ON REQUIREMENTS FOR MOBILE COMMERCE

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Resumen

Los avances en Internet y redes inalámbricas y el rápido crecimiento del número de equipos móviles han resultado en el crecimiento acelerado del comercio móvil. Consideramos el comercio móvil como un subconjunto del comercio electrónico en el que las transacciones se realizan utilizando un terminal móvil y una red inalámbrica. El usuario de equipos móviles y sus requerimientos juegan un rol en el desarrollo del comercio móvil, en adición al desarrollo tecnológico y el desarrollo de los marcos regulatorios. Este documento aborda los requerimientos para el comercio móvil de un modo sistemático. Primero, establece el escenario del comercio móvil revisando los conceptos y requerimientos básicos. Luego introduce un metamodelo publicado con anterioridad y consistente en cuatro esferas de interés: marcos regulatorios, modelos de negocios, infraestructura global y tecnologías de apoyo. Los requerimientos para el comercio móvil se agrupan por estas esferas y son analizados en este contexto. El énfasis se pone en aquellos requerimientos que han de persistir. Se muestra que, muchos de ellos se originan en una esfera y luego se propagan a otra esfera, de modo que con frecuencia toman una forma más concreta. La esfera de tecnologías de apoyo se refiere a las tecnologías futuras que están siendo desarrolladas ahora para responder a los requerimientos que surjan en el futuro.

1. Introduction

Nowadays, M-commerce and the adoption of related technologies have become very popular. Some of the factors that contrib-uted to this development are the tremendous developments of the Internet and related technologies, the understanding and exploitation of the business potentials that rest behind this development, the boost of E-commerce frameworks and technologies, and the growth of wireless commu-

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nications. Wireless technologies combined with Internet-enabled terminals constitute an ideal platform for the realization of new types of business transactions. The small and light, yet powerful, mobile terminals are almost always carried by their owners (like wallets). They can also store electronic cash, credit card information, tickets, certificates of the Public Key Infrastructure (PKI), etc. Thus, they can assume the role of an e-wallet, as well as function as authentication and authorization devices in various contexts. In addition, the terminals can be located either by using satellite technologies (e.g. GPS), terrestrial network facilities, or indoor mechanisms, based on WLAN/PAN technologies. Recent developments in these areas seamlessly extend the positioning of wireless devices into several environments. Thus, services based on the location of the terminals, referred to as location-based services (LBS), have become widely possible. They are a new service class for mobile computing and open new business opportunities. For these reasons, the telecom industry has begun to call portable terminals, with the above functionalities, Personal Trusted Devices (PTD).

Digital convergence of various separate technologies is continuing. As an important indication of this, a portable high-end terminal can basically host any other miniature device, such as a video camera. Game consoles combined with a terminal are already on the market. These developments will have considerable, yet largely unknown, effects on M-commerce in the future. Another convergence path is the emergence of common IP-based core networks. The Internet-enabled wireless terminals are already able to access services designed for normal Internet users

(e.g. WWW), and services specially designed for mobile users (e.g. WAP, I-Mode). Terminals run TCP/IP end-to-end over a wireless bearer, or a special WAP protocol suite to the WAP-gateway (WAP Forum, 2002). Further convergence of the IP and wireless technologies is anticipated so that the future devices will be seamlessly integrated with the IP infrastructure. This development started with earlier versions released by 3GPP and was finalized with Release 5 (Kaaranen et al. 2002, 3GPP 2002, MITA 2002a-c).

Concerning related work, there are many papers, books and reports that present requirements for various, mostly technical, aspects of M-commerce (E-Factors 2002, Kalakota and Robinson 2002, MITA 2002a-b, Sadeh 2002, Varshney and Vetter 2002). These are relevant to our work, but we are not going to repeat all possible individual requirements that have been established thus far in the cited sources. The main contribution of this paper is to present a systematic framework for the most persistent M-commerce requirements and show their origin and relationships. Our goal is not only to stratify requirements vertically, but also to investigate their life span. Some of them are more fundamental than others, which means that they originate at the legal level or are dictated by, for example, the laws of nature (bandwidth scarcity). Many requirements are actually established at the regulatory or business level and must find their implementation at the technical level. These are usually more persistent than those emerging, for example, from the restrictions of a particular network or terminal generation.

