4G MOBILE COMMUNICATION SYSTEM

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Certificate

Certified that this is a bonafide record of the seminar entitled

"4G mobile Communication system"

done by the following student

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ABSTRACT

4G (also known as **Beyond 3G**), an abbreviation for **Fourth-Generation**, is a term used to describe the next complete evolution in *wirelesscommunications*. A 4G system will be able to provide a comprehensive IP solution where voice, data and streamed multimedia can be given to users on an "Anytime, Anywhere" basis, and at higher data rates than previous generations.

As the second generation was a total replacement of the first generation networks and handsets; and the third generation was a total replacement of second generation networks and handsets; so too the fourth generation cannot be an incremental evolution of current 3G technologies, but rather the total replacement of the current 3G networks and handsets. The international telecommunications regulatory and standardization bodies are working for commercial deployment of 4G networks roughly in the 2012-2015 time scale. There is no formal definition for what 4G is; however, there are certain objectives that are projected for 4G. These objectives include, that 4G will be a fully IP-based integrated system. 4G will be capable of providing between 100 Mbit/s and 1 Gbit/s speeds both indoors and outdoors, with premium quality and high security.

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1.INTRODUCTION

The approaching 4G (fourth generation) mobile communication systems are projected to solve still-remaining problems of 3G (third generation) systems and to provide a wide variety of new services, from high-quality voice to high-definition video to high-data-rate wireless channels.

The term 4G is used broadly to include several types of broadband wireless access communication systems, not only cellular telephone systems. One of the terms used to describe 4G is MAGIC—Mobile multimedia, anytime anywhere, Global mobility support, integrated wireless solution, and customized personal service. As a promise for the future, 4G systems, that is, cellular broadband wireless access systems, have been attracting much interest in the mobile communication arena. The 4G systems not only will support the next generation of mobile service, but also will support the fixed wireless networks. This paper presents an overall vision of the 4G features, framework, and integration of mobile communication.

The features of 4G systems might be summarized with one word-Integration.The 4G systems are about seamlessly integrating terminals, networks, and applications to satisfy increasing user demands. The continuous expansion of mobile communication and wireless networks shows evidence of exceptional growth in the areas of mobile subscriber, wireless network access, mobile services, and applications. An estimate of 1 billion users by the end of 2003 justifies the study and research for 4G systems.

2.HISTORY

The history and evolution of mobile service from the 1G (first generation) to fourth generation are discussed in this section. Table 1 presents a short history of mobile telephone technologies. This process began with the designs in the 1970s that have become known as 1G. The earliest systems were implemented based on analog technology and the basic cellular structure of mobile communication. Many fundamental problems were solved by these early systems.

Numerous incompatible analog systems were placed in service around the world during the 1980s.The 2G (second generation) systems designed in the 1980s were still used mainly for voice applications but were based on digital technology, including digital signal processing techniques. These 2G systems provided circuit-switched data communication services at a low speed. The competitive rush to design and implement digital systems led again to a variety of different and incompatible standards such as GSM (global system mobile), mainly in Europe; TDMA (time division multiple access) (IS-54/IS-136) in the U.S.; PDC (personal digital cellular) in Japan; and CDMA (code division multiple access) (IS-95), another U.S. system. These systems operate nationwide or internationally and are today's mainstream systems, although the data rate for users in these system is very limited. During the 1990s, two organizations worked to define the next, or 3G, mobile system, which would eliminate previous incompatibilities and become a truly global system. The 3G system would have higher quality voice channels, as well as broadband data capabilities, up to 2 Mbps. Unfortunately, the two groups could not reconcile their differences, and this decade will see the introduction of two mobile standards for 3G. In addition, China is on the verge of implementing a third 3G system. An interim step is being taken between 2G and 3G, the 2.5G. It is basically an enhancement of the two major 2G technologies to provide increased capacity on the 2G RF (radio frequency) channels and to introduce higher throughput for data service, up to 384 kbps. A very important aspect of 2.5G is that the data channels are optimized for packet data, which introduces access to

the Internet from mobile devices, whether telephone, PDA (personal digital assistant), or laptop. However, the demand for higher access speed multimedia communication in today's

society, which greatly depends on computer communication in digital format, seems unlimited. According to the historical indication of a generation revolution occurring once a decade, the present appears to be the right time to begin the
research on a 4G mobile communication system.

