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<u>ΠΑΝΕΠΙΣΤΗΜΙΟ ΜΑΚΕΔΟΝΙΑΣ</u>

ΘΕΜΑ: ΥΛΟΠΟΙΗΣΗ ΕΠΙΚΟΙΝΩΝΙΑΚΩΝ ΥΠΟΔΟΜΩΝ ΚΑΙ ΥΠΗΡΕΣΙΩΝ ΓΙΑ MOBILE COMMERCE

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ΣΥΝΤΑΚΤΕΣ

ΣΤΑΜΠΟΛΟΓΛΟΥ ΣΑΒΒΑΣ

ΠΕΤΡΑΚΗΣ ΕΜΜΑΝΟΥΗΛ

ΘΕΣΣΑΛΟΝΙΚΗ ΙΑΝΟΥΑΡΙΟΣ 2006

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ENGLISH ABSTRACT

Advances in e-commerce have resulted in significant progress towards strategies, requirements, and development of e-commerce applications. However, nearly all e-commerce applications envisioned and developed so far assume fixed or stationary users with wired infrastructure. There is a vision of many new e-commerce applications that are or will be possible and significantly beneficial that will come from emerging wireless and mobile networks.

There is a proposal of a four-level integrated framework for mobile commerce, in order designers, developers, and researchers to strategize and create mobile commerce applications.

Mobile commerce core consists of mobile networks. Due to the high popularity of mobile phones most mobile commerce applications work on cellular networks. The first analog cellular networks like AMPS have very limited data transfer capabilites. But gsm proved to be a very big upgrafe. Furthermore GPRS introduced packet switched technology so the user can be always connected and be charged only for the amount of data that he downloaded from the netwrok. Now 3G applications have introduced high bandwith when on move and multimedia applications. Mobile commerce also makes heavy use of networks like WI-FI or bluetooth. We also must say that a new kind of ip , the mobile IP was introduced to make thing easier for the wireless reality.

Many applications in the most important areas are identified such as mobile financial applications, mobile inventory management, proactive service management, product location and search, and wireless re-engineering.

The future of m-commerce looks very promising with mobile phones like mini laptopts , 4G and WIMAX.

ΕΛΛΗΝΙΚΗ ΠΕΡΙΛΗΨΗ

Η πρόοδος που παρουσιάζεται στο ηλεκτρονικό εμπόριο είχε ως αποτέλεσμα την πρόοδο σε στρατηγικές προϋποθέσεις και ανάπτυξη εφαρμογών ηλεκτρονικού εμπορίου. Γεγονός είναι ότι σχεδόν όλες οι εφαρμογές του ηλεκτρονικού εμπορίου χρησιμοποιούνται από σταθερούς χρήστες με καλωδιακή υποδομή. Υπάρχει ένα όραμα από πολλές νέες εφαρμογές ηλεκτρονικού εμπορίου οι οποίες είναι ήδη ή θα είναι δυνατές και σημαντικά επικερδείς και θα προέρχονται από αναπτυσσόμενα ασύρματα και κινητά δίκτυα.

Παρουσιάζεται μία πρόταση για ολοκληρωμένο τεσσάρων πεδίων framework για mobile commerce, ώστε σχεδιαστές αναλυτές και ερευνητές να μελετήσουν στρατηγικά και να κατασκευάσουν εφαρμογές για mobile commerce.

Η καρδία του mobile commerce είναι τα κινητά δίκτυα. Επειδή σχεδόν καθένας έχει σήμερα κινητό οι πιο πολλές εφαρμογές του έχουν γίνει για κυψελοτά δίκτυα. Τα πρώτα αναλογικά δίκτυα όπως το AMPS δεν είχαν πολλές δυνατότητες για μεταφορά δεδομένων. Η κατάσταση αυτή άλλαξε άρδην με την έλευση του GSM. Τα πράγματα έγιναν ακόμα καλύτερα μετά την έλευση του GPRS επειδή ο χρήστης ήταν πάντα συνδεδεμένος και χρεώνονται μόνο για τα δεδομένα που κατέβαζε. ΤΑ δίκτυα 3 γενιάς έφεραν ακόμα μεγαλύτερη διαμεταγωγή και την δυνατότητα για πολυμεσικές εφαρμογές. Τέλος για το mobile commerce μεγάλο ρόλο παίζουν και οι τεχνολογίες WI-FI και bluetooth. Τέλος μια καινούργια έκδοση του IP που λέγεται mobile IP σχεδιάστηκε για να είναι κατάλληλο για τα κινητά δίκτυα.

Αναγνωρίζονται πολλές εφαρμογές στους πιο σημαντικούς κλάδους όπως οικονομικές εφαρμογές, κινητή διαχείριση αποθηκών, διαχείριση προενέργειας συντήρησης, έρευνα και εντοπισμός προϊόντων και ασύρματου re-engineering.

Το μέλλον του mobile commerce είναι πολλά υποσχόμενο. Οι συσκευές γίνονται ολοένα με περισσότερες δυνατότητες και τα δίκτυα 4 γενιάς αλλά και το WIMAX είναι προ του πυλών,

1. INTRODUCTION

1.1 Definition of Mobile Commerce

Mobile commerce or for short m-commerce is all about the use, application and embodiment of wireless technologies and appliances in the marketing system of the business environment. The area of m-commerce includes reports in substructures and electronic technologies necessary for wireless information and data transfer as well as multimedia forms (text, graphics video and audio). Also includes the study of various wireless technologies and mobile appliances for sending and receiving information and data (e.g. mobile phones, PDA, wireless modems).

The use of wireless technologies extends the nature and purpose of traditional electronic commerce (e-commerce) with the use of the ability of the mobilization of the human presence and the mobility of the, that is why the term mobile commerce is usually referred as mobile e-commerce. Mobile commerce is considered to be a flexible solution to the many disadvantages of the traditional e-commerce. Networks with wireless structure and the mobile devices that support such structures, offer mobility and flexibility to a company.

Basically, the most commercial application of the wireless communications is the ability to access the wireless internet from wireless devices such as mobile phones and PDAs. Wireless internet is based on many different network structures and technologies that support the access to the wireless internet. [1]

1.2 Short Historical Note

In 1897, Guilielmo Marconni was the first to present the ability to produce continuous wireless acoustic contact with the ships that sailed to and fro the shores of Great Britain through communication radio wave signals. Since and till today mobile wireless telecommunications have evolved to a certain level from the relatively simple initial analogue first generation technologies to the modern digital third generation technologies and broadband technologies.

Figure 1. Mobile communications evolution.

The high increase of mobile devices in the market helped the mobile commerce. At the end of 2001, there were more than 850 million users of mobile telephony in the world, 14% of the global population with annual sales of more than 400 million mobile phones. The last decade, mobile phones have evolved from accessory of the few that could afford it, to being a necessary every day devices for the entire world. In cities in Japan, Korea, Sweden and Finland, it is unthinkable for a person not to own a mobile phone since mobile phones become an important part of every day life. On the table below is presented the intrusion of mobile telephony at specific areas for the year 1997 to 2003.

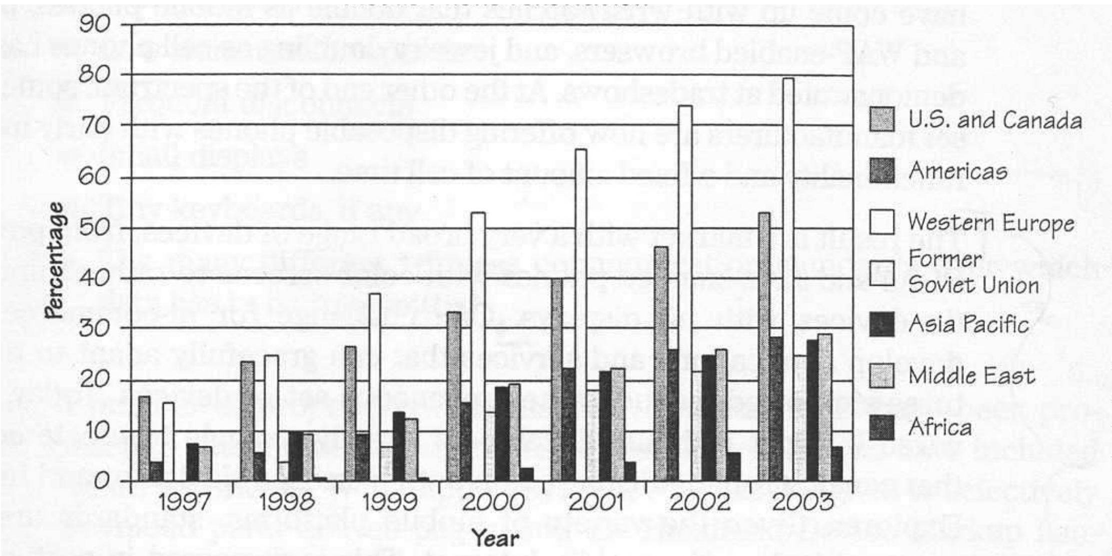

Figure 2. Mobile phone penetration by region.

The biggest intrusion presented is in Europe due to the liberation of the telecommunication industry and the adoption of the global standard system for mobile telephony known as GSM. Nowadays every user has the ability to move and communicate with any part of Europe. GSM is the most popular system today and it is used by the two thirds of the total mobile phones.[2]

As markets like Europe, Japan and North America will slowly be saturated the increase in mobile phone sales will be produced by the demand of Asian countries. In July 2001 the total number of users in China was bigger than 120 million and already bigger than USA and it is increase by 1 million users every week. This fact combined with the population of China which is more than 2 billion people, promise an great increase sales. Since mobile phones dominate the wireless communication other devices will contribute to mobile commerce growth like PDAs and laptops. In the year 2000, more than 6 million PDAs devices were sold worldwide and by 2002 this number reached the 20 million more than 300% growth. As mobile phones at that period evolved slowly, they started to provide abilities similar to PDAs, like big colored screens, personal data process services and internet access ability to web pages customized for these applications. Especially some mobile phones like 9210 and P900 that can provide almost all the services of a PDA and the ability for wireless access to internet and therefore for better m-commerce use.

The first bloom of m-commerce presented itself with the application of WAP in second-generation mobile phones thus creating mobile internet. It was then that the private protocol cHTML appeared. That protocol is used in i-Mode format.

In the beginning of 2000 an improved and enhanced version of this technology of the second generation GPRS(General Packet Radio Services) was introduced. This version offered even more data abilities like high but rates and permanent connection. Through the GPRS technology, mobile phones have the ability to send and receive data as well as the devices that are connected to them like PDAs or laptop. At that point user could send and receive electronic mail (e-mail) and have access to the world wide web.

The introduction of third generation technology extended the mobile telephony boundaries to cover a wide variety of services and abilities other than the traditional audio communication, like multimedia data transfer, video streaming, video telephony and full access to the internet with broadband bit rates (up to 2 Mbp/s) and pay-per-view television on the mobile phone screen.

On the table below are presented the data bit rates of each type of technology:

Technology	Bit rate	Access form to the internet
GSM	9,6 kbps	modem
HSCSD	43,2 kbps	modem through mobile phone (WAP)
GPRS	384 kbps	Permanent connection modem through mobile phone (WAP – WWW)
3G	2Mbps	Permanent connection modem through mobile phone (WAP – WWW)

Table 1. Technologies and bit-rates.

Nowadays there is a wide variety of portable devices that have the ability of wireless internet access, like PDAs, laptops, smart phones, mp3-players, digital cameras and car-pcs.

The experience of mobile internet differs a lot from traditional internet. It consists of actions based on the geographical position of the user and under time constraints (e.g. finding the nearest pharmacy or gas station).[3]

1.3 NTT DoCoMo Company Case

The most popular mobile commerce systems is the i-Mode. The most striking mobile commerce case company protocol i-Mode NTT DoCoMo Company, which made I-Mode widely known. It started in 1999 in Japan and in one month only they had 500.000 users today there are more than 60 million users worldwide (wigipedia). The offered services included e-mail, e-banking, yellow pages, phone catalogue information as well as buyng ticket service in traveling and theatre booking. The application of I-Mode over the PDC-P network is a permanent connection packet transaction system. i-Mode is based on cHTML language that was extended by NTT DoCoMo Company with some extra tags that aid and achieve the best usage of the network e.g. tags for calling phone numbers through hyperlink. The success of NTT

DoCoMo is due to the charging format that can differ from user to another. It charging format is the based on basic charges, the quantity of the data and the basic charges of each service provider.[4]

2. SUBJECT ANALYSIS

2.1 A Framework for m-commerce

To help future applications and technologies handle m-commerce, a proposition was made about a framework as shown in figure1. This framework will allow developers and providers to strategize and effectively implement mobile commerce applications [5]. The framework defines multiple functional layers, simplifying the design and development, so different parties (vendors, providers, and designers, etc.) can focus on individual layers. By following this framework, a single entity is not forced to do everything to build m-commerce system rather, they can build on the functionalities provided by others. This will speed up the development of m-commerce applications as designers and developers can assume that certain functions will be provided by lower layers, and therefore, they need not focus on the capabilities and constraints of individual devices and networks. This framework has four levels: m-commerce applications, user infrastructure, middleware, and network infrastructure. The framework shows that the design of new mobile commerce applications should take into consideration the general capabilities of user infrastructure (mobile devices), and not the individual devices. With its ability to hide details of underlying wireless and mobile networks from applications while at the same time providing a uniform and easy to use interface, mobile middleware clearly is an extremely important component in developing new mobile commerce applications. The network infrastructure also plays an important role in mobile commerce, as the user perceived service quality depends on available resources and capabilities of wireless and mobile networks.

Figure 3. M-commerce components.

An open framework will prevent the design and development of proprietary products and services that may be built in an ad hoc fashion. It is believe that this framework will allow interoperability of m-commerce applications and products from different providers and vendors. This would help in the adoption of m-commerce on a global scale. The framework also provides a developer and provider plane to address the different needs and roles of application developers, content providers, and service providers. Each one of these could build its products and services using the functionalities provided by others. A content provider can build its service using applications from multiple application developers. They can also aggregate content from other content providers and can supply the aggregated content to a network operator or service provider. Service providers can also act as content aggregators, but are unlikely to act as either an application or content provider due to their focus on the networking and service aspects of m-commerce. A service provider can also act as a clearing house for content and application providers in advertising and distributing their products to its customers. In any case, the developer and provider plane in our framework is likely to have multiple layers. Wireless carriers can play a very active and important role in the mobile commerce applications and services due to the fact that a mobile user is going through their networks to perform all mobile commerce transactions. Additionally, a mobile user is likely to prefer one common bill (bundled services) for voice, data, and mobile commerce services. However, there are many technical and non-technical hurdles (such as pricing for mobile commerce transactions) that need to be overcome before carriers can become major players in this emerging field. Many of these players and possible interactions are shown in figure 2.

Figure 4. A framework for m-commerce.

Figure 5. Mobile commerce life cycle.

This framework proposes a four-level integrated framework for m-commerce: m-commerce applications, wireless user infrastructure, mobile middleware, and wireless network infrastructure.

M-commerce applications require the support of technology from the foundation of wireless user infrastructure, mobile middleware, and wireless network infrastructure. In addition, corresponding theory and research activities are essential to provide guidance for the development of m-commerce.

The classification framework recognizes that m-commerce consists of five levels and each of them is discussed as follows:

a) M-commerce theory and research:

This is the lowest level of the framework. This is the development of m-commerce applications and guidelines, behavioral issues such as consumer behavior, the acceptance of technology, and the diffusion of m-commerce applications and services. M-commerce theory and research deal with economics, strategy, and business models and legal and ethical issues such as privacy, regulations, and the legal environment when using m-commerce.

b) Wireless network infrastructure:

This is one of the pillar technologies of m-commerce that supports the development of m-commerce applications. Wireless network infrastructure plays an important role in m-commerce as this is the core part of m-commerce technology [6]. It provides wireless networks and network standards such as the Global System for Mobile Communication (GSM), Bluetooth, the wireless local area network (WLAN), radio frequency identification (RFID), the Third-generation (3G) network, etc. In order to ensure the reliability and efficiency of the m-commerce applications and services running in a mobile environment, it is necessary for various networking requirements to be implemented in the wireless and mobile networks. The wireless infrastructure requirements of m-commerce deals with matters such as location management, multicast support, network dependability, quality-of-service, and roaming across multiple networks [7].

c) Mobile middleware:

Mobile middleware refers to the software layer between the wireless networks and the operating systems of the mobile devices to connect the m-commerce applications. While the connection time and data exchange for mobile devices are expensive, various agent technologies can be used to support different m-commerce activities such as making payments and locating merchants [10]. Mobile middleware supports m-commerce activities, for example, carrying out negotiations and searching for products. In a mobile environment, the query processing, database location and data recovery capabilities of a mobile database system may not use the traditional method to access information. There are many security issues in m-commerce, for instance, designing a secure wireless network infrastructure for m-commerce applications using public key infrastructure or other techniques [36][37][38]. A wireless and mobile communication system refers, to some techniques, algorithm, methods, and components to connect and manage m-commerce applications. In order to communicate with the m-commerce applications or mobile devices, a standard set of protocols is necessary. Hence, Wireless and mobile protocols are the protocols for m-commerce. Some common protocols for m-commerce include the wireless application protocol (WAP) and i-Mode.

d) Wireless user infrastructure:

Wireless user infrastructure consists of two parts, i.e., software and hardware [39]. Software refers to the operating systems and their interfaces while hardware means the mobile devices to communicate with the m-commerce applications, such as PDAs and mobile phones. In this classified framework, two issues relating to wireless user infrastructure were identified in this category. Mobile interfaces are the interface designs or issues relating to the mobile applications or devices [40][41][42]. A well-designed and usable interface is relatively difficult to achieve in a mobile environment because the mobile applications normally execute on a small and portable mobile hand-held device. Corresponding guidelines for designing suitable mobile interfaces are necessary. Clearly, the classification cluster, Mobile handheld devices covers articles related to mobile devices [8].

e) Mobile commerce applications and cases:

M-commerce covers a wide range of applications. There are several important classes of m-commerce applications including mobile financial applications, mobile advertising, mobile inventory management, locating and shopping for products, proactive service management, wireless re-engineering, mobile auctions or reverse auctions, mobile entertainment services and games, mobile offices, mobile distance education, and wireless data centers. The classification framework proposed in this study is based on observations of the reviewed articles.

Figure 6. The house of m-commerce.[9]

2.2 Networks for mobile commerce

2.2.1 Cellular networks

As we mentioned before mobile commerce contains applications and services that are accessible from internet-enabled mobile devices. In 2002 there were 454 GSM operators in 182 countries and served over 730 million users. So we can easily assume that the GSM networks are the mainly way to access Internet while on move. Except GSM networks there are other technologies too, some of them like Bluetooth and WI-FI are gaining popularity very fast. Some new mobile handsets offer all of them and it is not clearly yet which one will have the majority of users, The UMTS, the WI-FI or the WIMAX? In this part we will see about how all of them work and how an enterprise can use them for mobile commerce. .[10]

2.2.2 Factors of Mobile Communications that concern mobile commerce

Before explaining how the Mobile Communications work it is very important to report some factors that are very vital for the mobile commerce and make it different from the wired one. First of all radio transmission cannot be shielded as is the case with a coaxial cable. Whether conditions or nearby electrical engines can use severe interface, resulting in high data loss rates or high bit error rates. As users move around, the properties of the communication medium change: a building might prevent transmission or the user might find himself too far from any base station. This also provides for some interesting challenges when it comes to adapting Internet Protocols to run on mobile communication networks. Additional challenges arise when implementing m-commerce solutions over these networks. Imagine a user initiating a transaction from his mobile phone as he enters a tunnel and loses his signal. Special care must be taken to ensure that the transaction is properly executed or, at least that the user is informed of his status, so that she can restart the transaction if it was not completed the fist time. Mobile communications also suffer from low bandwidth, but with 3G become cheaper thing will become better in this sector. Another problem is that the wireless communication always takes place through a shared medium for which multiple users often have to compete. As the number of users in a particular cell increases, the communication channels they have each been allocated maybe start interfering with one another. At some point, it might be best to no longer accept additional users. In general because spectrum is limited, it is regulated, with the exception of a few frequency bands, and clever multiplexing protocols have to be used to efficiently share available spectrum among competing users. These multiplexing protocols include FDMS, TDMA and CDMA and combinations among them. Qos plays a vital role too, ensuring the delivery of a consistent and predictable service to the user in terms of delays, bit rates, and other parameters. Another important thing about mobile communications is security, which has more problems to be solved than of wired systems. Mobile devices are more easily to be stolen on lost than a desktop computer. Furthermore the air interface over which communication takes place is also more prone to eavesdropping. Analogue communication networks such as AMPS (which we will discuss in detail later) are 100% insecure. A number of incidents have been reported with AMPS where people with scanners would eavesdrop on conversations, steal credit card numbers and monitor the network's control channels to steal phone numbers, which they would later resell in one form or another. As we will see, more recent mobile communications standards have shown that is possible to address these problems with special encryption, authentication and other security mechanisms. One last fact that arises for mobile communications is the mobility issue. As users move from one cell to another, mobile communication networks need to ensure continuity of service. This involves transferring responsibility for the user from one base station to another, from one base station controller to another and in some cases from one network standard to another(for example from GSM to WI-FI). In the process, solutions need to be devised to provide for as seamless and secure transition as possible, rerouting voice and data communication as needed. This also involves making sere that all charges get posted to the user's account, while taking care of splitting revenue among all parties involved in the delivery of the service. While having all the above in mind the designers of mobile communications must also keep in mind the restrictions of mobile devices. Most of them have limited processing power, poor battery life, small amount of memory, and limited input/output functionality. QoS issues also require distinguishing between the requirements of different types of services. Having a phone conversation, accessing email, playing a game or even purchasing stocks involves very different requirements of QoS. For example delay requirements, different data integrity requirements, different bit rate requirements etc [11]

2.2.3 Before 2G GSM networks

Our current mobile services infrastructure is mostly based on 2nd generation (2G). Digital public mobile networks. Before them there were a lot of different mobile telephony systems that were deployed around the world through the 1950s, 1960s, and 1970s like the Improved Mobile Telephone System in the USA or the A-Netz in Germany. These systems generally required bulky antennas, which were built into cars and supported only very limited roaming functionality (if you were going to another city there was no way to make you phone working). Because of all that and plus that were a lot of different protocols that were not compatible with each other none of these mobile telephony systems ever had more than a few thousand users. The first mobile phone standard to really gained broad user acceptance was the Advanced Mobile Phone System (AMPS), it was first introduced in the USA by the BELL Telephone Laboratories. AMPS introduced for the first time term cells. All mobile networks nowadays are called cellular networks because are based on cells. In cellular networks a geographic area is subdivided into smaller areas called cells. Each cell has its own antenna that is set to operate at distinct transmit and receive frequencies. In AMPS these cells are organized in clusters with groups of frequencies fi being reused in nonadjacent cells.

