

# On Requirements for Mobile Commerce

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## **Abstract:**

Advances in Internet and wireless access network technologies and the rapidly growing number of mobile personal devices, that has already exceeded one billion in the world, result in the fast growth of M-commerce. .. We view M-commerce here as a subset of E-commerce, where the transactions are conducted using a mobile terminal and a wireless access network. The mobile user and her/his requirements play a role in the development of M-commerce, but also the technology development and the development of the regulatory frameworks play a role. This paper deals in a systematic way with requirements for M-commerce. It first sets the scene for the M-commerce by reviewing the basic concepts for M-commerce and requirements. It then introduces a meta model, published earlier, consisting of four spheres of concern, namely Regulatory Frameworks, Business Models, Global Infrastructure, and Enabling Technologies. The requirements for M-commerce are grouped within these spheres of concerns and analysed in their context. The emphasis is on those requirements that will persist. For many requirements it is shown that they originate in one sphere and propagate to other spheres, thereby often taking a more concrete form. The Enabling Technologies sphere refers to the future technologies that are now being developed and will respond to requirements arising in the future. Conclusion and further work concludes the paper.

**Keywords:** Mobile Commerce, Personal Trusted Devices (PTD), Requirements, Regulatory Frameworks, Global Infrastructure, Enabling Technologies

## **1. Introduction**

Nowadays, M-commerce and the adoption of related technologies is becoming more and more popular. Some of the factors that contributed to this development are the tremendous development 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 impressive growth of wireless communication networks. Wireless communication technologies combined with Internet-enabled terminals constitute an ideal platform for the realization of many, new kinds of business transactions. The small and light, yet powerful, mobile terminals are almost always carried by their owners (just like a wallet). They can indeed 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, such as GPS, terrestrial network facilities, or indoor mechanisms, based on WLAN or PAN technologies. Recent developments in these areas seamlessly extend the positioning of wireless devices into all possible environments. Thus, services based on the location of the terminals, referred to as location-based services, have widely become 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 telecom terminals with the above functionalities Personal Trusted Devices (PTD).

Furthermore, digital convergence of various formerly separate technology fields is continuing. As an important indication of this, a portable high-end telecom terminal can basically host any other miniature device, such as video camera, CD-player, radio, or even a TV-receiver. Game consoles combined with a telecom terminal are already also on the market. These developments will have considerable, yet largely unknown, effects for the M-commerce in the near future. Another convergence path is the emergence of common core network under the IP framework. The Internet-enabled wireless terminals are already able to access services designed for normal Internet users, such as email and WWW, and services specially designed for mobile users, such as WAP- and I-Mode. Terminals run TCP/IP end-to-end over a wireless bearer and HTTP(S), or a special WAP protocol suite to the WAP-gateway [WAP2002]. Further convergence of the IP technologies and wireless technologies is anticipated so that the future devices will be truly seamlessly integrated with the IP infrastructure. This development has started with earlier versions released by 3GPP and was finalized with Release 5 [KALNN01, 3GPP2003, Mita2002a, Mita2002b, Mita2002c].

As concerns related work, there are many papers, books and reports that present requirements for various, mostly technical, aspects of M-commerce [EFAC2002, EXPIDE2003, KaRo2002, Mita2002a-b, Sad2002, VaVe2002]. These are as such relevant to our work, but we are not going to repeat all possible individual requirements that have been so-far established in the cited sources or elsewhere. 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 within the framework. The goal of this paper is not only to stratify requirements vertically, but also to investigate their life span. Some of them are more fundamental than the others which in general means that they originate at the legal level or are dictated by the e.g. 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 also more persistent than those emerging e.g. from the restrictions of a particular network or terminal technology generation in use.

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 concludes.

## **2 The framework for requirements**

There has been much discussion in the scientific and commercial literature about the definition of E-commerce and M-commerce [Durl2000, OECD2002, KaRo2002, Mobicom2002, Sade2002, VaVe2002]. For the purposes of our research, we define M-commerce as an activity that consists of M-commerce transactions. An M-commerce transaction is an E-commerce electronic transaction [OECD2002] that is conducted using a mobile terminal and a wireless access network. Notice that the definition includes all portable telecom terminals and PDA:s, as well as terminals mounted in vehicles that are capable of accessing wireless telecom networks (2G,3G) and/or use short range wireless connections, such as infrared or Bluetooth, while performing M-commerce transactions. The activities that precede or follow the actual M-commerce transactions within the infrastructure belong, strictly speaking, to M-business [KaRo2002]. We confine ourselves below most 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 in this context can be a distributed system, a terminal, a company, a state, or even an international organization. Thus, we use a rather general definition of the term requirement. We will discuss at the appropriate points the different connotations of the concept of requirement.

Just to illustrate shortly 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 e.g. within the European Union, as stated in the relevant Directive [EUD58/2002/EC]. Because it is incorporated into the legal framework, it must be taken into consideration when designing business models. Such business models are illegal within the European Union, where e.g. the location data of the customer are somehow used without explicit consent from the customer (or authorities). The privacy must be supported by the technology at the infrastructure level. In practice this means that message encryption should be provided in the wireless air interface and protection for the coordinates of the terminal against misuse in any part of the service provider system must be provided. The user must also be empowered to switch the terminal positioning on and off using a terminal interface. The requirements are technology dependent. If, for instance, infrared link is used in wireless communication then encryption might, for various reasons, be unnecessary. The concrete user interface for positioning control is also highly dependent on the UI and positioning capabilities of a particular terminal and the access network.

We use the model introduced earlier in [VeWe03] as the framework to group requirements. Its basic structure is presented in Fig. 1

|                              |                              |
|------------------------------|------------------------------|
| <b>Regulatory Frameworks</b> | <b>Business Models</b>       |
|                              | <b>Global Infrastructure</b> |
|                              | <b>Enabling Technologies</b> |

Fig. 1 Spheres of concern in M-Commerce

- *Regulatory Frameworks*: The organizational and technical aspects of laws, standards and recommendations, as well as the bodies involved in their definition and/or ratification. The main actors here are international organizations, such as OECD and European Union, governments, standardization bodies (ISO, ANSI, ETSI, IEEE), and interest groups formed by diverse industry sectors to develop de-facto and de-jure standards, such as 3GPP [3GPP2003] and Open Mobile Software Alliance [OMA2003].
- *Business Models*: Business aspects, including business players, provided services, business protocols, revenue sharing, and code of conduct are important artifacts in this sphere [Timm1998]. This sphere captures the pertinent business aspects and persistent concepts and structures. At any particular moment and in different parts of the world, the business models have a different shape, 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 in place at a certain moment. The real global infrastructure is a patchwork of many wireless access networks and backbones, including the entire “Internet”. It is and will be heterogeneous at different architectural levels at any point of time. This is because in different parts of the world the development will progress with different pace. In Japan, for instance, the W-CDMA access networks are already deployed in a wide

scale, whereas in other parts of the world this development is at the beginning or lies ahead.

- *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. A typical example are 4G technologies and beyond, that are currently being researched into, and that will move into the standardization phase later. 4G networks are expected to be deployed around 2012 [Ylä-J2002].

The spheres are interdependent in various ways. We will elaborate on this below. For each of the above spheres we deduce requirements pertaining to the M-commerce.

Before going to the details of the framework we establish 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 rather 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 is experiencing various troubles from service unavailability to all kind of interoperability problems at different infrastructure levels. Thus, 1) and 2) can be understood as *a requirement of a very general nature* for M-commerce environments. They are at the same time the central aspects distinguishing M-commerce environments from other E-commerce environments.

### **3 Requirements originating within the Regulatory Frameworks sphere**

Regulatory frameworks 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 [MobiCom2002]. Regulation refers to formal regulation by authorities, such as legislation. Self-regulation refers to more informal regulation by the market players themselves. Co-regulation refers to a mechanism where a more general framework is set up by the regulatory authorities and the actual decisions will to be made between the market players and the authorities.

E-commerce market regulation is mostly regional. The basic requirements for all commercial activities are anchored in the constitutions of the states and statutes of certain international organizations, such as EU and expressed in legislation.. However, the customers acquiring M-commerce services are mobile and cross borders. That discrepancy generates problems and challenges to the development of the field. For example, which legislation should be applied to roaming people that use M-commerce services abroad?

The other bodies involved in M-commerce such as companies and industry consortia designing new technology, have a subordinate role regarding laws, i.e. they must comply with them while designing new technology. The same holds for companies defining business models and services that are used by consumers or other businesses. Consortia or companies developing new technology are, however, not regulated by laws in all respects. Often only later, in the deployment phase, the laws are passed or self-regulation applied by the industry. In EU, the regulatory framework for E-commerce (and M-commerce) has been established in 1997 [MobiCom2002]. Currently, there is consolidation phase going on. The current 12 directives relevant for E-commerce can be found at [EUEcom2003]. The telecom access is

regulated in [EUD22/2002] and other relevant directives mentioned in it. Concerning the above general requirement 2) EU establishes the access to basic telecom services as a right. Free mobility of the users is guaranteed within EU area and between Schengen-countries the border controls have indeed been dropped.

In Japan, there is also a special E-commerce legislation, as referenced in [METI2002]. The purpose of this legislation is to promote the use of electronic transactions for commercial activities by offering an appropriate environment with trust among users. General data protection law [DprotJ2003] is still in the parliament, and is expected to be adopted by June 2003. Law 137/2001 concerning ISP service provider liability is in effect since May 1, 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 more on self- and co-regulation of the E- and M-commerce market than Europe.

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

*Privacy of the data pertaining to the individual* including all data gathered by the telecom networks, such as positioning data. This requirement has far-reaching ramifications to the location-based services.

*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, the communication autonomy (C-autonomy) of portable devices should be under the user control<sup>1</sup>. Notice that “always on” assumption, understood as a requirement for a user to keep the terminal all the time “on” would restrict her freedom to decide upon her 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, as to 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 requirements of international regulation can be set: The regulatory frameworks for M-commerce should be interoperable. This is especially important among the three leading areas (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 also dispute resolution. For the latter, EU has envisioned automatic mechanisms [EUeE2003]. From content owner point of view, *Intellectual Property Rights (IPR)* should be globally guaranteed.

EXPIDE project [EXP2003] also discusses several requirements that can be set up for the standardisation and other bodies in the M-commerce scene.

#### **4 Requirements for the Business Models**

There is a wide variety of definitions of the term business model in the literature. A recent survey [HeKA2002] analyses 66 business models found in the literature. Another study

<sup>1</sup> 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

reviews them in a thorough way [EFACT2003]. Business model should further include marketing strategy, marketing mix, and product-market strategy. The Business Model Sphere (BMS) of concern in [VeWe2003] is primarily based on the definition of [Timm1998] which defines a business model 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... Business models should further include marketing strategy, marketing mix, and product-market strategy”. This Business Model Sphere of concern also makes explicit the logical business model level and its implementation through services and business protocols. The strategy level remains implicit. We stick to this view here.

The most important and the most general requirement for any business model 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 [EFACT2003], there are five separate groups of factors affecting this: technical, individual, organizational, industry, and societal factors. 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 originating within the Regulatory Frameworks sphere. Thus, the possible business models 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 business models are:

- Support for IPR in the business model. Especially one must specify, what rights are transferred to the customer, what not when an 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 initiates at the Regulatory Framework level. It means that business models must take into consideration the rights of a customer to return the goods purchased, or refuse to pay non-delivered services and preserve privacy. In this respect the *Automatic dispute resolution* mechanism suggested by the EU [EUeE2003] is noteworthy. The consumer *trust* is interrelated with the protection.
- *Support for appropriate taxation*. This is important for roaming customers, as often they are exempted from the Value-added tax (VAT) or similar consumption taxes. European Union wants to collect VAT from its own citizens, no matter which channel they choose to use, but non-resident individuals are primarily exempted from the VAT, whereas USA has allowed E-commerce to be tax-free since 1998. Japan levies 5 % tax on E-commerce transactions, as for any other purchases for residents, whereas, the non-residents do not need to pay this. In 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 is a problem for all players, including customers, merchants and governments.

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

- *the global coverage* for the global infrastructure (network) services; This is a rather hard requirement (services should be accessible anywhere, even on South Pole)
- *primarily automated services at the server (merchant) side*. This requirement is valid for the entire M-commerce infrastructure. Without a continuous accessibility, the M-commerce infrastructure is rather useless for global operation.

Requiring, in addition, that the user must be able to access the services with a *single terminal*, that is, using his or her PTD, one can further establish the following

- *roaming contracts* between the network operators making possible for a user to indeed access both the local services, his or her home network services or services in Internet irrespective of their physical location.
- support for *global electronic payment infrastructure* so that the local services can be reasonably acquired by a foreign roaming customer.
- *multilingual M-commerce service provision* so that the roaming customers can indeed access the local services and make use of them.

It is worth noticing that requirements for a business model 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 the individual customers.

## 5 Requirements for the Global Infrastructure

The concrete global infrastructure changes over time. In Fig. 2, a schematic, network technology-oriented view on the global infrastructure is presented. The view corresponds to situation in a few years from now, after the backbone network has indeed converged to the "ALL-IP" network envisaged by 3G standardization [KALNN2001, 3GPP2003].

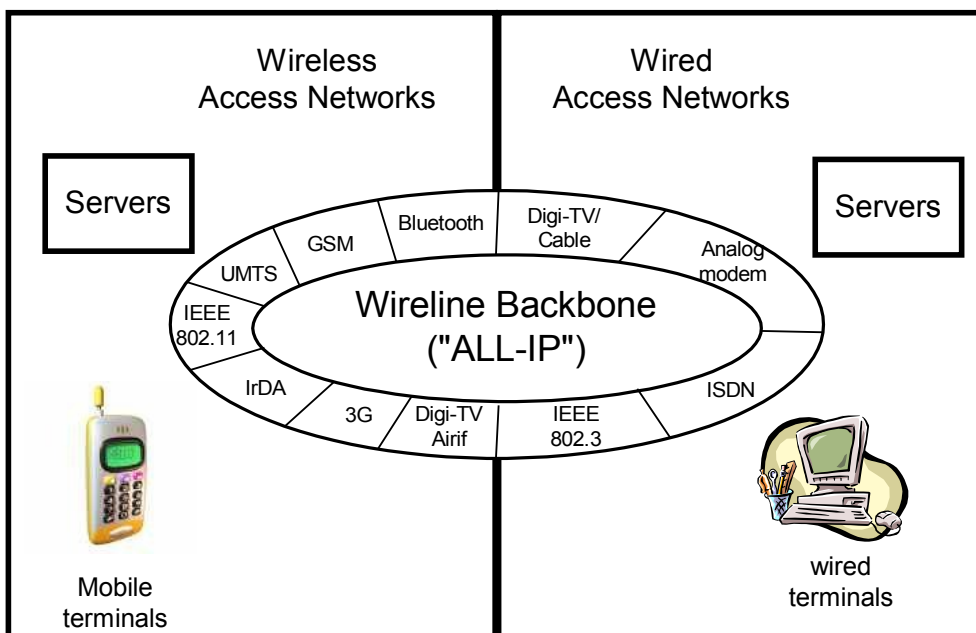


Fig. 2 A schematic horizontal view on the Global Infrastructure [cf. VeWe2003, Fig. 1]

The wireline infrastructure in Fig. 2 that serves resource-rich terminals is also used by the mobile terminals. The black line separating the “ALL-IP” area into two regions reminds of the separation of the IP-networks to operator controlled ones and to the “global Internet”. Vertically, the global infrastructure consists of several layers. One way of viewing them is presented in Fig. 3. As stated in [KALNN2001], 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.

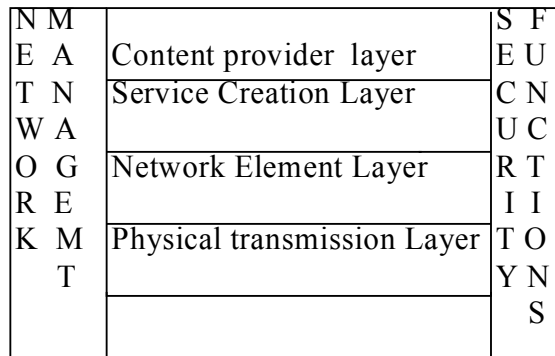


Fig. 3 UMTS Network Architecture, Service Model [KALNN2001, p.11]

### 5.1 Requirements for the backbone

All requirements stated above for Regulatory Framework and Business Model spheres must find their support within the global infrastructure in one form or another. Thus, the business processes must have their implementations at this level through suitable services and protocols. The access network must be able to identify the user in order to be able to charge the right entity for the usage of the network resources. The concrete revenue generation at Network Element Layer and Content Provider Layer must be guaranteed by *billing and/or payment infrastructure*. *Security* and *privacy* of the customers and authentication/authorization of the parties engaged in a M-commerce transaction must be guaranteed by suitable 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 from anytime, anywhere service accessibility requirement discussed above. The limiting factor for the service coverage is mainly the cost of the infrastructure. Contents can be provided by smaller players, but in practice only big players can offer mobile network infrastructure

*Dependability*. This can be seen as a more detailed requirement deducible from anytime, anywhere requirement. Dependability can be characterized by *reliability*, *availability*, and *survivability* of the infrastructure [MaVS2002]. Failures or overload 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 quality of service 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 location-based services, where the actual position of the terminal is determined and represented in a coordinate reference system, the *positioning accuracy* is a crucial issue. In addition, the *quality of the data* used to provide the

service is another issue. The effects of low-quality data for the service quality are not well understood currently.

*Transactional Service delivery.* M-commerce transactions should preserve 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 correct payment was received by the merchant. This requirement has far-reaching ramifications for the entire infrastructure. The issue is further complicated by the consumer protection legislation that allows the customer to return the goods within certain period of time or raise arguments against the merchant leading to dispute. A more elaborate treatment of these issues can be found in [Ve2000].

*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*.

The first requirement, *interoperability of two backbone networks*, if satisfied, 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 guaranteed currently in general. GSM terminals are not able to communicate in CDMA or W-CDMA networks and vice versa. Vodafone is one of the first operators to offer a terminal that is compatible both with GSM and W-CDMA air interface at several frequency bands.

*Interoperability of any terminal and any service.* This is a highly complex requirement. The requirement is more important while the user is roaming than while he or she is serviced in the home network.

*Roaming support.* A necessary condition for roaming is that the terminal and network are interoperable. In addition, there are technical requirements following from the regulatory and business model level. These include *terminal authentication*, *profile management*, *encryption key management*. M-commerce transactions often require *service discovery* facilities in order to access the 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 level, and beyond that to the natural language level (try to use Japanese or Chinese services without understanding Japanese or Chinese characters!). It is an open question, which M-commerce applications could be designed in such a way that the natural language is not an issue. Ordering taxi [VeWe2003] might be, as well as simple wireless payments over infrared using a credit card information stored in the PTD.

## 5.2 Requirements for the terminals

Much of the progress in M-commerce is due to the rapid development of the 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 terminal used solely for voice traffic has different usage and usability characteristics than a terminal used for complicated M-commerce transactions, taking notes in meetings, or used as a game console. Usability, including battery life, tends to increase with terminal size and weight to a certain point. Thus, the design of a terminal should be based on optimal compromise between portability and usability. *General terminal usability requirements* are: high quality color displays, efficient and easy-to-use input means (keypad, voice input), UI designs that offer the best tested usability. Internally, the terminal should

offer extended battery life, high speed processor(s), large enough memory, and so on. The list is by no means exhaustive.

The *functionality* provided by terminals is also crucial for M-commerce. The high-end terminals, such as Nokia 9210i Communicator, are supporting wireless voice and data communications on several frequency bands, Java applications, a WWW and WAP browser, email client, as well as a fax-client. In Japan, J-phone allows the Java-applications and data to be downloaded to their 2G/3G terminals and run, facilitating a large variety of location-based and other applications, such as games. The evolution of the terminals enables the provision of constantly expanding class of applications.

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

*Interoperability with the wireless access 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 stack) should run. Further, *support for short-range wireless access technologies* (Infrared, Bluetooth) is required for payment and ticketing applications that interact with cash registers. At the highest architectural level, *compliance with the mobile Internet standards*, specified by OMA [OMA2003] 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 and 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 the services over Internet (cf. Fig. 2), or over a short-range wireless connection, cannot obtain the terminal identity. Besides, even if they would 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 a further requirement for the terminal: it must *offer an appropriate protection mechanism* to the PKI objects stored into the WIM module.

2G and 3G terminals encrypt the outgoing voice and data traffic so that basic privacy and security protection is provided for the air interface. But this is not sufficient for the 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 additional, *optional requirement* for terminals is the direct support for payments. These include credit card information stored into the handset, electronic wallet storing cash for micro-payments, and support for various tickets [MeT2001]. In February 2003, KDDI AU launched a service in Japan, where the credit card information is read from the terminal over an Infrared link, instead of using the physical card reader and credit card.

Another optional set of requirements consist of those for *location-based services* (LBS). The primary functionality required by a terminal is the capability to position itself. This can be based on satellite positioning (GPS), or network-based positioning [KALNN2001]. The former requires the functionality of the terminal to be enhanced with a GPS receiver, as compared to a standard telecom terminal. Most of the network positioning methods also

require enhancements in the functionality of the terminal, albeit not Cell Identity and its variants.

Should positioning of terminal be possible, it is required that the terminal provides adequate privacy protection means. These include possibility to prohibit tracking from an external entity. Tracking of the terminal for emergency purposes should, however be always possible.