Table 1. Short History of Mobile Telephone Technologies

Technology	1G	2G	2.5G	3G	4G
Design Began	1970	1980	1985	1990	2000
Implementation	1984	1991	1999	2002	2010?
Service	Analog voice, synchronous data to 9.6 kbps	Digital voice, short messages	Higher capacity, packetized data	Higher capacity, broadband data up to 2 Mbps	Higher capacity, completely IP-oriented, multimedia, data to hundreds of megabits
Standards	AMPS, TACS, NMT, etc.	TDMA, CDMA, GSM, PDC	GPRS, EDGE, 1xRTT	WCDMA, CDMA2000	Single standard
Data Bandwidth	1.9 kbps	14.4 kbps	384 kbps	2 Mbps	200 Mbps
Multiplexing	FDMA	TDMA, CDMA	TDMA, CDMA	CDMA	CDMA?
Core Network	PSTN	PSTN	PSTN, packet network	Packet network	Internet

Symbols:

1xRTT = 2.5G CDMA data service up to 384 kbps

AMPS = advanced mobile phone service

CDMA = code division multiple access

EDGE = enhanced data for global evolution

FDMA = frequency division multiple access

GPRS = general packet radio system

GSM = global system for mobile

NMT = Nordic mobile telephone

PDC = personal digital cellular

PSTN = pubic switched telephone network

TACS = total access communications system

TDMA = time division multiple access

WCDMA = wideband CDMA

3.VISION OF 4G

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 seamlessly 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 domain. 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 network),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. Figures 2 and 3 demonstrate the key elements and the seamless connectivity of the networks.