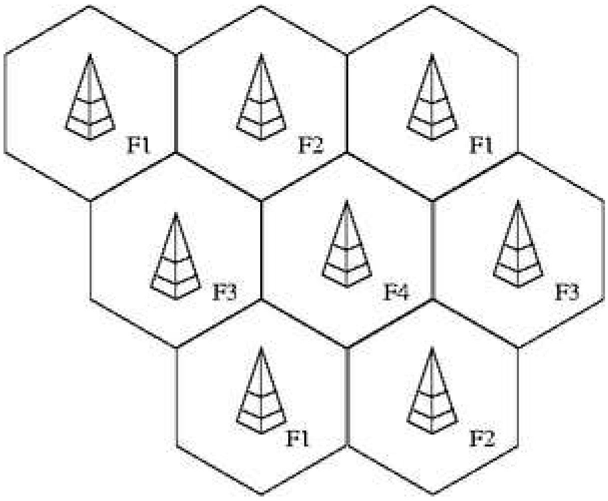

Figure 7. Pattern of seven-cell cluster.[12]

In the picture above we see a pattern with clusters of seven cells (frequencies from f1-f7) Most of the mobile networks today use clusters of seven cells. AMPS phones can operate on 0.6 watts and car transmitters require about 3 watts in contrast to the 200 watts required by previous systems like the IMTS. The result is much cheaper and lighter handsets.

2.2.4 Amps architecture

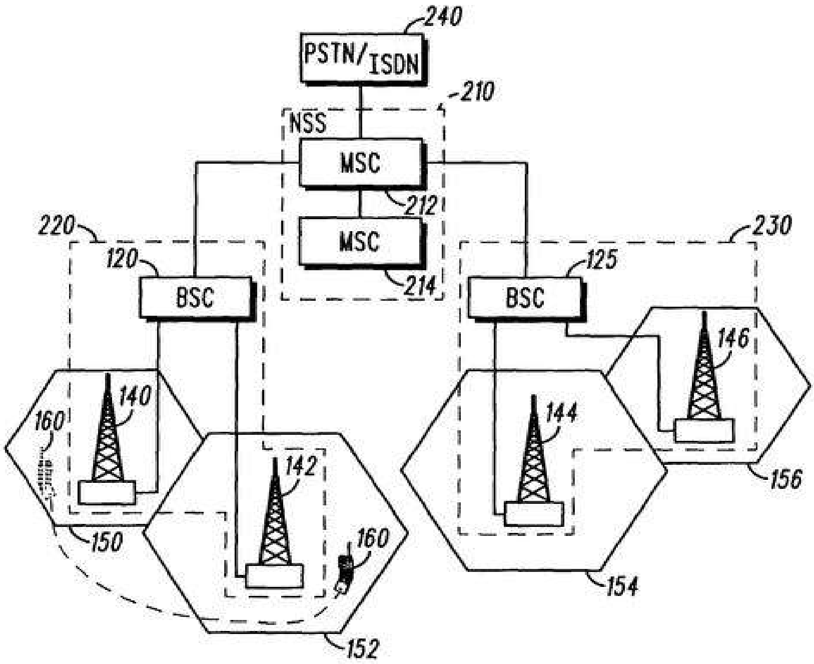

Figure 8. Basic elements of AMPS.

The picture above shows the basic elements of AMPS and other cellular mobile phone systems. It has base stations located at the centre of each cell (no 140-146) and being responsible for allocating communication channels to the mobile stations(mobile phones) and relaying communication to the core wire line phone networks via base station controllers (no 120 & 125). As the mobile stations move from cell to cell, BSCs are responsible for handing over responsibility for that mobile station from one base station to the next. For each particular geographical area there is one BSC responsible for all BTs. Also in this picture we can see the Mobile Switching Centres (no 212&214). Their main job is to perform additional bookkeeping tasks, making it possible to efficiently find, authenticate, and bill users as they roam from one area to the next.[13]

2.2.5 Data over Amps

Amps wasn't designed for data transmission so it's not suitable for it. It supports speed of 9.6 kbps and it circuit switched, that means that you pay for the time you are connected even if you don't send or receive any data at all. Because amps doesn't have a mechanism to check for lost packets when a message goes form the base station to the subscriber it is repeated 11 times to ensure that nothing is lost, on the opposite direction each message is repeated 5 times. Only for this we can see how unsuitable is for data transfer use. All these are happening for two mainly reasons. First, the reason for achieving only 9.6 is due to the lower power level of AMPS and the variable power levels at a receiver associated with wireless transmission. Moreover when transmitting in mobile environment it is very possible for cell handoffs to break up a call connection. When travelling fast from cell to cell, throughput may be degraded significantly. To enhance a bit the transfer rate some vendors create modem protocols. Some of the most known of them are the Microcom Networking Protocol, the Microcom Enhanced Cellular protocol and the Paradyne Enhanced Throughput Cellular protocol. [14]

2.2.6 Global system for mobile communications

Amps, which we discussed above was an analogue standard. Despite it was very popular in the United States it became clear very soon that analogue standards would eventually have to give way to digital ones. The whole standard was born in Europe where the analogue cellular communications were experiencing both rapid growth and congestion. More particular cellular service becomes so popular in the Nordic countries that it was difficult for subscribers to obtain access to analogue networks. Recognizing that problem Nordic Telecom and the Netherlands Post Telephone & Telegraph developed a proposal for a new digital standard that would provide the capacity to support the rapidly growing base of mobile phone users. This proposal was issued to the Conference of European Post and Telecommunications during 1982. After 5 years the Conference of European Post and Telecommunications

GSM advisory group signed a charter for use and standardization of the technology that was then referred by its French name, Groupe Speciale Mobile, and now is knows worldwide as GSM which became the first and most used digital standard was the European Global system for mobile communications. GSM has the following advantages compared to the older analogue standards.

- GSM digitises voice so it has the ability to compress data and achieve a better use of the available spectrum.

- Digital signals can be encrypted, thereby offering the potential for greater security (which is very important for mobile commerce)

- Digital transmission allows for use of error correction techniques, which make it possible to improve transmission quality

- With digital voice transmission, it becomes possible to integrate voice, fax, and data transmission into the same standard (which is very useful for the growth of mobile commerce)

Another advantage for GSM is that unlike the other wireless standards either that are promoted by a company, as in case of Qualcomm's CDMA technology, or for which the technology is essentially obsolete as in the case of AMPS, GSM has a governing body. This committee meets every 4 months to allow members of the GSM's to consider potential revisions and improvements to the standard Their primary goal is to establish internationally compatible GSM networks and make GSM more friendly fore data transfer etc. Its plenary has a chairperson and proposals are voted on, also it is administered by a Dublin, Ireland permanent secretariat.

While in USA the AMPS was a standard in Europe each country had developed it's own analogue system, each being very different and incompatible with those of other national networks. The resulting situation was untenable when it came to achieving economies of scale or when was needed to have roaming among the European countries (which was very important because Europe was going to become an single open market.). Given it was impossible to develop a standard backward compatible with 1G European networks the governments and operators set out to develop a brand new standard that would support roaming across the entire continent. This standard was introduced in the early 1990s and was the GSM. It was essentially intended as a wireless counterpart to the wire line Integrates Digital Services Network (ISDN). Originally it supported data transfer rates of 9,6 and 14. 4 kbps. Due to its broad adoption across Europe, it quickly became the dominant 2G standard with more than 500 million users across the planet (2001) This makes GSM the most used 2G network (about 70% of all 2G networks) source emc world cellular database The second most popular 2G network is cdmaONE , a standard introduced by Qualcomm in the mid 1990. CdmaONE relies on a more efficient code division multiplexing technology, which was first deployed by Hutchinson Telecom and then gained broad acceptance in USA, Korea, Japan and several other countries mainly in Asia. One another 2G network that has to be mentioned is the Personal Digital Cellular(PDC) it is used by NT-DoCoMo and upon it was built the most popular m-commerce platform the i-mode. PDC was the first 2G network that supported packet –switched transmission.

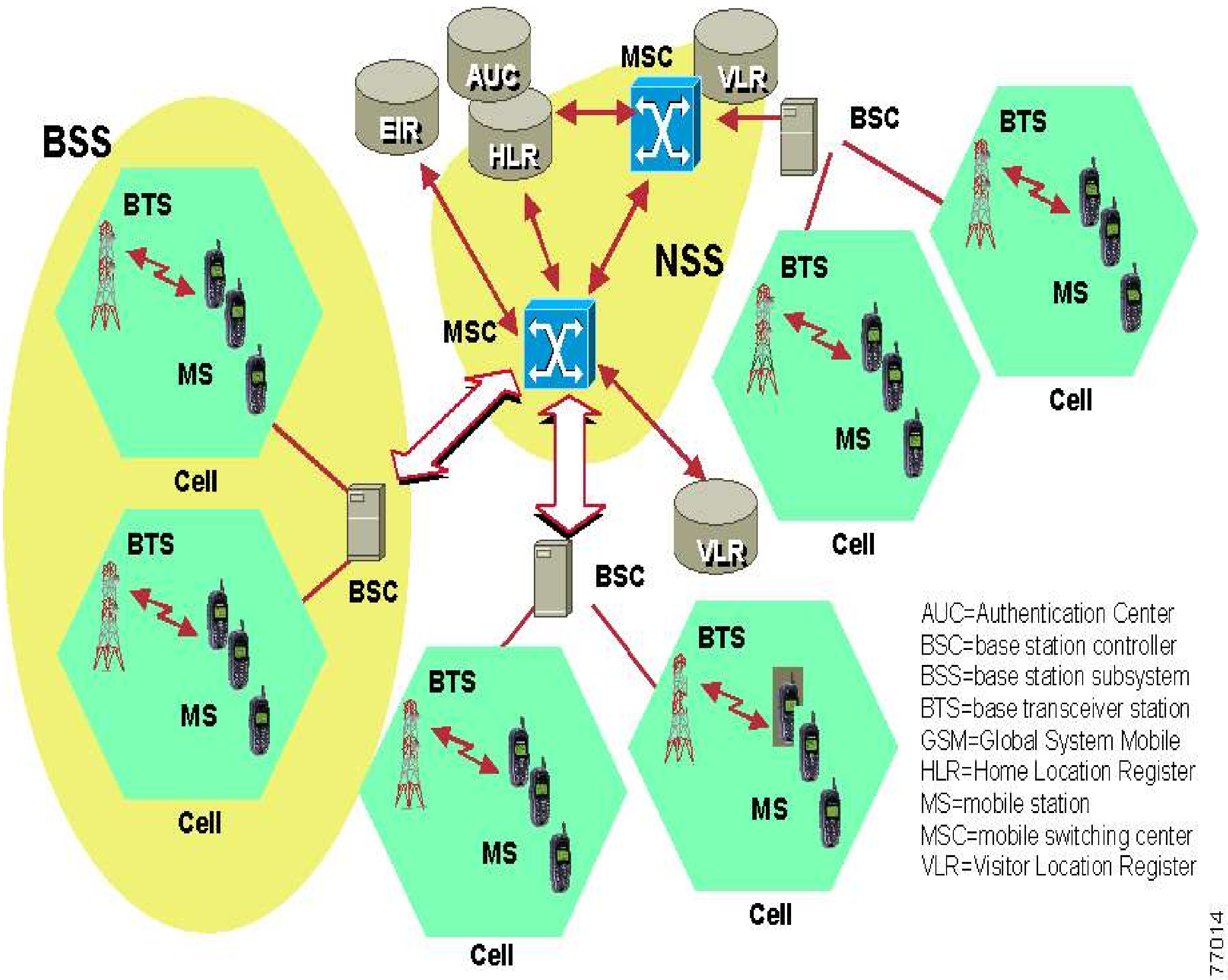

Figure 9. GSM system architecture. [15]

