2nd Generation and 3rd Generation mobile Services

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Abstract :
3G services represents an evolution in telecommunication industry. However, 3G services has not received great adoption rate as expected despite of various benefits provided by this service. This study aims to investigate the factors affecting the intention to adopt 3G services among the university students in Malaysia since they expected to be the group with great potential to adopt 3G services. Diffusion of innovation theory is modified and applied in this study to achieve the objective. Results of this study show that perceived compatibility, perceived relative advantage, perceived results demonstrability, perceived trailability, perceived image, and perceived enjoyment are significantly associated with intention to adopt 3G services. Surprisingly, perceived cost of using 3G services is found to be positive but insignificant associated with intention to adopt 3G services. Managerial implications and conclusion have been discussed. All mobile operators with both 2G and 3G license require the maximum reuse of the existing infrastructure when building the 3G-network. Because of the importance of a seamless mobile network, Ericsson has been involved and working very much with definition of the interfaces, new protocols and to create a solution for integration of the 2G and 3G mobile systems. Ericsson as a leading company in the telecommunication field is active in all standardization forum, including ITU, 3GPP, etc.
Ericsson Seamless Network for 2G and 3G, includes:
- Common core & Service network
- Common Network Management
- Common Transmission
- Common sites (one seamless radio network)

Good Quality of Service, requires the possibility of Handover between the existing 2G and 2.5 G network and the 3G network. With respect to this requirement, the best effort service, in both GSM/GPRS and WCDMA will be achieved with the seamless network from Ericsson.

Keywords: 3G Services Adoption, Diffusion of Innovation Theory, University Students

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1. Introduction

Third Generation (3G) mobile devices and services will transform wireless communications into on-line, real-time connectivity. 3G wireless technology will allow an individual to have immediate access to location-specific services that offer information on demand. The first generation of mobile phones consisted of the analog models that emerged in the early 1980s. The second generation of digital mobile phones appeared about ten years later along with the first digital mobile networks. During the second generation, the mobile telecommunications industry experienced exponential growth both in terms of subscribers as well as new types of value-added services. Mobile phones are rapidly becoming the preferred means of personal communication, creating the world's largest consumer electronics industry. The rapid and efficient deployment of new wireless data and Internet services has emerged as a critical priority for communications equipment manufacturers. Network components that enable wireless data services are fundamental to the next-generation network infrastructure. Wireless data services are expected to see the same explosive growth in demand that Internet services and wireless voice services have seen in recent years. This white paper presents an overview of current technology trends in the wireless technology market, a historical overview of the evolving wireless technologies and an examination of how the communications industry plans to implement 3G wireless technology standards to address the growing demand for wireless multimedia services. Finally, this paper presents

Trillium's solutions, which enable wireless communications and Internet infrastructure equipment manufacturers to develop 3G network elements for quick and efficient deployment.

2. Existing Mobile Networks

2.1 First Generation Wireless Technology

The first generation of wireless mobile communications was based on analog signaling. Analog systems, implemented in North America, were known as Analog Mobile Phone Systems (AMPS), while systems implemented in Europe and the rest of the world were typically identified as a variation of Total Access Communication Systems (TACS). Analog systems were primarily based on circuit-switched technology and designed for voice, not data.

2.2 Second Generation Wireless Technology

The second generation (2G) of the wireless mobile network was based on low-band digital data signaling. The most popular 2G wireless technology is known as Global Systems for Mobile Communications (GSM). GSM systems, first implemented in 1991, are now operating in about 140 countries and territories around the world. An estimated 248 million users now operate over GSM systems. GSM technology is a combination of Frequency Division Multiple Access (FDMA) and Time Division Multiple Access (TDMA). The first GSM systems used a 25MHz frequency spectrum in the 900MHz band. FDMA is used to divide the available 25MHz of bandwidth into 124 carrier frequencies of 200kHz each. Each frequency is then divided using a TDMA scheme into eight timeslots. The use of separate timeslots for transmission and reception simplifies the electronics in the mobile units. Today, GSM systems operate in the 900MHz and 1.8 GHz bands throughout the world with the exception of the Americas where they operate in the 1.9 GHz band. In addition to GSM, a similar technology, called Personal Digital Communications (PDC), using TDMA-based technology, emerged in Japan. Since then, several other TDMA-based systems have been deployed worldwide and serve an estimated 89 million people worldwide. While GSM technology was developed in Europe, Code Division Multiple Access (CDMA) technology was developed in North America. CDMA uses spread spectrum technology to break up speech into small, digitized segments and encodes them to identify each call. CDMA systems have been implemented worldwide in about 30 countries and serve an estimated 44 million subscribers. While GSM and other TDMA-based systems have become the dominant 2G wireless technologies, CDMA technology is recognized as providing clearer voice quality with less background noise, fewer dropped calls, enhanced security, greater reliability and greater network capacity. The Second Generation (2G) wireless networks mentioned above are also mostly based on circuit-switched technology. 2G wireless networks are digital and expand the range of applications to more advanced voice services, such as Called Line Identification. 2G wireless technology can handle some data capabilities such as fax and short message service at the data rate of up to 9.6 kbps, but it is not suitable for web browsing and multimedia applications.

3. Next Generation Mobile Networks

3.1 Second Generation (2G+) Wireless Networks

As stated in a previous section, the virtual explosion of Internet usage has had a tremendous impact on the demand for advanced wireless data communication services. However, the effective data rate of 2G circuit-switched wireless systems is relatively slow -- too slow for today's Internet. As a result, GSM, PDC and other TDMA-based mobile system providers and carriers have developed 2G+ technology that is packet-based and increases the data communication speeds to as high as 384kbps. These 2G+ systems are based on the following technologies: High Speed Circuit-Switched Data (HSCSD), General Packet Radio Service (GPRS) and Enhanced Data Rates for Global Evolution (EDGE) technologies. HSCSD is one step towards 3G wideband mobile data networks. This circuit-switched technology improves the data rates up to 57.6kbps by introducing 14.4 kbps data coding and by aggregating 4 radio channels timeslots of 14.4 kbps. GPRS is an intermediate step that is designed to allow the GSM world to implement a full range of Internet services without waiting for the deployment of full-scale 3G wireless systems. GPRS technology is packet-based and designed to work in parallel with the 2G GSM, PDC and TDMA systems that are used for voice communications and for table look-up to obtain GPRS user profiles in the Location Register databases. GPRS uses a multiple of the 1 to 8 radio channel timeslots in the 200kHz-frequency band allocated for a carrier frequency to enable data speeds of up to 115kbps. The data is packetized and transported over Public Land Mobile Networks (PLMN) using an IP backbone so that mobile users can access services on the Internet, such as SMTP/POP-based e-mail, ftp and HTTP-based Web services. EDGE technology is a standard that has been specified to enhance the throughput per timeslot for both HSCSD and GPRS. The enhancement of HSCSD is called ECSD, whereas the enhancement of GPRS is called EGPRS. In ECSD, the maximum data rate will not increase from 64 kbps due to the restrictions in the A interface, but the data rate per timeslot will triple. Similarly, in EGPRS, the data rate per timeslot will triple and the peak throughput, including all eight timeslots in the radio

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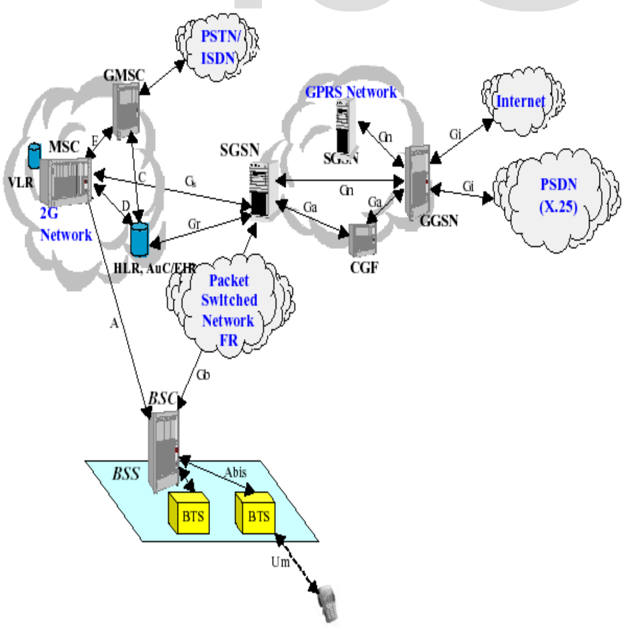
interface, will exceed 384 kbps. GPRS networks consist of an IP-based Public Mobile Land Network (PLMN), Base Station Services (BSS), Mobile handsets (MS), and Mobile Switching Centers (MSC) for circuit-switched network access and databases. The Serving GPRS Support Nodes (SGSN) and Gateway GPRS Support Nodes (GGSN) make up the PLMN. Roaming is accommodated through multiple PLMNs. SGSN and GGSN interface with the Home Location Register (HLR) to retrieve the mobile user's profiles to facilitate call completion. GGSN provides the connection to external Packet Data Network (PDN), e.g. an Internet backbone or an X.25 network. The BSS consists of Base Transceiver Stations and Base Station Controllers. The Base Transceiver Station (BTS) receives and transmits over the air interfaces (CDMA, TDMA), providing wireless voice and data connectivity to the mobile handsets. Base Station Controllers (BSC) route the data calls to the packet-switched PLMN over a Frame Relay (FR) link and the voice calls to the Mobile Switching Center (MSC). MSC switches the voice calls to circuit-switched PLMN network such as PSTN and ISDN. MSC accommodates the Visitor Location Register (VLR) to store the roaming subscriber information. The reverse process happens at the destination PLMN and the destination BSS. On the data side, the BSC routes the data calls to the SGSN, and then the data is switched to the external PDN through the GGSN or to another mobile subscriber.

Figure 1 shows a GPRS network.



3.2 Third Generation (3G) Wireless Networks

3G wireless technology represents the convergence of various 2G wireless telecommunications systems into a single global system that includes both terrestrial and satellite components. One of the most important aspects of 3G wireless technology is its ability to unify existing cellular standards, such as CDMA, GSM, and TDMA, under one umbrella. The following three air interface modes accomplish this result: wideband CDMA, CDMA2000 and the Universal Wireless Communication (UWC-136) interfaces. Wide band CDMA (W-CDMA) is compatible with the current 2G GSM networks prevalent in Europe and parts of Asia. W-CDMA will require bandwidth of between 5Mhz and 10 Mhz, making it a suitable platform for higher capacity applications. It can be overlaid onto existing GSM, TDMA (IS-36) and IS95 networks. Subscribers are likely to access 3G wireless services initially via dual band terminal devices. W-CDMA networks will be used for high-capacity applications and 2G digital wireless systems will be used for voice calls. The second radio interface is CDMA2000, which is backward compatible with the second generation CDMA IS-95 standard predominantly used in US. The third radio interface, Universal Wireless Communications – UWC-136, also called IS-136HS, was proposed by the TIA and designed to comply with ANSI-136, the North American TDMA standard. 3G wireless networks consist of a Radio Access Network (RAN) and a core network. The core network consists of a packet-switched domain, which includes 3G SGSNs and GGSNs, which provide the same functionality that they provide in a GPRS system, and a circuit-switched domain, which includes 3G MSC for switching of voice calls. Charging for services and access is done through the Charging Gateway Function (CGF), which is also part of the core network. RAN functionality is independent from the core network functionality. The access network provides a core network technology independent access for mobile terminals to different types of core networks and network services. Either core network domain can access any appropriate RAN service; e.g. it should be possible to access a "speech" radio access bearer from the packet switched domain. The Radio Access Network consists of new network elements, known as Node B and Radio Network Controllers (RNCs). Node B is comparable to the Base Transceiver Station in 2G wireless networks. RNC replaces the Base Station Controller. It provides the radio resource management, handover control and support for the connections to circuit-switched and packet-switched domains. The interconnection of the network elements in RAN and between RAN and core network is over Iub, Iur and Iu interfaces based on ATM as a layer 2 switching technology. Data services run from the terminal device over IP, which in turn uses ATM as a reliable transport with QoS. Voice is embedded into ATM from the edge of the network (Node B) and is transported over ATM out of the RNC. The Iu interface is split into 2 parts: circuit switched and packet-switched. The Iu

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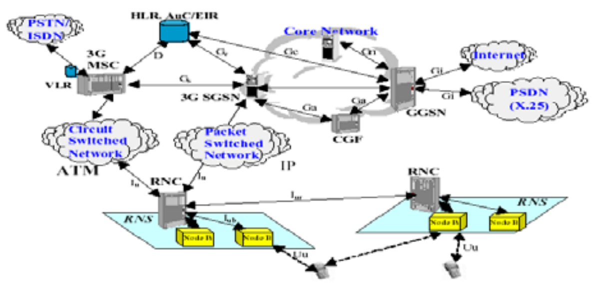
interface is based on ATM with voice traffic embedded on virtual circuits using AAL2 technology and IP-over-ATM for data traffic using AAL5 technology. These traffic types are switched independently to either 3G SGSN for data or 3G MSC for voice.

Figure 3 shows the 3G wireless network architecture.



4. Evolution to 3G Wireless Technology

Initial coverage

Initially, 3G wireless technology will be deployed as "islands" in business areas where more capacity and advanced services are demanded. A complete evolution to 3G wireless technology is mandated by the end of 2000 in Japan (mostly due to capacity requirements) and by the end of 2001 in Europe. NTT DoCoMo is deploying 3G wireless services in Japan in the third quarter of 2000. In contrast, there is no similar mandate in North America and it is more likely that competition will drive the deployment of 3G wireless technology in that region. For example, Nextel Communications has announced that it will be deploying 3G wireless services in North America during the fourth quarter of 2000. The implementation of 3G wireless systems raises several critical issues, such as the successful backward compatibility to air interfaces as well as to deployed infrastructures.

5. Comparison of 2G and 3G Mobile Networks

As mentioned above, although there are many similarities between 2G and 3G wireless networks (and many of the 2G and 3G components are shared or connected through interworking functions), there are also many differences between the two technologies. Table 1 compares the differences between the core network, th radio portion and other areas of the two networks.

Table 1: Comparison between 2G+ and 3G wireless networks

Feature	2G	2G+	3G
Core Network	MSC/VLR, GMSC, HLR/AuC/EIR MM, CM, BSSAP, SCCP, ISUP,TCAP, MAP, MTP 3, MTP 2, MTP 1 TDM transport	MSC/VLR, GMSC, SGSN, GGSN, HLR/AuC/EIR, CGF GMM/SM/SMS, MM, CM, GTP, SNDCP,NS, FR, LLC, BSSGP, BSSAP, BSSAP+, SCCP, TCAP, MAP, ISUP, MTP 3, MTP 2, MTP 1 TDM, Frame Relay transport	3G MSC/VLR (with added interworking and transcoding), GMSC, HLR/AuC/EIR, 3G-SGSN, GGSN, CGF GMM/SM,MM,CM,BSSAP, RANAP,GTP,SCCP, MTP3B, M3UA, SCTP, Q.2630.1 (NNI), TCAP, MAP, ISUP, MTP 3, MTP 2, MTP 1, Q.2140, SSCOP ATM, IP transport
Radio Access	BTS, BSC, MS FDMA, TDMA, CDMA MM, CM, RR, LAPDm, LAPD, BSSAP, SCCP, MTP 3, MTP 2, MTP 1	BTS, BSC, MS TDMA, CDMA, EDGE MAC, RLC, GMM/SM/SMS, LLC, SNDCP, BSSGP, NS, FR,RR, BSSAP, SCCP, MTP 3, MTP 2, MTP 1	Node B, RNC, MS W-CDMA, CDMA2000, IWC-136 GMM/SM, MAC, RLC, PDCP,RRC,Q.2630.1(UNI+ NNI),NBAP, RNSAP, RANAP, SCCP, MTP3B, M3UA, SCTP, GTP-U, Q.2140, Q.2130, SSCOP, CIP
Handsets	Voice only terminals	New type of terminal Dual mode TDMA and CDMA Voice and data terminals WAP, no multimedia support	New type of terminal Multiple modes Voice, data and video terminals WAP, multimedia mgmt
Databases	HLR, VLR, EIR, AuC	HLR, VLR, EIR, AuC	Enhanced HLR, VLR, EIR,AuC
Data Rates	Up to 9.6 Kbps	Up to 57.6 Kbps (HSCSD) Up to 115Kbps (GPRS) Up to 384 Kbps (EDGE)	Up to 2Mbps
Applications	Advanced voice, Short Message Service (SMS)	SMS, Internet	Internet, multimedia
Roaming	Restricted, not global	Restricted, not global	Global
Compatibility	Not compatible to 3G	Not compatible to 3G	Compatible to 2G, 2G+ and Bluetooth

6. About Trillium

Trillium Digital Systems is the leading provider of communications software solutions for the converged network infrastructure. Trillium's source code solutions are used in more than 500 projects by industry-leading suppliers of wireless, Internet, broadband and telephony products. Trillium's high-performance, high-availability software and services reduce the time, risk and cost of implementing SS7, IP, H.323, MGCP, ATM, Wireless and other standards-based communications protocols. Trillium actively participates in the development of 3rd generation systems by developing standards-based wireless communications protocols. It is likely that the first 3G mobile terminals will be multi-mode devices, which means that they will support a number of 2nd generation protocol standards in order to reach wide network coverage and to provide 3rd generation advanced services. Trillium has extensive know-how in all the major communications protocol standards in the world and can provide solutions for many types of networks. Trillium designs all its portable software products using the Trillium Advanced Portability Architecture (TAPA□), a set of architectural and coding standards that ensure the software is completely independent of the compiler, processor, operating system and architecture of the target system. This makes Trillium products portable, consistent, reliable, high quality, high performance, flexible, and scaleable. This architecture also ensures that all Trillium protocols can interwork seamlessly in the same or between different networks. As mentioned above, successful implementation, adoption, and overall acceptance of the 3G wireless networks depends largely on the ability of these new mobile networks to interface and interwork with the existing 2G and legacy networks currently deployed worldwide. Trillium's products allow wireless communications equipment manufacturers to develop "best-in-class" next-generation mobile networks, to ensure success of the network operator and service provider, and to ensure wide acceptance of the new services by end-users.

3G Weaknesses and Proposed Improvements 3G Architecture Weaknesses

Backup procedure for TMSI reallocation. IMSI confidentiality in wireline part

Firewall Issues

WAP Architecture (V1.2.1) Data Privacy Voice Call Transcoded Threat Backup Procedure for TMSI Reallocation.VLR cannot associate the TMSI with the IMSI because of TMSI corruption or database failure when the user roams, and the SN/ VLRn cannot contact the previous VLRo.

Voice Call Transcoded Threat

Voice calls may need to be transcoded when they cross network borders. Such as, bit rate change it is not possible to apply such transformation on an encrypted signal. Signal has to be decrypted before transcoding. Network-wide confidentiality lacks flexibility.

3G security weakness and Security Issues

Important Changes in Security Defeat the false base station attack. Key lengths were increased. Support security within and between networks Integrity mechanisms.

Types of Attacks

Eavesdropping Impersonation of a user Impersonation of the network Man-in-the-middle Compromising authentication vectors in the network

3G Security Feature

3G network enhances much vulnerability in 2G.
Many 2G attacks are not suitable for 3G network.

Denial of service Attack

De-registration request spoofing the intruder spoofs a de-registration request (IMSI detach) to the network Location update request spoofing User spoofs a location update request in a different location area camping on a false BS/MS

Denial of Service Solution

Integrity protection of critical signaling messages Location update request spoofing and Deregistration request spoofing. In Camping on a false BS/MS Integrity can't prevent the false BS/MS ignoring certain service requests and/or paging requests.

Identity Catching Attack

Passive identity catching requires a modified MS. Expect network may sometimes request the user to send its identity in plaintext. Active identity catching Requires a modified BS Requests the target user to send its permanent user identity in plaintext.

Identity Catching Attack Solution

Identity confidentiality mechanism counteracts this attack Encryption key shared by a group of users to protect the user identity when new registrations or temporary identity database failure in the serving.

Eavesdropping on user data

Suppression of encryption between the target user and the true network Modified BS/MS When set up a connection, false BS/MS modifies the ciphering capabilities of the MS; network may then decide to establish an un-enciphered connection.

Eavesdropping on user data Solution

Message authentication and replay inhibition of the mobile's ciphering capabilities. Network can verify that encryption has not been suppressed by an attacker.

Conclusion

We know that, Wireless Communication have numerous advantages and valuable features so, this technology will survive forever. The day-by-day additional advancements have contributed upto greater extent to this technology. As, wireless is a vast and never-ending field it shall still continue to serve the world with its full efficiency and effect. Hence, it can be said that Mobiles and Wireless devices of the future will be more powerful, light-weighted and comprise new interface to the user and to new networks. Not only Mobiles but also almost entire wireless communication system shall be the key lifelines for the human beings.

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