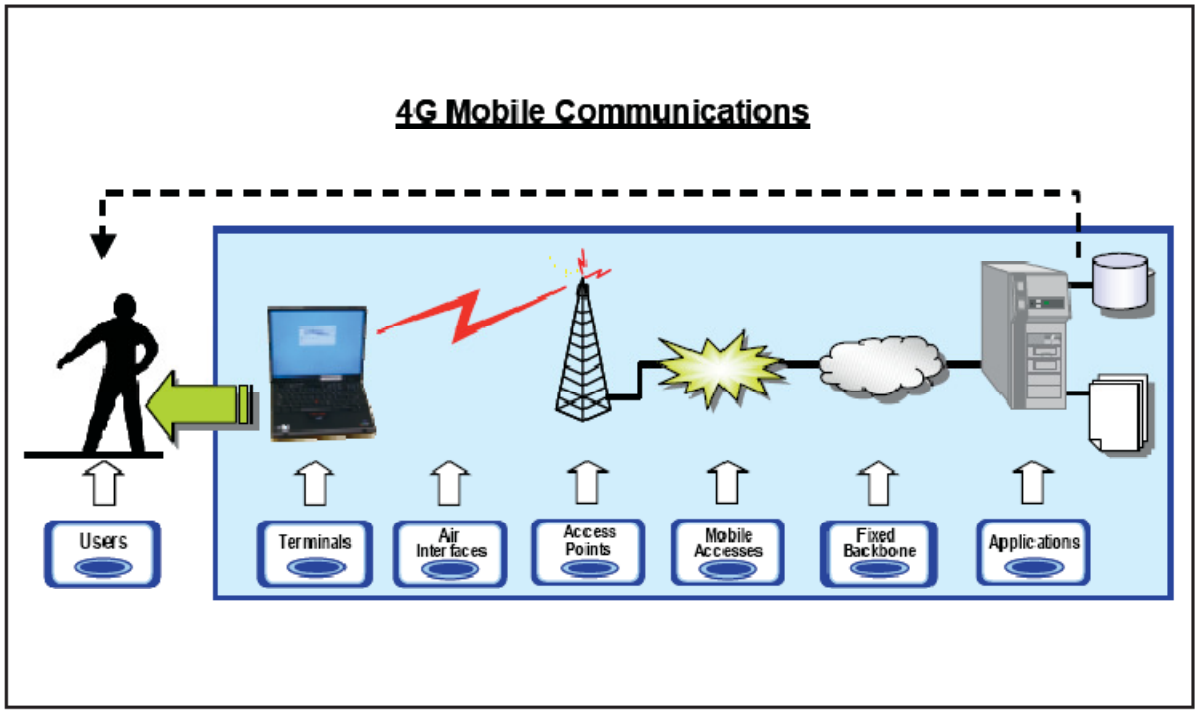

Figure 1. 4G Visions (Ref. 1)

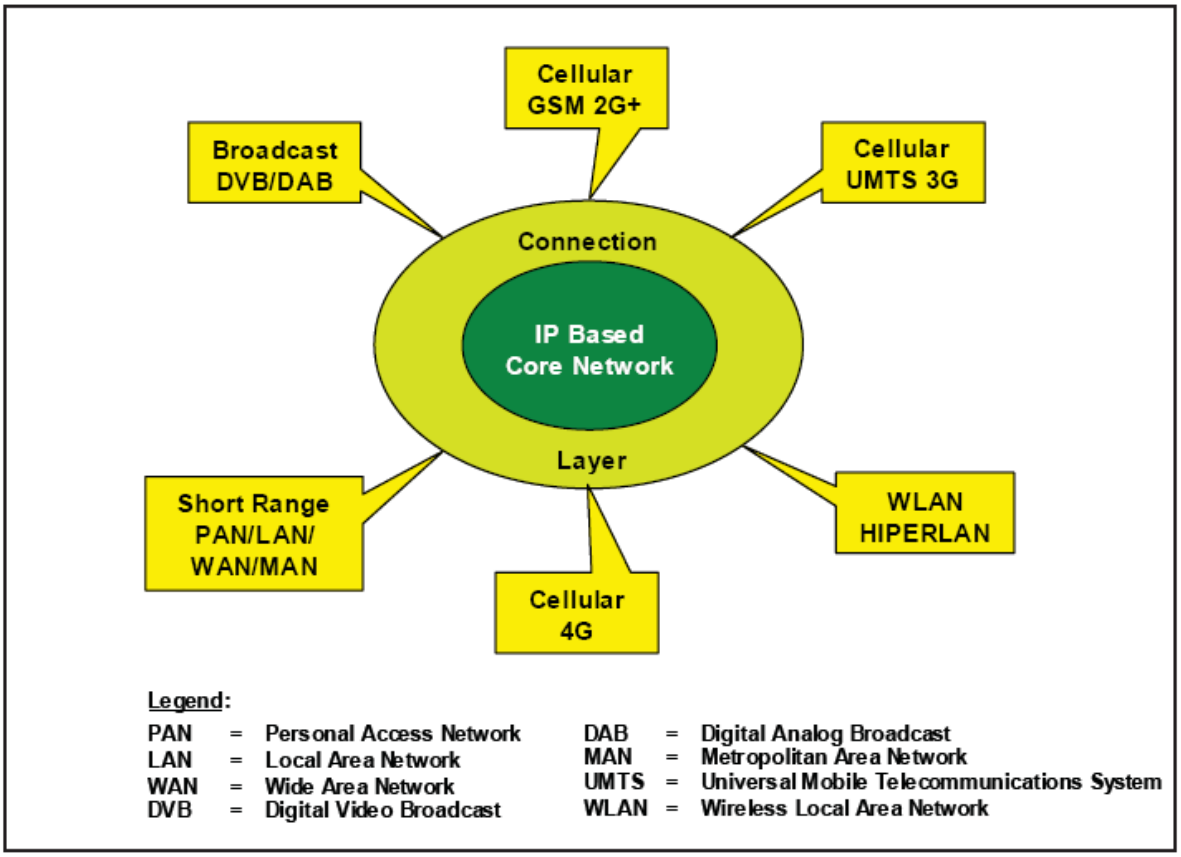

Figure 2. Seamless Connections of Networks (Ref. 2)

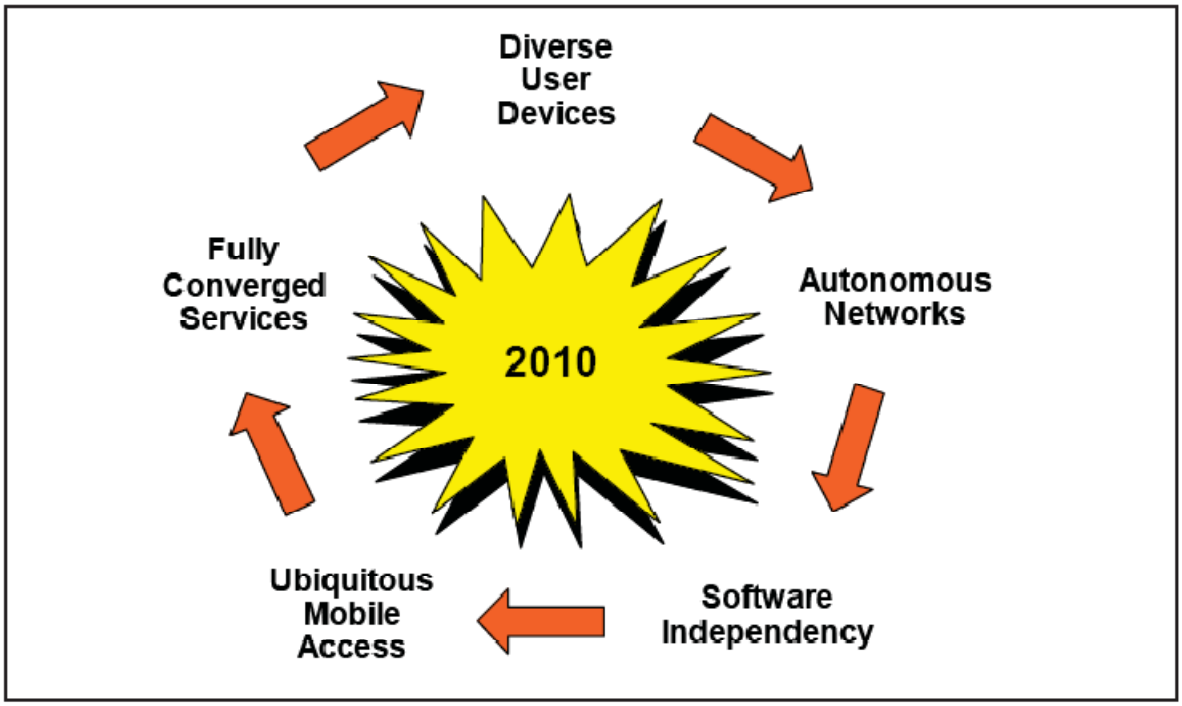

Figure 3. Key Elements of 4G Vision (Ref. 3)

4.KEY 4G TECHNOLOGIES

Some of the key technologies required for 4G are briefly described below:

4.1 OFDMA

Orthogonal Frequency Division Multiplexing (OFDM) not only provides clear advantages for physical layer performance, but also a framework
for improving layer 2 performance by proposing an additional degree of free- dom. Using ODFM, it is possible to exploit the time domain, the space domain, the frequency domain and even the code domain
to optimize radio channel usage. It ensures very robust transmission in multi-path environments with reduced receiver complexity.
OFDM also provides a frequency diversity gain, improving the physical layer performance .It is also compatible with other enhancement
Technologies, such as smart antennas and MIMO.OFDM modulation can also be employed as a multiple access technology (Orthogonal Frequency Division Multiple Access; OFDMA). In this case, each OFDM symbol can transmit information to/from several users using a different set
of sub carriers (sub channels). This not only provides additional flexibility for resource allocation (increasing the capacity), but also enables cross-layer optimization of radio link usage.

4.2 SOFTWARE DEFINED RADIO

Software Defined Radio (SDR) benefits from today's high processing power to develop multi-band, multi-standard base stations and terminals. Although in future the terminals will adapt the air interface to the
available radio access technology, at present this is done by the infrastructure.

Several infrastructure gains are expected from SDR. For example,
to increase network capacity at a specific time (e.g. during a sports event),an operator will reconfigure its network adding several modems at a given Base Transceiver Station (BTS).

SDR makes this reconfiguration easy. In the context of 4G systems, SDR will become an enabler for the aggregation of multi-standard pico/micro cells. For a manufacturer, this can be a powerful aid to providing multi-standard, multi-band equipment with reduced development effort and costs through simultaneous multi-channel processing.

4.3 MULTIPLE-INPUT MULTIPLE –OUTPUT

MIMO uses signal multiplexing between multiple transmitting antennas (space multiplex) and time or frequency. It is well suited to OFDM, as it is possible to process independent time symbols as soon as the OFDM waveform is correctly designed for the channel. This aspect of OFDM greatly simplifies processing. The signal transmitted by *m* antennas is received by *n* antennas. Processing of the received signals may deliver several performance improvements:range, quality of received signal and
spectrum efficiency. In principle, MIMO is more efficient when many multiple path signals are received. The performance in cellular
deployments is still subject to research and simulations . However,
it is generally admitted that the gain in spectrum efficiency is directly related to the minimum number of antennas in the link.

4.4 HANDOVER AND MOBILITY

Handover technologies based on mobileIP technology have been considered for data and voice. Mobile IP techniques are slow but can be accelerated with classical methods (hierarchical, fast mobile IP).

These methods are applicable to data and probably also voice. In single-frequency networks, it is necessary to reconsider the handover methods. Several techniques can be used when the carrier to interference ratio is negative (e.g. VSFOFDM,bit repetition), but the drawback of these techniques is capacity. In OFDM, the same alternative exists as in CDMA, which is to use macro-diversity. In the case of OFDM, MIMO allows macro-diversity processing with performance gains. However, the implementation of macro-diversity implies that MIMO processing is centralized and transmissions are synchronous. This is not as complex as in CDMA, but such a technique should only be used in situations
where spectrum is very scarce.

5.QUALITY OF SERVICE

- Traffic generated by the different services will not only increase traffic loads on the networks, but will also require different quality of service (QoS) requirements (e.g., cell loss rate, delay, and jitter) for different streams (e.g., video, voice, data).
- Providing QoS guarantees in 4G networks is a non-trivial issue where both QoS signaling across different networks and service differentiation between mobile flows will have to be addressed.
- One of the most difficult problems that are to be solved, when it comes to IP mobility, is how to insure the constant QoS level during the handover.
- Depending on whether the new access router is in the same or some other subnetwork, we recognize the horizontal and vertical handover.
- However, the mobile terminal can not receive IP packets while the process of handover is finished. This time is called the handover latency.
- Handover latency has a great influence on the flow of multimedia applications in real-time.
- Mobile IPv6 have been proposed to reduce the handover latency and the number of lost packets.
- The field “Traffic Class” and “Flow Label” in IPv6 eader enables the routers to secure the special QoS for specific packet series with marked priority.

6.SECURITY

- The heterogeneity of wireless networks complicates the security issue.
- Dynamic reconfigurable, adaptive, and lightweight security mechanisms should be developed.
- Security in wireless networks mainly involves authentication, confidentiality, integrity, and authorization for the access of network connectivity and QoS resources for the mobile nodes flow.
- AAA (Authentication Authorization Auditing) protocols provide a framework for such suffered especially for control plane functions and installing security policies in the mobile node such as encryption, decryption and filtering.

7.BENEFITS

7.1 CONVERGENCE OF CELLULAR MOBILE NETWORKS AND WLANS

7.1.1 Benefits for Operators:

- Higher bandwidths.
- Lower cost of networks and equipment.
- The use of licence-exempt spectrum.
- Higher capacity and QoS enhancement.
- Higher revenue.

7.1.2 Benefits for Users:

- Access to broadband multimedia services with lower cost and where mostly needed.
- Inter-network roaming.

7.2 CONVERGENCE OF MOBILE COMMUNICATIONS AND BROADCASTING

7.2.1 From broadcaster point of view:

Introducing interactivity to their unidirectional point-to multipoint Broadcasting systems. That is, a broadband downlink based on DAB/DVB-T and a narrowband uplink based on 3G cellular systems.

7.2.2 From the cellular mobile operator point of view:

. Providing a complementary broadband downlink in vehicular environments to support IP-based multi-media traffic which is inherently asymmetrical.

7.3 CONVERGENCE BENEFITS

Broadcasters will benefit from the use of cellular mobile systems to adapt the content of their multi-media services more rapidly in response to the feedback from customers.

Cellular operators will benefit from offering their customers a range of new broadband multi-media services in vehicular environments.

Users will benefit from faster access to a range ofbroadband multi-media services with reasonable QoS and lower cost.

7.4 WIRELESS SYSTEM DISCOVERY

- A multimode terminal attaches to the WLAN and scans the available systems.
- It can download suitable software manually or automatically.

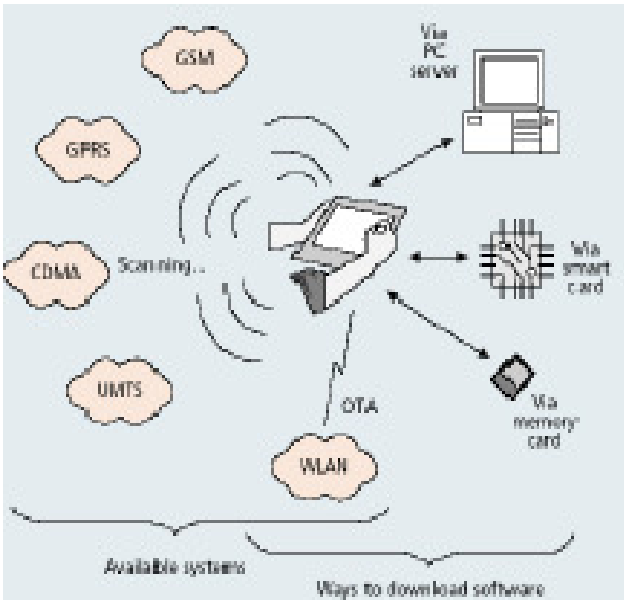

Figure 4. Wireless System Discovery

7.5 RE-CONFIGURABLE TECHNOLOGY

• In order to use the large variety of services and wireless networks, multimode user terminals are essential as they can adapt to different wireless networks by reconfiguring themselves.

• This eliminates the need to use multiple terminals (or multiple hardware components in a terminal).

• The most promising way of implementing multimode user terminals is to adopt the software radio approach.

An ideal software radio receiver

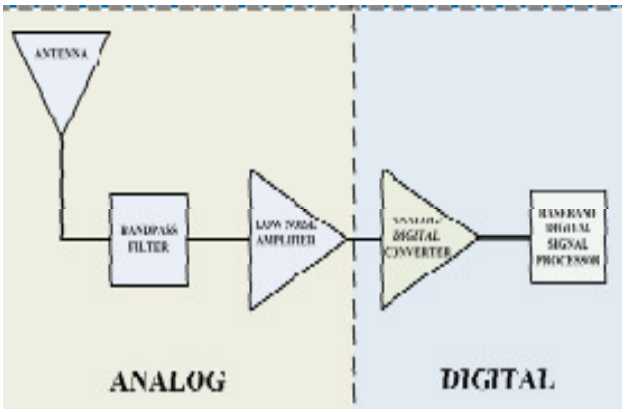

Figure 5. SDR(Software Defined Radio)

RE-CONFIGURABLE TECHNOLOGY

CHALLENGES:

• Regulatory and Standardisation issues

• Business models

• User preference profiles

• Inter-system handover mechanisms and criteria

• Software download mechanisms

• Flexible spectrum allocation and sharing between operators

RE-CONFIGURABLE TECHNOLOGY

BENEFITS FOR:

USERS:

- Select network depending on service requirements and cost.
- Connect to any network – Worldwide roaming.
- