Recent Trends In 4G Over 3G Technology

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Abstract- The objective of this paper is to evaluate recent trends in Fourth generation (4G) mobile services. Given the success of Third generation (3G) mobile communications systems and services, the third generation mobile networks and applications are faced with a lot of expectations such as providing omnipresent access to online services via mobile terminals. However, 3G technologies and applications have encountered obstacles that have stalled both the technology development and user acceptance. This paper reviews existing literature related to 3G as well as evaluate a framework that presents the factors that contribute to the success of 4G.

Keywords: 3G, 4G, User Acceptance, OFDM, UWB.

I. Introduction

3G refers to technologies associated with wireless communications and is most often associated with cell phones. Popular use of the term 3G, such as "a 3G phone," refers to the types of cell phones equipped to access to a wireless data network using 3G standards. Cell phones and other Internet-enabled devices that use 3G wireless technology are perceived as achieving higher speeds when browsing the Web, downloading files or performing other wireless Internet-related tasks. Technically, 3G stands for 3rd generation and refers to the third generation of related standards established by the ITU, or International Telecommunication Union. The family includes technologies recognized by consumers such as GSM EDGE and WiMAX. The 3rd Generation Partnership Project (3GPP) has taken an active role in establishing and promoting 3G standards in order to increase the benefit of 3G technologies to consumers.

As consumer expectations relating to the performance of cell phones and similar devices in connecting to the Internet increase, device technology increases as well. As devices become capable of higher-performance functions such as playing larger, higher-definition videos with higher-quality audio, the need for data transfer rates that support larger, higher-quality multimedia files increases. There is no 4G standard from the ITU in place. The 3GPP consortium is seeking to expedite the creation of 4G standards.

II. ANTECEDENTS OF THE SUCCESS OF 3G SERVICES

A. Industry Standards

The importance of common industry standards with 3G networks has been emphasized in many studies (see e.g., Curwen, 2000; Grundström & Wilkinson, 2004; Harrison & Holley, 2001; Kumar, 2004). The
mobile phone industry is currently using many standards [e.g. Japanese PDC (Personal Digital Communication), European GSM, American CDMA], which has made it difficult for users travelling to utilize their phones worldwide. The evolution of 3G is expected to simplify this because in Europe there are only two standards competing; the WCDMA (Wideband Code Division Multiple Access) which will become the European UMTS (Universal Mobile Telecommunications System) and the CDMA2000 (Code Division Multiple Access). Although the WCDMA and the CDMA2000 are regarded as the two main standards (Mobile IN, 2004) in the world, there are other variants of 3G such as NTT Do Com’s Freedom of Mobile Multimedia Access (FOMA) and the Chinese TD-SCDMA (Time Division-Synchronous Code Division Multiple Access), which are also competing for market share. As the TD-SCDMA developed by Siemens and its Chinese partners has suffered technical problems it is not to date ready for commercialization (Hillman, 2004). The WCDMA standard is said to dominate the global market for the next five years (Sehovic, 2003). However, 3Gnetworks still require large investment efforts in for example in base stations, in order to provide promised transfer speeds (Robins, 2003). With standardization it is possible to meet one of the basic goals of 3G; to provide global access for the same services. This means creating a truly single, worldwide standard. The International Telecommunication Union (ITU) is working on 3G international standardization through its project IMT-2000 (International Mobile Telecommunications) that aims at setting the global standard for 3G.

B. User Acceptance

It is important to consider user acceptance of 3G services and to classify different user needs. Generally speaking, in designing 3G applications and planning profitable business models, the end-users’ needs and wants should be in the hot spot (e.g., Fenton et al., 2001; Gerstheimer & Lupp, 2004). The main challenge when exploring user needs and wants lies in the intersection of unknown future customers’ needs and wants and new technology that is not even available for many users. Therefore, it is suggested that service developers can only meet the needs and wants with a profound understanding of the mobile communication system, ranging from voice-centric services to multimedia centric services (Gerstheimer & Lupp, 2004). Furthermore, their study suggests that an interpretative-creative approach should be used when designing 3G services rather than taking linear or analytic problem solving approaches. Therefore designers should examine users’ needs and requirements, with concrete reference to situation-oriented and social-spatial contexts; concentrating on open parameters like ‘user’, ‘place’, ‘process’, and ‘time’ (Figue, 2004; Gerstheimer & Lupp, 2004). To get the big picture, it is essential to understand the different situations in which consumers and business users use mobile services. First, we can distinguish the different types of presence people typically have. Presence can be broadly defined as reachability, availability, and willingness to communicate with other users. Presence is one of the central factors in designing mobile services (Camarillo & Garcia-Martin, 2004: 303). Presence data includes information about whether users are online or not, if they are idle or busy, and various other information users have given to the presence service such as information about their communication means and capabilities concerning their mobile terminals, for example. At a basic level, presence information can be classified to at home, at work and mobile (on the move) (Dholakia & Dholakia, 2004).

