changes as one of the four categories above.

Intuitively, a network with shorter average link lifetime is more dynamic than a network with longer average link lifetime. This metric may be computed as the sum of the duration of the existence of each link that has existed in the network, divided by the number of links that have existed. We give the link lifetime average for network X with n total links in Equation 1.

$$\text{Avg\_LLt(X)} = \frac{\sum_{i=1}^{n} LLi}{n} \qquad (1)$$

The link lifetime metric is not routinely considered when planning static networks, since link lifetimes in that environment are sufficiently reliable in that very long link lifetimes are the norm. In such an environment, the most commonly used metric is the well understood mean time to failure (MTTF) metric, where link loss is always considered as a type of failure of some piece(s) of network equipment, and where the mechanical failure rates are empirically established.

In highly dynamic ad hoc networks, link loss is a routine factor in the network structure. Thus, rather than reason about the time between failures of essential equipment, we reason about the duration that links can be expected to be operationally available.

Practically, it is more difficult to compute the average link lifetime of an ad hoc network than of static networks, since acquiring complete information is unlikely. Rather than computing the average link lifetime of a network, we may estimate or assume a value for this metric and reason about the resulting impact on network functionality. It is straightforward to model link lifetime using statistical methods. By fixing link lifetime and varying the distributions and impacts of differing assumptions, we can observe the results as the link lifetime increases and decreases, as most structure and functionality metrics have a cause-effect relationship with average link lifetime. For example, link lifetime will almost always be causally correlated with node lifetime, which we introduce in the next section.

### *Node Lifetime*

The second metric that we offer is node lifetime. Each time a node enters or leaves the network, there is a connectivity impact that will likely be greater than having a single link change. The computation for the average node lifetime is similar to the average link lifetime, where m is the number of nodes that have existed in X:

$$\text{Avg\_NLt(X)} = \frac{\sum_{i=1}^{m} NL_i}{m} \tag{2}$$

### *Number of Links per Node*

We next introduce a metric that relates links and nodes: the average number of links per node. This metric characterizes the redundancy and connectivity of the target network. In a wireless network, it also characterizes the density of the network, since in most wireless networks, links are a function of proximity and broadcast range. Thus, when many nodes are within a close proximity and are within broadcast range of one another, the number of links per node increases.

When considered as a factor of change, the number of links per node metric also allows reasoning about how functionality changes as connectivity changes. Simply stated, the number of links per node is represented as the number of links (n) divided by the number of nodes (m) in the network.

$$\text{LpN(X)} = \frac{n}{m} \tag{3}$$

Network dynamic nature has a significantly different impact in sparse networks than in dense networks. In sparse networks, the primary concern is maintaining full connectivity in the face of link loss, since loss of a single link is more likely to separate a single node from the network, or to separate two sections of the network, than in dense networks. Mechanisms to address this factor focus on recognizing the vulnerability and establishing mechanisms to overcome link loss.

In dense networks, network partitioning due to loss of a single link is unlikely. Unfortunately, a different, but equally challenging problem exists in dense networks: bandwidth saturation. Regardless of the signaling paradigm, ad hoc wireless networks that are densely populated run the risk of saturation based on factors such as bandwidth available, transmission volume per node, message routing protocol employed, and the collision avoidance mechanism employed.

## Percentage of Change per Unit Time

We now return to our earlier example of the total and percent of network changes and use this metric as the springboard into talking about application metrics. We define this metric as the number of changes divided by the desired number of intervals of the selected time units. In very large (thousands of nodes) or highly dynamic networks, change may be best measured in terms of minutes, or even seconds. In smaller or more stable networks, hourly change rates may apply. Equation 4 is a mathematical representation of this metric.

$$\text{Change}(X) = \frac{\Delta m + \Delta n}{time} \tag{4}$$

Clearly, change (X) will be related to the link lifetime in a network. In fact, when combined with the size of the network, link lifetime is telling regarding the overall network change. This general metric gives some intuition about overall functional opportunity in ad hoc networks.

Still, other properties such as network size and density play a part in functionality so we need to be able to represent their impact in order to accurately analyze potential network functionality. For example, a network with 10 changes per minute is not *relatively* dynamic if there are 100,000 nodes and 500,000 links in the network. To give a better picture of this characteristic, we generate an enhancement to this metric by including the total number of nodes and links in the computation to produce the percent of change, given in Equation 5.

$$\text{Percent\_Change}(X) = \frac{\Delta m + \Delta n}{time * (m + n)} \quad (5)$$

The metrics that we have defined so far are interrelated. For example, if the link and node lifetimes for network X are longer than those for node Y, the percent change of X will necessarily be larger than the percent change of Y. We can also observe limits between these metrics. For example, the number of links can change without the number of nodes changing, since a node may have several links in the network, but since a node is only a member of the network if it has a link in the network, if there are changes in the number of nodes, there must also be changes in the links.

## Application-Oriented Rate of Change Metrics

We now consider application-oriented metrics. These metrics reveal the properties that allow us to recognize boundaries on ad hoc network functionality.

### *Path Length*

Nodes in ad hoc networks communicate through a series of links that together constitute a path. Consider an ad hoc network where we desire to identify a path between nodes A and B. Notationally, a path is an ordered set of nodes (represented in lower case) that begins at the source and terminates at the destination. For example, if node C lies between A and B and if A can send messages to B, but they must be relayed by C, we represent the path between A and B as {a, c, b}, or equivalently {b, c, a}, and we say that C is an intermediate node between A and B.

As with links, paths come and go in ad hoc networks. Because we assume bidirectionality, there must be at least one path between any two nodes in a network. However, as links dissolve, paths may also disappear. Since many applications are focused on setting up paths or are dependent for their functionality, we need to reason about the nature of paths in ad hoc networks.

We now consider the average path length within a network. For simplicity, we assume that we can determine the shortest path (the path that traverses the

fewest number of links) between any two nodes in a network and that if there are two or more paths of this length, we select one as the primary path (heretofore when we refer to "path" we are addressing the "primary path"). Thus, we can enumerate the paths in a network. Under these assumptions, there is only one path between any two nodes, so a network of m nodes has exactly $q = \frac{(m-1)^2}{2}$ paths. We then define the average path length of the network as the sum of the number of links in all paths divided by the sum of the number of paths in the network as given in Equation 6.

$$\text{Avg\_PL}(X) = \frac{\sum_{i=1}^{m} | m_i |}{q} \tag{6}$$

*Path Lifetime*

Another network metric for functions that utilize paths is path lifetime. This metric is important to all functions that operate between nodes, for example, by forming a circuit or authenticated route. The path lifetime provides a guideline on how much time the function can take and yet expect not to run out of time before its purpose is met.

Our metric for average network path lifetime is similar to that for link lifetime. It is based the proportionality of the network average path length and the average link lifetime and is given in Equation 7.

$$\text{Avg\_PLt}(X) = \text{Avg\_LLt}(X) / \text{Avg\_PL}(X) \tag{7}$$

Clearly, path lifetimes will be significantly shorter than link lifetimes in ad hoc networks, since dissolution of any link also disables every path that traverses that link. Similarly, and more importantly from a functional standpoint, longer paths will necessarily have shorter expected lifetimes than shorter paths. This means that network applications must be concerned about not only the average path lifetime, but also the maximum path length, also called the network diameter, which directly correlates to the minimum expected path lifetime that the application may encounter in the network. As intuition may suggest,

networks with longer paths will, in general, be less tolerant of protocols with high overhead.

Notice that we cannot compute the network average path lifetime based on the node lifetime. The difficulty here is that multiple paths may come and go without any node changes whatsoever occurring within the network.

## Metrics Summary

Table 1 is taxonomy of metrics for change rates in ad hoc networks. We do not

*Table 1.*

| METRICS FOR RATE OF CHANGE IN AD HOC NETWORKS | | | |
|---|---|---|---|
| **Category** | **Type** | **Sub-type** | **Description** |
| Network | Bandwidth | Available | Total capacity usually in bytes per second |
| | | Utilization/consumption | Expected bandwidth that is normally consumed at any given instant |
| | Size | Total # nodes | |
| | | Total # links | |
| | | Network diameter | Length of the longest path in the network |
| | Change rate | Total changes per unit time | Number of links and nodes that are added or lost over time |
| Links | Link lifetime | | Expected period a link remains active once it is established |
| Nodes | Node lifetime | | Expected period a node will be available once it is established |
| | Link add rate | | # of links that are added to a randomly selected node over time |
| | Link drop rate | | Expected # of links that are lost to a node over time |
| Paths | Path length | | The expected # of links in a randomly selected path |
| | Path redundancy | | The expected # of disjoint paths between two nodes |
| | Path lifetime | | Expected duration that paths will be available |
| Density | # links per node | | Expected number of links that any node will have |

claim that the list is comprehensive, but believe it reveals usable metrics for establishing functional limits.

## Rate of Change Categories and Illustrations

The underlying premise of this chapter is that before ad hoc networks can be widely utilized, we must be able to reason about the impact of the rate of its inherent change. In this section, we define four categories of change rates that allow us to solve problems for classes of networks rather than for each specific network. More importantly, it allows us to clearly state the assumptions about ad hoc network functional characteristics.

We now give a few examples to illustrate the partitioning that we desire. These examples also show that the metrics we give are practical. Below, we identify four potential ad hoc network categories that correspond to different rates of change.

1) **Low Rate of Change Ad hoc Network**. The least dynamic (or the most stable) category includes ad hoc networks where links exist on the average some number of hours, up to several days. Changes at this rate are relatively easy to handle and do not consume a significant percentage of network resources. An example of such a network is an office environment where employees carry their laptop computers, connected by roaming wireless communications, home and work with them. While the change rates may peak in the morning and again in the afternoon, the average link lifetimes will likely be hours.
2) **Medium Rate of Change Ad hoc Network**. We consider networks with average link lifetime of 10 minutes to a few hours as a medium rate of change network. The changes at these intervals do not consume even a local majority of the network resources, but the resources consumed are statistically significant. An example of such a network is a delivery service network, where communication between carriers is via short wave radio. Each vehicle may operate primarily within its own area with links to adjoining areas that are interrupted intermittently.

3) **High Rate of Change Ad hoc Network**. High rate of change networks are characterized by link lifetimes between a few seconds and a few minutes. Managing change in these networks can take a majority of the available resources. An example of such a network is a wireless network between handheld devices in a crowd where individuals move about independently and communicate via low-power, broadcast medium.
4) **Very High Rate of Change ad hoc Network**. These networks are characterized by average link lifetimes of just a few seconds. The primary concern for any function on these networks is resource allocation, and their utility is suspect with current technology. An example of such an ad hoc network environment is that of jet aircraft in a combat or other high-speed environment.

## Impact of Rate Change

Thus far we have presented the foundation for reasoning about the nature of rate of change limitations. We now address the impact that rate of change has on applications.

There has been a significant amount of work done on ad hoc routing (Bose, Morin, Stojmenovic & Urrutia, 2001; Carter & Yasinsac, 2002; Ko & Vaidya, 1998; Obraczka, Viswanath & Tsudik, 2001; Perkins & Royer, 1999), most geared toward optimizing either the number of messages or time required to acquire an effective route, where a route is available (we do not consider "wait and see" routing protocols where route requests are held and re-forwarded when new links appear). Flood routing provides a ceiling in both the amount of overhead and message deliverability.

More formally, for any ad hoc network comprised of m nodes, the most messages that are required to derive a route is 2m (each of m nodes floods two messages). If we choose to optimize the number of messages in a new routing protocol, any routing protocol that systematically produces a route with fewer than 2m messages is superior to flooding. In a given environment, if there is no protocol that can systematically produce an effective route with fewer than 2m messages, then flooding is the optimal routing algorithm in that environment.

The metrics described above help us to reason about this problem. In this section, we argue that optimization is not possible for some functions in highly

dynamic networks and use of predetermined routes or circuits may not be possible in networks that are highly dynamic.

## Bounds on Routing Protocols in Ad hoc Networks

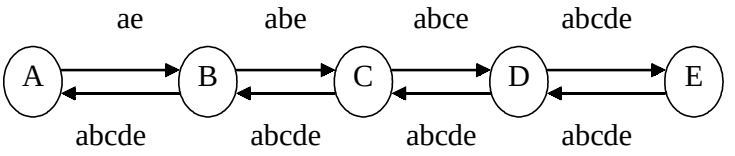
As we described earlier, applications that require circuits are particularly vulnerable to the network dynamic nature. On demand routing protocols generally produce such a circuit. We use the Secure Routing Protocol (SRP) (Papadimitratos & Haas, 2002) to illustrate how rate of network change can limit network functionality.

SRP is a leapfrog protocol that begins with a route request. Each node that receives the route request appends its address and retransmits if the request is new, and discards otherwise. The route request protocol continues until all nodes in the network receive the route request. If the destination node receives the route request, it prepares a route reply packet directed to the reverse path of the first received route reply. When the originating node receives the route reply, it utilizes the established circuit to communicate with the destination node. Figure 2 illustrates the messages in SRP.

The goal of SRP is to establish a secure route (circuit) between two hosts on an ad hoc network. SRP establishes a route with only n + *l* messages, where n is the number of nodes in the network and *l* is the path length, a substantial reduction in the number of messages over flooding.

The time required to complete SRP is twice the sum of the time required to move between nodes on the resulting path. Our first observation regarding the impact of the dynamic network nature is that SRP cannot be effective unless the average path lifetime is at least twice as long as the average time required to

*Figure 2.*



complete SRP. Otherwise, we should expect that the path identified in SRP would be invalid by the time the protocol completes.

While SRP offers an improvement in the number of messages over flooding, in terms of time SRP is no better than flooding. Flooding can establish a circuit in the time that it takes to traverse the path from the source to the destination and back, the same amount of time as SRP.

This leads to our first rule regarding bounds on functionality of highly dynamic ad hoc networks, where T(f) is the time required to complete function f that must traverse its path twice.

**Rule 1**. For any function f that must access a circuit on network X cannot expect to complete successfully unless:

$$T(f) < avg\_PLt(X)$$

Consider some subtleties of this observation. First, we do not claim that functions that violate this rule will never work. Certainly, for shorter circuits or with low probability on longer circuits, functions that violate this rule may occasionally work. However, we cannot *expect* the function to complete its task if Rule 1 is not met. In fact, if T(f) is equal to the average path lifetime, the function should expect to fail 50% of the time.

Secondly, the average link lifetime is a critical element of this computation. In networks in category 4 (very high rate of change), where link lifetimes are only a few seconds, it is likely impractical to expect to be able to utilize circuits at all. Even category 3 networks may be constrained if reliability is essential or if transmission times are long because of high traffic load or other reasons. Intuition has sensed these observations in the past, but Rule 1 formulates a mechanism to systematically reason about these limiting factors.

## Tuning Factors for Effective Functions in Ad hoc Networks

Another important question is: "Can we use Rule 1 to derive a rule that guarantees that such a function will complete?" Since our approach is loosely probabilistic, we prefer to deal with terms such as "likely" and "expected"

rather than "guaranteed". However, if we accept a slightly loosened form of guarantee, "insignificant," and set that threshold arbitrarily, we can derive some helpful results.

**Rule 2**. Any function f that must access a circuit on network X will not be time constrained if:

$$T(f) < \text{minimum\_PLt}(X)$$

To make a strong assurance of success, T(f) should be (ideally substantially) less than twice the minimum path lifetime of the network. While our discussion has focused on the time necessary to traverse paths in the network, the communication time is frequently a small percentage of the total function completion time. Thus, functionality is determined by the demands of the clients as well as the characteristics of the network. Functions that require longer time to execute are less likely to be completed successfully than those with shorter time demands.

