Impact of Security and Quality Attributes of 3-G Based M-Commerce Systems Based on B2C Operation

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Abstract- A year ago, everyone was talking about the great opportunities for 3G, and accessing the Internet from one's mobile terminal. Today 3-G network has grown up. Mobile-commerce (m-commerce) systems have been developed at a significant rate in recent years. M-commerce can be viewed as a subset of e-commerce and refers to transaction with monetary value that is conducted via a mobile network. 3-G based M-Commerce offer functions and services in order to fulfill the end-users requirements and to provide secure services of high quality through a more usable and user friendly environment. In m-commerce applications, the design process still lacks a systematic quality control procedure. There are also variations on these attacks which exploit weaknesses in the architecture and some of the protocols used in 3-G cellular data networks. In this paper we study the security and quality attributes on which B2C m-Commerce system held through the 3-G Network. We will correlate quality characteristics of ISO9126 quality standard to M-Commerce Quality. Also discuss the security issues from mobile devices, from 3G network and from customer's perspective.

Keywords: ISO9126, 3-G Mobile, UMTS, ICICI Mobile Banking, Security & Quality Attributes

1. INTRODUCTION

The full scope of how mobile technologies will affect individuals’ lives in the areas of business, education, public safety, politics, and other sectors has yet to be appreciated. Innovative mobile technologies are causing disruptive, tectonic changes that will shape inalterably the way the next generation will live, work, play and interact with the rest of the world. 3-G networks are wide area cellular telephone networks, which have evolved to incorporate high-speed Internet access and video telephony. 3-G technologies enable network operators to offer users a wider range of more advanced services while achieving greater network capacity through improved spectral efficiency. Services include wide-area wireless voice telephony and broadband wireless data, all in a mobile environment.

The evolution of mobile network technology can be divided into four generations: 1-G (first generation), 2-G, 2.5-G, and 3-G. Some of the standards for each generation are:

- 1-G: Advance Mobile Phone System (AMPS)
- 2-G: Global System for Mobile Communication (GSM), Code Division Multiple Access (CDMA), High Speed Circuit Switched Data Technology (HSCSD)
- 2.5-G: General Packet Radio System (GPRS), Enhanced Data Rate for GSM Evolution (EDGE)
- 3-G: Universal Mobile Telephone Standard (UMTS)

A mobile commerce is the one that involves exchanging Internet contents with a network of mobile people via wireless device. The need for mobile strategy: M-Business strategy can help the enterprise increase its business agility by applying the right M-Business application and processes to the right M-Business applications and processes to the right areas of need and opportunities across all user systems. The following are the critical factors while deciding on a mobile enterprise strategy:

- Readiness of back-end systems
- Quality at end user
- Network diversity
- Security issues

2. BACKGROUND

M-Commerce application includes banking services, shopping services, etc. Also, mobile users access to high-end data applications on their phones, including high-speed interactive gaming and Internet access, video conferencing, video streaming and other multimedia features. These features require a high security of data and also the quality of services to customers as well as to businesses. Though 3-G has created a lot of buzz, it is unlikely to have an immediate impact on M-Commerce applications. Recently, M-Commerce applications are using GSM, CDMA and GPRS technologies. Furthermore, there are not many services, which are data speed dependent. But a definite
impact would be considerably the higher speed of Internet access for 3G enabled M-Commerce. Therefore, 3-G will not only be used to provide data services but also a better security and quality data transfer. The market for 3-G in the country is expected to be huge with over 65 million wireless subscribers till 2010, who use their handsets to access data services on the Web. These subscribers are currently using mobile handsets, which are Internet-enabled and are potential broadband subscribers with the deployment of advanced wireless technologies such as 3-G. According to Indian Cellular Association (ICA), about 5% of mobile users already have handsets that can work on 3-G spectrum. In addition, out of all those possessing the 3-G enabled handsets, the number of people who would use 3-G services would be determined by the quality of content available. Hence, the service quality is proposed to be given due attention in the present study. The quality model consists of:

- Conversation real time traffic, such as mobile video conferencing.
- Real time streaming traffic, such as online audio/video reception.
- Interactive traffic, such as Internet browsing.
- Background traffic, such as downloading the contents.

Over the last five years, the telecom industry has realized the importance of Mobile Value Added Services (MVAS). Today, the various MVAS entities are still struggling with issues such as the correct definition of MVAS, the roles and responsibilities of each entity in the value chain, the revenue sharing arrangements between them and other critical issues such as the regulation of the MVAS market. Another mistake in the over-hyping of mobile solutions was to suggest that mobile solutions could replace many existing telephone and computing solutions. Mobile solutions will never be as fast as a fixed connection, or have anything like the graphics or processing power of a PC. For example, even by 2005, 3G is likely to be offering speeds of below 200Kbit/s, while already residential broadband (ADSL) offers 1.5 Mbit/s. The small screen size of mobile terminals is also a major deterrent to many applications.