To begin with, at home users are typically connected with at least two types of networks. More and more households have fixed Internet access (LAN) that allows relatively fast Internet connection speed (starting from 256 kbps). Thus, it is expected that households with fixed Internet access will use mobile devices (classified in this paper as phones and PDAs, but excluding laptops) differently than households without fixed Internet access. For instance, mobile terminals can be used to get online access, either directly from mobile terminal or in connection with another terminal such as laptop or PC. With the help of 3G, mobile terminals as mentioned can offer faster connection speeds than some LAN connections. However, with the diffusion of 3G networks, we should expect 3G phones to be used in combination with personal computers. For example, many mobile operators in Europe (e.g. Vodafone, Orange, T-Mobile, O2) already offer 3G data cards that allow fast access to Internet services via laptops, and are able to utilize also GPRS connection when 3G is not available (ZDNet UK, 2004). The idea is that data cards provide abroad band wireless link to the Internet or company network (like WLAN) allowing users to do the same computer activities on the road as in the office.

At work, users typically also have fixed Internet access that is used to access many Informative services related to work. However, more people are relying on mobile terminals to manage their daily activities. With the diffusion of smart phones, computers and mobile terminals are more and more used in combination. As smart phones can be synchronized with laptops and table
computers, followed by their ability to send and receive e-mails and use of other company related services, the line between different terminal is faded. The third option, mobile, means that the services users can access are limited due to network constraints. On the go users mainly rely on mobile networks that to date offer limited data transmission speeds, although the rise of the 3G network and Wireless Local Area networks (WLAN) provide faster data transmission. The most important development in relation to mobile users and the services they need relate to the networks’ ability to provide the same services globally. As mobile users are increasingly travelling worldwide, it is important to develop networks and services that can be accessed with one mobile terminal. This has been mentioned as one of the main challenges mobile network development will face in the coming years (e.g., Birchler et al., 2003). In conclusion, mobile data services undoubtedly have the most value for users on the go, or for users who are not currently able to access the services the Internet provides via other means such as fixed Internet connection (LAN) or wireless local area network (WLAN).

III. LIMITATIONS OF 3G AND DRIVERS FOR 4G

3G performances may not be sufficient to meet needs of future high-performance applications like multi-media, full-motion video, wireless teleconferencing. We need a network technology that extends 3G capacities by an order of magnitude[4].

A] There are multiple standards for 3G making it difficult to roam and interoperate across networks. We need global mobility and service portability.

B] 3G are based on primarily a wide-area concept. We need hybrid networks that utilize both wireless LAN (hot-spot) concept and cell or base-station wide area network design.

C] We need wider bandwidth.

D] Researchers have come up with spectrally more efficient modulation schemes that cannot be retrofitted into 3G infrastructures.

E] We need all digital packet networks that utilizes IP in its fullest form with converged voice and data capability.

IV. 4G MOBILE TECHNOLOGIES

This new generation of wireless is intended to complement and replace the 3G systems, perhaps in 5 to 10 years. Accessing information anywhere, anytime, with a seamless connection to a wide range of information and services, and receiving a large volume of information, data, pictures, video, and so on, are the keys of the 4G infrastructures. The future 4G infrastructures will consist of a set of various networks using IP (Internet protocol) as a common protocol so that users are in control because they will be able to choose every application and environment. Based on the developing trends of mobile communication, 4G will have broader bandwidth, higher data rate, and smoother and quicker handoff and will focus on ensuring seamless service across a multitude of wireless systems and networks. The key concept is integrating the 4G capabilities with all of the existing mobile technologies through advanced technologies. Application adaptability and being highly dynamic are the main features of 4G services of interest to users. These features mean services can be delivered and be available to the personal preference of different users and support the users' traffic, air interfaces, radio environment, and quality of service. Connection with the network applications can be transferred into various forms and levels correctly and efficiently. The dominant methods of access to this pool of information will be the mobile telephone, PDA, and laptop to seamless access the voice communication, high-speed information services, and entertainment broadcast services. Figure 1 illustrates elements and techniques to support the adaptability of the 4G domains. The fourth generation will encompass all systems from various networks, public to private; operator driven broadband networks to personal areas and ad hoc networks. The 4G systems will interoperate with 2G and 3G systems, as well as with digital (broadband) broadcasting systems. In addition, 4G systems will be fully Ip based wireless Internet. This all-encompassing integrated perspective shows the broad range of systems that the fourth generation intends to integrate, from satellite broadband to high altitude platform to cellular 3G and 3G systems to WLL (wireless local loop) and FWA (fixed wireless access) to WLAN (wireless local area network) and PAN (personal area net-work), all with IP as the integrating mechanism. With 4G, a range of new services and models will be available. These services and models need to be further examined for their interface with the design of 4G systems. 4G Wireless Systems or Fourth generation wireless system is a packet switched wireless system with wide area coverage and high throughput. It is designed to be cost effective and to provide high spectral efficiency. The 4g wireless uses Orthogonal Frequency Division Multiplexing