## Conclusion

All network functionality depends on the characteristics of its architecture. In wired, or fixed structure networks, link lifetime, given in terms of hours, days, or longer, dominates function time sufficiently that reliability is measured as the mean time between failures. In highly dynamic networks, link loss cannot be considered the exception that occurs only, or primarily, through failure. Rather, link establishment and dissolution are not only normal, but also required for ad hoc functionality.

We have shown how the varying rates of change in ad hoc networks affect their functionality. We categorized these rates and established metrics to allow systematic analysis of their impact. We went on to address specific functional bounds that may occur for highly dynamic ad hoc networks, showing how one secure routing algorithm cannot be effective in very highly dynamic networks. We further show how to use our metrics to gauge functionality in any ad hoc network.

Our work and examples focus on applications that employ circuits in ad hoc networks. However, these metrics and techniques are applicable to a wide variety of functions and environments and can be a productive mechanism for designing and analyzing applications in ad hoc networks.

If ad hoc networks are to mature into a viable networking architecture, we must establish a solid foundation for evaluating them in terms of the parameters that dictate changes in their architecture. This work must be highly probabilistic, founded in theory and proven in the laboratory.

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# Section IV

# Electronic Commerce Issues and Applications

## Chapter IX

# Loyalty Differences in the Effect of Negative Critical Incidents and Quality Attributes Satisfaction: An Empirical Study of Online Shopping

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## Abstract

*This chapter introduces the effect of negative critical incidents and quality attributes satisfaction to heed the call for theoretically based empirical work in terms of loyalty difference on Internet shopping. There are some findings and recommendations. First, FNCIs would affect overall satisfaction indirectly by QASAT. Second, either highly loyal customers or less loyal customers, although the important order of*

*relationship between four latent factors of QASAT and FNCIs are not equal, have causal relationships that were all significant. Third, the slow response that affected overall satisfaction indirectly by QASAT seems to be more important to customers who have less purchase frequency or purchase amount than higher ones. Finally, online bookstores with incomplete content that have untrustworthy transactions would affect overall satisfaction indirectly to customers with high loyalty by QASAT; this seems to be more important than it is to less loyal customers. It is hoped that the results of this chapter could provide a valuable strategy for marketers to rethink how they can find out and reduce the FNCIs that customers may encounter.*

## Introduction

Strides in information technology and improvements in networking technology have set the pace for rapid growth in new applications of electronic commerce in a variety of settings. Business-to-business (B2B), business-to-customer (B2C), customer-to-business (C2B), and customer-to-customer (C2C) have become prevalent business channels and have reshaped the ways that business transactions are conducted in the marketplace. According to Internet Data Corporation (IDC), by the year 2005, there will be nearly one billion Internet users, about 15% of the world's population. IDC further predicts that those users will promote more than $5 trillion of business in the Internet commerce by 2005 (IDC, 2001). Given recent trends and forecasting, it is clear that no business enterprise can afford to ignore the tremendous potential of these emerging technologies in terms of the rate of creating, processing, and distributing the volume of business.

The proliferation of the Web potential for business, together with its profuse customer information, have offered an alternative sales channel for a growing number of firms and have prompted extensive research on the effect of negative critical incidents on customer satisfaction with Internet shopping. The increase in business-to-customer (B2C) channels has made several firms look for new strategies to understand online shopping behavior in order to attract, retain and satisfy customers' needs (Ranganathan & Ganapathy, 2002). In fact, many researchers have considered that customer satisfaction leading to higher levels

of customer retention would depend on the success of critical factors, such as quality design (Huizingh, 2000; Liu & Arnett, 2000), security concerns (Bhimani, 1996; Denning, 1997), and other factors for electronic commerce. However, Waterhouse and Morgan (1994) reported an interesting finding that just one factor of dissatisfaction and defection would be enough to cause customers to become disenchanted with Internet shopping. This finding is be consistent with Friman et al. (2001), who found that negative critical incidents (NCIs) play an important role for users' cumulative satisfaction with public transport services. A critical incident is an encounter that is particularly satisfying or dissatisfying (Bitner et al., 1990). NCIs are customer encounters that do not proceed normally but create friction, irritation, and dissatisfaction (Edvardsson, 1992).

Occasionally, due to loss aversion (Kanheman & Tversky, 1979) or distinctiveness in memory (Bower, 1981; Oliver, 1997), customers treated negative critical incidents more silently and are unlikely to remember specific critical incidents for a long time. However, they may accurately judge the frequency of the critical incidents, in particular since such events stand out (Woodley & Ellis, 1989).

Additionally, Jones and Sasser (1995) have shown that the relationship between satisfaction and loyalty is neither linear nor simple. High levels of measured satisfaction sometimes go hand in hand with a continuous decline in turnover (Heskett et al., 1994) or an increase in customer defection (Reichheld, 1996).

Given the literature review above, although many researchers have identified critical incidents from different perspectives, little has been reported in the literature with regard to the influence of negative critical incidents for Internet shopping from the viewpoint of customer satisfaction. Therefore, this study pursued better measures and models for use in predicting and explaining online bookstores as an example of customer Internet shopping satisfaction. The purpose of this study was twofold. First, it examined the frequency of NCIs in combination with quality attributes satisfaction (QASAT), in an attempt to understand their effects on the overall satisfaction of Internet shoppers. Second, it heeded the call for theoretically based empirical work, in terms of loyalty difference, on Internet shopping.

From the loyalty perspective, a number of studies (e.g., Goodman, 1992; Hughes, 1994; Stone, 1995 ) have discussed the evaluation of customer lifetime value in terms of RMF (recency, frequency and monetary). Recency is

time period since the last purchase; frequency is number of purchases made within a certain time period and monetary is the amount of money spent during a certain time period. Bult and Wansbeek (1995) and Liu and Shih (2002) indicated that customers with less recency, and higher frequency and monetary ratings represent who has high loyalty. However, since recency is hard to determine in this study, a customer with high loyalty is defined as their purchase frequency is more than three times a month and spends above 1,000 NT dollars a month in online bookstores.

## Proposed Model

With the boom in the online shopping, these proliferated Web sites have also provided various online services. Understanding consumer behaviors relating to online shopping is essential to effective Internet marketing. Recently, numerous studies related to e-business have attempted to explore influences on online shopping behavior (e.g., Bhatnagar et al., 2000; Koufaris et al., 2002; Liao & Cheung, 2001). However, customer satisfaction with service quality of course is essential to the success of any business system. Customer satisfaction also has been linked to firm profitability and repurchase probability (for example, Labarbera & Mazursky, 1983). It is imperative that satisfaction is distinguished from cumulative satisfaction (Firman et al., 2001) and in both cases satisfaction is either defined as an overall judgment of satisfaction or quality attributes (Cronin & Taylor, 1992; Gotleib et al., 1994).

Research on Web quality attributes for measuring Internet shopping falls into four broad categories: quality e-store, information content, security concerns and consumers' experience. These four categories were specified to construct a set of critical incidents for encounter satisfaction. The four factors consisted of 34 items from previous literature described as follows:

(1) Quality e-store (10 items): fast Web page download, store size, promotions, ease of use and so on (Huizingh, 2000; Liu & Arnett, 2000).

(2) Information content (eight items): availability of information to compare across alternatives, completeness of information provided about a firm, product and service and so on (Huizingh, 2000; Ranganathan & Ganapathy, 2002).

(3) Security concerns (five items): availability of secure modes for transmitting information, provisions made for alternatives, overall concern about security of transactions over the Internet, gathering of personal information and so on (Mannix, 1999; Mardesich, 1999; Ranganathan & Ganapathy, 2002).

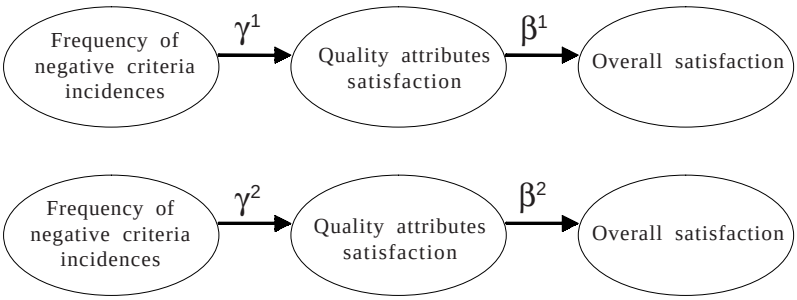
(4) Consumer experience (11 items): increased customization, convenience in purchasing, responsiveness in product delivery and so on (Elliot & Fowell, 2000; Jarvenpaa & Todd, 1996).

These items were initially assessed using a Delphi method. Three e-commerce scholars were asked to evaluate the items and make changes to eliminate repetitive items. After two evaluation rounds, there remained 22 critical incidents of Web quality attributes for further study.

Two questions were used to measure overall satisfaction. One is "What is the degree of satisfaction for online bookstores?" The other question is "Will you recommend using online bookstores to a friend?"

In order to compare the model difference and path coefficients between customers with high loyalty and with less loyalty, a proposed model was shown as Figure 1. A structural equation modeling (SEM) was used to evaluate the group difference, where $\gamma$ and $\beta$ are path coefficients used in SEM. Herein, group A is measured by frequency of purchasing; group B is measured by amount of money spent.

*Figure 1. Casual relationships among frequency of negative critical incidents, quality attributes satisfaction and overall satisfaction*



At first, the causal relationships among the frequency of NCIs, QASAT, and overall satisfaction were shown as hypothesis $H_1$.

$H_1$: FNCIs affected overall satisfaction indirectly by QASAT.

According to Figure 1, the following hypotheses will be subject to test.

$H_2$: FNCIs affected overall satisfaction indirectly by QASAT and determine if there are differences by customer loyalty (less group/high group).

- $H_{2a}$: FNCIs affected overall satisfaction indirectly by QASAT and determine if there are differences by frequency of purchasing (less/high purchase frequency).
- $H2_{1b}$: FNCIs affected overall satisfaction indirectly by QASAT and determine if there are differences by amount of money spent (less/high purchase amount).

# Methodology

## Measurement

A questionnaire was designed to measure satisfaction of service quality, frequency of negative critical incidents, overall satisfaction, demographic variables, and experience of online purchasing. The questionnaire was based on the previous studies (Fang et al., 2003). A measurement of quality attributes satisfaction and overall satisfaction, such as "What is the degree of satisfaction for online bookstores?" included a five-point Likert scale from "strongly agree (5)" to "strongly disagree (1)." A measurement of the second question of overall satisfaction, "Will you recommend using online bookstores to a friend?" included a five-point Likert scale from "strongly willing (5)" to "strongly unwilling (1)". A measurement of frequency of NCIs also included a five-point Likert scale from "never experienced (5)" to "always experienced (1)". In addition, two demographic variables (gender and income) and three variables with experience of online purchasing (number of online bookstore visits per month, frequency of purchasing per month, average amount of money spent in

online bookstores per month) are all measured by a nominal scale from respondents to obtain more information for explaining the analytical results.

## Data Collection

In this study, two pilot tests were conducted. For the purpose of content validity, seven participants were asked to review the first draft of survey instruments with 22 critical incidents of Web quality attributes for clarity, content, and appropriateness of the questions. Modifications, served as the second draft of the survey instrument, were made in accordance with their suggestions. In order to remove the bias from inexperienced customers, 30 customers who have at least one online purchase were asked to respond to the second draft of the instrument. Seven infrequently experienced negative indices, including price, promotion activities, discounts, variety of payments, personalized service, variety categories and search engine, were dropped. There remained 15 critical incidents for further analysis. Once again, the number of measuring variables, 15 critical incidents, was the same for measuring the constructs of FNCIs and QASAT.

An online survey was performed for collecting the data. Participation in this study was completely voluntary, but respondents of at least one online purchase were considered qualified for analysis. In this online survey, our system would check incomplete data and ask the respondents to fill out the questionnaire on time.

This study used 210 respondents to examine the model differences among loyalty. Table 1 presents the characteristics of respondents. The sample included 88 (42%) males and 122 (58%) females, all of whom had made purchases online, with 75% having had at least one or two experiences in online book purchasing per month, spending varying amounts.

This study defined high loyalty as a person who purchases online books more than three times a months and spends more than 1,000 NT dollars a month in online bookstores. Therefore, for frequency of purchasing, there is a group with less frequency of purchasing and a group with high frequency of purchasing of. For amount of money spent, there is a group with less amount of money spent and a group with high amount of money spent. Table 2 displays descriptive statistics of the effective sample for each of the groups.

*Table 1. Profile of respondents (N=210)*

| | Frequency | (%) | | Frequency | (%) |
|---|---|---|---|---|---|
| Gender | | | No. of books purchased a month | | |
| Male | 88 | 42 | 1-2 | 158 | 75.2 |
| Female | 122 | 58 | 3-4 | 43 | 20.5 |
| Income | | | 5-6 | 6 | 2.9 |
| <=20000 | 134 | 61.9 | 7-8 | 2 | 1.0 |
| 20001~40000 | 45 | 21.4 | >8 | 1 | 0.4 |
| 40001~60000 | 27 | 12.9 | Average spending a month | | |
| 60001~80000 | 4 | 1.9 | <=500 | 88 | 41.9 |
| 80001~100000 | 4 | 1.9 | 501-1000 | 85 | 40.5 |
| No. of bookstores a month | | | 1001-1500 | 16 | 7.6 |
| 1-2 | 75 | 35.7 | 1501-2000 | 13 | 6.2 |
| 3-4 | 48 | 22.9 | >2000 | 8 | 3.8 |
| 5-6 | 31 | 14.8 | | | |
| 7-8 | 17 | 8.1 | | | |
| >8 | 39 | 18.6 | | | |

*Table 2. Respondents' information with different groups*

| | Frequency of purchasing | | Amount of money spent | |
|---|---|---|---|---|
| | Less | High | Less | High |
| Number of respondents | 158 | 52 | 88 | 122 |
| Percentage of total respondents | 0.75 | 0.25 | 0.42 | 0.58 |

## Research Design

This study examined whether the FNCIs affected overall satisfaction indirectly by QASAT for diverse customers; for example, whether high loyal customers and less loyal customers are the same or not. Therefore, a proposed model was used for each of the subgroups. At first, we would like to examine whether the FNCIs affected overall satisfaction indirectly by QASAT, namely the integrated model. For analysis purpose, this study might adopt a dummy variable for loyalty (customer with high loyalty equals 1; customers with less loyalty

equals 0). If a positive effect is significant, the latent variable is higher for customers with high loyalty, and vice versa. Since the loyalty was measured by frequency (frequency of purchasing) and monetary (amount of money spent), customers with high purchasing frequency and amount of money spent equals 1; otherwise it equals 0. To examine the similarities or differences between subgroups, structural equation modeling analysis was used in two stages. First, a structural equation modeling (SEM) was used to compare the high loyal customers to the less loyal customers in terms of frequency of purchasing and amount of money spent, respectively, to determine if there were significant differences. Then to verify this difference, a SEM was also run comparing the high loyal customers to the less loyal customers.

The Lisrel 8.3 package (Joreskog & Sorbom, 1993) was selected for all model fitting. A matrix of covariance between variables was input to Lisrel 8.3 using the maximum likelihood estimated. There are five recommended fit indices that were considered to determine if the proposed model fit the observed data. These were described as follows: (1) normed Chi-square (Chi-square/df) (the recommended level was between 1.0 and 2.0) was the most appropriate parsimonious fit measure for the model fit (Hair et al., 1995). (2) Goodness-of-fit index (GFI), which is an indicator of the relative amount of variances and covariance jointly accounted by the mode. A marginal acceptance level is 0.9 (Hair et al., 1995). (3) Root-mean-square error of approximation (RMSEA, Browne & Cudek, 1993), value below 0.05 indicates good fit. (4) Relative fit index (RFI, Hair et al., 1995). (5) Comparative fit index (CFI & Bentler, 1990), which takes values between 0 and 1; the closer to unity, the better the model fit.

For explanation, the total coefficient of determination (TCD) $R^2$ for structural equations was shown herein. Furthermore, t-statistics for examining the correlation between the latent constructs and correlation among latent constructs were used to test path links. T-statistics exceeded the critical value (1.96) for the 0.05 significant levels and the 0.01 significance level as well (critical value = 2.576) (Reisinger & Turner, 1999).

# Analysis Results

## Quality Attributes Satisfaction (QASAT)

Principal component analysis (PCA) is a useful strategy for recovering an underlying model that can then be evaluated with CFA (Gerbing & Hamilton, 1996). Therefore, this study used PCA to identify items belonging to the different hypothesized latent variables first. Hair et al. (1995) suggested that item loadings greater than 0.3 are considered significant, greater than 0.4 are more important, and greater than 0.5 are considered very significant. Generally, there are no accepted "absolute" standards for the cutoffs; the choice is based on judgment, purpose of the study, and prior studies. Since our goal is to examine a set of the most significant items evaluated in confirmatory factor analysis (CFA), we decided to use a cutoff point of 0.7 for item loadings and the factor analysis revealed four factors with an eigenvalue of greater than one (as shown in Table 3).

*Table 3. Principal component analysis with varimax rotation — Quality attributes*

| Quality attributes | Variable (Coded) | Factor1 | Factor2 | Factor3 | Factor4 |
|---|---|---|---|---|---|
| Acceptable service charge | Sat4 | 0.65 | 0.16 | -0.08 | 0.17 |
| Diversity shipping | Sat5 | 0.82 | 0.14 | 0.11 | -0.03 |
| Diversity ordering | Sat6 | 0.78 | 0.10 | 0.19 | 0.10 |
| Diversity receiving | Sat7 | 0.81 | 0.10 | 0.05 | 0.14 |
| Speedy product delivery | Sat8 | 0.24 | 0.56 | 0.35 | 0.12 |
| Simple transaction process | Sat9 | 0.46 | 0.42 | 0.14 | 0.28 |
| Variety of communication | Sat10 | 0.21 | 0.70 | 0.12 | 0.20 |
| Quick response | Sat11 | 0.09 | 0.83 | 0.15 | 0.14 |
| Convenience to exchange product | Sat12 | 0.10 | 0.77 | 0.11 | 0.13 |
| Book preview service | Sat13 | 0.10 | 0.41 | 0.50 | -0.09 |
| Infrequent books | Sat18 | 0.05 | 0.01 | 0.82 | -0.01 |
| Complete introduction of books | Sat19 | 0.08 | 0.23 | 0.81 | 0.21 |
| Accurate book reviews | Sat20 | 0.08 | 0.24 | 0.66 | 0.32 |
| Security of transactions | Sat21 | 0.25 | 0.17 | 0.22 | 0.81 |
| Privacy of personal details | Sat22 | 0.12 | 0.23 | 0.06 | 0.85 |

The following changes were made. Since three item scales (Sat8, Sat9 and Sat13) did not load on any factors, they were removed. Sat4 and sat20 factor loading less than 0.7 were removed. Finally, 10 measured variables onto the four latent factors of positive emotions were constructed. Furthermore, quality e-store, customer experience, and information content were renamed into "ease of use, quick response, complete information, and trustworthy".

It was found that ease of use consisted of three items and dealt with such attributes as diversity shipping, diversity ordering, and diversity receiving. "Quick response" reflects concerns related to finding specific details about supporting multiple channels of communication with organizations and response quickly. "Complete information" consisted of two items: support of infrequent books and complete introduction of books. "Trustworthy" contains two items: security of transactions and privacy of personal details. The standardized Cronbach's alpha coefficients with 0.81, 0.79, 0.70, and 0.78 for ease of use, quick response, complete information and trustworthy were all exceeding the generally accepted guideline 0.7 and above (Hair et al., 1995).

In order to test that quality attributes satisfaction on Internet shopping is judged with respect to ease of use, quick response, complete information, and trustworthiness, maximum likelihood of confirmatory factor analysis (CFA) was conducted. The following indices were shown: Norm Chi-square = 1.19, RFI = 0.93, GFI = 0.99, AGFI = 0.94, RMSEA = 0.023. According to the

*Table 4. The measurement model of the ratings of positive emotions*

| Latent factor | Variable (Coded) | Quality attributes | Standardized parameter estimates | T-statistics |
|---|---|---|---|---|
| Ease of use | Sat5 | Diversity shipping | 0.73 | 11.16** |
| | Sat6 | Diversity ordering | 0.81 | 12.46** |
| | Sat7 | Diversity receiving | 0.76 | 11.69** |
| Quick response | S10 | Diversity channel of communication | 0.76 | 11.60** |
| | Sat11 | Quick response | 0.86 | 13.61** |
| | Sat12 | Convenience to exchange product | 0.64 | 9.43** |
| Complete information | Sat18 | Infrequent books | 0.54 | 8.50** |
| | Sat19 | Complete introduction of books | 1.00 | 20.45** |
| Trustworthy | Sat21 | Security of transactions | 0.92 | 12.10** |
| | Sat22 | Privacy of personal details | 0.70 | 9.62** |

***: Level of significance = 0.01, *: = 0.05*

criteria enumerated above, we judge this to be an acceptable fit. The standardized parameter estimates and t-statistics are shown in Table 4. According to the analytical results, all of the t-statistics of critical incidents exceeded the 1.96 and 2.57 thresholds for both 0.05 and 0.01 levels of significance, respectively.

## Frequency of Negative Critical Incidents (FNCIs)

As described above, FNCI measures were the same as the construct of quality attributes satisfaction and thus FNCIs were mapped into four factors, useless, careless, incomplete information, and untrustworthy, directly. In addition, the results of a principal analysis extracting four factors suggested that six critical incidents (Unsat1, Unsat5, Unsat7, Unsat9, Unsat10 and Unsat13) were removed, since item loadings were less than 0.7 (as shown in Table 5). Standardized Cronbach's alpha coefficients for useless, careless, incomplete information and untrustworthy were 0.85, 0.81, 0.68, and 0.85, respectively.

Same as QASAT constructs, the FNCIs on Internet shopping were judged with respect to useless, slow response, incomplete information and

*Table 5. Principal component analysis with varimax rotation — Critical incidents*

| Critical incidents | Variable (Coded) | Factor1 | Factor2 | Factor3 | Factor4 |
|---|---|---|---|---|---|
| Need more service charge | Unsat1 | 0.55 | 0.20 | -0.16 | 0.40 |
| Less diversity shipping | Unsat2 | 0.30 | 0.79 | 0.03 | 0.24 |
| Less diversity ordering | Unsat3 | 0.22 | 0.87 | 0.10 | 0.18 |
| Less diversity receiving | Unsat4 | 0.21 | 0.77 | 0.18 | 0.12 |
| Slow product delivery | Unsat5 | 0.66 | 0.18 | 0.41 | -0.02 |
| Complicated transaction process | Unsat6 | 0.71 | 0.17 | 0.10 | 0.27 |
| Lack of variety of communications | Unsat7 | 0.61 | 0.46 | 0.26 | 0.09 |
| Slow response | Unsat8 | 0.73 | 0.38 | 0.18 | 0.19 |
| Inconvenience to exchange product | Unsat9 | 0.58 | 0.20 | 0.20 | 0.41 |
| Don't provide book preview service | Unsat10 | 0.37 | 0.18 | 0.63 | -0.08 |
| Less variety of products | Unsat11 | -0.05 | 0.12 | 0.80 | 0.05 |
| Incomplete introduction | Unsat12 | 0.11 | 0.04 | 0.85 | 0.26 |
| Misleading book review | Unsat13 | 0.32 | 0.06 | 0.60 | 0.26 |
| Poor security of transactions | Unsat14 | 0.20 | 0.27 | 0.13 | 0.84 |
| Poor privacy of personal details | Unsat15 | 0.23 | 0.17 | 0.23 | 0.83 |

*Table 6. The measurement model of the ratings of negative emotions*

| Latent factor | Variable (code) | Negative critical incidents | Standardized parameter estimated | t-value |
|---|---|---|---|---|
| Useless | Unsat2 | Less diversity shipping | 0.83 | 14.09** |
| | Unsat3 | Less diversity ordering | 0.90 | 15.64** |
| | Unsat4 | Less diversity receiving | 0.72 | 11.48** |
| Slow response | Unsat6 | Complicated transaction process | 0.66 | 9.5** |
| | Unsat8 | Slowly response | 0.78 | 12.20** |
| Incomplete information | Unsat11 | Less variety products | 0.59 | 9.37** |
| | Unsat12 | Incompletely introduction | 1.00 | 20.45** |
| Untrustworthy | Unsat14 | Poor security of transactions | 0.88 | 14.01** |
| | Unsat15 | Poor privacy of personal details | 0.84 | 13.17** |

untrustworthiness, and maximum likelihood of confirmatory factor analysis was also conducted. It was revealed that the fit indices (normed Chi-square = 1.70, RFI = 0.93, GFI = 0.96, AGFI = 0.93, RMSEA = 0.053) were all greater than the criteria with an acceptable fit. The standardized parameter estimates and t-statistics are shown in Table 6. All of them are significant.

## Integration of FNCIs and the QASAT Fit Model

The maximum likelihood estimated was also used to fit this model. Convergence was achieved in 26 iterations, and no estimation problems were encountered for the calibration sample of 210 respondents. A path analysis of the integrated model shows acceptable fit to the data (norm Chi-square = 1.38, RFI = 0.88, GFI = 0.90, AGFI = 0.87 and RMSEA = 0.039). The amount of variance in the dependent variable, overall satisfaction, explained by this integral model was 44%. There are eight paths (causal relationships) between the FNCIs, QASAT constructs and overall satisfaction (Figure 2). Six of these eight links, except the links between ease of use, trustworthiness, and cumulative overall satisfaction, have path coefficients significant, in which all of the remembered frequency of negative critical incidents are directly related to quality attributes satisfaction. Accordingly, hypothesis $H_1$ was support based on the above findings.

Moreover, from the analytical reports of total effects in Table 7, indirect paths between incomplete content, untrustworthiness and construct of overall satisfaction mediated by QASAT were significant.

*Figure 2. Integrated model with NCIs and QASAT path analysis*

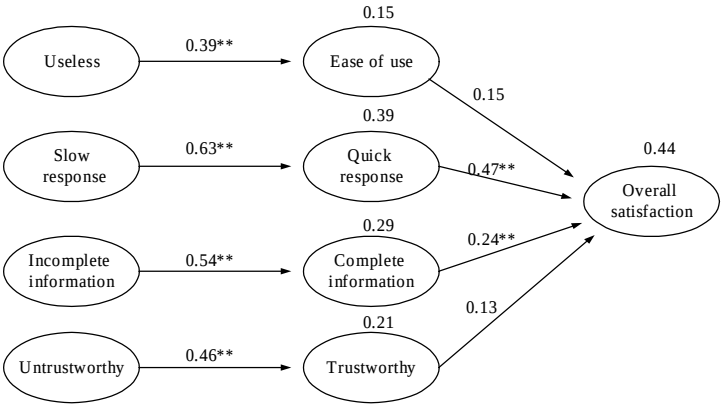



*Table 7. Total effect, direct effect and indirect effect in the integrated model fit*

| Latent (endogenous) | Latent (exogenous) | Indirect effect | Direct effect | T-value | Total effect |
|---|---|---|---|---|---|
| Ease of use | Useless | | 0.39** | 6.22 | 0.39 |
| Quick response | Slow response | | 0.63** | 6.92 | 0.63 |
| Complete information | Incomplete content | | 0.54** | 6.87 | 0.54 |
| Trustworthy | Untrustworthy | | 0.46** | 6.48 | 0.46 |
| Overall satisfaction | Useless | 0.15 | | 0.62 | 0.15 |
| | Slow response | 0.47** | | 3.61 | 0.47 |
| | Incomplete content | 0.24** | | 2.07 | 0.24 |
| | Untrustworthy | 0.13 | | 0.88 | 0.13 |

## Multiple Group Analysis

A structural equation modeling was used to change relationships between high loyal customers and less loyal customers in terms of frequency of purchasing and amount of money spent. Item means and standard deviations for each group of loyalty are displayed in Table 8.

For frequency of purchasing and amount of money spent, three (RFI, GFI and RMSEA) of five recommended indices to the overall goodness of fit of the

*Table 8. Item means and standard deviations for QASAT and FNCIs*

| | | Frequency of purchasing | | | | Amount of money spent | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Less | | High | | Less | | High | |
| QASAT | | Mean | (SD) | Mean | (SD) | Mean | (SD) | Mean | (SD) |
| Ease of use | Sat5 | 3.81 | (0.96) | 3.98 | (1.08) | 3.88 | (0.91) | 3.81 | (1.05) |
| | Sat6 | 3.85 | (0.90) | 3.85 | (1.09) | 3.89 | (0.92) | 3.85 | (1.06) |
| | Sat7 | 4.10 | (1.03) | 4.17 | (1.08) | 4.11 | (1.02) | 4.19 | (1.05) |
| Quick | S10 | 3.33 | (0.97) | 3.31 | (1.15) | 3.32 | (0.97) | 3.42 | (1.05) |
| response | Sat11 | 3.40 | (0.99) | 3.35 | (1.17) | 3.41 | (0.93) | 3/42 | (1.10) |
| | Sat12 | 3.15 | (0.98) | 2.98 | (1.11) | 3.13 | (0.96) | 3.10 | (1.04) |
| Complete | Sat18 | 3.51 | (1.08) | 3.40 | (1.27) | 3.42 | (1.00) | 3.50 | (1.21) |
| information | Sat19 | 3.52 | (1.01) | 3.50 | (1.26) | 3.55 | (0.87) | 3.54 | (1.20) |
| Trustworthy | Sat21 | 3.55 | (0.95) | 3.44 | (0.98) | 3.58 | (0.91) | 3.50 | (0.98) |
| | Sat22 | 3.46 | (0.93) | 3.28 | (0.88) | 3.51 | (0.88) | 3.31 | (0.93) |
| FNICs | | | | | | | | | |
| Useless | Unsat2 | 3.72 | (1.06) | 3.81 | (1.16) | 3.86 | (0.10) | 3.81 | (1.14) |
| | Unsat3 | 3.83 | (1.01) | 4.00 | (0.93) | 3.90 | (0.92) | 4.00 | (1.03) |
| | Unsat4 | 3.84 | (1.06) | 3.89 | (1.00) | 3.81 | (0.98) | 3.87 | (1.09) |
| Slow | Unsat6 | 3.67 | (1.00) | 3.62 | (1.00) | 3.71 | (0.96) | 3.67 | (1.02) |
| response | Unsat8 | 3.57 | (1.13) | 3.42 | (1.16) | 3.72 | (1.11) | 3.54 | (1.15) |
| Incomplete | Unsat11 | 3.51 | (1.13) | 3.15 | (1.26) | 3.64 | (1.09) | 3.25 | (1.23) |
| information | Unsat12 | 3.19 | (1.10) | 3.17 | (1.22) | 3.14 | (1.01) | 3.27 | (1.21) |
| Untrustwort | Unsat14 | 3.17 | (1.10) | 3.1 | (1.10) | 3.22 | (0.99) | 3.14 | (1.14) |
| hy | Unsat15 | 3.75 | (0.96) | 3.64 | (0.95) | 3.91 | (0.89) | 3.58 | (1.07) |

proposed model for the data collected from each of subgroups indicated that the FNCIs that affected overall satisfaction indirectly by QASAT are different. Although not all of the indices would indicate the differences existed absolutely, we still retain this result. Then, hypothesis $H_2$ (either $H_{2a}$ or $H_{2b}$) was supported by the data.

Therefore, we concluded that the FNCIs that affected overall satisfaction and were indirectly mediated by QASAT of less loyalty and high loyalty are different. Five recommended indices for each subgroup were summarized into Table 9.

*Table 9. Model difference between less and highly loyal customers*

| | Purchase frequency | Purchase amount |
|---|---|---|
| Chi-square | 421.37 | 425.78 |
| Degree of freedom | 350 | 354 |
| Norm Chi-square | 1.20 | 1.20 |
| RFI (above 0.9 is good fit) | 0.88 | 0.89 |
| GFI (above 0.9 is good fit) | 0.88 | 0.82 |
| CFI (greater than 0.9) | 0.97 | 0.98 |
| RMSEA (0.05 or less is better) | 0.059 | 0.057 |

## Group Difference

The results of the group comparison in purchase frequency and purchase amount were shown in Figures 3 and 4. The overall satisfaction variance explained in less loyalty (either customers with purchase frequency 0.55 or purchase amount 0.87) was higher than in customers with high loyalty. These coefficients depicting the relationship between FNCI and QASAT were all significant in these two groups. However, the order of $R^2$ was not similar. In addition to this, slow response that affected overall satisfaction for a group of less frequency of purchasing was stronger than when customers have high frequency of purchasing. In either customers with high frequency of purchasing or with high amount of money spent, incomplete content and untrustworthiness

*Figure 3. Group difference in terms of frequency of purchasing*

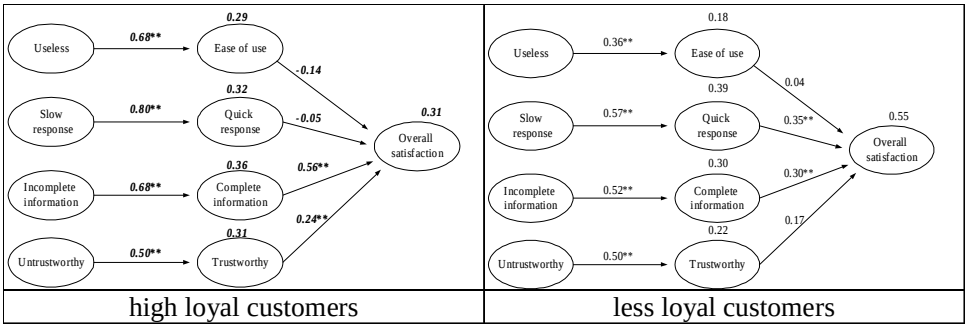
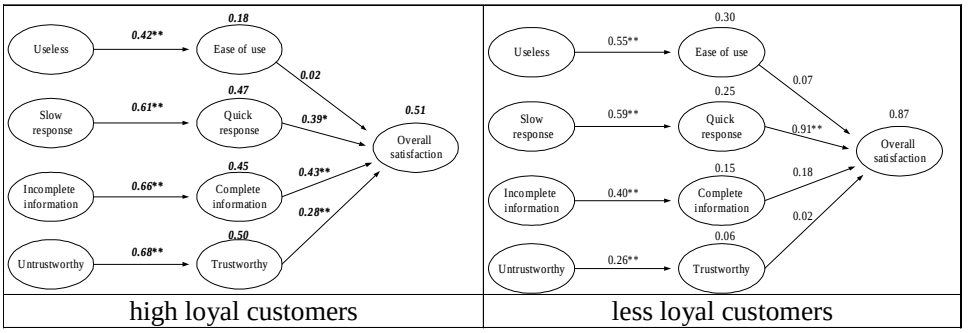


*Figure 4. Group difference in terms of amount of money spent*




that affected overall satisfaction mediated by QASAT were stronger than in customers with less.

# Discussion and Conclusions

This chapter used structural equation modeling to examine and verify whether the difference loyalty would similar or difference in the FNCIs affected QASAT. We summarized into the following findings and proposed some recommendations for researchers and marketing practitioners in online bookstores.

(1) FNCIs would affect overall satisfaction indirectly by QASAT. The integrated model explains not only the variance in the dependent variable, overall satisfaction being 44%, but also much more than variance accounted for NCIs (23%) alone (Fang et al., 2003). In NCIs, only one latent variable, slow response, affected overall satisfaction significantly. In the integrated model, not only slow response but also incomplete content showed an indirect effect of 0.47 and 0.24 mediated by quality attribute satisfaction.

(2) In either high loyal customers or less loyal customers, although the importance order of relationship between four latent factors of frequency of negative critical incidents and quality attributes satisfaction are not equal, causal relationships were all significant. To sum up, negative

emotions have an effect on positive emotions and satisfaction in each subgroup.

(3) The slow response that affected overall satisfaction indirectly by QASAT seems to be more important to customers who have low purchase frequency or purchase amount than high ones. It implies that customers with low purchase frequency or purchase amount in online bookstores have more expectations than higher ones. Once they have a feeling with the slow response, slow product exchange or slow communication channels, positive emotions will be influenced by these negative emotions, and affect overall satisfaction indirectly, even affect re-purchase intentions.

(4) Online bookstores with incomplete content and that have untrustworthy transactions would affect overall satisfaction indirectly to customers with high loyalty by QASA; this seems to be more important than to customers with less loyalty.

According to above findings, there are some implications for researchers and market practitioners. For researchers, Fang et al. (2003) have discussed that cumulative overall and quality attributes satisfaction with online shopping service are related to the remembered frequency of negative critical incidents. Extending to their analytical results, this chapter also examined whether diverse customers have different or similar effects. In conclusion, FNCIs that affected overall satisfaction indirectly by QASAT was different by loyalty difference, especially differences in slow response and incomplete content. Therefore, managers in online bookstore would provide quick response for customers with less loyalty, providing complete books' content for customers with high loyalty. In my opinion, few researchers focus on discussing this in previous studies.

From the standpoint of business, market managers of online bookstores need to be aware that cumulative overall satisfaction depends not only on positive emotions, but also on negative emotions. This idea is similar to an example that Babin et al. (1998) proposed – if a customer were to fill out a "satisfaction" survey to indicate some satisfaction on the scale rating, the customer would never return because of the high levels of negative emotion also experienced but unassessed. From the commercial viewpoint, online shopping has become more and more essential and is broadly well known. How to build, maintain, and enhance customer relationships is an important issue in a fiercely competi-

tive environment. Therefore, the results of this study indicate that it would be a valuable strategy for marketers to rethink how they can find out and reduce the frequency of NCIs that customers may encounter.

Several issues for future research need to be addressed. First, in this study, only online bookstores were examined; other types of online shopping mall or auction sites (for example, Acer mall, CoolBid.com) can be explained in future studies. Finally, this study collected a set of quality attributes satisfaction and asked customers to note the frequency of NCIs they encounter, regardless of whether they repurchase or not. However, in fact, satisfaction also has been linked to firm profitability and repurchase probability (e.g., Anderson & Sullivan, 1993; Labarbera & Mazursky, 1983). Therefore, whether any differences and similarities between customers with high loyalty and with less loyalty in customer profitability or intention behavior are uncertain. These issues are valuable and interesting for future studies.

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## Chapter X

# Benefits and Difficulties of Internet Use in Hotels and Its Effects According to the Facilities Rank, Property Size, Manager's Age and Experience

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## Abstract

*This study aims to analyze the perception of managers on the benefits and difficulties of Internet use in hotels and its effects according to the facilities rank and property size plus managers' age and experience time. It used a questionnaire to collect data from the managers of 35 hotels in the city of Natal, RN, Brazil. By using analysis of variance (ANOVA) and Tukey test, results showed that there is no significant difference in the*

*perception of managers on the impact of Internet use in hotels. Hence, the managers of these hotels had similar opinions about the benefits and difficulties of the Internet use in their hotels.*

## Introduction

Tourism is the most important industry in the world in terms of the numbers of employees and its effect on the social and economical development of a region or country (Holjevac, 2003). And Holjevac (2003) believes that by the year 2050, tourism will be by far the largest industry worldwide, with 2 billion tourists and US $24 billion in domestic and international receipts. Moreover, the major tourist destinations will be India, China, Indonesia and Brazil.

Tourism, along with the hotel industry, depends progressively on the resource of new information technology to follow and update the tools that allow an efficient development of activities in each section of the hotel, leading to better results for its management (Matoso, 1996). To Phillips and Moutinho (1998), IT is one of the critical factors of success in the hotel industry.

According to studies and data, the use of technological tools will allow a bigger competitiveness for hotels. Technology will be the catalyst of change, a source of growing connectivity and one of the most important factors in distinguishing success among hotel companies. Few issues have greater importance to the hospitality business than the technology decisions that will be made in the coming years (Buhalis, 1998; Cline, 1999; Olsen & Connoly, 2000; Van Hoof et al., 1995).

In tourism, the use of information technologies for basic functions is becoming usual — conferences, business meetings in distant places, training, designed routes and airlines, reservations and tickets purchased through computer systems, tourist shops, and restaurants — all these services have led tourist companies to adopt more updated methods in order to increase competition. Consumers are already becoming familiar with new technologies and they demand more flexible, interactive and specialized products and services, which will bring new management techniques from the intelligent use of IT used to accomplish tour companies' business processes (Buhalis, 1998).

Note the importance of information technology and its significance for the tourism industry as organizations use the WWW for interactivity and competitiveness. The key factor for successful organizations is their willingness to do business in this new way.

Though many experts and businesspeople agree that the Internet is probably the most important technological tool, it is still relatively new and misused in the hotel industry (Van Hoof & Verbeeten, 1997).

Viewing this scenario of Internet use in hotels, most precisely in the city of Natal, estate of Rio Grande do Norte, Brazil, we had posed a research question — *which benefits and difficulties affect the perception of hotel managers on the impacts of Internet in their facilities?*

In order to answer that question, field research was carried out to identify the benefits and difficulties that contribute to the perception of hotel managers relating to Internet use in their hotels. The following specific aims were defined:

1. Describing the hotel and manager profiles and their organizational and individual features of Internet use, respectively.
2. Determining which aspects of Internet use are considered important to hotel managers, identifying their individual perceptions in terms of benefits and difficulties of Internet use in hotels.
3. Identifying which benefits and difficulties contribute to the perception of managers as to the use of Internet in hotels, particularly according to the number of rooms, rate, manager age and their experience in the hotel business.

This chapter is divided in five parts – the first one in the introduction itself. On the second part we present basic concepts and a theoretical background. The third part deals with methodological resources used on the research. In the fourth part, results are presented and discussed through descriptive and inferential analysis. In the end, a few statements are presented on the Internet's role in the hotel industry according to the results and main problems of the research.

# Background

The hotel sector, which is part of the tourism and travel industry, includes accommodation (hotels, motels, inns, hostelry, cottages, etc.) and food and drink operations (Sheldon, 1997).

Decades ago, before the use of the computer in the accommodation sector, those charged with making reservations performed their service checking availability tables exposed on the wall or in large, updated, hand-written lists (O'Connor, 1999).

The hotels received innumerous telephone calls, letters and telex from potential clients, sometimes larger than that of the hotel's reception, and worked to select correspondence, type letters, send telegrams and deal with other demands. The delays were frequent, the cost of correspondence writing went sky-high and specialized typists were in demand (O'Connor, 1999).

A way found by the American hotel chains to streamline the reservation services was to centralize this function in a main office serving the consumer better and offering a valuable service to the hotels belonging to that chain.

O'Connor (1999) states that the reservation process in hotels in the USA was made even easier with the introduction of free telephone services in the mid-60s, which permitted potential clients to perform only one call to obtain information or make reservations in any of the hotels in the world of that chain.

Although the reservation area became faster and more efficient, two large costs remained, those of telecommunications (free telephone service payment) and labor costs of the reservation agents necessary to answer the phones.

With the increase in trips during the 1960s, the airline companies developed the Computer Reservation System (CRS), which pressured the hotel sector to develop its own (O'Connor, 1999).

The main focus in hotel and restaurant management has always been the maximization of consumer satisfaction and personalized attention. The use of IT has, at times, seemed incompatible with this objective and the hotel sector has, in a way, delayed the application of IT in its operations. The technology has been viewed as a hindrance to personalized service because it creates an impersonal, mechanical and cold environment with the clients.

However, this belief is being changed within the hotel sector. Nowadays, according to Sheldon (1997), the establishments are noticing that IT can bring efficiency to the hotel, besides reducing costs and being a great potential to increase the levels of personalized service to the clients.

In a survey performed by financial managers of American hotels, all stated that IT increased the hotel's productivity (David, Grabski & Kasavana, 1996). The motives used to justify this statement were the following: the technology reduces the administrative costs, decreases the amount of paperwork between sectors, minimizes operational errors, increases the earnings/profits of the hotel and makes the reservation management more efficient. This same survey proved that IT is not only used to increase the hotel's productivity but also to improve the service as well as offer new services to the guests.

According to Namasivayam, Enz and Siguaw (2000), IT can also be used be employed to reach business objectives. American and European hotel executives have performed planning to use the technology to reduce operational costs, increase sales, improve the service to the client, increase the productivity of employees and increase the earnings of the hotel.

In research performed by Van Hoof et al. (1995), 550 American hotel managers answered about their perceptions of the use and implementation of technology in their establishments. Those responding identified the front office (reception and reservations) of the hotel as the sector that can benefit the most from the use of the technology, followed by sales and marketing, accounting and the food and drink sector.

According to Van Hoof et al. (1995), having a quality service is a challenge to the hotel industry, which has high employee turnover indexes, employee salary increase and low age of the most qualified people. Consequently, technology applications have been developed in the hotels to increase this quality in the services and improve the interaction of the hotel employees with the guests.

## Impacts of the Internet in Hotel Industry

During the 80s and 90s several authors from companies and universities had already foreseen that as new technologies would increasingly be used, hotels could benefit from that in a great range of situations, for example: better qualified services for customers, increased sales and profits, efficiency in operation and integration of hotel sectors, quick communication and cost reduction (Laudon & Laudon, 1999; Van Hoof et al., 1995).

Technological applications enable information and knowledge to bring competitive advantage to the future profile of the hotel. The "Age of Information" idea is that the most modern companies will build their success upon the amount of knowledge they have about their clients as well as give information on their products and services and how they will get profit in this new environment (Olsen & Connoly, 2000).

Internet being used as a means of communication gives several advantages or benefits compared to other vehicles. According to Lage (2000), when it comes to the tourist area, the main points are: the new relationship between consumers and companies, marketing for actively participating consumers, the importance of detailed information, self-service application, credibility and agility of communication.

Tourism is among the largest online industries and is one of the most important kinds of commerce through the Web. It corresponds to almost 40% of all global electronic commerce transactions (Scottish Executive, 2000, Werthner & Klein, 1999). So the data show that all major companies linked to the tourism industry (hotels, agencies, air companies, rentals) do possess some kind of e-commerce activity through the Web (O'Connor, 1999). Internet is probably the newest star on communication and it is extremely valuable in the tourism industry. The use of the Internet and the World Wide Web is spreading quickly on most developments of consumers' access area to travel databases. There are hundreds of thousands of suppliers' homepages, associations, e-news, newsgroups and chats for the travel and tourism community. This bunch of technologies provides many opportunities for the industry to interact with its consumers and suppliers. It is also possible that, through information technology, products and services may be personalized according to the tourist needs and thus become a differential feature for those who adopt it (Buhalis, 1998; Sheldon, 1997).

The purchase of products and services through the Internet is revolutionizing the world of business and people's lives as well. For some clients it is more comfortable to book an air ticket through the company homepage rather than going to the travel agency (Franco, Jr., 2001).

No technology had ever had such full acceptance to allow that to happen. As the Internet began and grew, the use of such technologies at home or work and also the new opportunities that arose from the lower costs in telecommunication equipment made it possible for suppliers to distribute information to their clients and process reservations directly with the clients (O'Connor, 2001). So it became easy for IT to link clients to suppliers and thus, many new ways of doing

business have been created and also reshaped the industry and created new intermediates in the tourism industry.

According to Jeong and Lambert (2001), the Internet has already modified the competitive strategy of some hotels. It is through the Internet that the client can have a "self-understanding" in a service that is being offered to him or her in a more efficient way. In hotels, check-in processes can already be totally automatic, from the Internet booking until the moment the client takes his or her keys in an automatic dispenser. The result is that clients can become more informed and willing to have quick answers from the orders online.

On the other hand, several authors have identified impediments to the growth of the Internet in the industry and hence, have reservations about the willingness of hotel operators to adopt the Internet wholeheartedly (Wei et al., 2001). These problems include user-friendliness, the quality and accuracy of information obtained from the Web, and the issue of data security (Wei et al., 2001). Here are other difficulties found by Lituchy and Rail (2000) in their research: problems in updating new information in hotel Web pages, managers expressed annoyance at inaccessible Webmasters, hard to find hotel Web sites, some hotel employees do not know how to use the technology and impersonality of the medium. That way, consumers have been slow to adopt the Internet as a means to make hotel reservations; only 4% of reservations are made online (Maselli, 2002).

Namasivayam, Enz and Siguaw (2000) summarize that almost 60% of the hotels in their study had few technologies. To Van Hoof, Verbeeten and Combrink (1996), a lack of proper training, high turnover rates and limited financial resources were major barriers to the successful use and implementation of new technologies.

In addition to this, many hotels still believe that conventional means of advertising, such as radio, television and printed material are the most effective way of promoting their properties. The share of reservations received through the Internet remains minute as compared to reservations received through conventional means, such as phone, fax or mail (Van Hoof & Combrink, 1998). However, these problems are diminishing with the growth of the number of Internet users. And if customers become accustomed to browsing for rooms and making reservations through the Internet, more and more properties will be forced to get on the Internet as well (Mendes-Filho & Ramos, 2002).

In a specific way, the Internet provides an expansion on hotel services, changing this industry and giving new opportunities to clients, thus being a new

channel to be developed. Besides online reservation services, the Internet allows hotels to sell their services and charge them electronically and also to offer new products through the World Wide Web (Blank, 2000; Laudon & Laudon, 1999).

Through the Web, the customer can check hotel location, compare rates, see pictures and watch videos, get tourist destination information about other facilities, check room availability, book and confirm his or her booking for the amount of time he or she wants to stay, among other services (Jeong & Lambert, 2001). Hence, the interactivity of the Web provides an ideal medium for distributing accommodation online, consolidating itself as a very adequate platform for bringing information and services to the client in a very straightforward, efficient and quick way (Blank, 2000; Hotels, 2001).

Marriot, Hospitality Services of America and Hilton are a few of the hospitality industry members that have successfully used marketing on the Internet to reach new markets, track customers, take online reservations and offer information about their products and services (Lituchy & Rail, 2000).

From the theoretical fundaments and similar studies briefly presented above, a frame has been developed for the research, aiming at three targets to be explored through the two dimensions of analysis that build the construct of "the perception of the importance of Internet use": benefits and difficulties.

On the other hand, to relate these dimensions of Internet use to conditioning factors the model suggests a group of four variables: two on organizational level (hotel rate and number of rooms) and two on an individual level (managers' age and hotel experience).

## Research Methodology

The research was defined as descriptive, for it describes the features of a certain population as well as establishes relationships between variables through a standardized data collection technique. Its approach is quantitative, since the research used quantification not only in the data collection process but also in its treatment through statistical methods.

The data collecting tool was a questionnaire with closed questions, organized in two parts: the first one had profile questions for manager/respondent, hotel and Internet use; the second part had perception questions using a non-metric

scale for measuring the importance from 1 to 5 (five-point Likert-type scale), which tried to measure different levels of individual manager importance on the following aspects of Internet use: benefits and difficulties, containing 16 perception evaluation items. This questionnaire was adapted from Van Hoof and Combrink (1998) and validated for Brazilian reality, enabling confirmation of the variables that belong to the questionnaire's blocks.

The field research was developed in the city of Natal, capital of Rio Grande do Norte state in Brazil. The organizational unity chosen was hotel enterprises with more than 40 rooms (in the research area they are considered as medium to big-sized) rated on the Guia Quatro Rodas Brazil (2003). The subjects of the research were the managers who were more involved with Internet use in his hotel.

The Guia Quatro Rodas Brazil was used as a reference for rating the categorized researched hotels because this guide has been currently used by tourists, tour agencies and tour operators for over 39 years in Brazil.

Small properties are out of the study, for this sort of facility has less awareness on the importance of adopting technological solutions and also has less financial conditions to invest in IT (Cooper et al., 1998). It is also believed that this could interfere in the perception of managers on the impacts of the Internet.

Nine out of the 44 hotels selected were not given the questionnaire application, as it is explained below: three of them had already taken the pre-test; four were not rated in the Guia Quatro Rodas Brazil, one was not working, and another one it was not possible to contact its manager to answer the questions, though it was visited three times. So, 35 hotels were studied and the managers spent 25 minutes to answer the questionnaire.

This study is considered of the unique transversal type, for it extracted only one sample from the interviewees of the target population and also the information was collected only once. The first phase of collecting data refers to the pre-test application period developed in the first week of August 2002, in three hotels. After that phase, some due changes were made and the questionnaires were then applied from August 14, 2002 to September 13, 2002.

With respect to statistical treatment of data, Microsoft's STATISTICA software for Windows was used to do the descriptive analysis of data, and for inferential results, analysis of variance (ANOVA) and HSD Tukey test were carried out.

In the descriptive analysis, software calculated the frequency table in each one of the variables used in the study and distributed in five parts of the question-

naire. On the first and second parts (interview/hotel profile and Internet use) it was calculated only the percentages of each one of the variables involved. On the remaining parts (manager perceptions, benefits and difficulties), the variables' percentages and averages were calculated.

The analysis of variance was used to check if there was any significant difference on the opinions of hotel managers according to the hotel rate. The ANOVA allows the researcher to compare averages of several different samples (three or more) with data from the ordinal level to determine if population averages from these samples have any significant differences (Montgomery, 1996).

Tukey's HSD test ("honestly significant difference") was also used to locate where significant differences were located between the averages. Tukey's HSD test that was used is specific for differently sized samples, which is the case of this research. Tukey's HSD test is one of the most useful tests for multiple comparisons.

# Results

The results of the research were divided in two parts: The first one consists on a descriptive analysis where hotels and managers are profiled and also the perception of managers of the use of the Internet in hotels; the second part presents the analysis based on Tukey's variance statistical tests.

## Descriptive Results of the Research

### *Sampled Hotels' and Managers' Demographic Profiles*

On Table 1 it is checked that most of the respondents were women (65.7%), hotel reservation managers (60%), and relatively young, up to 35 years old (68.6%). In respect to their hotel experience, results were concentrated on six to 15 years of experience (42.9%) but it is important to say that there is also a considerable percentage of five years of experience (40 %).

*Table 1. Managers' profile*

| **Position** | **N** | **%** |
|---|---|---|
| General Manager | 3 | 8.6 |
| Guest Manager | 2 | 5.7 |
| Commercial Manager | 4 | 11.4 |
| Administrative Manager | 2 | 5.7 |
| Reception Manager | 3 | 8.6 |
| Reservation Manager | 21 | 60.0 |
| *Total* | 35 | 100.0 |
| **Age** | **N** | **%** |
| Less than 25 years old | 8 | 22.9 |
| 26 to 35 years old | 16 | 45.7 |
| Over 36 years old | 11 | 31.4 |
| *Total* | 35 | 100.0 |
| **Hotel Experience** | **N** | **%** |
| Less than 5 years | 14 | 40.0 |
| 6 to 15 years | 15 | 42.9 |
| Over 16 years | 6 | 17.1 |
| *Total* | 35 | 100.0 |

*Table 2. Hotels' profile*

| **Hotel Rate** | **N** | **%** |
|---|---|---|
| Simple | 14 | 40.0 |
| Medium Comfort | 12 | 34.3 |
| Comfortable/ Very Comfortable/ Luxury | 9 | 25.7 |
| *Total* | 35 | 100.0 |
| **Number of hotel rooms** | **N** | **%** |
| Less than 50 rooms | 7 | 20.0 |
| 51 to 100 rooms | 11 | 31.4 |
| 101 to 150 rooms | 10 | 28.6 |
| Over 151 rooms | 7 | 20.0 |
| *Total* | 35 | 100.0 |

Table 2 shows that the 35 researched hotels are rated as "simple" or "medium-comfortable" (74.3%); a little more than a half of them have less than 100 rooms.

## *Aspects of Internet Use in Hotels*

When questioned about the use of the Internet in the hotels, most of the managers answered that they did have Internet of some kind in their facilities (97.1%). Other data show that 97.1% of the hotels have their own e-mail address.

When it was asked if the hotel used the Internet to build up any kind of relationship with its clients, 85.7% of managers answered "yes," which seems to demonstrate their interest in using the Web as an electronic marketing tool aiming their customers' faithfulness. Another relevant piece of information is that only four (11.4%) out of the 35 managers said they had Intranet in their work. This indicates that hotels do not seem to consider the importance of using the Internet as a communication and cooperation tool for their employees. A possible reason for these data is that some of these hotels do not use an Internet platform as a way of corporate communication and cooperation.

Relating to hotel-supplier integration, only 20% of the hotels use Internet to purchase from the supplier. Mendes-Filho and Ramos (2001) stated that administration and food and beverage managers do research their product prices but do not buy them through the Web; therefore the Web is used only for price investigation.

A little more than 90% of hotels already have their homepages and 54.3% of such pages have existed for over two years, which resembles the research carried out by Lituchy and Rail (2000) in the U.S. and Canada, where 89.2 % of these facilities already have a Web site on the Internet and the vast majority (55.9 %) have already been on the Web for over two years. Most of these hotels are also using their homepages to offer Web room reservation services, for 85% of them do have that service.

Wei et al. (2001) accomplished a research about homepage too, and they concluded that of the hotels that had a Web page and also allowed their guests to make reservations through the Internet, only a small proportion of their reservations were received through the Web. In fact, less than 1% of the hotels had received more than 20% of reservations through the Web. In the same investigation, most respondents (73.6%) indicated that making reservations through the Web was actually the same or worse compared to making reservations by conventional means. Some common features were found on these Web pages: photos of property features (78.2%), information on reservations (67.3%), information on availability (22.4%), and virtual tours of the property (21.2%).

## *Internet Benefits*

The Internet enables the hospitality industry to control costs, improve employee productivity and provide superior customer service (Cisco Systems, 2003). As a result of this innovation, the hospitality industry has discovered that it is possible to cut labor and overhead costs without sacrificing product quality or customer service. It is relevant to hospitality-related businesses of every size, from single-unit operations to multinational corporations (Cisco Systems, 2003).

On the managers' opinion, the most expressive benefit reached was the increase of hotel advertising and marketing in the local and worldwide media, considered the most important by 85.7% of the interviewees (Table 3). Another benefit that also had a great result was the increase of sales and reservations through the Web: 80% of the managers said it is very important for their facilities. The result is coherent to the Abreu and Costa study (2000), in which it was demonstrated that the increase in the sales was the main aim expected by hotels when using the Internet.

However, there were two benefits that were mentioned by 5.7% of the managers as less important for their hotels: to facilitate the relationship with the client through messages, forwarded messages and birthday cards and to allow a greater knowledge on the client through homepage register forms.

*Table 3. Biggest benefit that the Internet can bring to a hotel*

| **Benefits** | Not important | Little important | Neutral | Important | Very Important | Average |
|---|---|---|---|---|---|---|
| Increasing hotel advertising and marketing | 2.9% | 0.0% | 0.0% | 11.4% | 85.7% | 4.8 |
| Increasing sales and reservations | 0.0% | 2.9% | 0.0% | 17.1% | 80.0% | 4.7 |
| Improving client service by providing hotel information | 0.0% | 0.0% | 0.0% | 37.1% | 62.9% | 4.6 |
| Reducing hotel costs | 0.0% | 0.0% | 5.7% | 31.4% | 62.9% | 4.6 |
| Improving hotel image | 0.0% | 2.9% | 5.7% | 45.7% | 45.7% | 4.3 |
| Facilitating the relationship with clients through messages and direct mail | 0.0% | 5.7% | 2.9% | 45.7% | 45.7% | 4.3 |
| Increasing competition (by competing with other hotels) | 0.0% | 2.9% | 2.9% | 51.4% | 42.9% | 4.3 |
| Allowing bigger knowledge on the client | 0.0% | 5.7% | 2.9% | 60.0% | 31.4% | 4.2 |

## *Internet Difficulties*

The tourism industry's advantage over most of the other sectors of electronic commerce is that the consumer goes and collects the product at the point of production. However, several issues have been identified as necessary steps towards the full exploitation of tourism's electronic commerce full potential (Deimizi, 2003):

- Increase security of transmissions;
- Ensure credibility of information;
- Secure intellectual property and copyright issues;
- Enhance bandwidth and reduce speed limitations;
- Reduce user confusion and dissatisfaction;
- Provide adequately trained specialists;
- Develop equal access for smaller and larger partners;
- Establish pricing structures for distribution of information and reservations;
- Enhance the standardization of information and reservation procedures.

*Table 4. Biggest difficulty for the hotel to use the Internet*

| **Difficulties** | Not difficult | Little difficult | Neutral | Difficult | Very difficult | Average |
|---|---|---|---|---|---|---|
| Cost and time involved on Internet installation process | 17.2% | 17.2% | 14.2% | 5.7% | 45.7% | 3.5 |
| Clients and employees are not used to using Internet | 14.3% | 14.3% | 5.7% | 34.3% | 31.4% | 3.5 |
| Developing training courses for employees who do not have any knowledge about Internet | 20.0% | 31.4% | 5.7% | 22.9% | 20.0% | 2.9 |
| Client becomes suspicious about using Internet | 28.5% | 25.7% | 14.3% | 22.9% | 8.6% | 2.6 |
| Safety and trust of hotel data to be exposed on the Web | 40.0% | 11.4% | 17.2% | 17.2% | 14.2% | 2.5 |
| Employees waste time by using Internet for personal purposes | 31.4% | 17.2% | 11.4% | 20.0% | 20.0% | 2.4 |
| Specialized labor cost for homepage maintenance and update | 20.0% | 51.4% | 5.7% | 14.3% | 8.6 | 2.4 |
| Complex Internet management | 48.6% | 22.8% | 8.6% | 8.6% | 11.4% | 2.1 |

According to Table 4, for 45.7% of the managers interviewed, cost and time involved in the setting of the Internet makes its use very difficult in a hotel. A reason that may justify this statement is that most hotels are quite simple and with less than 100 rooms, which may mean less financial power to invest time and money for Internet access. The variable "clients and employees are not used to using Internet and/or a computer" reached 31.4% of manager opinion as an item that makes it difficult for their facilities to use the Internet.

According to managers' opinions, the complexity of Internet management (48.6%), and also the safety and trust of hotel data that can be exposed on the Web (40%), do not seem to be difficult elements to be dealt with when it comes to Internet presence in the hotel.

## Inferential Results of Internet Use in Hotels

The one-way average comparison technique (ANOVA) was used with a 0.05 significance level to check if there were differences in the opinions of managers, followed by a Tukey test to determine the bias of such differences.

Through the results of the research it is intended to identify which factors contributed to the perception of managers relating to Internet use in hotels. The analysis was developed for four variables: according to the number of rooms and rate – both related to the organizational profile; age of managers and experience time in hotel industry- both related to individual profile. Inside each one of the profiles the perception on the importance of Internet use with the benefits and difficulties of the Internet was analyzed.

### *Effect of Manager's Age on Perception on the Use of the Internet*

The analysis of variance (Table 5) has identified significance in two benefits given by the use of the Internet in hotels: to allow a greater knowledge on the client and to reduce the costs of the hotel.

In the area of difficulties related to the installation of the Internet, only one variable had a significance level lower than 0.05: the development of training for employees who do not know how to use the Internet.

Through the Tukey test it was possible to conclude that managers up to 25 years old agreed that the Internet allows a greater knowledge of the client than the older managers did. Managers who were from 26 to 35 years old consider the

*Table 5. Effect of managers' age on the perception of the importance of Internet use*

| **IMPORTANCE OF INTERNET USE**<br>***Mean*** | **Less than 25 years old** | **26 to 35 years old** | **Over 36 years old** | **F-value** | **P** |
|---|---|---|---|---|---|
| **Benefits*** | | | | | |
| Increasing hotel advertising and marketing on local and global media | 4.88 | 4.63 | 4.91 | 0.582 | 0.565 |
| Increasing hotel reservations and sales | 5.00 | 4.75 | 4.55 | 1.308 | 0.285 |
| Improving client service by providing hotel information | 4.88 | 4.56 | 4.55 | 1.340 | 0.276 |
| Reducing hotel costs | 4.63 | 4.81 | 4.18 | 4.218 | **0.024*** |
| Improving hotel image and facilitating the consolidation of its name/brand | 4.38 | 4.25 | 4.45 | 0.258 | 0.774 |
| Increase competition (Competition with hotels from other places) | 4.63 | 4.25 | 4.27 | 0.881 | 0.424 |
| Facilitating relationship with the client | 4.75 | 4.06 | 4.36 | 2.158 | 0.132 |
| Allowing greater knowledge on the client | 4.63 | 4.31 | 3.64 | 5.904 | **0.007*** |
| **Difficulties*** | | | | | |
| Cost and time required for installing Internet in the hotel | 3.88 | 3.81 | 2.64 | 2.225 | 0.125 |
| Clients and employees are not used to using IT | 3.25 | 3.94 | 3.18 | 1.117 | 0.340 |
| Need of training for employees who do not know the Web | 2.50 | 3.75 | 2.00 | 6.564 | **0.004*** |
| Client suspicious of using the Internet | 2.63 | 2.38 | 2.82 | 0.342 | 0.713 |
| Safety and trust of data in Internet ambient | 2.38 | 2.50 | 2.73 | 0.129 | 0.880 |
| Waste of time due to the use of Internet by employees for personal purposes | 2.75 | 2.81 | 2.82 | 0.005 | 0.995 |
| Specialized labor cost | 2.63 | 2.38 | 2.27 | 0.191 | 0.827 |
| Complex Internet management | 2.13 | 2.31 | 1.82 | 0.387 | 0.682 |

**Variable with significance $p<0.05$*

Internet more important to reduce costs than the ones who are over 35 years old.

By using the Tukey test the conclusion is that 26 to 35 year-old managers agree that training for employees who do not have any knowledge on the Web makes the use of IT more difficult than the ones who are over 35.

## *Effect of Manager's Experience Time in Hotel Industry on the Perception on the Use of the Internet*

When it comes to the effect of managers' experience in hotel industry in their perceptions, there were no identified significant variables related to the difficulties in Internet use.

From Table 6 it is observed that the ANOVA test found a variable with a significance level below 0.05: Internet facilitates the relationship with the client in terms of its benefits.

*Table 6. Effect of manager's experience time on their perception*

| IMPORTANCE OF INTERNET USE<br>*Mean* | Less than 5 years | 6 to 15 years | Over 16 years | F-value | P |
|---|---|---|---|---|---|
| **Benefits*** | | | | | |
| Increasing hotel advertising and marketing on local and global media | 4.64 | 4.87 | 4.83 | 0.351 | 0.706 |
| Increasing hotel reservations and sales | 4.64 | 4.80 | 4.83 | 0.306 | 0.738 |
| Improving client service by providing hotel information | 4.79 | 4.40 | 4.83 | 3.254 | 0.052 |
| Reducing hotel costs | 4.64 | 4.60 | 4.33 | 0.558 | 0.578 |
| Improving hotel image and facilitating the consolidation of its name/brand | 4.14 | 4.47 | 4.50 | 0.886 | 0.422 |
| Increase competition (Competition with hotels from other places) | 4.50 | 4.27 | 4.17 | 0.649 | 0.529 |
| Facilitating relationship with the client | 4.71 | 4.20 | 3.67 | 4.776 | **0.015*** |
| Allowing greater knowledge on the client | 4.43 | 4.00 | 4.00 | 1.416 | 0.257 |
| **Difficulties** | | | | | |
| Cost and time required for installing Internet in the hotel | 3.07 | 3.73 | 3.67 | 0.656 | 0.526 |
| Clients and employees are not used to using IT | 3.86 | 3.33 | 3.33 | 0.539 | 0.588 |
| Need of training for employees who do not know the Web | 2.93 | 3.13 | 2.33 | 0.611 | 0.549 |
| Client suspicious of using the Internet | 2.64 | 2.67 | 2.17 | 0.310 | 0.735 |
| Safety and trust of data in Internet ambient | 2.93 | 2.13 | 2.67 | 1.014 | 0.374 |
| Waste of time due to the use of Internet by employees for personal purposes | 3.00 | 2.67 | 2.67 | 0.181 | 0.836 |
| Specialized labor cost | 2.36 | 2.67 | 1.83 | 1.019 | 0.372 |
| Complex Internet management | 1.93 | 2.13 | 2.50 | 0.334 | 0.719 |

**Variables with significance $p<0.05$*

Tukey test indicated that managers who have less than 5 five years of hotel experience think that the use of the Internet facilitates the relationship with the client far more than the more experienced managers.

## *Effect of Hotel Rate on the Perception of Internet Use*

ANOVA test found no significant result relating to the effect of hotel rating on the difficulties of Internet. However, as it is shown in Table 7, the ANOVA test applied to the benefits of the Internet to the hotel has found a variable with a significance level below 0.05: Internet use does improve the service to clients by providing information of the hotel through its Web page and e-mail.

From the Tukey test, luxurious hotel managers consider it more important to use the Internet to improve service to the client rather than simple hotel managers.

*Table 7. Effect of hotel rate on the perception of managers*

| IMPORTANCE OF INTERNET USE<br>*Mean* | Simple | Medium comfort | Luxury | F-value | P |
|---|---|---|---|---|---|
| **Benefits*** | | | | | |
| Increasing hotel advertising and marketing on local and global media | 4.86 | 4.58 | 4.89 | 0.595 | 0.558 |
| Increasing hotel reservations and sales | 4.71 | 4.67 | 4.89 | 0.352 | 0.706 |
| Improving client service by providing hotel information | 4.36 | 4.67 | 5.00 | 6.232 | **0.005*** |
| Reducing hotel costs | 4.64 | 4.50 | 4.56 | 0.174 | 0.841 |
| Improving hotel image and facilitating the consolidation of its name/brand | 4.36 | 4.25 | 4.44 | 0.180 | 0.836 |
| Increase competition (Competition with hotels from other places) | 4.14 | 4.50 | 4.44 | 1.017 | 0.373 |
| Facilitating relationship with the client | 4.29 | 4.50 | 4.11 | 0.615 | 0.547 |
| Allowing greater knowledge on the client | 4.00 | 4.42 | 4.11 | 1.048 | 0.362 |
| **Difficulties** | | | | | |
| Cost and time required for installing Internet in the hotel | 3.21 | 3.33 | 4.00 | 0.689 | 0.509 |
| Clients and employees are not used to using IT | 3.14 | 3.50 | 4.22 | 1.597 | 0.218 |
| Need of Training for employees who do not know the Web | 2.50 | 2.67 | 3.89 | 2.966 | 0.066 |
| Client suspicious of using the Internet | 2.71 | 2.08 | 3.00 | 1.329 | 0.279 |
| Safety and trust of data in Internet ambient | 2.36 | 3.08 | 2.11 | 1.241 | 0.302 |
| Waste of time due to the use of Internet by employees for personal purposes | 2.57 | 2.92 | 3.00 | 0.244 | 0.785 |
| Specialized labor cost | 2.00 | 2.92 | 2.33 | 1.953 | 0.158 |
| Complex Internet management | 1.86 | 2.33 | 2.22 | 0.390 | 0.680 |

**Variables with significance p<0.05*

*Table 8. Effect of the number of rooms in the perception of managers*

| IMPORTANCE OF INTERNET USE<br>*Mean* | Less than 50 rooms | 51 to 100 | 101 to 150 | Over 151 rooms | F-value | P |
|---|---|---|---|---|---|---|
| **Benefits** | | | | | | |
| Increasing hotel advertising and marketing on local and global media | 4.86 | 5.00 | 4.50 | 4.71 | 0.853 | 0.476 |
| Increasing hotel reservations and sales | 5.00 | 4.45 | 4.80 | 4.86 | 1.387 | 0.265 |
| Improving client service by providing hotel information | 4.43 | 4.64 | 4.70 | 4.71 | 0.508 | 0.679 |
| Reducing hotel costs | 4.57 | 4.64 | 4.40 | 4.71 | 0.413 | 0.745 |
| Improving hotel image and facilitating the consolidation of its name/brand | 4.57 | 4.27 | 4.20 | 4.43 | 0.405 | 0.750 |
| Increase competition (Competition with hotels from other places) | 3.86 | 4.64 | 4.30 | 4.43 | 2.087 | 0.122 |
| Facilitating relationship with the client | 4.29 | 4.64 | 4.10 | 4.14 | 0.949 | 0.429 |
| Allowing greater knowledge on the client | 4.29 | 4.27 | 4.00 | 4.14 | 0.282 | 0.838 |
| **Difficulties** | | | | | | |
| Cost and time required for installing Internet in the hotel | 3.57 | 2.73 | 3.60 | 4.29 | 1.457 | 0.245 |
| Clients and employees are not used to using IT | 3.14 | 3.27 | 3.90 | 3.86 | 0.602 | 0.619 |
| Need of training for employees who do not know the Web | 2.57 | 2.82 | 3.10 | 3.14 | 0.231 | 0.874 |
| Client suspicious of using the Internet | 2.29 | 2.55 | 2.90 | 2.43 | 0.306 | 0.821 |
| Safety and trust of data in Internet ambient | 2.57 | 3.09 | 2.40 | 1.86 | 0.978 | 0.416 |
| Waste of time due to the use of Internet by employees for personal purposes | 3.14 | 2.73 | 2.30 | 3.29 | 0.662 | 0.582 |
| Specialized labor cost | 2.71 | 2.36 | 2.10 | 2.57 | 0.385 | 0.764 |
| Complex Internet management | 2.29 | 1.45 | 2.80 | 2.00 | 1.751 | 0.177 |

**Variables with significance p<0.05*

*Effect of the Number of Rooms on the Perception of Internet Use*

According to Table 8, the effect of the number of hotel rooms on the perception of the managers showed no significant variable related to the benefits and difficulties.

## Future Trends

A hotel chain's success has always depended on excellent services performed by operation, marketing and human resources sectors. For Withiam (2000), in the 21st century an essential factor will be technological support, making it possible for computers to process information of reservation systems, affinity programs and marketing data banks.

Improvements in the integration, centralized data banks and the use of Web sites are some of the tendencies in the development of software for hotels (Adams, 2001). Therefore, the connection of a hotel system to the Internet will integrate information of the internal system with the Web site, and this will make a lot of information available to managers. The new systems are being developed with this integration with the Web site.

With the increasing demand of information in the tourist sector the importance of IT use in this industry will only tend to increase in the future. Therefore, the tourist businesses must understand, incorporate and use IT strategically to serve the target markets, improve their efficiency, maximize profitability, perfect services and maintain the profitability in the long term (Buhalis, 1998).

To Olsen and Connoly (2000), the volume of information about the guests collected electronically is too large for the directors to be able to manage without the help of technology. Data warehousing and data mining are technologies that are gaining popularity to analyze information about clients. These technologies may be used to help hotel- keepers construct good relationships with their guests, increasing their loyalty to them.

Using the Internet in the hotel industry has good prospects of growth, though in many hotels the use of such technology is still moving slowly. It will be an important and strategic issue for businesspeople to stimulate such Internet use policies inside the tourist trade so that they become wired to this new reality and can work on even terms with their competitors.

# Conclusion

Despite the fact that Internet use is very common, the proportion of reservations received from the Internet is small. The public could still be concerned about issues of

security for financial transactions, or could not be satisfied with its inability to synchronize inquiries. A low reservation rate from the Internet may also be partly attributed to the lack of certain relevant information, such as room availability, and virtual tours of the property not commonly included in the homepage (Wei et al., 2001).

In general, the Internet does enable tourist companies to increase their competitiveness. IT can improve the efficiency of suppliers and provide tools for the development and delivery of different tourist products (Mendes-Filho & Ramos, 2003). One of the benefits reached is the reduction of the dependence on the middle-person in the distribution of tourist products. Hotel owners should invest more money in technology besides concentrating more time and attention to subjects in that area. IT affects all aspects of a hotel chain's value, going far beyond sectors and departments. As technology will be intrinsically linked to hotel business, its executives will insert technology in all their strategic decisions for the facility. That implies that all the employees (including managers and directors) need to have enough knowledge to extract the potential the technology provides.

Moreover, the Internet has decreased expenses and enabled small businesses to conduct international business from home (Lituchy & Rail, 2000). Small inns and bed & breakfasts are advertising on the Web and are therefore becoming a presence in the global market. So, they face the likelihood of serving foreign customers that may have different hospitality expectations.