The paper is organized as follows. In Section 2 we discuss the basic definitions

of M-business and related concepts, the definition of requirement, and introduce the framework model. In Sections 3, 4, 5, and 6 we look at the requirements for the four spheres of concern. Section 7 presents our conclusions.

2. The Requirements Framework

There has been much discussion in the scientific and commercial literature about the definition of E-commerce and M-commerce (Durlacher 2000, OECD 2002, Kalakota and Robinson 2002, Aarnio 2002, Sadeh 2002, Varshney and Vetter 2002). We define M-commerce as an activity that consists of M-commerce transactions. An M-commerce transaction is an E-commerce electronic transaction (OECD 2002) that is conducted using a mobile terminal and a wireless network. Notice that the definition includes all portable terminals and PDAs, as well as terminals mounted in vehicles that are capable of accessing wireless networks and/or use short range wireless connections while performing M-commerce transactions. The activities that precede or follow the actual M-commerce transactions belong, strictly speaking, to M-business (Kalakota and Robinson 2002). We confine ourselves below on the M-commerce aspects.

Our goal is to treat various requirements for M-commerce. A requirement in this context is a statement that holds invariably for an entity during its lifetime. An entity can be a distributed system, a terminal, a company, a state, or even an international organization. We adopt a rather general definition of the term requirement.

To briefly illustrate the relationship between the requirements at different levels, and within different regions, let us discuss privacy. It is a requirement that originates at the legal level, for example, within the European Union, as stated in the relevant Directive (European Union 2002a). As it is incorporated into the legal framework, it must be taken into consideration when designing business models (BMs). Such BMs are illegal within the European Union, if, for example, the location data of the customer is somehow used without explicit consent from the customer (or authorities). Privacy must be supported at the infrastructure level. In practice, this means that message encryption should be provided in the wireless interface and protection for the terminal's coordinates against misuse in any part of the service provider must be provided. The user must also be empowered to switch the terminal positioning on and off. The requirements are technology-dependent. The user interface for positioning control is also highly dependent on the interface and positioning capabilities of a particular terminal and the access network.

Regulatory Frameworks	Business Models
	Global Infraestructure
	Enabling Technologies

Figure 1: Spheres of concern in M-Commerce

We use the model introduced earlier in Veijalainen and Weske (2003) as the framework to group requirements. Its basic structure is presented in Figure 1.

- *Regulatory Frameworks*: The organizational and technical aspects of laws, standards and recommendations, as well as the bodies involved in their definition. The main actors here are international organizations, such as OECD and EU, governments, standardization bodies (ISO, ANSI, ETSI), and interest groups formed by diverse industry sectors to develop standards, such as 3GPP (3GPP 2002) and Open Mobile Software Alliance (Open Mobile Software Alliance 2003).

- *Business Models*: Business aspects, including business players, providing services, business protocols, revenue sharing, and code of conduct are important artifacts in this sphere (Timmers 1998). This sphere captures the pertinent business aspects, persistent concepts and structures. At any moment and in different parts of the world, the BMs have different shapes, due to differences in regulatory environment, local (business) culture, economic strength of the individuals and companies in a particular region, etc.

- *Global Infrastructure*: The global infrastructure sphere deals with the global network and the concrete terminals that facilitate M-commerce, as well as the real services. The real global infrastructure is a patchwork of many wireless access networks and backbones, including the Internet. It is and will be heterogeneous at different architectural levels at any point in time. This is because different parts of the world will progress at different paces.