The above picture shows the GSM system architecture. With the green colour we can see the radio subsystem, which includes all the elements directly responsible for radio transmission. They are the mobile stations (MS), base stations (BS) and base station controllers (BSC). This is similar to the AMPS architecture we saw before with the exception that in GSM the communication is encrypted. The encryption key is stored on both the network and the mobile station and is used to both encrypt and decrypt communication at both ends of the wireless link. This key is dynamically generated each time a new connection is set up, by combining the user's authentication key (which is stored in his sim card) and a random number exchanged between the network and the mobile station. The authentication and encryption keys themselves are never communicated under the network. This is very important for mobile commerce because one of its most important issues is security. Above the radio subsystem is the network switching subsystem. It is the core of the GSM and it is very important because it connects the wireless network with the core telephone and data networks via Gateway Mobile Services Switching Centres (MSCs). This is the part of the network that made the mobile internet access a much easier task. This part is also responsible for handovers between base station controllers, supports worldwide localization of users and also supports charging, accounting and roaming as users connect via networks of different mobile operators, while moving to another country. The network switching subsystem also has two very important databases. The one is called Home Location Register and serves as a repository for all user information, including the users telephone number and his authentication key(which is also in the sim card as mentioned earlier). Each mobile operator maintains one or more HLRs with information about each of its users typically stored in only one HLR. It also maintains dynamic information about user such as the local area where his mobile station is currently located. Local area information stored in the user's HLR allows to keep track of his location across GSM networks. The HLR also helps maintain important billing and accounting information. The second database is called Visitor Location Register (VLR). Each MSC has a VLR database. This database helps store information about all users currently in the local area associated with the MSC. As new users move into an MSC's local area, information form their HLR is copied into the VLR so that it can be accessed more easily. The last big part of the GSM architecture is called Operation Subsystem. It is responsible for all network operation and maintenance activities. It has 3 main components. The Operation and Maintenance Centre, which takes care of functions such as traffic monitoring, watching the status of different networks entities, accounting and billing. The Authentication Centre, which may actually be collocated with the HLR, and is responsible for running authentication algorithms using keys stored in the HLR. The last element is called Equipment Identity Register and stores identification numbers for all devices registered with the network. It also maintains a list of mobile stations reports stolen or lost(another important issue about mobile commerce) This is particularly important , given that anyone can use a GSM phone by simply inserting a new SIM module in it. [16]

2.2.7 GSM and mobile commerce

The GSM standard has some elements that are a necessity for the mobile commerce and without them it would be almost impossible for mobile commerce to arise. First of all it supports a very good and secure billing and accounting system. This can guarantee that when one does transactions from his mobile he is paying the exactly money he has to pay no overcharges, so people can trust their mobile operator for handling their mobile payments. This is what NTTDo-Co-Mo made so successfully to have multiple revenue streams. It used the regular billing cycle and charged a eshop for example with a percentage of the total money of the transaction. Furthermore GSM provided more advanced security than the AMPS by using encryption on the wireless link and the use of the sim card, making it very difficult for someone to eavesdrop or to pretend that his is someone else (spoofing). GSM also introduced mechanisms that give the possibility to track someone's position so it become possible to make m-commerce location sensitive, for example when someone is looking for a gas station we can provide him automatically with all the gas stations near his area. GSM also introduced the SMS. SMS relies on unused capacity in the signalling channels to support transmission of messages of up to 160 characters and became soon one of the most profitable services for the mobile operators. SMS is very important to mobile commerce because it is used to deliver news updates, traffic information, promotional messages or even an alternative way to buy something while on move!!! Another advantage of GSM is that because it represents a digital networking technology you don't need a modem to use your notebook or PDA. Instead, you can use an adapter (a USB cable, IrDA or Bluetooth) and software and you will be able to connect your data device to your GSM phone. This allows to surf the Internet and send e-mail, faxes, and short messages. Finally GSM permits a subscriber to swap voice and data modes during a call and then resume the conversation if so desired.

Because nothing is perfect GSM has also some disadvantages that create several major problems when it comes to supporting mobile Internet services. The most important is its reliance on circuit-switched technology. Circuit-switched systems involve long setup times each time a new connection is established. For example, if you drive into a tunnel and lose our connection it ill often take 15 to 30seconds to reconnect. Circuit-switched technology is also inefficient in its use of available bandwidth, as it requires maintaining a communication channel for the entire duration of a session, not just the time to download your email or the list of movies playing at the theatre, but also the time to compose email replies or the time to go over the movies before reserving a seat at the theatre. This in turn translates into particularly high usage charges. Low data rates, lack of integration with Internet protocols, and patchy security policy are some areas in which GSM has to be improved.

2.2.8 The GPRS standard

As we saw the GSM standard solved many of the problems that the AMPS had but there was a lot of problems that wee unsolved so by the time when GSM was being deployed, work started on the development of a more better standard which was 3G. The motivations behind the creation of this new standard were the expected demand for higher data rates, the need to provide a better interface with the Internet, which involves moving away from the circuit-switched technology, and the desire to support a broader range of QoS options, as required by a variety of emerging applications and services. But because there were several hundred million 2G mobile phone users, the new standard had to be backwards compatible. Furthermore because the different operators wanted a gradual transition to the 3G standards some 2.5G standards were created. Finally there were created 3 different standards for the 3G networks. These standards were the WCDMA/UMTS , the cdma2000 and EDGE. Today, the brunt of standardization activities is taking place under the 3GPP partnership for EDGE and WCDMA/UMTS, and under 3GPP2 for cdma2000.

GSM relies on time division multiple access technology (TDMA). This multiplexing technology allows multiple users to share a given frequency band as long as they use it at different times.

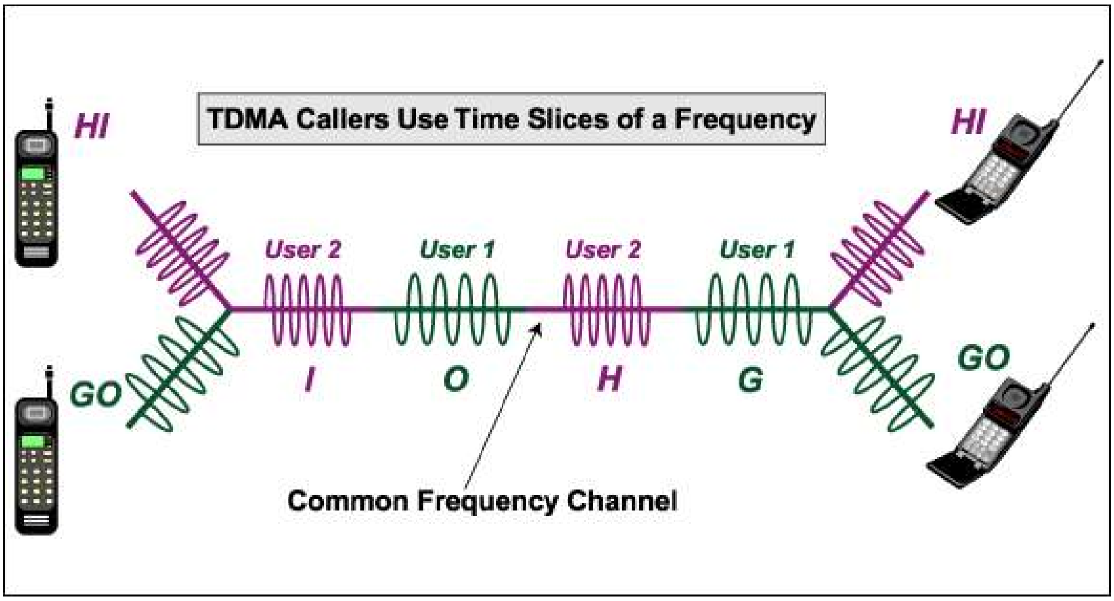

Figure 10. TDMA operation.

This is done by portioning the frequency band into very short time slots which are allocated in a round robin fashion.GSM relies on TDMA frames that are divided into eight time slots, each allocated to a different communication channel. A straightforward way to increase peak data rates is to allow a given channel to be allocated more than one time slot in each TDMA frame. This is known as high speed circuit switched data (HSCSD), which makes it possible, to increase GSM data rates by 8, meaning a rate of 40kbps. HSCSD only requires software upgrades to the GSM network and hence is very cheap to deploy. However, as its name indicates it remains a circuit switched technology. So a packet switched technology was needed. The first technology towards the support of always on packet-switched communication was the deployment of the General Radio Packet Service(GPRS). The way in which GPRS increases the data rate associated with the GSM air interface similar to the one used in HSCSD. It allows channels to be allocated more than one time slot per TDMA frame. However, rather than requiring a fixed allocation scheme, GPRS allows the number of time slots to be allocated to a channel to vary over time to flexibly adjust to actual traffic. The result is a much more efficient utilization of the available bandwidth. GPRS is a 2.5 G overlay technology, which means it can easily be deployed on top of GSM networks.[18]

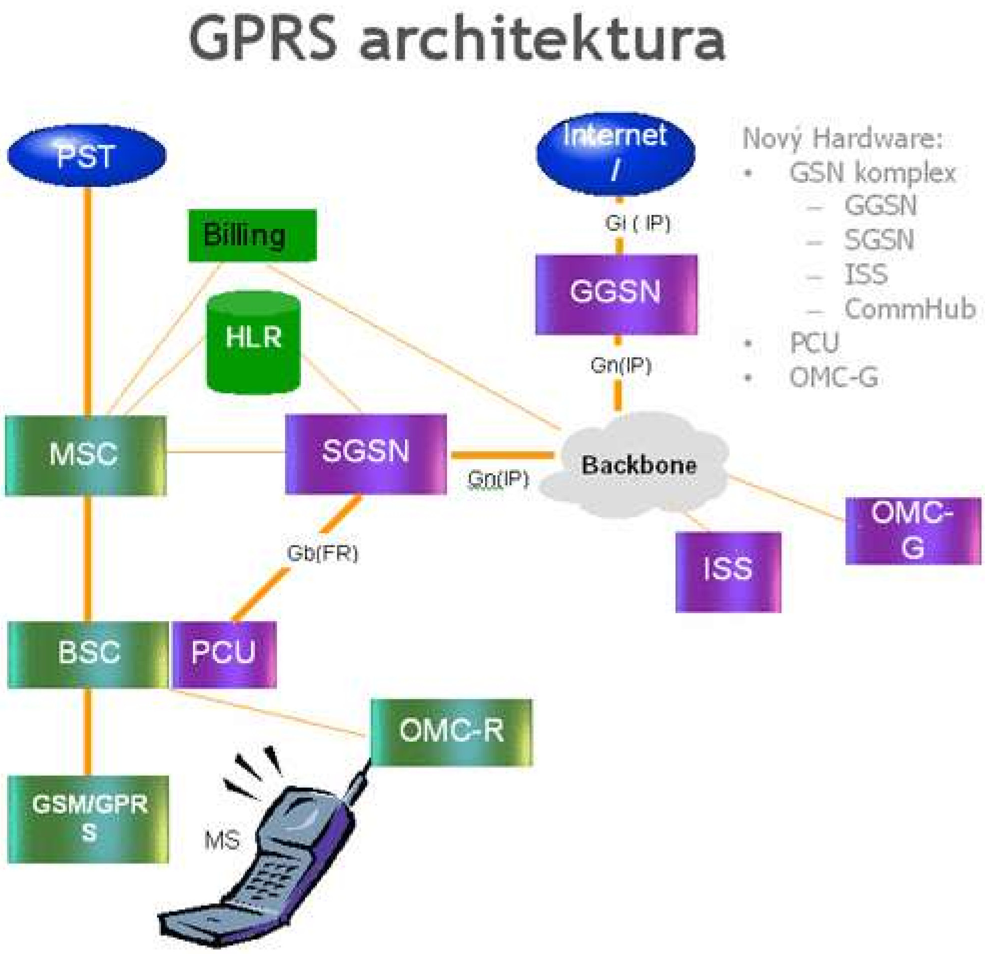

Figure11. GPRS architecture.[19]

The above diagram shows the GRPS architecture. For deploying GPRS over a GSM network infrastructure we must. 1st do changes at the level of air interface in the form of software upgrades to base stations, and the distribution of new handsets to those who want access to the new packet switched services (but anyone who want can continue to use its GSM handset). 2nd we must do hardware and software upgrades to base station controllers with, in particular, the introduction of a packet control unit (PCU) to separate circuit switched and packet switched traffic. 3rd we must deploy a separate core network to manage packet-switched data. As you can see GPRS is a relatively cheap upgrade because it does not require any hardware modifications to base stations. As you can see on the architecture diagram in GPRS each base station controller is connected to a serving GPRS support node. For each mobile station under its responsibility, the SGSN keeps track of the base station controller through which it is currently connected. It takes care of forwarding data to the proper BSC, as the user goes from one BSC area to another. Essentially the SGSN acts as a router that buffers and forwards packets to the mobile station. When a user moves into an area under the responsibility of another SGSN, packets buffered in the old SGSN are discarded and copies are sent to the new one. A separate gateway GPRS support node acts as interface between the GPRS network and the Internet giving to the outside the impression that each mobile station operates as a regular Internet node. In practice, the SGSN implements what is known as a tunnelling protocol where packets intended for a particular mobile station are encapsulated into a second packet and redirected to the proper SGSN. Upon receive the SGSN retrieves the original packet and forwards it to the mobile station via the base station controller currently responsible for it. The network which connects the SGSN and GGSN nodded to each other and to other nodes like the billing gateway that is used by operators to keep track of user traffic and maintain billing information is referred as the backbone GPRS network. It is a IP network with routers and firewalls.

2.2.9 Advantages of GPRS in comparison with the GSM

GPRS has a lot of important advantages. 1st it is packet switched meaning that has always on functionality. 2nd has more efficient capacity utilization. 3rd has more flexible billing options and last it has much faster data rates. Specifically in GSM, to remain connected, the user need to maintain an open channel by reserving a time slot whether or not that time slot is actually used. Because this slot is unavailable for use by anyone else, the mobile operator has no choice but to charge the user for the corresponding airtime. Additionally, when the user reconnects for example to watch the latest stock news, a new connection has to be started, lasting from 15 to 30 seconds. In contrast, with GPRS, because bandwidth is only reserved as needed a user can maintain an open connection without consuming any capacity. The result is an always-on environment where the user can stay connected, while only being charged for the actually capacity he consumes. Also in GPRS there aren't the 15 seconds it takes to reconnect when the connection is lost, you are instantly reconnected. On average, this also makes it possible for the operator to accommodate a greater number of users. Moreover, because GPRS users can be dynamically allocated multiple slots as needed, they can achieve much higher data rates. Finally another interesting aspect of GPRS is its support for a variety of QoS profiles. In practice however limitations at the level of the packet control unit are such that most of the time the QoS will be best effort.

2.2.10 UMTS networks

As I wrote before 3 types of 3g networks were created, the one used in Europe and by the most of the operators in the world is the UMTS standard. UMTS was jointly developed by Europeans and Japanese. It was first deployed in Japan by DoCoMo in October 2001 and is in the process of being introduced by a number of other operators worldwide. UMTS relies on the same core data network as GPRS. It introduces 2 completely new wideband CDMA radio interfaces one based on frequency division duplex(FDD) for outdoor use , and one for indoor use based on time division duplex, which are very complicated multiplexing methods. The new radio interface requires interface controllers, which are called radio network controllers(RNC). Because deployment of this new air interface is rather expensive, most operators have started deploying it only in big urban areas, where they can easily have a great ROI and rely the rest of the network on GPRS and GSM technology. Most of the 3g handsets are compatible backwards but are still very expensive and quite bulky. UMTS can support up to 2Mbps, although as always actual rates are much lower (about 400kbps). UMTS data rates vary with the distance between the mobile phone and the base station, with smaller distances allowing for faster transmission. As the distance increases, power levels need to be increased to maintain the same data rate. This can be done only to a limit. The RNC implement mechanisms that attempt to maintain data rates compatible with QoS profiles for each user. UMTS like GPRS allows for a number of QoS profiles. But in UMTS there is not the problem of the PCU, which limits the ability of the network to actually satisfy QoS requirements, UMTS provides support for genuine end-to-end QoS management, thanks to its radio network controllers. In particular, it distinguishes between 4 classes of data traffic. The first is called Conversional and it is for applications such as voice and intensive games that require low delays and the preservation of time relation between packets. Another class is the steaming one and it is used for multimedia streaming applications, where preserving the time relation between packets is critical, although actual delays are somewhat less important. The third class is called interactive and is used for web browsing and most mobile commerce services and applications such as purchasing movie tickets or looking for a nearby restaurant. This class guarantees a decent response time and preserves data integrity. Because it is not as demanding in terms of delays as the conversional class, it will also typically come with lower charges. The last class is called background class and is the most basic one and is much more cheaper than the others. It preserves data significant discounts in comparison to the others. It preserves data integrity and provides best effort QoS. In other words, delays might vary widely and be as long as a minute or more when network load is particularly high. This class is well suited for background applications such as synchronizing your calendar or downloading a new game. But QoS levels can be beyond these classes by 10 parameters that can be specified. These parameters include maximum required bit rate, a guaranteed minimum bit rate, or a maximum transfer delay. These parameters make it possible for operators to offer a variety of plans to their customers and to differentiate between the requirements of individual types of services and applications. Mobile application developers and content providers, will, however have to figure how to best set up these many parameters so that their applications and services degrade gracefully as users move into areas that are highly congested or where only GPRS or GSM is available. Finally one very important issue is that the UMTS is compatible with the Internet Protocol and hence is much easier for people to develop mobile Internet applications and services such as mobile commerce services. But with 3G networks mobile application developers will not only have to pay attention to the bandwidth requirements of their solutions, but also to what happens when their users move from 3G to 2.5G and 2G networks. For conclusion we want to say that all this bandwidth is more than enough because as we can see form the I-mode example because DoCoMo made more than 30 million users only from a 9.6 kbps packet switched network.[20]

2.2.11 Wireless networks

As we saw in the previous chapter, there is a high level of asymmetry between server and client systems, increasing the ranger by increasing the power of the client is difficult, due to the limitations of battery technology, and undesirable, because of health and safety implications. Therefore, in order to increase data rates, new generation systems need to reduce the range that a signal must travel. This requires implementing more and more 3G stations, which are very expensive as we saw. So an alternate solution for data transfer emerged and was more suitable. It is the Wireless LAN and the Bluetooth technology. Wireless LANs operate over much shorter distances, typically 30m within buildings; even with data rates of about 11mpbs the signal strength and consequent power consumption and health risk are much lower. Nevertheless the power consumption on most wireless LAN systems is too great for many handhelds devices, such as PDAs and mobile phones. But nowadays almost every PDA has wireless LAN built in support, and now some mobiles have support to. Another wireless technologies are the Bluetooth and the IEEE 802.15 PAN standards which both aim to enable wireless networking within a 10m POS at data rates of about 1mbps.

2.2.12 WI-FI

IEEE 802.11b wireless Ethernet is also known by most people as WI-FI and it is a wireless version of the bus based Ethernet which operates in two separate modes. It utilizes a system called Carrier Sense Multiple Assess with Collision Avoidance (CSMA/CA) which is used to regulate the radio frequency(because WI-FI like all LANs uses a single channel) to avoid interference. Like the wired Ethernet, all CSMA/CA devices listen for traffic all the time, if there is no signals any device can start to transmit. But unlike the wired Ethernet not all the devices on the network will be in range of the transmitting device. It is therefore, not possible for any particular device on the network to know that another device has transmitted so, instead of transmitting data and listening for a collision, the sender fist transmits a short control code. This is broadcast to all devices in range and includes the address of the device that the sender wishes to communicate with. When the target device receives this control code, it broadcasts to all devices in its range that it is waiting for a frame form the sender. All other machines then wait for the time it takes to send a frame before attempting to send a control code of their own. If two control messages are received one after the other the first one to arrive will get to transmit. The reply received by the other machine will not match its code and it will wait for the frame to be transmitted before trying again. If two control codes arrive simultaneously then they are both ignored. If a machine does not receive a reply to its control code within a certain time frame it back off and tries again. So there is very little time for collision because the control code messages are very short.

Wireless Ethernet will work though most brick walls but it would be blocked by the slate of granite. It would operate effectively throughout a wooden building, provided tat it doesn't have a metal frame, but it will not penetrate the reinforced concrete common in office block construction. Where there is direct sight between two transceivers it can operate at distances up to 300m, and a typical network access point can cope with 70 connections at a time, making it an ideal, low cost option for venues such as shopping malls and airports to provide Internet access to customers via their laptops.[21]

2.2.13 Other versions of the wireless Ethernet

There are two other versions of the wireless Ethernet. The 802.11a which is the same as the 802.11b but operating at 5Ghz instead of 2.4Ghz. It used the same wireless Ethernet and media access approach as the 802.11b. The other version is called 802.11g and uses OFDM multiplexing, it operates at 2.4Ghz and finally supports data rates of 54 Mbps instead the 11Mbps of the 802.11b.[22]

2.2.14 HiperLAN2

High performance LAN (HiperLAN2) was developed by the ETSI and defines an air interface for a family of wireless protocols operating in the 5 GHz (which is a non free frequency in Greece because it is used by the Greek army) and the 17Ghz bands known collectively as Broadband Radio Access Networks(BRAN).HiperLan2 operates at the 5Ghz band and has been specifically designed to provide short-range wireless access to wired infrastructure networks providing mobile terminals with access to IP, ATM, and 3G networks like the UMTS. In contrast to the wireless Ethernet technologies, Hyperlan provides a connection-oriented service with multiple levels of QoS like the GPRS and the UMTS we saw before. It is a broadband wireless LAN that has been specifically designed to work well with a wide range of wide area wireless network standards and with PANs. It is designed to support handover between access points and between local and wide area networks, including movement between corporate and public environments. It aims to provide a high level of security that is extendable and to support wide range of QoS options for multi service networks. HiperLan used OPFDM multiplexing scheme to transmit the analog signal at the physical layer. This makes it very efficient in ‘time-dispersive environments, such as a typical office where signals are likely to be bounced off many different points before they reach their destination so that some parts take no longer to arrive than others. On top of the MAC HiperLan uses Dynamic Time Division Duplex for creating logical channels. This enables rates of 54mbits. Furthermore HiperLan is connection oriented, mobile Terminals and Access Points establish connections before transmitting data using TDMA; connections are logically defined as particular time slices of the channel. This supports QoS by allowing multiple logical channels to be assigned to each Mobile Terminal to suit the level of support they need. Another aspect of this orientation is the security model, This supports both the access point which authenticates the Mobile Terminal to ensure that is authorized to join the network and vice versa.

2.2.15 Bluetooth ®

Bluetooth was specifically designed to support the concept of a mobile PAN. It consists of a radio antenna and Radio Frequency transceiver logic on a chip and a set of protocols with which a host information appliance can interface with the Bluetooth unit. It has been developed expressly to make ad hoc interaction between heterogeneous information devices as simple as possible. As is typically the case with information technology, making a device which is simple, cheap, secure, reliable and dependable for its users requires that the technology behind it is quite complex. It is based on the 802.11 ad hoc network standard and also has a lot in common with the Infrared data transfer standard IrDa. But it is not intended as an alternative form of Wireless LAN, it aims to offer highly dynamic, ad hoc networking ability in fast changing noisy environments. It is ideal for linking together devices in a room such as speakers, hands free or a computer and its peripherals or PDA accessories. The clear relative advantage it offers is that it links devices without wires, making it easy to install and rearrange equipment. It also supports the discovering of other Bluetooth devices as they come into range and negotiate to share services. For example a Bluetooth enabled phone in a department store might become aware of a Bluetooth port from which it can download a store plan and which it can query about where to find things, may it download an advert too having the stores latest promotions. The requirements of a device that can achieve this go beyond simply detecting the presence of other devices to include determining their capabilities, negotiating terms of use of those capabilities and creating the network to support that use. This requires a coordination of behavior at a number of different levels, from the application to the air interface. A Bluetooth enabled device includes both specialist hardware and software to manage the interface, the hardware parts consists of three modules: The Radio Frequency transceiver the Link Controller and the Input Output Manager. The radio transceiver operates in the 2.4Ghz range. The main functionality of the device has three protocols. The logical Link Control and Adaptation Protocol (L2CAP), the Service Discovery Protocol (SDP) and provides the main interface to higher-level protocols. It is essentially the bottom half of the data link layer of the OSI model and corresponds to the MAC layer of the 802 standard. L2CAP converts between the digital electrical signals and the baseband signal and vice versa. The SDP supports operations concerned with discovering and getting information about identity and characteristics of the services offered by other devices informing them of the characteristics of the device. Finally the RFCOMM is the cable replacement. It provides transport capabilities for all high level services that use serial line as the transport mechanism. Each device uses the whole band in each transmission, by employing a frequency hopping technique that overcomes noise in the environment.

There are two types of physical data transmissions between Bluetooth units. Synchronous Connection Oriented which are point-to-point transmissions between master and slave and in which transmissions are made in reserved time slots determined by the master unit when it sets up the link. The other one is the Asynchronous Connection Less, which is a multi cast link where transmissions provide packet switched connections between master and all connected slaves. Bluetooth's network topology is a version of the IEEE 802 standard, which is called piconet. Up to eight devices can be joined together in a Bluetooth piconet. Only one of them can and must be the master all the others are considered as slaves. Slaves in a piconet have no direct communication with each other. All communication is between the master and each slave in turn. Each device in the piconet has a simple 3-bit address (from here springs the eight device limit). The role of the master is to synchronize communication by determining a common time for the start of a time slot sequence and to determine a common pseudo random frequency-hopping scheme. All Bluetooth devices have device type information built in so that one device can tell, with the minimum amount of communication, whether another is of a type it might want to communicate with, When entering into a communication relationship each device must select to be either a master or slave. This is a purely practical arrangement for the shake of managing matters effectively in an ad hoc environment. Typically a device wishing to make use of a service will naturally take the master role and the device offering the service will be the salve, making the master-slave relationship very similar to a client-server relationship. The difference between these two notions is that the nature of the RF channel requires that the master maintain synchronous control of the physical behavior of the slave, where as a client server is a purely asynchronous relationship.

Except piconets another interesting issue a about Bluetooth is scatternet. Typically a slave in one piconet will become a master of another or a master of a piconet will became a slave in another. These relationships create extended networks that, allow communications between devices in different piconets through these gateway devices. So it is possible (in theory) to create a high structured pyramid network with a supreme master who has seven slaves, each of which is in turn a master with seven slaves etc.. Such networks of piconets are called scatternets. As Bluetooth-enabled devices become more and more ubiquitous it is possible that such networks might extend over considerable areas. But we must notice that piconets don't support call-forwarding and a Bluetooth device is only aware of these devices within the POS and those that it has met. There is no equivalent of a name service within this topology. This is of course important for ensuring the low power consumption of devices. Users are not likely to be impressed if their PDA battery runs down because it has been forwarding messages just to be neighborly, but we expect that maybe some modifications will come out and solve this problem.[23]

2.2.16 Bridging of networks

Above we saw the most used wireless networks, but because we speak about mobile commerce we have to see how we can combine all of the above, because mobile commerce is based upon all of them. This connection is becoming reality with the gateways. A gateway us a network connection between two types of network computer systems. The gateway provides suitable translation services between the two systems. The Personal Area Network connects together a variety of personal information appliances, such as headsets, mp3 players, digital cameras, mobile phones, laptops, pdas etc and an intelligent mobile network gateway. The wireless nature of PAN means that the same resource sharing that was the main economic driver behind LAN development can be applied to personal devices. This in turn allows those devices to become more specialized and fit for their specific purposes. So, for instance, a digital movie camera that can send its digital straight to a CF card of a PDA(which is inside a briefcase), so it is not bound in its form by the need to contain its own storage device and associated motors. The getaway we are speaking for is intelligent in that it can sense the availability of any wireless LAN or WAN in the locality of the PAN and establish a connection with any other device that is similarly connected, whether wired or wireless. So if there are a variety of networks available that the gateway will be capable of determining the ideal network for the data transfer requirements of the accessing device and balancing this against power, priority and pricing considerations as appropriate.

2.3 The mobile Internet

M-commerce is about the provision of mobile Internet Services. So the mobile Internet is the heart of mobile commerce. But unfortunately the mobile Internet is not quite like its fixed counterpart. As we saw its wireless network standard has its one idiosyncrasies so developers are left isolated. Furthermore the basic TCP/IP was not developed with wireless links and mobile devices in mind. The mobile internet is in part about reconciling the many bearer services developed by mobile infrastructure providers and the IETF but also the W3C. While these standards have started to converge, like the development of mobile IP and its integration with the 3G standards or the move toward the next version of IP, but all of these will take many more years to complete. So in the meantime were created same standards like the WAP to bridge the GAP.

Mobile Internet is more than reconciling different standards or providing end-to-end security. It is also about recognizing the limitations of mobile devices and the new usage scenarios they entail. It is about rethinking the way in which we develop Internet applications and services to accommodate the I/O limitations of these devices, the time critical nature of the tasks in which mobile users engage and their limited attention as they talk to friends or drive trough busy roads. Developing services that accommodate these constraints requires moving away from wired Internet solutions such as search engines with millions of results.[24]

2.3.1 Mobile IP

Suppose we have a PDA, which starts moving around and attaching through parts of networks with different prefixes, thing start breaking down, especially if there are many mobile nodes such as the hundreds of millions of Internet enabled mobile devices. This is because regular IP only offers two options for dealing with this situation. The first one is to start updating all routing tables with node specific entries. It is very clear that this approach does not scale up. The second option is to assign new IP addresses to the mobile node as it reattaches through different parts of the network. By doing so, we could at least ensure that the nodes IP address is compatible with the prefix of the network area through which it is currently connected. However we have trouble with the packets that already have been sent to the nodes old address. To remedy these problems, a new variation of IP has been developed, called Mobile IP. The nice thing about mobile IP is that is does not require any hardware or software changes to the existing installed base of IP hosts and routers other than those nodes directly involved in the provision of mobility services. Each mobile node keeps its IP address and relies on a home agent to intercept all packets sent to this address. As it reattaches to different parts of the network, the mobile node informs its home agent of this new location by sending it a care of address. The home agent encapsulates packets destined for the mobile node in new packets, which are forwarded to the care-of-address. This is called tunneling.

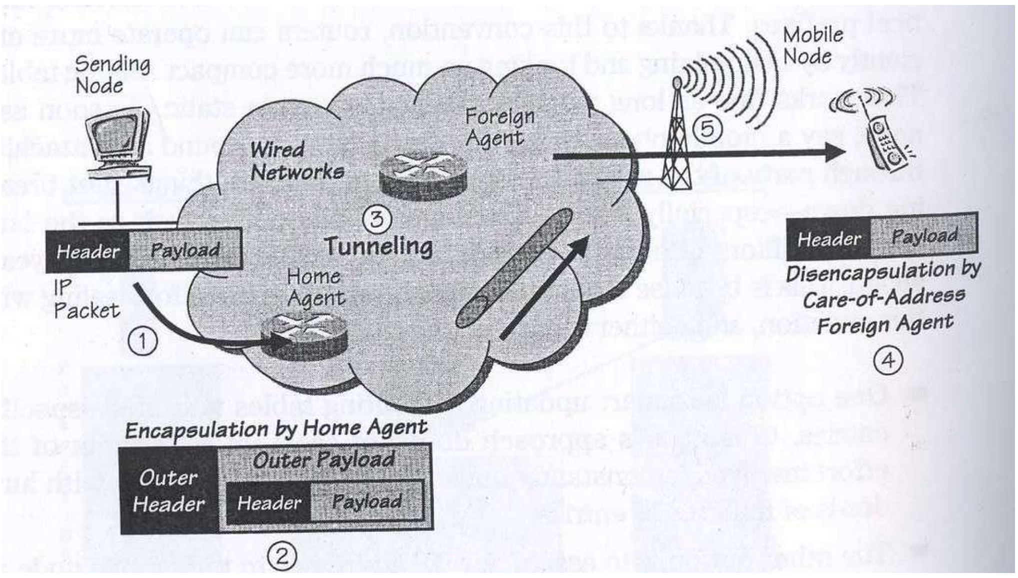

Figure 12. Packet tunneling.

Authentication procedures are required to make sure a malicious node does not attempt to pose as the mobile node and send its home agent a misleading care of address. We must also say that some element of Mobile IP is intergraded within Ipv6. With mobile IP we can be sure that packets will be routed to the proper destination, even when that destination is a mobile device. However IP is best effort service, so this is why we need a transport layer running TCP. So TCP worries about making sure that all the packets are received, reassembled in the right order, and delivered to the proper application. This includes detecting lost packets and ensuring that they are resent. Over wireless links, lost or corrupted packets and transmission errors are very common, also connections are frequently dropped. Furthermore roundtrip times are harder to predict due to greater variations in latency. Often when acknowledgments fail to come back, the correct reaction is not to reduce the transmission rate, but it should be to keep it the shame or perhaps even increase it to make up for lost time. For example if one wants to download the latest stock news on his mobile phone as his car entered a tunnel, as his emerge from the tunnel and his connection gets reestablished, the last thing you want is the server on the other side to slow the rate at which it send your stock update (but this is exactly what TCP does). To solve this there are a lot of solutions. The most common is Indirect TCP, more specially simply portions the connection and relies on the foreign agent, introduced in the context of the mobile IP or some equivalent node, to act as an intermediary, sending its own acknowledgments. This allows for transmission parameters such as the window size to best differently over the wired network and the wireless link, although it introduces other complications. For example, when the mobile node moves and reattaches to a different foreign agent, all the packets buffered by the old foreign agent need to be forwarded to the new one, a possibly lengthy process.

2.3.2 A simple look at the WAP architecture.

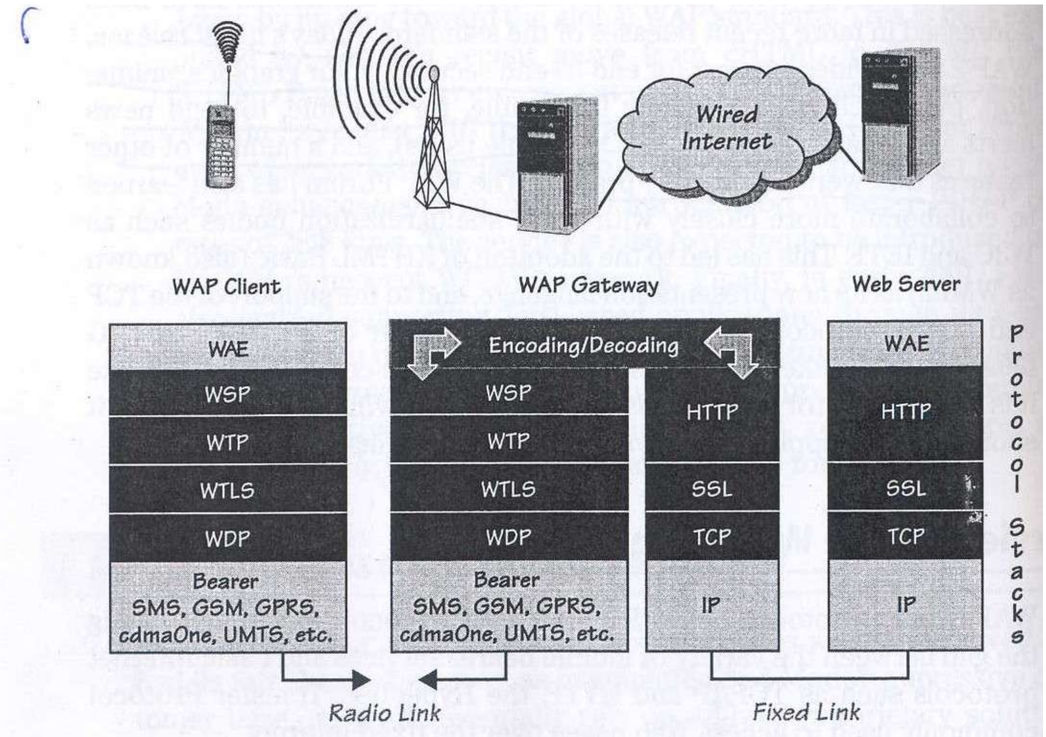

Figure 13. WAP architecture.

WAP is not a protocol, but rather a suite of protocols aimed at bridging the gap between the variety of mobile bearer services and basic Internet protocols such as TCP/IP and HTTP. Until the release of WAP version 2, it required always the introduction of a WAP gateway or proxy. The gateway's role includes interfacing between the WAP protocol stack, which is specifically designed for operation over the wireless link, and the regular Internet protocol stack. Because of bandwidth limitations, WAP content is encoded into a compact binary format before being transmitted over the wireless link. The WAP gateway us responsible for decoding it into text that can be interpreted by HTTP, and vice versa. In other words, when a user attempts to access a particular website from his mobile device by entering its URL address, his WAP device first encrypts the request into WAP's compact binary format and then send it to the WAP gateway over the wireless link. The gateway converts it into a regular HTTP request, which is forwarded to the URL's server over the fixed Internet. The server then return a WML script (or XHTML) document to the gateway, which encrypts it and forwards it to the mobile device. More generally, the WAP gateway helps improve communication efficiency by caching content between the server and the mobile device. It is also used to authenticate users, making sure they have a plan that includes access to WAP services, and often provides support for additional billing functionality.

With the release of WAP 2.0 the original suite of wireless protocols is now referred to as the WAP legacy stack. This is because, as a result of close cooperation's with IETF, WAP 2.0 now supports an alternative stack, which is available for fast bearer services that already include the IP protocol. This alternative stack essentially consists of variations of the TCP and HTTP protocols whose parameters have been specifically configured for operation over a wireless link. The wireless version of HTTP also provides for compression of content and the establishment of secure tunnels between the mobile device and the Web server. When using this protocol stack, is possible to do away with the WAP gateway. In many cases however, the gateway is still needed, as it helps optimize communication and can also provide support for additional functionality such as billing, location based services or primary features. A WAP gateway is also required for push services. [25]

2.4 Applications of m-commerce

2.4.1 Emerging mobile commerce applications

Since there are potentially an unlimited number of mobile commerce applications, we attempt to identify several important classes of applications and provide examples within each class. Table 1 shows many such classes and example applications. According to estimates more than half of the European mobile commerce market in the next few years may consist of financial, advertising and shopping services. However, it is important to cover a comprehensive range of mobile commerce applications under different classes with varying requirements in terms of devices, middleware, and networks. In the following subsections discuss the mobile financial applications, mobile advertising, mobile inventory management, proactive service management and other application classes in more detail. Some scenarios provided and also the required infrastructure and related business issues are discussed.

2.4.2 Mobile financial applications (MFA)

Mobile financial applications are likely to be one of the most important components of m-commerce. These could involve a variety of applications such as mobile banking and brokerage service, mobile money transfer, and mobile micro-payments as shown in figure 3. These services could turn a mobile device into a business tool, replacing bank, ATM, and credit cards by letting a user conduct financial transactions with mobile money. Certainly, more work is needed in providing transaction support in the applications and network infrastructure. Secure transactions are required before any of these applications are widely deployed. One interesting mobile financial application is micro-payment involving small purchases such as vending and other items. A mobile device can communicate with a vending machine using a local wireless network to purchase desired items. Micro-payments can be implemented in a variety of ways. One way is that the user could make a call to a certain number where per-minute charges equal the cost of vending item. This approach has been used by SONERA, a Finish wireless provider, in their famous Coke (and now Pepsi) machine service [26]. In effect, it collects money from the users and credits it to the vending providers. Another way to perform micro-payments may be via using pre-paid numbers purchased from a service provider, bank, or credit-card company. To support financial transactions including micro-payments, a mobile service provider could act as a bank, acquire a bank, or compete with a bank. There are many questions that have to be addressed. One such question is the real cost of mobile micro-payments. Another question is how a phone company or other payer would make any profit on mobile micro-payments. There are several possible answers to these questions. First, service providers could require pre-payments by users, thereby leading to some financial profits. Also, the cost of micro-payments may decrease with increased numbers of transactions or users. A provider can also charge a small amount for the payment service or can absorb the cost in order to provide this micro-payment as a competitive feature leading to increased number of customers and possibly higher revenues for wireless provider.

The table below mentions many application and the details and networking needs for each one:

Table 2. Table of applications.

Table 3. M-commerce value chain.

The figure below demonstrate many mobile financial applications:

Figure 14. Mobile financial application examples.

2.4.3 Mobile advertising

Mobile advertising is also a very important class of m-commerce applications. Using demographic information collected by wireless service providers and information on the current location of mobile users, very targeted advertising can be done. The advertising messages can be personalized based on information provided by consulting the user at an earlier stage or by the history of users' purchasing habits. Advertisements sent to a user can also be location-sensitive and can inform a user about various on-going specials (shops, malls, and restaurants) in surrounding areas as shown in figure 5.

Figure15. A possible scenario for mobile advertising and shopping.

This type of advertising can be performed using Short Messaging Service (SMS) or by using short paging messages to mobile users. The messages can be sent to all users located in a certain area (the geographic region can be identified by advertisers or even by users in advance), a user-specific message can be sent independent of the user's current location. As more wireless bandwidth becomes available, content rich advertising involving audio, pictures and video clips can be produced for individual users with specific needs, interests, and inclinations. Also depending on interests and the personality type of individual mobile users, a network provider may consider using a "push" or "pull" method of mobile advertising based on a per-user basis or a class of users. Other interesting issues include the number of advertisements and the level and type of content that should be transmitted. These advertisements should be limited to avoid overwhelming the user with information and also to avoid the possibility of congestion of the wireless links. Wireless networks may consider such advertising lower priority traffic if network load crosses a certain threshold. Since these services need the current location information of a user, a third party may be needed to provide location services. However, this may require a sharing of revenues between the network service provider and location service provider. One very interesting question here is who owns the location information and in what ways such information can be shared between wireless service providers and others. Other issues include the amount of storage (user location and profiles) and real-time processing requirements to capture user information in a high variability environment. The dependability of infrastructure (database/networks) will also play an important role. The impact of a message transmission to an unintended receiver should also be considered. Many different ways to charge for advertising (size of message, number of customers, value of the items to be sold) can be used. It is also possible that direct advertising to users may be performed without much control from the wireless service providers.

2.4.4 Mobile inventory management (MIM)

This class of applications involves location tracking of goods, services, and possibly even people. The tracking of goods may help service providers in determining the time of delivery to customer, thus improving customer service and obtaining a competitive edge over other businesses. One very interesting application is "rolling inventory" – which may involve multiple trucks carrying a large amount of inventory while on the move. Whenever a store needs certain items/goods, it can locate a truck (preferably in nearby area) and just-in-time delivery of goods can be performed. The rolling inventory and delivery application can reduce the amount of inventory space and cost for both vendors and stores and may also reduce the time between when an order is placed and the goods are delivered (figure 16).

Figure 16. Location tracking of goods.

Rolling inventory is a B2B m-commerce application while location tracking can be considered a B2C application. Using inexpensive embedded radio/microwave devices (chips), a wireless network can track goods and services.

Since satellite signals may not work well inside a truck, a separate wireless LAN can be provided on-board for intratruck communication and tracking. An interesting research problem is to determine an appropriate match for the amount of inventory carried by trucks in a geographical area with dynamically changing delivery demands. Also traffic in a city may affect the just-in-time delivery in nearby areas. Another example of MIM is just-in-time delivery/movement of components in an assembly plant based on the rate of consumption of existing components (figure 17).

Figure 17. Location tracking and just-in-time movement of components.

A variety of new components can be moved a certain speed after receiving a wireless signal from the components reaching the assembly line or from a device on the assembly line itself. This will allow just-in-time delivery leading to a reduced inventory and assembling cost. If the new components are delayed for some reason, then signals can be sent to the assembly line for possible adjustment of the assembly speed to match the arrival time of new components. Such an application would reduce the inventory cost while increasing productivity by matching the speed of new component arrival to the rate of assembly. For implementation purposes, location tracking of components can be broken into two components: indoor and outdoor. Indoor tracking can be performed by a chipset (Tx/Rx) and location information may be transmitted over a satellite or cellular/PCS system to the component supplier where such information is needed. Implementation considerations in MIM include cost, reliability of wireless infrastructure, and the level of comfort with a new technology. Since these applications (especially the rolling inventory application) may present a paradigm shift in how inventories are managed today, an interesting research problem would be a study involving the cost and

ailability comparison of two inventory systems (regular and rolling) under dynamically changing demands. Potential MIM customers may include shipping companies, assembly plants (auto, manufacturing), airline/mass-transit industry, and supermarket chain stores. One positive factor is that many of these industries are already increasing their use of wireless technologies.

Possible wireless technologies that can be used with MIM include Global Positioning Satellite Systems (GPS) that are operated by the Department of Defense for location tracking (the accuracy level is based on the type of receiver and the type of user). Many luxury cars already have built-in GPS receivers that compute location information based on received signals from at least 4 (out of 24) GPS satellites. GPS may not work well for indoor environments, as they require line of sight transmission between devices and satellites. Another location tracking application is called E (enhanced) 911. E-911 allows operators to receive location information of cell phone users along with their emergency calls . Since it is difficult for cellular/PCS systems to provide such location information, it is likely that a GPS chip will be installed on cell phones to help 911 operators to determine the location of mobile users. If such a chip is installed in cell/PCS phones, then location tracking of such users under normal circumstances will also be possible. Since, "people" can also be considered inventory resources, they could also be better managed.

2.4.5 Product location and search (PLS)

This class of applications includes locating an item in a particular area or location. This is somewhat different from the previous class of applications as here we are concerned with finding an item (or person) with certain specifications, and whether it is available in a specified area or not. Potentially, there could be multiple places where such an item or an item of similar attributes (also specified by the user) are located. Currently, many people go to several stores to find an item (certain brand/size of TV, VCR or an automobile) and compare price and features. Using a mobile device (such as PalmPilot, Nokia Communicator or Net Phone) and a centralized/distributed database containing information on products, a user should be able to find the exact location of a store where a certain item is located. A list of locations and distance from a specified point can also be displayed. After that the user can buy on-line using a browser on his/her mobile device. In the case of multiple stores/vendors carrying an item desired by a user, they could compete to get the customer by real-time manipulation of prices or by offering instant discounts. From a technological point of view, a mobile user can send a query message to a centralized location (shown in figure 8), which in turn can interface several different stores/dealers and decide if the item is available or not (and if yes, at what price).

Figure 18. Product location and search.

Alternatively, stores/vendors may connect their inventory record systems to this site. Since the inventory of different vendors may use different code names, a uniform product naming system (or existing code such as UPC) that allows for easy translation to standard web content will be required. If a database is not employed, the mobile user may need to query the stores directly. The amount of wireless traffic may become a problem if the total number of queries per item per user exceeds the capacity of the wireless infrastructure. To avoid high traffic levels, one may prefer to ship only product codes rather than entire data sets. Two factors to consider are: (a) how the database will price its services to vendors/dealers and (b) the correctness of information (related to availability or price) from inventory to the database or website. We also believe that software agent technologies will prove to be invaluable as multiple agents can be deployed (cooperating & negotiating) to conduct various transactions at different places.

2.4.6 Proactive service management (PSM)

This class of applications is based on collecting pertinent information about current or near-future user needs and providing services to users proactively. One such application may involve collecting information about the aging components of an automobile (shown in figure 9). Many vendors including car dealers/repair shops can increase their business by acquiring information about aging components of an automobile. Information can be collected and used by car dealers for ordering components (thus reducing inventory costs).

In a more elaborate scenario, several dealers/shops can compete for business by offering discounts or lower rates. Such information can also be collected and analyzed by manufactures to improve the design and manufacturing of future products. This service could even be offered as part of the warranty for new cars or could be purchased by current automobile owners. This would help reduce anxiety levels of owners and improve the general conditions of automobiles on the road leading to a reduced number of traffic jams, accidents, and even fatalities. From a technological point of view, automobiles can be equipped with smart sensors that keep track of how much wear and tear a car component has gone through. This information can then be transmitted using a radio/microwave/satellite system to a specified service center or other location. Some implications of such applications are privacy, security, reliability, and cost of deployment. However, we envision that car dealers, repair shops, automobile owners, and even law enforcement officers (from the public safety point of view) would be interested in such an application.

Figure 19. Example of information transmission on ageing automobile components to dealers.

2.4.7 Wireless business re-engineering

Many insurance business situations involve going to customers' premises, taking notes of a particular situation, going back to the office, and then taking suitable actions. This process takes a long time and is not very efficient. To improve this business practice, a wireless business re-engineering application can be used which allows on-the-spot claim adjustment. In such a scenario, a claim adjuster goes to the customer's place, takes pictures and stores them in his/her mobile device for uploading to the company's database. Next the adjuster downloads necessary information (customer's profile and coverage information) from insurance company's database. Using a small printer attached to the mobile device, he/she prints a claim check. This entire process is performed in minutes as opposed to days. The speed of this kind of service can significantly add to a company's bottom line and competitive advantage. Security and connectivity issues are important as they may affect the perceived quality of service by a customer.

2.4.8 Mobile auction, entertainment and other services

With an increasingly mobile society, more and more people are on the move. While mobile, people may prefer to be involved in some business or entertainment activities. Many of these services can be offered to people through mobile devices and wireless networks. These include mobile auction/reverse auction, video-on-demand services, and other entertainment-oriented services. The technologies needed include mobile devices with capabilities to match desired applications, suitable mobile middleware, and wireless networks with high bandwidth (such as emerging LEO satellites or third generation wireless networks). Continued connectivity is a real important issue as it may affect the perceived quality of service for entertainment/information services. For auction/reverse auction, frequent disconnection may seriously affect the usefulness of this service unless it can be guaranteed that if users get disconnected, the state of auction will be maintained and disconnected users will not suffer any loss during periods of disconnection [27].

CONCLUSIONS – FUTURE RESEARCH

Mobile commerce has just passed his infantry and becomes more mature. Devices are starting to have more CPU power, more memory and more advanced feaures that even desktop computers didn't had before 5 years. The future user wireless devices, dubbed as universal wireless handheld devices, will have numerous functionalities, all aiming to establish communications, enhance education,furnish entertainment, provide information, and conduct transactions for mobile users.

Furthermore the smart phones are becoming cheaper and there is an explosition in their sales the last years. This among with the better bandwith and packet switched networks , is giving a great boost in mobile commerce, what was just a dream or a expensive "hobby" before some years now is becoming every day life. Mobile commerce (m-commerce) is expected to evolve significantly in the future, especially in view of the current implementation of 3G systems and the future deployment of 4G systems, inter-connecting a multitude of diverse wireless networks, such as WBAN, WPAN, WLAN, and WMAN.

Although the growth and pervasiveness of this continuing wireless revolution appears to be inevitable, the path and speed of growth of this technology are not so predictable. It is clear that different generations of mobile communication systems have evolved to satisfy the demands of high data rate, high mobility, wide area coverage, diverse applications, high spectral efficiency,high flexibility of mobiledevices and networks, and lowcosts. In view of this backdrop, it is anticipated that mcommercewill become widely popular and ubiquitouslyavailable. In this paper, future trends in m-commerce servicesand technologies, as well as privacy concerns and securitychallenges will be highlighted. In the future, 4G systems will focus on seamlesslyntegrating all wireless networks, and they will be the platform for mobile systems. This focus contrasts with 3G systems, which merely focus on developing new standardsa nd hardware. 4G systems will be all IP-based multimedia services in heterogeneous networks that allow users to useany system at anytime anywhere. The new challenge facingthe mobile industry is to minimize the fragmentation of the market and to enable seamless interoperability so as to simulate the growth of mobile services. 4G devices should be multi-band, multi-functional, and multi-mode capable and be able to handle various contents. Also, 4G systems will provide the best connection to users [28]. It is believed that the interfaces for 4G systems will exploit the new frequency spectrum that is to be identified by WRC-2007; therefore, a speculative time scale for a mature 4G system is beyond 2010. 4G systems will be an evolved version of 3G systems and will also be based on a cellular system but will require very small cells [29]. 4G systems will warrant the realization of automatic switching functions for such flexible networks, mobility control, coordination functions between layers 2 and 3 to realize fast handover, rapid routing of packets, and so on. 4G systems will improve coverage in highly populated areas (i.e., hot spots) to carry more traffic by utilizing diverse access technologies to deliver the best possible services, while taking into account both cost and bandwidth efficiency [30-32]. The primary 4G systems objectives over 3G systems objectives—higher transmission rate (by two orders of magnitude), larger capacity (by one order of magnitude), higher frequency band (beyond 3 GHz), single-device (ubiquitous, multi-functional, multi-service, multi-band), increased coverage (global roaming), simple billing (one bill with reduced total access cost), high quality of service (accommodating varying transmission rates, channel characteristics, bandwidth allocation, fault-tolerance levels, and different hand-off support), and lower system costs (one order of magnitude) - will directly play pivotal roles in all aspects of the next generation of m-commerce.

There appears to be no m-commerce application that can be qualified as a "killer" application, per se. However, the key advantage of m-commerce is its ability to support a wide variety of attractive and innovative applications, and that will be the "killer" characteristic of m-commerce. It is worth highlighting that the highly-personalized, context-aware, location-sensitive, time-critical applications, conducted in a very secure environment are the most promising mcommerce applications. There are indications that the nextgeneration of wireless communications services based on 4G systems will not be limited to human (as it has been before) but rather to anything that very small wireless chips can be attached to (i.e., machine-to-machine communications) [33-34]. Table-1 highlights the m-commerce service categories encompassing sets of attractive applications. So we can close by saying that The major limitations of m-commerce, as viewed today, are small screens on wireless devices, limited processing power, modest memory, restricted power consumption, poor voice quality, low-speed data transmission, non-ubiquitous coverage, unproven security, scarce bandwidth, and possible health hazards. In view of the fact that mobile computing is accelerating at a rate faster than Moore's law, and according to Edholm's law of bandwidth [35], wireless transmission rates also follow Moore's law, many of these limitations are expected to diminish, if not being eliminated, over time. In light of the fact that m-commerce is just at its inception, the real potential has yet to be visualized, let alone tapped. Noting that the highly-personalized, context-aware, locationsensitive, time-critical applications are the most promising applications in m-commerce, there are many m-commerce applications envisaged to become very widely popular. They include:

i) digital cash (to enable mobile users to settletransactions requiring micro-payments),

ii) human-to machine communications (to facilitate mobile users to communicate to stationary locations for access and security and to moving objects for asset and logistic purposes using RFID technologies),

iii) telemetry (to activate remote recording devices for sensing and measurement information), and

iv) broadband-interactive multimedia communications and messaging anytime, anywhere.

4G systems with more security, higher speeds, higher capacity, lower costs, and more intelligent infrastructures and devices will help realize m-commerce applications. With improved wireless security and privacy through data encryption and user education, on the one hand, and with the wide deployment of 4G systems, on the other hand, it is anticipated that m-commerce will, inescapably, become the most dominant method of conducting business transactions.

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