(OFDM), Ultra Wide Radio Band (UWB), and Millimetres wireless. Data rate of 20mbps is employed. Mobile speed will be up to 200km/hr. The high performance is achieved by the use of long term channel prediction, in both time and frequency, scheduling among users and smart antennas combined with adaptive modulation and power control. Frequency band is 2-8 GHz. It gives the ability for world wide roaming to access cell anywhere.

Fig. 1. 4G Mobile Communications

Features of 4G Mobile Technology:

- Support for interactive multimedia, voice, streaming video, Internet, and other broadband services
  - IP based mobile system
  - High speed, high capacity, and low cost per bit
  - Global access, service portability, and scalable mobile services
  - Seamless switching, and a variety of Quality of Service driven services
  - Better scheduling and call admission control techniques
  - Ad hoc and multi hop networks (the strict delay requirements of voice make multi hop network service a difficult problem)
  - Better spectral efficiency
  - Seamless network of multiple protocols and air interfaces (since 4G will be all IP, look for 4G systems to be compatible with all common network technologies, including 802.11, WCDMA, Blue tooth, and Hyper LAN).

- An infrastructure to handle pre-existing 3G systems along with other wireless technologies, some of which are currently under development.

V. The Future and 4G

According to the International Telecommunication Union (ITU), the future of mobile phone connectivity now lies in the hands of 4G technologies. According to ITU in October 2010, "harmonization among these proposals has resulted in two technologies, 'LTE-Advanced' and 'Wireless MAN-Advanced' being accorded the official designation of IMT-Advanced, qualifying them as true 4G technologies." In the United States, 4G technologies are already being incorporated into phone units, such as the Sprint Samsung 4G and products provided by Verizon Wireless. According to a Yahoo News article in October 2010, "while the initial [Verizon] LTE rollout will be for laptops and other mobile devices, 4G smart phones will quickly follow. Currently, there are only a handful on the market, made by HTC and Samsung and sold by Sprint Nextel for its WiMAX 4G network. Metro PCS has also announced some 4G phones for its growing 4G network." With the fast-changing world of mobile technology it seems that users will be migrating to 4G phone technologies in the near future.

A. 4G Technology

Meanwhile, researchers and vendors are expressing a growing interest in 4G wireless networks that support global roaming across multiple wireless and mobile networks—for example, from cellular network to a satellite-based network to a high-bandwidth wireless LAN. With this feature, users will have access to different services, increased coverage, the convenience of a single device, one bill with reduced total access cost, and more reliable wireless access even with the failure or loss of one or more networks. 4G networks will also feature IP interoperability for seamless mobile Internet access and bit rates of 50 Mbps or more. Because deployment of 4G wireless technology is not expected until 2006 or even

later, developers will hopefully have time to resolve issues involving multiple heterogeneous networks such as
- access,
- handoff,
- location coordination,
- resource coordination to add new users,
- support for multicasting,
- support for quality of service,
- wireless security and authentication,
- network failure and backup,
- pricing and billing.

Network architectures will play a key role in implementing the features required to address these issues.

B. Possible Architectures:
One of the most challenging problems facing deployment of 4G technology is how to access several different mobile and wireless networks. Figure 2 shows three possible architectures: using a multimode device, an overlay network, or a common access protocol.

(a) A multimode device lets the user, device, or network initiate handoff between networks without the need for network modification or interworking devices. (b) An overlay network—consisting of several universal access points (UAPs) that store user, network, and device information—performs a handoff as the user moves from one UAP to another. (c) A device capable of automatically switching between networks is possible if wireless networks can support a common protocol to access a satellite-based network and another protocol for terrestrial networks.

C. Multimode devices
One configuration uses a single physical terminal with multiple interfaces to access services on different wireless networks. Early examples of this architecture include the existing Advanced Mobile Phone System/Code Division Multiple Access dual-function cell phone, Iridium’s dual function satellite-cell phone, and the emerging Global System for Mobile telecommunications/Digital Enhanced Cordless Terminal dual-mode cordless phone.