In this research it was possible to portray the situation of mid- and large-sized hotels in Natal, RN, Brazil, and also contribute by offering a panoramic view on the use of Internet and some impacts perceived by managers in the hotel industry. It has been demonstrated that there are not so many differences of opinion as to the use of Internet in hotels. That leads to an important conclusion: Nowadays the Internet has become a highly relevant instrument notwithstanding any demographic variables that may occur (e.g., age, experience, size and rate).

However, for its transversal and temporal character as well as its restraint to Brazilian hotels with more than 40 rooms in a specific city, it is not possible to

generalize all hotel universes. Hence, there is an expectancy that other research on the academic level may complete and broaden this basis of knowledge on the impacts of IT applications, remarkably the ones developed for the Web platform, and therefore help the production sector to better understand them and adopt them effectively in their businesses.

For that purpose to be fulfilled other research should be developed by incorporating other variables, using other analysis techniques and observing different cities, bigger hotel samples or even comparative studies with the results obtained.

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## Chapter XI

# A Reverse Auction Case Study: The Final Chapter

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## Abstract

*The reverse auction tool has evolved to take advantage of Internet technology and has been identified by many large organisations as a tool to achieve substantial procurement savings. As companies adopt this technology it is important for them to understand the implications of this type of procurement. This chapter re-visits a reverse auction event and discusses the impacts the reverse auction format had upon all participants involved in the auction. In late 2001 a small Australian supplier of transport and logistics services was asked to participate in a reverse auction for services they had provided for five years to a multi-national organisation. They were not successful in retaining their contract position*

*and this chapter looks at the reverse auction and its business impacts two years after the initial auction. The case study is viewed through the eyes of the winning supplier, losing supplier, auction vendor, and buyer. The main outcomes show that the reverse auction struggles to adapt to fluid business conditions and is limited if it is used as only a price fixing mechanism. It did not engender co-operative supply chains or win-win situations between the auction players.*

## Introduction

Today, organisations spend over US$20 trillion globally on external goods and services, and thus, the supply chain is now the focus in cost reduction and efficiency increase (Minahan, 2001). As more and more innovative applications are developed, electronic commerce has increasingly adopted an ever-widening definition. One recent application that has sought the "e" treatment is procurement. Minahan (2001) defined e-procurement as:

> *"The process of utilising Web-based technologies to support the identification, evaluation, negotiation, and configuration of optimal groupings of trading partners into a supply chain network, which can then respond to changing market demands with greater efficiency"* (Minahan, 2001).

Activities that could be applied to the e-procurement process include:

- Advertisement of tenders.
- Electronic submission of tenders.
- Electronic ordering.
- Internet sourcing via third parties.
- Electronic mail between buyers and sellers.
- Electronic mail in contract management.
- Research into supplier markets.
- Integration of procurement within the financial and inventory systems.

Accordingly, there are a plethora of tools that have been developed to support these business activities. As organisations extend the reach of their information systems into the supply chain, e-procurement has become a driving force for achieving substantial cost savings. One mechanism that facilitates e-procurement is the reverse online auction. Reverse online auctions are delivered by intermediaries, many of whom promise to deliver savings of up to 20% for the buying organisations. The rhetoric of B2B collaboration has "win-win" scenarios for all who participate in online auctions. But is this true? This chapter will re-visit a case study of an Australian reverse online auction asking the basic questions: what long-term impacts resulted from the original reverse auction? It will analyse the online auction from all viewpoints, questioning the value proposition of the reverse online auction as a tool in B2B e-commerce.

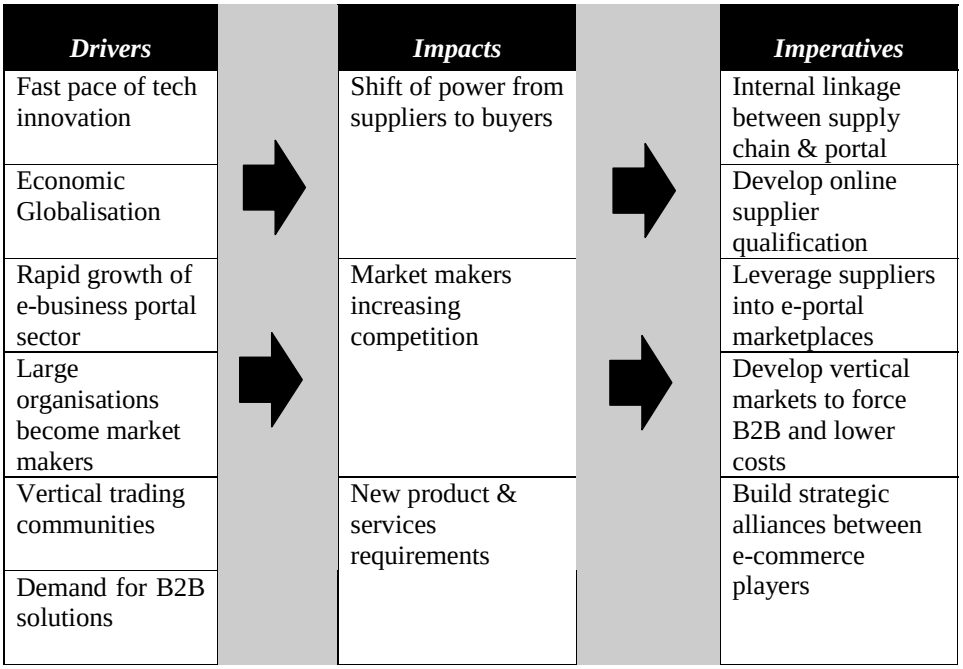
## The Growth of E-Procurement

Many research organisations predict massive growth in the B2B market. Bowles (2000) saw the global B2B market growing to US$968 million in 2002 and then US$1.551 billion in 2004. Yet, these figures pale into insignificance when considering other market analysts, predictions:

- Gartner: US$2.9 trillion by 2003.
- AMR: US$5.7 trillion by 2004.
- Forrester: US$7.29 trillion by 2004 (Diba, 2001; Hersch, 2000; Regan, 2001).

These predictions should be accepted with caution, however. In a recent article in *Management Research News*, Wyld (2002) cautions that we are entering the end of the "trough of disillusionment" phase of e-business, where exponential gains in efficiencies and cost reductions will be replaced with incremental progress. Yet, there does seem to be a sea change in how procurement is conducted in organisations. B2B has promised — and delivered in many instances — to drive costs down and streamline procurement operations (McGarvey, 2000). In fact, Metcalfe et al. (2001) predicted that European companies could achieve a 50% gain in productivity through adopting Internet-enabled B2B processes by 2010. Wyld (2000) developed an e-procurement

*Figure 1. The Wyld (2000) e-procurement model*




*Source: Wyld (2000, p. 4).*

model, presented in Figure 1, looking at the totality of the e-procurement process, from drivers through impact to imperatives. The model demonstrates some of the changes that are affecting the e-procurement value chain. Organisations on the buying and selling side will need to address these challenges to capture both the tactical cost control and the more strategic market developments. One of the critical aspects will be decisions regarding buyers' employment of and sellers' participation in online auctions.

## The Auction Economy

Batsone (1999) asked the question whether in the future, what if the price of everything would be negotiable? We have grown accustomed – both in the

business and consumer marketplace – to the concept of market prices. Yet, at the heart of the auction economy is the concept of pricing, and more importantly, dynamic pricing. Dynamic pricing simply means that a good or service is priced according to what the market determines. The Web introduces the element of real-time pricing and further elevates the importance of personal price elasticities. Customers will determine the price, depending upon the price/value trade-off. No longer is the supply/demand model determining price. Rather, a more complicated, customer-centric price/value trade-off determines pricing (Batsone, 1999). Many service-based companies use this principle when they have multiple – and sometimes hundreds – of price points for the one product, most notably airlines and hotels.

O'Malley (1998) saw the Web being "a giant bidding war," and Queree (2000) commented that online auctions were fast becoming a mainstream business model. The auction model has settled into the B2B marketplace and has been developed for various e-government applications (NSW, 2001). Wyld (2000) saw the auction model being adaptable for use in:

- Procurement.
- Disposition of used assets.
- Internal corporate management.

There are several differing auction formats used in online auctions, including:

- English.
- Yankee.
- Dutch.
- Sealed bid.
- Vickrey.
- Forward and Reverse Auctions (Wyld, 2000).

Kafka et al. (2000) predicted that by 2004, US$ 746 billion of business will be conducted through online auction models, based on dynamic pricing.

# Reverse Auctions for E-Procurement

While many first think of eBay and *forward auctions* (where prices rise) when the subject of online auctions is discussed, *reverse auctions* play an important role in e-procurement strategies. In fact, growing numbers of firms worldwide, led by the global Fortune 1000 companies, have successfully used online auctions as a tool to reduce prices for goods and services (Emiliani, 2000). One of the pioneers of online B2B auctions for e-procurement is Freemarkets, which was established in 1995 and launched their online auction site in 1999. To date, they have conducted auctions involving more than 19,000 suppliers from more than 70 countries worth $US 30 billion (Freemarkets, 2002).

In the first quarter of 2000, they conducted auctions involving 47 Fortune 500 buyers and 4,000 suppliers (Freemarkets, 2002). Mayne Group, one of

*Table 1. The reverse auction process*

| Step | Activities |
|---|---|
| 1) Market Made (Client focus) | Make market (specifications) |
| | Identify Suppliers |
| 2) Pre-Qualification (Supplier Focus) | Pre-Award Review<br>Contract/schedule, Specifications<br>Ability to deliver, Quality assurance<br>Past performance, Responsibilities<br>Set-up technicals |
| | Approved suppliers listing |
| | Identify specific terms & conditions |
| | Invite suppliers |
| 3) Pre Auction Planning (Client/Supplier) | Set up Auction<br>Create auction content, Set-up security<br>Register bidders, Ensure readiness<br>Contingency planning |
| | Supplier Auction Strategy |
| 4) Auction Activity (Supplier) | Conduct Auction<br>Suppliers bid real-time, Buyers monitors auction<br>Winners selected, Contingencies ready |
| 5) Post Auction (Client) | Contract write-up |

*Source: Adapted from* Buyers.gov, *2000.*

Australia's leading companies with major interests in health care and logistics, signed a three-year deal in 2000 with Freemarkets to manage their procurement and operate online auctions. Other major B2B auction facilitators include:

- Ariba.
- CommerceOne.
- Andale.
- Elcom.com.
- Procuree.
- Verticalnet.

The B2B auction facilitators usually work with buyers to select bidders to participate in each auction, develop specifications in detail, and tailor the bidding process to the situation. This service is billed to buyers accordingly. There could be additional costs, based on a percentage of the anticipated savings (Messmer, 2000). Freemarkets (2002) promotes the ability of their auction format to decrease service prices by 16-18% and goods by 2-3%. The reverse auction process involves intensive work on behalf of the buyer and market maker to structure the bidding process and prepare suppliers for qualification. This process is represented in Table 1.

## Reverse Auctions: State of Play

A recent comprehensive report by the CAPS Research Group (Beall et al., 2003) detailed the landscape for the operation and success for reverse auctions. The report recognises that reverse auctions are controversial and are implemented for many reasons:

- Get buyers and sellers to interact in a real-time Internet enabled world.
- Recognise that service quality and product quality are "givens".
- Massive cost savings are possible.
- ROI is rapid with reverse auction tools.

- Cycle-time savings in the procurement process are significant.
- Buyers can reach more suppliers and thereby increase competitive advantage.

While the literature shows rapid acceptance of the reverse auction format there are several impediments to the successful operation of reverse auctions:

- Unfamiliarity of the new procurement process and methodology.
- False premise that price is the only determinant of the reverse auction.
- Potential that the reverse auction will diminish buyer/supplier value trust network.

Reverse auctions are still in their formative years. Organisations are only now implementing their second and third iterations of reverse auctions. Issues to do with ethical use of reverse auctions and business viability of the reverse auction format are being developed. There is no doubt that the reverse auction tool is becoming part of mainstream procurement operations as shown in Table 2 (ISM, 2002).

Beall (2003, p. 60) concludes by mentioning the acceptance and potential impact that reverse auctions can have and makes the following points:

- Definite acceptance for highly standardized products and services.
- Reported payback after a few uses of reverse auctions.
- Little evidence of reverse auctions harming buyer/supplier value trust network.
- Late adopters rushing to catch first adopters.

*Table 2. Use of online reverse auctions for procurement*

| | Q1-2001 | Q2-2001 | Q3-2001 | Q4-2001 | Q1-2002 | Q2-2002 | Q3-2002 | Q4-2002 |
|---|---|---|---|---|---|---|---|---|
| All Companies | 15.8% | 15.0% | 20.4% | 17.4% | 23.1% | 20.2% | 22.4% | 18.8% |

*Source Data: ISM/Forrester. (2002).* Reports on e-Business.

- Ethical concerns are less than existing negotiations practices.
- Predicted growth of reverse auctions into the future.

# Reverse Auction Case Study

## Methodology

The primary objective of this chapter was to return after two years to a study of an Australian example (Stein et al., 2003) of reverse auction procurement and analyse the auction process and outcomes. Whilst the growth of the reverse auction has been marked in recent years few studies have looked at long-term impacts of the process. The viewpoints of the winning and losing suppliers, auction vendor and buyer will be presented, as there is a dearth of literature of long-term case studies of participants in an online auction. This analysis will be presented as a case study. More specifically, the research question to be addressed in this study is: What are the long-term business impacts of the online auction?

Case study research methodology was used in this research, as this project represented an exploratory look at implications of reverse online auctions. Yin (1994, p. 35) emphasises the importance of asking "what" when analysing information systems. Yin goes further and emphasises the need to study contemporary phenomena within real-life contexts. Walsham (2000, p. 204) supports case study methodology and sees a need for a move away from traditional information systems research methods, such as surveys, toward more interpretative case studies, ethnographies and action research projects. Several works (Benbasat et al., 1987; Chan & Roseman, 2001; Lee, 1989) have used case studies in presenting information systems case-study research. Cavaye (1996) used case study research to analyse inter-organisational systems and the complexity of information systems. The data collection process for the present research included:

- Examination of existing documentation.
- Content analysis of e-mail.
- Interview of actors.
- Direct observations.

The initial auction event was analysed (Stein et al., 2003) from the supplier organisation's viewpoint but this analysis will have emphasis on all participants and outcomes of the event.

## The Initial Reverse Auction

In April 2001, AusBuyer[1] commissioned Auction.com to make a market for the logistics component of their manufacturing activities. The market was broken down into 19 channels, both state and nationally based. AusSupplier received notification that a contract that it had partially carried out for five years was to be auctioned on the Internet. AusSupplier started a six-month exploration into online auctions and B2B procurement. Considerable time and financial resources were expended to first learn about and then to participate in a reverse online auction.

## The Participants

AusSupplier is a micro-business, having two full-time and five part-time consultants. It is an "infomediary," or - in older parlance - a "middleman". AusSupplier turns over AUD$10 million and has a small client base. The role of the "infomediary" is to win a contract for packing and exporting commodities into the Asian marketplace. AusSupplier wins a contract from a large manufacturer (AusBuyer) and then negotiates transport and rates from shipping organisations. The commodity that was to be auctioned was worth about AUD$1.6 million per year. Currently, AusSupplier was responsible for about 20% of the contract, with a major transport company being responsible for the other 80%.

Auction.Com is a multi-national, market leading e-commerce company, specialising in e-procurement and auctions. It has about 1,000 employees worldwide and operates for about 140 large multi-national clients. It has conducted about US$ 21 billion in auctions, resulting in savings of about US$ 6 billion. It is obvious when looking at Auction.Com and AusSupplier, the difference in size, technology and more importantly, the chasm in understanding e-business.