However, this portability is one of the great advantages of mobile terminals and their convenience. GPRS and 3G offer 'always-on' connections to the Internet, so a mobile terminal can provide you with continuous links to the Internet and to your e-mail.

The quality of m-commerce systems is an extremely new and challenging task; especially the quality of mobile commerce systems as it is perceived by the end-user is an open research issue for the software quality community. The end user interacts with mobile system using software through mobile devices and expects a well designed environment where he/she can proceed a commercial transaction.

M-Commerce is predicted to be the ‘killer application’ for the emerging 3-G based mobile Internet world. The main challenge for 3-G M-Commerce is to gain end users’ trust in the security of purchasing and financial transactions and to gain better understanding of how various financial sectors and their customers are affected by the service quality. Much hype and scepticism surrounds the deployment and provision of 3-G M-Commerce services, but essentially it will provide a service beneficial for financial organisations, service providers, retailers and of course end users. Emerging technologies are expected to address security concerns and provide standards in all aspects of service provision. The 3G security objectives are

- Ensure that information generated by or relating to a user is adequately protected against misuse or misappropriation.
- Ensure that the resources and services provided are adequately protected against misuse or misappropriation.
- Ensure that the security features standardised are compatible with world-wide availability.
- Ensure that the security features are adequately standardised to ensure world-wide interoperability and roaming between different serving networks.
- Ensure that the level of protection afforded to users and providers of services is better than that provided in contemporary fixed and mobile networks (including GSM).
- Ensure that the implementation of 3G security features and mechanisms can be extended and enhanced as required by new threats and services.

3. SECURITY AND QUALITY STANDARDS

ISO 9126 is a quality standard for software product evaluation and provides quality characteristics and guidelines for their use (ISO, 2001). This standard, composed of several parts, aims at defining a quality model for software and a set of guidelines for measuring the characteristics associated with it. This work is based on the ISO 9126 quality standard and specifically it relies on the external quality characteristics which are directly related to quality as perceived by the end-users. ISO 9126 may be used as basis for m-commerce quality evaluation but further analysis and mapping of its characteristics is required. The main issue is how m-commerce system’s quality can be analyzed using this standard.

ISO 9126 provides the definition of the characteristics and associated quality evaluation process to be used when specifying the requirements for and evaluating the quality of software products throughout their life cycle.

Functionality is the set of attributes that bear on the existence of a set of functions and their specified properties. The functions are those that satisfy stated or implied needs. The meaning of Functionality is to provide integrative and interactive functions in order to ensure end-user convenience. Especially for m-commerce systems Functionality refers to the existence of these functions and services that support end user’s interaction via the mobile system.
Reliability is the set of attributes that bear on the capability of software to maintain its level of performance under stated conditions for a stated period of time. Especially for m-commerce systems reliability refers to systems tolerance on end users actions.

Usability is the set of attributes that bear on the effort needed for use, and on the individual assessment of such use, by a stated or implied set of users. Usability is an important quality characteristic as all functions of an m-commerce system are usually developed in a way that seeks to facilitate the end-user by simplifying end-user’s actions; this fact can however affect negatively the system in certain cases.

Efficiency is the set of attributes that bear on the relationship between the level of performance of the software and the amount of resources used, under stated conditions. One of the main criteria of efficiency of an m-commerce system is the quality relating to time and resource behaviour.

Maintainability is the set of attributes that bear on the effort needed to make specified modifications.

Portability is the set of attributes that bear on the ability of software to be transferred from one environment.

The biggest challenge to Mobile Commerce is the security of payment through mobiles. Mobile Commerce Services like the mobile wallet which helps make payments at retail outlets through text messages have been hindered by the guidelines issued by the Reserve Bank of India due to security concerns.

For the security point of view, the mobile customer and the e-merchant involved in an m-commerce transaction want to ensure:

- Confidentiality: those messages are kept secret.
- Authentication: that each party knows whom the other party is.
- Message integrity: those messages are passed unaltered from sender to receiver.
- Replay attack prevention: that any unauthorized re-sending of messages is detected and rejected.
- Non-repudiation: that neither party can later reject that the exchange took place.

3-G networks are vulnerable for several reasons:

- Mobile operators are building out high speed wireless networks that are based on the Internet Protocol (IP) which allow users to do more while connected.
- Mobile operators have opened up their networks to the public Internet and to other data networks, making their 2.5G/3G networks more vulnerable to attacks.
- Mobile operators are evolving their networks to IP Multimedia System, enabling interconnected networks all running on IP.

4. M-COMMERCE QUALITY ATTRIBUTES

Currently, m-commerce is in its early stages of development and little is known about the factors that influence quality’s attitudes and their value from the end-users’ perceptions. Mobile commerce systems include mobile financial systems, mobile advertising, mobile inventory management, product locating and shopping, wireless re-engineering, mobile auction, and wireless data-centre. These systems aim to provide the appropriate attributes for the end user in order to complete a purchase or to get information using his/her mobile device. The basic advantage of m-commerce systems is that location and time do not constrain people from completing their transactions.

In order to model the interactions among the end user and the m-commerce system we consider two different steps: Presentation, Navigation and Transaction. Presentation describes how a product or service is presented to the end-user. Navigation describes the various mechanisms provided to the end user for accessing information and services of the m-commerce system. Transaction refers to the facilities provided for the money transaction. Applying the above steps to m-commerce requires an adjustment to the attributes that the system presents because of its wireless communication character. In this work m-commerce attributes are categorized in the above categories providing an overview of m-commerce systems’ quality from end users’ point of view.

Presentation is supported basically by text and images because mobile devices have limitations such as screen size and resolution, number of supported colours, computation power, memory size, rate of data transfer and energy required for proper functionality. Colour usage is also important. Using colours obviously gives a pleasant and friendly interface, but a too coloured screen confuses. All the pages of the m-commerce system must have the same colours so the user can feel that he/she is navigating in the same environment. By removing background images, background colours and text colours the readability of the content is increased. The use of images in Internet applications is common. Nevertheless, using images in mobile web applications significantly increases download and response time and thus, usage cost. The clarity of the text presented with meaningful, short and simple words and the presentation of the central meaning at the first page of each mobile device contributes attributes that a m-commerce system should provide to the end user for an accessible mobile environment. Additionally, providing a descriptive title for the page allows easy identification of the content; by keeping the title short reduces page weight.

Navigation is an important design element, allowing users to acquire the information they are seeking and making that information easier to find. Navigation issues support m-commerce systems quality by taking into account the quality of components such as indexes, navigation bars, site maps and quick links. The availability of these components facilitates access to information and services and enables users to locate efficiently the information they need, while avoiding usability bottlenecks. Additionally, navigation concerns the facilities for accessing information and the
connectivity of the above systems. Navigation refers at attributes that support the navigability of m-commerce systems. It is important that users should be able to see page content once the page has been loaded with the minimum possible scrolling. M-Commerce systems provide simple metaphors such as shopping cart where the end-user may add the products that he/she intends to buy. Mobile devices present limitations on text inputting so an m-commerce system should be enabled by attributes such as access keys (keyboard short cuts), by providing defaults at any function that the user should select an action and also by avoiding free text with minimum text inputting. Additionally, because of the limitations in display and input mechanisms, the possible absence of a pointing device and other constraints of mobile devices, care should be exercised in defining the structure and the navigation model of a Web site. Especially the use of links should be limited aiming at providing a balance between having a large number of navigation links on a page and the need to navigate multiple links to reach content.

Transaction refers to all m-commerce systems attributes that strongly support their commercial character. In particular, it refers to attributes that support the interaction with the m-commerce system. These attributes are also related to the navigability of the system but they are categorized differently because of their significant contribution to the purchasing process. Authentication and personalization attributes support an m-commerce system where the end user can provide private information. Additionally notification services provide a great advantage to m-commerce systems because they can also be combined with localized information. Alternative payments methods support either a complete transaction via the m-commerce system or otherwise combined with localized information allow mobile users to conclude transactions efficiently. Transaction process success is also related to the stability of the process via the m-commerce system and issues like error tolerance and error recovery are crucial.

5. M-COMMERCE SECURITY ATTRIBUTES

The 3-G M-Commerce requires the various types of security issues:

From the Mobile Devices:

- Infrastructure Enumeration— common tools such as ping and traceroute often reveal elements of the infrastructure that should not be visible. Furthermore mis-configured SNMP services can expose device configuration, which can be useful to attackers.

- Attempts to send GTP traffic from a mobile device— The protocol used to control GPRS connections on the core network is called GTP (GPRS Transport Protocol). If GTP messages could be sent from a mobile device then control of other subscribers connection could be gained. Several outdated vulnerabilities associated with core devices involved sending GTP message from the mobile devices which were then mis-interpreted by the GGSN, causing denial of service. However these vulnerabilities are unlikely to be present on modern equipment.

- Subscriber Intercommunication— if the network operator has decided not to filter direct network based communication between subscribers then there is the possibility that the path the data takes through the infrastructure may bypass the billing mechanism. Therefore users can exploit this by using VoIP software and making calls that are not charged to their count.

From the 3-G Network

- Routing to an unauthorized Access Point Name (APN)— The GTP is seriously flawed with respect to security, as it provides no encryption or authentication, therefore if unauthorized access is gained to the core network then data destined for one corporate customer can be intercepted and routed to another customer's network.

- Routing to another user on the air interface— As with the previous example misuse of the GTP can result in corporate data being routed to another customer's mobile device.

- Setting up GPRS connection on behalf of a user— The GTP specifications states that connections may be initiated by the network rather than the user, if this functionality has been enabled within the core infrastructure. This could potentially result in large bills for the unfortunate victim, of this attack.

- Teardown of established connections— With access to the core network, an attacker could target an individual subscriber and selectively remove their network connectivity.

These security issues can be handled by considering the following aspects e.g. Confidentiality, Integrity and Availability.

Network operators should ensure that all devices and interfaces that are accessed by customers should be adequately hardened with respect to security to ensure that excessive information leakage with the network infrastructure is minimized.

6. EVALUATION METHOD FOR QUALITY AND SECURITY

Quality evaluation of mobile applications, as long as the end user’s requirements are concerned, gives emphasis on the systems’ quality and especially on ISO 9126 external quality characteristics: Functionality (F), Reliability (R), Usability (U), Efficiency (E) Maintainability (M) and Portability (P). It is within this framework that the end-users, who are also the customers of a mobile network, will specify the relative significance for each function that the mobile system provides to the user. End-user is the best judge (when properly questioned) of the degree to which their needs are satisfied, and thus of the quality of the system viewed as a service.

Firstly, the evaluators were asked for to do M-Commerce task using a mobile phone. For the evaluation process 3G mobile phone is used with resolution 176 × 208 pixels and supports high colours. The phone can also connect to 3G networks for high rate data transfers using the ICICI Bank iMobile Applications. Ten evaluators use ICICI Bank
Mobile Banking Applications for Fund Transfer in order to have the best m-commerce experience possible. The end users have to give grading according to the following:
1. No Support for quality and security standards.
2. Weak Support for quality and security standards.

7. EVALUATION RESULTS (AVERAGE GRADES)

<table>
<thead>
<tr>
<th>M-Commerce Quality Attributes</th>
<th>(F)</th>
<th>(U)</th>
<th>(E)</th>
<th>(R)</th>
<th>(M)</th>
<th>(P)</th>
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<td>Speed</td>
<td>4</td>
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<tr>
<td>Visibility of content of page</td>
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<td>Colours</td>
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<td>4</td>
<td>4</td>
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<tr>
<td>Clarity</td>
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<td>4</td>
<td>3</td>
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<tr>
<td>Central meaning of content</td>
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<td>Text inputting</td>
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<tr>
<td>Navigation mechanism</td>
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<td>Uploading Time</td>
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<tr>
<td>Access keys</td>
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<tr>
<td>Use of Links</td>
<td>4</td>
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<td>3</td>
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<td>Undo functions</td>
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<td>Redirection</td>
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<table>
<thead>
<tr>
<th>Security Attributes</th>
<th>Average Grade</th>
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<td>Confidentiality</td>
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<tr>
<td>Message integrity</td>
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<tr>
<td>Replay attack prevention</td>
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<td>Non-repudiation</td>
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<tr>
<td>Security mechanism</td>
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<td>Transaction Mechanism</td>
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<td>Alternative payment methods</td>
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<td>Authentication</td>
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<td>Personalization</td>
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<td>Localization</td>
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<td>Transaction recourses behaviour</td>
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<td>Notification services</td>
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<td>Error recovery</td>
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<td>Errors tolerance</td>
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<tr>
<td>Stability</td>
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</tbody>
</table>

Based on the evaluation results, the quality and security of m-commerce systems can be modelled in external characteristics and attributes. Providing a value for each attribute, an ordered list for each external characteristic is provided. These values provide a first impression of end users preferences and perquisites about m-commerce systems’ attributes. The categorization of these attributes provides important feedback for m-commerce systems’ assessment which is in an initial stage. End user’s experience is a critical determinate of success in mobile web applications. If end users, who are also the customers, cannot find what they are searching for, they will not transact it. Poorly designed interfaces increase user errors, which can be costly. A user-centric evaluation approach supports all the tasks users need to accomplish using different m-commerce systems’ attributes. The above evaluation process provides measurement results which can be also be defined as metrics for a quantitative representation of m-commerce systems’ security and quality.

8. CONCLUSION

We have discussed the security and quality evaluation for selected attributes of m-commerce systems and particularly B2C m-commerce systems. These dimensions provide an extendable framework useful for m-commerce users. We believe that this is a step towards more effective measurement of m-commerce systems’ security and quality. 3G networks’ standards were evaluated within various security and quality framework and found to be medium secure and high quality. This fact, however, should be considered with realization that mobile phone systems first and foremost need to provide telecommunication service to their subscribers and have certain limitations that prevent them from achieving higher levels of security.
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