The multimode device architecture may improve call completion and expand effective coverage area. It should also provide reliable wireless coverage in case of network, link, or switch failure. The user, device, or network can initiate handoff between networks. The device itself incorporates most of the additional complexity without requiring wireless network modification or employing interworking devices. Each network can deploy a database that keeps track of user location, device capabilities, network conditions, and user preferences. The handling of quality-of-service (QoS) issues remains an open research question.

1). Overlay network:
In this architecture, a user accesses an overlay network consisting of several universal access points. These UAPs in turn select a wireless network based on availability, QoS specifications, and user-defined choices. A UAP performs protocol and frequency
translation, content adaptation, and QoS negotiation-renegotiation on behalf of users.

2). Communication:

4G wireless networks support global roaming across multiple wireless and mobile networks. network, rather than the user or device, performs handoffs as the user moves from one UAP to another. A UAP stores user, network, and device information, capabilities, and preferences. Because UAPs can keep track of the various resources a caller uses, this architecture supports single billing and subscription.

3). Common access protocol:

This protocol becomes viable if wireless networks can support one or two standard access protocols. One possible solution, which will require interworking between different networks, uses wireless asynchronous transfer mode. To implement wireless ATM, every wireless network must allow transmission of ATM cells with additional headers or wireless ATM cells requiring changes in the wireless networks. One or more types of satellite-based networks might use one protocol while one or more terrestrial wireless networks use another protocol.

D. Quality of service

Supporting QoS in 4G networks will be a major challenge due to varying bit rates, channel characteristics, bandwidth allocation, fault-tolerance levels, and handoff support among heterogeneous wireless networks. QoS support can occur at the packet, transaction, circuit, user, and network levels. Packet-level QoS applies to jitter, throughput, and error rate. Network resources such as buffer space and access protocol are likely influences. June 200195

Wireless LAN Cellular network Fixed wireless network Satellite network Handoff96 Computer

- **Transaction-level QoS**: describes both the time it takes to complete a transaction and the packet loss rate. Certain transactions may be timesensitive, while others cannot tolerate any packet loss.
- **Circuit-level**: QoS includes call blocking for new as well as existing calls. It depends primarily on a network’s ability to establish and maintain the end-to-end circuit. Call routing and location management are two important circuit-level attributes.

- **User-level**: QoS depends on user mobility and application type. The new location may not support the minimum QoS needed, even with adaptive applications. In a complete wireless solution, the end-to-end communication between two users will likely involve multiple wireless networks. Because QoS will vary across different networks, the QoS for such users will likely be the minimum level these networks support.

E. End-to-End QoS

Developers need to do much more work to address end-to-end QoS. They may need to modify many existing QoS schemes, including admission control, dynamic resource reservation, and QoS renegotiation to support 4G users’ diverse QoS requirements. The overhead of implementing these QoS schemes at different levels requires careful evaluation.

A wireless network could make its current QoS information available to all other wireless networks in either a distributed or centralized fashion so they can effectively use the available network resources. Additionally, deploying a global QoS scheme may support the diverse requirements of users with different mobility patterns. The effect of implementing a single QoS scheme across the networks instead of relying on each network’s QoS scheme requires study.

F. Handoff delay

Handoff delay poses another important QoS-related issue in 4G wireless networks. Although likely to be smaller in intranetworking handoffs, the delay can be problematic in internetwork handoffs because of authentication procedures that require message exchange, multiple-database accesses, and negotiation-renegotiation due to a significant difference between needed and available QoS. During the handoff process, the user may experience a significant drop in QoS that will affect the performance of both upper-layer protocols and applications. Deploying a priority-based algorithm and using location-aware adaptive applications can reduce both handoff delay and QoS variability.

When there is a potential for considerable variation between senders and receivers’ device capabilities, deploying a receiver-specific filter in part of the network close to the source can effectively reduce the amount of traffic and processing, perhaps satisfying other users’ QoS needs.
CONCLUSIONS

Nowadays, wireless technology is getting popular and important in the network and the Internet field. In this paper, we briefly introduced the history background of 3G to 4G. The lack of radio spectrum suitable for 4G deployments will be a major impediment to the migration of 3G to 4G networks, especially in the U.S. Two 4G candidate systems are commercially deployed: The Mobile WiMAX standard (at first in South Korea in 2006), and the first-release Long term evolution (LTE) standard (in Scandinavia since 2009). However, we can get the general idea about 4G from academic research; 4G is the evolution based on 3G’s limitation and it will fulfill the idea of WWW (World Wide Wireless Web) offering more services and smooth global roaming with inexpensive cost.

REFERENCES