AusBuyer is an Australian manufacturer that is part of a global organization, based in the United States. The global organisation was undergoing financial

strain, due to the poor commodities market worldwide. In order to reduce costs AusBuyer turned to Auction.Com to conduct a number of auction events. This case study outlines the first of over 300 auction events conducted over the last two by Auction.com for Ausbuyer.

## The Auction Process

The auction event was an Australia-wide procurement exercise, focusing on logistics and transport services. The entire procurement operation of AusBuyer was placed in 19 lots, with each lot undergoing a 1.5-hour auction. For AusSupplier the auction event went through five stages:

1. Market-made (client).
2. Pre-qualification (supplier).
3. Pre-auction planning & strategy (client/supplier).
4. Conduct auction (supplier).
5. Post-auction (client).

## Stage 1

In stage 1 (Market-made), AusSupplier undertook research into the reverse auction process, and then received a CD containing Web-based bidding software and documentation from the manufacturer. This documentation consisted of over 50 files: tender documents, quote spreadsheets, specifications and information sheets. It was updated four times before the final auction. Initially, the deluge of information was overwhelming.

> *"I have spent hours retrieving, printing, reading and just trying to make sense of the process."* Managing Director, AusSupplier, May 2001.

At this stage, considerable effort was expended to determine if AusSupplier could participate in more than one channel (auction). It was felt that other channels, including some interstate, could be bid for. However, a more conservative approach was adopted, due to uncertainty about the online auction process.

## Stage 2

Stage 2, (pre-qualification), involves Auction.Com and AusBuyer weeding out non-performing suppliers. Yet, at the same time, they are trying to ensure an adequate number of bidders to be able to create the auction dynamic. AusSupplier had no idea how many other companies had pre-qualified; it only learned of the exact number at the auction event. Pre-qualification also introduces some financial parameters for the event. Auction.Com set the switching price at $AUD 1.3million; that is, the price when AusBuyer would consider awarding the contract away from the existing supplier. Market research by AusSupplier showed the existing contract was worth $AUD 1.6million. The difference between the price of switching to a new supplier and the existing contract price was about 18%. This figure is similar to the figure quoted in the advertising material by Auction.Com, which quotes savings of 18%.

AusSupplier again had expended considerable resources at this stage:

- two site visits.
- four sub-contractor meetings.
- 200 phone calls.
- 45 e-mails out.
- 15 e-mails in.
- 30 hours of managing director time.
- 20 hours of consultants' time.

Thus, the bill for participating in the reverse auction was climbing. Summarising the financial details thus far:

- AusSuppliers market entry price AUD$2 million
- Existing contract price. AUD$1.6 million
- Reserve (switching) price. AUD$1.3 million

The AusSupplier's high market entry price ($AUD 2 million) was formulated on the basis of entry into an unknown scenario. It was formulated on the rate

of moving the commodity by the tonnages quoted by AusBuyer, with a margin built in. At this stage, it became apparent that the auction format was introducing an element of incredulity to the quoting process.

> *"We are flying in the dark, some cowboy could underbid us and have no real idea of what is involved in the job…."* Managing Director, AusSupplier, June 2001.

AusSupplier had no idea of how many others bidders there were, no idea of their market entry point and only one Auction.Com tutorial on a simulated auction. Being pre-qualified and waiting for the auction became quite stressful for the AusSupplier. Questions were raised in regards to:

- What strategy should be adopted?
- What would happen if the power failed, or if the ISP went down?
- What would be the "bottom-line" position?
- Would AusSupplier be swept up in the auction dynamic?
- Who would press the buttons, and would they be able to keep their nerve?

Auction.Com conducted a training session from their Asian headquarters, and AusSupplier personnel had soon mastered the auction interface.

## Stage 3

In Stage 3, (Auction Strategy), AusSupplier developed three strategies for the auction:

- Entry strategy.
- Middle strategy.
- End strategy.

The *entry* strategy was to come in at the high pre-qualification bid after about three minutes and then watch the market develop. The *middle* strategy was to maintain control on the screen and drive the bids down in a controlled manner.

During the auction event, AusSupplier would not know who were responsible for the other bids. The only strategy for the end was to be in the "*end game,*" and if they did not have the lowest bid, then, at least, they would be under the switching cost at the end. It was believed that this would show AusBuyer that AusSupplier was a serious bidder. It was stated that AusBuyer was not under any obligation to accept the lowest bid. AusSupplier had seen sample auction events, and they knew the "*end game*" was frantic.

## Stage 4

Stage 4, (auction), was delayed a week with a late flurry of updates and clarifications. Finally, the day of the auction arrived and at 10:33 a.m. AusSupplier pressed the bid accept button to indicate they were part of the event. Within five seconds, AusSupplier's early and middle strategies were destroyed. The screen showed there were three other bidders, with one bidder right on the switching price (AUD$1.3 million). This was felt to be a ploy to scare off other bidders and AusSupplier was confident that this was the existing contractor, who had 80% of the existing contract. After about half an hour, another bidder entered and soon started to drive the bidding price down further. AusSupplier's strategy was to drive down the bids to the reserve price. As the scheduled auction time was nearing completion the bidding intensified and AusSupplier's phones were put on hold. A bid in the last minute extends the auction minute-by-minute. There were three bidders left. There was tension in AusSupplier personnel as the low price previously agreed upon was passed. This resulted in the staff member in front of the computer handing over control to the managing director.

The auction entered the phase that Auction.Com refers to as the "*auction dynamic,*" the dynamic that drives the price down even further. In fact, the reserve was driven down $90,000 in seven minutes. The number of bids in the last seven minutes tripled all bids in the previous 1.5 hours. The managing director became caught up in the auction dynamic, as he did not want to lose to the other bidders. AusSupplier's lowest bid was based on an agreed upon margin of 12%, but this was reduced to 5% towards the end of the auction.

AusSupplier did not win the auction, but that did not mean that they had not won the contract. They were in the game at the end, and they were determined to drive the market down to inflict some pain on the other bidders.

### Stage 5

In Stage 5, (post-auction), AusSupplier was told that they would have to wait five weeks for the result. However, the answer came much earlier. AusSupplier was unsuccessful; they had lost the 20% of the contract that they had owned previously. The managing director took about 2 weeks to get over losing to the competition. There are several issues that need to be discussed concerning the winners and losers of reverse auction e-procurement.

## Discussion

### What are the Long-Term Business Impacts of the Online Auction?

A full case study analysis of the auction event is described in Stein et al. (2003). The following analysis will focus on the long-term business impacts as experienced by all participants of the initial auction.

### The Auction Vendor – Auction.com

So, who benefited initially from the auction event and was this benefit maintained over the course of the contract? Auction.com was the big winner by gaining their initial consulting fees for setting up the auction event and also a percentage of the savings from AusBuyer. They also used this auction event to demonstrate their auction technology to other large Australian companies. They were very successful in demonstrating their ability to achieve savings and this resulted in them conducting 300 reverse auctions for Ausbuyer in the following year. Many organisations have moved to reduce the cost of the reverse auction by moving from using auction vendors in an ASP format to conducting their own auctions (Beall et al., 2003, p. 8) on site.

One year after the auction, Auction.com (Rawlings, 2002) commented on the processes, transparency and fairness of reverse auctions. It is hard to argue with the auction vendor, as the growth in reverse auction has been significant (Beall et al., 2003:31). Auction.com did acknowledge the challenging nature of

the reverse auction process but still felt that both suppliers and buyers were in a win-win situation. Auction.com commented on the acceptance of the reverse auction process by suppliers who appreciated the transparent nature of the process and the widening of markets for suppliers. It is interesting to note the impact of the reverse auction on middleman suppliers. In the case described above (Stein et al., 2003), the auction vendor was able to prune 20% from the contract price whilst charging something up to 20% for their fees. The sum effect is a transfer of profit margin from the supplier to the auction vendor and it is hard to imagine a more effective Internet enabled business strategy.

Beall et al. (2003, p. 11) point to the effect that changing external economic conditions can have on the effectiveness of the reverse auction format. The buyer is using the reverse auction tool to magnify their competitive advantage over their suppliers. The more suppliers the better, but what happens if the supply market tightens and suppliers have competitive advantage over buyers? Beall suggests that suppliers might then conduct forward auctions to sell their capacity to buyers. Again the auction vendor may be able to intercede and transfer buyer margin into auction vendor fees.

The original auction event as described above specified a contract length of 2 years; would a reverse auction be sustainable a second or third time? Would the auction vendor get a substantial fee for a claimed saving of another 20% on repeated buys? As described below the contract in this case lasted only six months before the commercial conditions were substantially changed. The auction vendor was not penalised even though they play a major role in setting the market in the first stage of the reverse auction process. Indeed the more unsettled external market conditions render potential for auction.com to conduct more auctions.

## The Winning Supplier

The auction produced one clear-cut winner, or did it? The winning supplier, prior to the auction, had 80% of the contract at a price of AUD$1.28 million. They won the full contract at approximately the same price. Thus, they garnered 20% more work for a nominal extra margin. They did dispel the competing supplier and became the preferred supplier. As the winning supplier was a large national transport company and the losing supplier was an SME it is felt that the winning supplier took a loss-leader position to win the contract.

In the initial contract the predicted product tonnage was specified. Six months after the auction event additional logistics facilities became available to Ausbuyer, and they began to move products without using the winning supplier. The initial product specification in the RFQ was changed substantially. Would the winning or losing supplier be able to have redress in terms of changing contracts? Perhaps, but in the commercial environment where powerful multi-national buyers are using smaller suppliers the buyer dictates changes in contract conditions.

Two years after the initial auction, business circumstances have returned to those existing before the auction. The winning supplier has about 90% of the contract while the losing supplier has regained about 10%. Rates are as set in the reverse auction and essentially this example of a reverse auction had only two winners, Ausbuyer and Auction.com. Beall et al. (2003, p. 10) point to the use of reverse auctions for indirect and direct procurement for commodity-like products. Services or products that are irregular or subject to frequent change do not lend themselves for reverse auction formats; these could include:

- Design services.
- Repair services.
- Emergency deliveries.
- Sudden surges in product demand.

The dramatic change in product tonnages and changed transport options meant that the reverse auction was originally deciding a two-year contract when in reality it was only a six-month contract period. So would it be viable to conduct an auction every time the contract conditions changed markedly, or would Ausbuyer go back to the original suppliers and negotiate new terms and conditions? If negotiations are used, and Beall et al. (2003, p. 11) suggest they are, then the reverse auction again reverts to a price fixing role with more complex negotiations necessary to complete the contract. Does this then affect the claim by Auction.com that the new reverse auction process is all-encompassing and transparent?

## The Losing Supplier

There were four losing bidders. AusSupplier had 20% of the contract prior to the auction but lost all entitlements to the contract. This was devastating to AusSupplier. At the time of the auction the AusSupplier management team pondered whether there would be a price to pay when the contract lapses and a premium paid to bring in another supplier to complete the contract. Indeed this is precisely what happened 18 months into the contract. The winning supplier could not service the contract with respect to margin and product tonnages. Ausbuyer contacted AusSupplier and asked that they again fulfil the role that they had prior to the reverse auction.

Another issue that AusSupplier had to contend with was the low availability of new markets that Auction.com had said would eventuate for suppliers. In two years only one potential new business opportunity was sourced for AusSupplier through Auction.com. This opportunity was non-viable as it was in a product area that AusSupplier had no expertise in. The greatest impact for AusSupplier is in the area of supplier-buyer relations. Over a period of two years the trust that had been developed over a period of 15 years had been eroded; all together, the auction inspired a drop of 12% in margin. Was it worth the potential savings? Beall (2003, p. 11) indicates many suppliers drop previously "free" services because they are not value adding for them, or not affordable. Goodwill and trust are negated in favour of the letter of the contract and the last 30-minute drop in price as observed in the reverse auction. The price focus of the auction again seems to dominate accepted long-term business practices.

## The Buyer

In the initial auction AusBuyer appeared to be the big winner, with a tangible savings of a 20% reduction in the cost of the contract. There were minimal switching costs, as they awarded the contract to the company who held the majority (80%) of the contract previously. However, from this Auction.com's costs need to be subtracted. An intangible benefit was the pre-qualifying process that identified future suitable suppliers. It appears the pre-qualifying process was flawed in one of the other auction events conducted on the same day when only one supplier was identified and this was the existing contractor. The auction event still went ahead and resulted in a 5% increase in the contract cost. In this case, the auction dynamic was missing, and therefore, no savings

were made. AusBuyer used the reverse auction process over 300 times in the next year. There can be no doubt that reverse auctions can provide a value adding business process in the procurement area. Beall (2003, p. 11) supports this analysis when he comments on the benefit of reverse auctions to buyers:

> *"For a growing number of buying firms, e-Reverse auctions have found an appropriate niche in their strategic sourcing toolkit, allowing them to efficiently source goods and services that are highly standardized, have sufficient spend volume, can be replicated by a reasonable number of qualified competitors, and have insignificant switching costs."* (Beall et al., 2003, p. 13)

## Conclusion

Many analysts (e.g., Deise et al., 2000; Wyld, 2000) believe that the use of the Internet - as a medium for business - provides the opportunity for companies to restructure their supply chains in collaboration with the other supply chain partners. One of the imperatives in the e-procurement model proposed by Wyld (2000) was to build strategic alliances between business partners. This involves both buyers and vendors, working collaboratively to provide cost efficiencies and add value to products and services. Many believe that this strategic collaboration is *essential* to survive in the e-world. This is the premise of the Value Trust Network (VTN). Raisch (2001) sees the supply chain being enhanced by the established relationships between buyers and suppliers, not just by the adoption of Internet technology. If reverse auction e-procurement is to enhance enterprise competitiveness, then value must be delivered to ease industry pain points, with trust being enhanced between suppliers and buyer (Emiliani & Stec, 2002; Jap, 2000; Raisch, 2001).

The question that needs to be asked is to what extent does a reverse online auction contribute to this value and trust? The whole issue of driving costs down to the lowest possible level would seem to present a serious impediment to the creation of any value *or* trust (Bartholomew, 2001). The attributes and skills that buyers would like to foster in their suppliers are placed at a lower priority to price. Mozer (2002) questions the elevation of cost savings over service offerings, suggesting that buyers should be looking for the fairest price for the supplier of choice, rather than the lowest offer. Do companies really want their business to run on the lowest price?

Emiliani and Stec (2002) proposed several unresolved questions in their recent study of reverse auctions:

- Where do the cost savings come from?
- Are reverse auctions one-time events?
- Will online auction vendors replace the in-house buying function?
- Is there a conflict between supply chain management and online auctions?
- Do online auctions actually increase productivity?

The reverse auctioning method may indeed only be a short-term solution in a business world that is increasingly based on long-term alliances and partnerships. Whilst Rapport (1998) believes that a reverse online auction is only a "quick fix" to satisfy management objectives for increased shareholder value, Beall (2003) points to the reverse auction being one tool applicable for specific circumstances. Driving forces include the speedy ROI of reverse auction and the overall shortening of the whole procurement cycle.

In the case study presented in this chapter, the reverse auction:

- Did render massive cost savings.
- Did replace existing in-house procurement.
- Did increase supplier distrust.
- Did have massive impacts on the suppliers, buyers and auction vendor.
- Showed that price alone will not replace trust and negotiation in complex business interactions.

## Endnote

[1] All company names are fictionalized.

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