## **6 Requirements for the emerging technologies in the Enabling Technologies sphere**

The Enabling Technologies in the framework model presented in [VeWe2003] 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 the technical development of the terminals that has made it possible to enhance their functionality a way beyond voice traffic without sacrificing the portability. Steps in this development have been miniturisation of the hardware components in general. This has made possible large memories and faster processors, and integration of GPS hardware and software (see e.g. [Ben2003]), as well as CD-players, radio receivers, etc. On the other hand, the development of operating systems with small memory requirements (e.g. Symbian), advances in software engineering platforms for small devices (esp. Java) 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, after the above prerequisites are given, it is realistic to run on the small terminals the complicated PKI and other encryption and decryption algorithms with long keys developed for resource-rich environments.

The big mega-trend penetrating very large technology and business area is *digital convergence*. It means, first, that digital control and information processing conquers new areas from car engines and communication networks to tiny “processor dust” devices and to the identification tags of EU cattle. Second, the previously separate digital technologies converge into interoperable or even integrated seamless technologies. The above terminal development is an example of it. The communication networks in general are at the heart of this development. Where as the wireless access technologies in Fig.2 are currently somewhat separate and not fully integrated with the “All-IP” backbone, the goal is to make them seamless. The number of access technologies depicted in Fig. 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 moment of 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 for this. There are also initiatives such as Mobile Internet Technical Architecture (MITA) pursued by a single manufacturing company [mita2002a, mita2002b, mita2002c].

Finally, orthogonal to the above considerations, *terminals should have a longer operating time than currently* as concerns the need to recharge the battery.

*General foreseeable requirements relevant for M-commerce.*

In the current situation, the user tends to have phone numbers, email-addresses, URLs, etc. The convergence of the networks raises the question, whether one could have a *single user identity at the technical level*. [Mita2002a-c]. This idea would have many further ramifications for privacy, security etc., as well as at the business models and the technology level.

In the presence of many wireless networks, the terminal should select the best one. This is sometimes called “*Always Best Connected*” requirement. From this requirement one can further deduce that the terminal must be able to operate on several frequency bands and host several protocol stacks. Further, 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. Furthermore, within the network infrastructure *support for interoperable user profile* must exist.

The latter requirement contributes to increasing complexity of the terminals. A further complication comes from the fact that the terminals should be *interoperable also on the service level* (cf. the discussion on this within the Global Infrastructure sphere). An additional aspect emerging and required especially by M-commerce is *Mobile Digital Rights Management* that is supposed to protect the rights of the content providers.

Finally, the big picture in Fig. 2 and convergence suggests that M-commerce channel is only one technical 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 homogeneity requirement among the channels. An example of this direction is PTP protocol specified by MeT [MeT2001]. There might be also other transaction types where the PTD is used as an authentication and authorization device but the actual service provisioned through another channel, such as Internet or Digital-TV. Finally, terminal and digital-TV might be integrated into the same device, making the again a large variety of new M-commerce applications possible, such as mobile pay-TV.

## 7 Conclusions and further work

In this paper we have analyzed essential requirements for M-commerce. In many previous papers there have been scattered statements about requirements and their analysis but a systematic framework has been lacking. Further, the 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. In addition, 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 customers. Many lower-level requirements can be deduced from these to all spheres. *Privacy protection* of individuals, as well as *consumer protection* and general laws regulating the E-commerce, as well as *code of conduct* are further important sources of requirements that also penetrate the spheres and must find their support in the concrete wireless networks, terminals and the M-commerce infrastructure.

An additional source of requirements relevant to M-commerce is the technological development that drives towards further convergence of many digital technology areas (digital photographing, 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, because this brings economic savings. There should be a common E-infrastructure in place. These requirements impose extra requirements for the terminals that should become more and more complex. The general requirements for terminals are *portability and usability*.

The former limits the terminal complexity indirectly by requiring the terminals be reasonably light and small in order to be easily carried, whereas a terminal that is universally usable for M-commerce tends to be highly complex, because of support for many air interfaces and M-commerce service dialects encountered while roaming. This tends to mean also less portability.

The current M-commerce market is rather fragmented in the sense that with a particular terminal one can perform M-commerce transactions only in the home network (Japan, Korea). The exception are the high-end Internet-enabled terminals that can access normal Web sites and banking web services. Deliberate countermeasures are actually required from the international actors (governments, international organizations, companies contributing to the M-commerce infrastructure) if one wants the global M-commerce market to develop into non-fragmented direction from the current fragmented stage. This can be understood as a high-level requirement for the actors within the Regulatory Framework sphere.

In further research the emergence of the requirements within different spheres of concerns should be investigated. Also, the requirements for successful M-commerce from user perspective, because users are the ultimate source of revenues in M-commerce.

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