- *Enabling Technologies*: This sphere includes emerging technologies for user terminals and network technologies, such as cryptography, privacy-protecting technologies, positioning with high accuracy, and new batteries and other energy sources for the terminals. It also includes standardization and business interest groups and other organizations developing these emerging technologies. Typical examples are 4G (and beyond) technologies, that are currently being researched, and that will later move into standardization.

The spheres are interdependent in various ways. For each of the above spheres we deduce requirements pertaining to M-commerce.

Before going into the details of the framework, we established two fundamental aspects of the M-commerce that are very persistent, and that penetrate the spheres. These are (1) *global user mobility* and (2) *anytime, anywhere service accessibility.* Without the former it is useless to discuss *mobile* commerce and its particular problems, albeit various other issues in E-commerce are still relevant. Without the latter guaranteed to a lesser or higher degree, a user attempting to conduct M-commerce will experience various problems, from service unavailability to all kinds of interoperability problems at different infrastructure levels. Thus, (1) and (2) can be understood as *requirements of a very general nature* for M-commerce environments. They are, at the same time, the central aspects distinguishing M-commerce from other E-commerce environments.

3. Requirements from the Regulatory Frameworks Sphere

The regulatory framework is the highest organizational level imposing requirements to M-commerce. It regulates markets and existing and emerging technologies. Market regulation can be divided into three different types: regulation, self-regulation and co-regulation (Aarnio 2002). Regulation refers to formal regulation by authorities (legislation). Self-regulation refers to more informal regulation by the market players themselves. Co-regulation refers to a mechanism where the regulatory authorities set up a more general framework and the actual decisions are made by the market players and the authorities.

E-commerce market regulation is mostly regional. The basic requirements for all commercial activities are anchored in the states' constitutions, statutes of certain international organizations, like the EU, and legislation. However, the customers acquiring M-commerce services are mobile and cross borders, thus introducing problems and challenges to the development of the field.

The other bodies involved in M-commerce, such as companies and industry consortia, have a subordinate role regarding laws, i.e. they must comply with them while designing new technology. The same holds for companies defining BMs and services that are used by consumers or other businesses. However, consortia and companies developing new technology are not regulated by laws in all respects. Often only later, in the deployment phase, the laws are passed or self-regulation is applied by the industry. In EU, the regulatory framework for E-commerce (and M-commerce) was established in 1997 (Aarnio 2002). Currently, there is a consolidation phase going on. The current 12 directives relevant to E-commerce can be found in European Union 2003b. Telecom access is regulated in European Union 2002b and other relevant directives mentioned in it. Concerning the above general requirement (2) the EU establishes access to basic telecom services as a right. Free mobility of the users is guaranteed within the EU and between Schengen countries border controls have been dropped.

In Japan, there is also a special E-commerce legislation, as referenced in METI 2002. The purpose of this legislation is to promote the use of electronic transactions for commercial activities by offering an appropriate environment of trust among users. General data protection law is still in Parliament, and is expected to be adopted by June 2003. Law 137/2001 concerning ISP service provider liability has been in effect since May 2002. There is a separate Telecommunication Business Code that establishes a regulatory framework for the provision of telecommunication services in Japan. In general, Japan relies on self- and co-regulation of the E and M-commerce market more than Europe.

Requirements originating at the Regulatory Framework (civil rights) sphere include:

- *Privacy of the data pertaining to the individual*, including all data gathered by the telecom networks, such as positioning data.
- *Protected private communications between individuals and legal entities*. This requirement imposes that network communication should be encrypted.

- *Freedom to determine with whom and when to communicate*. The technical ramification of this is that the communication autonomy (C-autonomy) of portable devices would be under user control[1]. Notice that the «always on» assumption, understood as a requirement for a user to keep the terminal «on» all the time, would restrict his freedom to decide upon his communication behavior.

- *Freedom to enter into contracts with any other party*. For roaming customers this would mean that they are entitled to use the services of foreign providers. This also means that a contract with a certain party must not restrict the rights of a consumer to terminate service contracts and enter into new ones.

- *Consumer protection*. The legislation determines when a consumer should be protected against businesses and which jurisdiction to use in case there is a dispute in a border-crossing transaction.

Considering the global nature of M-commerce, certain demands for international regulation requirements can be set. The regulatory frameworks for M-commerce should be interoperable. This is especially important among the three leaders (USA, Japan, EU), if the desire is to maximally support M-commerce over the borders and business of the roaming customers. The issues are taxation and consumer protection, including dispute resolution. For the latter, the EU has envisioned

1. C-autonomy means that a device is not always reachable through the wireless network, and that it can start and stop communicating at any time with another party.

automatic mechanisms (European Union 2003a). From the content-owner point of view, *Intellectual Property Rights* (IPR) should be globally guaranteed.

4. Requirements for the Business Models

There is a wide variety of definitions for the term BM. A recent survey (Hedman and Kalling 2002) analyzes 66 BMs found in the literature. Another study reviews them in a thorough way (E-Factors 2003). BMs should further include marketing strategy, marketing mix, and product-market strategy. The Business Model Sphere (BMS) of concern in Veijalainen and Weske 2003 is primarily based on the definition of Timmers 1998 which defines a BM as «an architecture for the products, service and information flows, including a description of the various business activities and their roles; and a description of the potential benefits for the various business actors; and a description of the sources of revenues… BMs should further include marketing strategy, marketing mix, and product-market strategy». This BMS of concern also makes explicit the logical BM level and its implementation through services and business protocols. The strategy level remains implicit. We stick to this view here.

The most important requirement for any BM is to be economically feasible, i.e. to generate more revenues than expenditure. There is a plethora of literature analyzing economic feasibility of E-business models. According to E-Factors 2003, there are five separate groups of factors affecting this: technical, individual, organizational, industry, and societal. It is beyond the scope of this paper to

go deeply into this area, although it is of outmost practical relevance. We pick some aspects mostly related with the requirements from the Regulatory Frameworks sphere. Thus, the possible BMs must be compatible with the applicable law and code of conduct. As the rules are territorial, heterogeneity between different regions in the world is bound to appear, unless deliberate countermeasures are taken.

General requirements for BMs are:

- Support for IPR in the BM. One must specify what rights are and are not transferred to the customer when a M-commerce transaction is performed.

- *The authentication and authorization of the customer and authentication of the merchant.* The authentication of the merchant is primarily required for customer protection purposes. The authentication of the customer is primarily required for protection of both the merchant and the customer.

- *Support for consumer protection.* This requirement begins at the Regulatory Framework level. It means that BMs must take into consideration the rights of a customer to return the goods purchased, refuse to pay non-delivered services and preserve privacy. In this respect the *Automatic dispute resolution* mechanism suggested by the EU (European Union 2003a) is noteworthy. Consumer *trust* is interrelated with protection.

- *Support for appropriate taxation.* This is important for roaming customers, as they are often exempt from the Value Added tax (VAT) or similar consumption taxes. The EU wants to co-llect VAT from its own citizens, no matter which channel they choose to use. Non-residents are basically exempt from VAT. The USA has allowed E-commerce to be tax-free since 1998. Japan levies a 5% tax on E-commerce transactions, as well as on other purchases by residents. Non-residents are exempt. In the EU, the VAT varies from country to country and it can be different for different commodities in the same country. Unless taxation is uniformly handled for all customers, it presents a problem for all players.

The mobile technology makes possible *anytime, anywhere access to M-commerce infrastructure.* As above, this should be understood as a requirement at the BM level. The BMs applied in M-commerce should be such that the customer is served at any time no matter where he resides or moves to. From this requirement and the free user movement stated above, one can deduce that:

- *Global coverage* must be available for the global infrastructure (network) services.

- *Primarily automated services at the server (merchant) side* are needed. This requirement is valid for the entire M-commerce infrastructure. Without continuous accessibility, the M-commerce infrastructure is rather useless for global operation.

In addition, users must be able to access the services with a *single terminal, i.e. a PTD*. One can further establish the following:

- *Roaming contracts* between the network operators, making it possible for

users to access both the local services and their home network services or Internet services irregardless of their physical location.

- Support for *the global electronic payment infrastructure* so that the local services can be reasonably acquired by roaming customers.

- *A multilingual M-commerce service provision* so that the roaming customers can actually access the local services and use them.

It is worth noticing that requirements for a BM are different in different parts of the M-commerce value network. In this section, the emphasis is on the actors that have a direct relationship with customers.

5. Requirements for the Global Infrastructure

The global infrastructure changes over time. Figure 2 presents a schematic, technology-oriented network view of the global infrastructure. The view corresponds to the situation in a few years from now, after the backbone network has converged to the «ALL-IP» network envisaged by 3G standardization (Kaaranen et al. 2002, 3GPP 2002).

The wireline infrastructure in Figure 2 that serves resource-rich terminals is also used by mobile terminals. The black line separating the «ALL-IP» area into two regions emphasizes the separation of the IP-networks from operator-control and from the «global Internet». Vertically, the
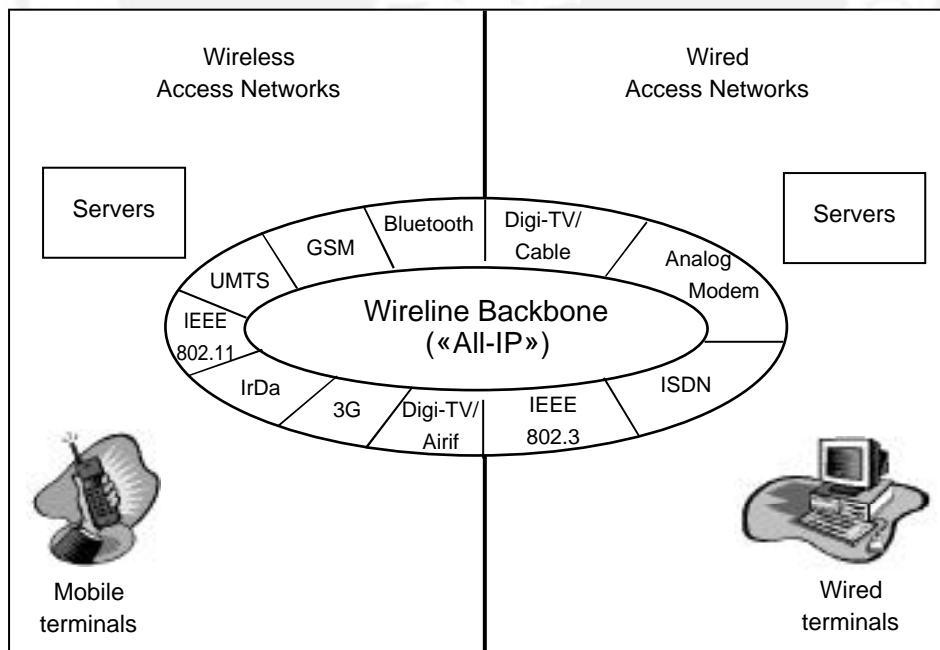

Figure 2: A schematic horizontal view on the Global Infrastructure

global infrastructure consists of several layers as shown in Figure 3. As stated in Kaaranen et al. 2002, the investment cost in hardware and software increases as one moves downwards through the layers, and investment cost in people and ideas increases when one moves upwards. We discuss the requirements for the global infrastructure having in mind the above horizontal layering.
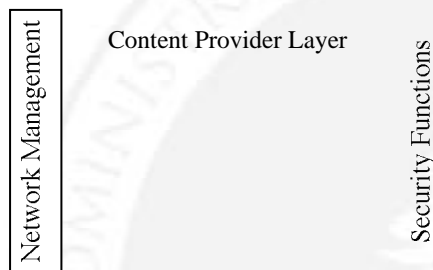

Figure 3: UMTS Network Architecture, Service Model (Kaaranen et al. 2002)

5.1. Requirements for the Backbone

All requirements for Regulatory Framework and Business Model spheres must find their support within the global infrastructure. Thus, the business processes must be implemented at this level through suitable services and protocols. The network must be able to identify the user in order to be able to charge the right entity for the use of resources. The concrete revenue generation at the Network Element Layer and the Content Provider Layer must be guaranteed by *the billing and/or payment infrastructure. Security* and *privacy* of the customers and authentication/ authorization of the parties engaged in M-commerce transactions must be guaranteed by technical means. These include

PKI certificates and *encryption/decryption* algorithms.

- *Service coverage.* This is a basic requirement for communication networks. The requirement for the maximal geographical coverage follows the *any-time, anywhere service* accessibility requirement.

- *Dependability.* This can be seen as a more detailed requirement deducible from the *anytime, anywhere* requirement. Dependability can be characterized by *reliability, availability,* and *survivability* of the infrastructure (Malloy et al. 2002). Failures or overloads in different parts of the infrastructure can violate dependability and, thus, the anytime and anywhere requirement. In practice, different applications have different vulnerabilities as concerns dependability.

- *Quality of Service* (QoS). The QoS for the basic data transmission and call connection are well understood. The parameters are connection latency, data transfer capacity, bit-error rate, and jitter. For dynamic LBS, where the actual position of the terminal is determined and represented in a coordinate reference system, *positioning accuracy* is an issue. In addition, the *quality of the data* used to provide the service is another issue.

- *Transactional Service delivery.* M-commerce transactions should preserve the so-called goods atomicity property. Thus, all necessary steps to deliver the service should guarantee that the correct goods or services are delivered to the customer if and only if the merchant has received the correct

payment. The issue is further complicated by the consumer protection legislation that allows the customer to return the goods within a certain period of time or raise arguments against the merchant, leading to a dispute. A more elaborate treatment of these issues can be found in Veija-lainen 2000.

- *Interoperability*. This requirement can be divided into three broad subsets: *interoperability of two backbone networks, interoperability of a terminal and an access network* and *interoperability of any terminal and any service.*

  – *Interoperability of two backbone networks* guarantees that voice and data traffic flows from one wireless or wired network to another.

  – *Interoperability of a terminal and an access network* is not currently guaranteed in general.

  – *Interoperability of any terminal and any service.*

- *Roaming support.* A necessary condition for roaming is that the terminal and network are interoperable. Furthermore, there are technical requirements following from the regulatory and BM levels. These include *terminal authentication, profile management, and encryption key management.* M-commerce transactions often require *service discovery* in order to access appropriate local services. The interoperability of the *terminal and services* in the roaming situation must be guaranteed at all levels, up to the content format and natural language levels.

5.2. Requirements for Terminals

Much of the progress in M-commerce is due to the rapid development of portable telecom terminals and PDAs. Basic requirements for the terminals are *portability* and *usability*. *Portability* boils down to «sufficiently» small physical size and weight. *Usability* is clearly context-dependent: a voice terminal has different usage and usability characteristics from a terminal for M-commerce transactions. Usability, including battery life, tends to increase with terminal size and weight. Thus, terminal design should be based on an optimum trade off between portability and usability. *General terminal usability requirements* are quality color displays, efficient and easy-to-use input means (keypad, voice input), etc. The terminal should offer extended battery life, high-speed processor(s), large memory, etc.

The *functionality* provided by terminals is crucial for M-commerce. High-end terminals (e.g., Nokia 9210i Communicator) support wireless voice and data communications on several frequency bands, Java applications, WWW and WAP browsers, client emails, and client faxes. In Japan, J-phone allows the Java applications and data to be downloaded and run on terminals, facilitating a large variety of applications.

Other essential requirements for the terminals, from a M-commerce point of view, are:

- *Interoperability with the wireless networks and services*. At the physical and network element level this means support for at least one IMT-2000 air interface standard (voice and data); without this capability, global roaming

is not possible. At the higher protocol levels, WAP 1.x stack or TCP/IP+HTTP(S) (i.e. WAP 2.x) should run. Further, *support for short-range wireless technologies* (Infrared, Bluetooth) is required for payment and ticketing applications. At the highest architectural level, *compliance with the mobile Internet standards*, specified by OMA (Open Mobile Software Alliance 2003) and related bodies, should be available.

The requirements originating at the Regulatory Framework sphere, such as individual privacy and security, must find adequate technical support in terminals. Furthermore, the additional requirements originating within the Business Models sphere must also be supported. These include:

- *Authentication and authorization support*. Terminal authentication is handled by the 2G/3G networks. For basic voice and data services that are billed afterwards, this is a functioning option. But this is not enough for M-commerce services in general, because the servers providing services over Internet (cf. Figure 2), or over a short-range wireless connection, cannot obtain the terminal identity. Besides, even if they could obtain it, the connection between the terminal identity and the identity of the person using it remains unconfirmed. Thus, there must be *end-to-end user authentication support at the application level*. This requires either server-side login with password or use of one of the PKI certificates stored at the terminal. The latter option brings up an extra requirement for the terminal; it must *offer an appropriate pro-*

tection mechanism to the PKI objects stored into the WIM module.

2G/3G terminals encrypt outgoing voice and data traffic so that basic privacy and security protection are provided at the air interface. But this is not sufficient for end-to-end message security and privacy. The terminal *must be able to encrypt and decrypt the wireless data traffic at the application level* using PKI and/or other mechanisms, such as SSL or TSL (HTTPS).

An *optional requirement* for terminals is payment support, including credit card information stored into the handset, an electronic wallet storing cash for micropayments and support for tickets (Mobile Electronic Transactions Forum 2002).

Another set of requirements refers to LBS. The primary functionality required by a terminal is the capability to position itself. This can be based on satellite or network-based positioning (Kaaranen et al. 2002). The former requires that the terminal be enhanced with a GPS receiver. Most of the network positioning methods also require enhancements in the terminals' functionality. Should terminal positioning be possible, it is required that the terminal provides adequate privacy protection means. These include the possibility to prohibit tracking by an external entity. Tracking of the terminal for emergency purposes should, however, always be possible.

6. Requirements for Emerging Technologies

The Enabling Technologies in the framework model presented in Veijalainen

and Weske 2003 are the non-deployed existing and emerging technologies that have relevance for the M-commerce. Which technologies are of relevance depends on many factors, including the regulations in force within a certain geographic region, cultural issues, economic situation of the users, etc.

One of the most important factors in this respect seems to be terminal development, which has made it possible to enhance the terminals' functionality beyond voice traffic without sacrificing portability. Steps in this development have been miniaturization of the hardware in general. This has made possible large memories, faster processors the integration of GPS hardware and software (e.g. Benefon), radio receivers, etc. On the other hand, the development of operating systems with small memory requirements (e.g. Symbian) and advances in software platforms for small devices have vastly enhanced the application range usable on those terminals. All these factors together contribute to the proliferation of various contents and, thus, of M-commerce. Furthermore, it is realistic to run the complicated PKI and other encryption and decryption algorithms with long keys developed for resource-rich environments on small terminals.

An important concept that drives technology and business development is *digital convergence*. It means, firstly, that digital control and information processing conquers new areas from car engines and communication networks to tiny «processor dust» devices. Secondly, the previously separate technologies converge into interoperable or even integrated seamless technologies. Terminal development is an example of this. Communication networ-

ks are at the heart of this development. Whereas wireless access technologies shown in Figure 2 are currently separate and not fully integrated with the «All-IP» backbone, the goal is to make them seamless. The number of access technologies depicted in Figure 2 will not necessarily increase in the future, although new technologies, such as 4G, will emerge. At the same time, networks based on older technologies will disappear from the global infrastructure. It is extremely difficult to predict when this will happen and what degree of heterogeneity (i.e. number of different wireless access and data transmission technologies) the global infrastructure will exhibit at a certain time.

One can argue that the technical requirements for the terminals and for the new global infrastructure will mainly arise from the convergence of different network technologies. This has been recognized by manufacturers that are working in different forums (e.g. OMA) to cater to this need. There are also initiatives, such as Mobile Internet Technical Architecture (MITA), being pursued by a single manufacturing company (MITA 2002a, MITA 2002b, MITA 2002c).

Orthogonal to the above considerations, *terminals should have a longer operating time than they currently do* when concerning battery characteristics.

On the other hand, users tend to have phone numbers, e-mail addresses, etc. The convergence of networks raises the question of whether one could have a *single user identity at the technical level* (MITA 2002a-c). This idea would have many further ramifications for privacy, security etc., as well as at the BM and the technology level.

In the presence of many wireless networks, terminals should select the best one. This is sometimes called the «*Always Best Connected*» requirement. From this requirement, one can deduce that the terminal must be able to operate on several frequency bands and host several protocols. Furthermore, it should be able *to make a seamless hand-over between* two overlapping access networks while the user roams. Moving outside the coverage area of one network, the *roaming facilities* must be exploited. At the terminal there must be support for several roaming protocols. The network infrastructure must *support interoperable user profiles.* Further complication comes from the fact that terminals should also be *interoperable on the service level*. An additional aspect is *Mobile Digital Rights Management* that is intended to protect the rights of content providers.

Finally, Figure 2 and convergence suggest that the M-commerce channel is only one channel among several others capable of supporting E-commerce. This raises the question of *inter-channel interoperability requirements*. These originate from the need to perform M/E-commerce transactions using more than one channel and from the channel homogeneity requirement. An example of this direction is the PTP protocol specified by MeT (Mobile Eectronic Transactions Forum 2002). There might also be other transaction types where the PTD is used as an authentication and authorization device, but the actual service is provisioned through another channel (e.g. Digital-TV).

7. Conclusions and Further Work

In this paper we have analyzed the essential requirements for M-commerce. In previous papers there have been scattered statements about requirements and their analysis, but a systematic framework has been missing. Furthermore, earlier work has mostly concentrated on technical requirements for the Global Infrastructure, whereas in this work we have included the Regulatory Frameworks and Business Models sphere. We also discuss future requirements within the Enabling Technologies sphere. We show that two rather fundamental requirements are *anywhere, anytime service acquisition* and *free user mobility*. The latter is rooted in the civil legislation of individual countries and international treaties; the former is an ideal requirement for M-commerce. Many lower-level requirements can be deduced from these to all spheres. *Privacy protection* of individuals, as well as *consumer protection*, general laws regulating the E-commerce, and the *code of conduct* are further important sources of requirements that also penetrate the spheres and must find their support in networks, terminals and the M-commerce infrastructure.

An additional source of requirements is the technological development driving towards further convergence of many digital technologies (voice and video communications, Internet, etc.) and channels. From the merchant's point of view, the mobile and other channels should not be separate, but integrated, as this creates economic savings. There should be a common E-infrastructure in place. Thus, terminals should become more and more complex. The general requirements for terminals are *portability and usability.*

The current M-commerce market is rather fragmented in the sense that with a particular terminal one can only perform transactions in the home network. Only with the high-end Internet-enabled terminals can one access normal websites and banking services. Deliberate countermeasures are actually required from the international actors (governments, international organizations, companies) if one wants the global M-commerce market to develop without fragmentation. This can be understood as a high-level requirement for the actors within the Regulatory Framework sphere.

Further research is needed about the emergence of the requirements within different spheres of concerns. The requirements for successful M-commerce from a user perspective should also be investigated because users are the ultimate sources of revenue in M-commerce.

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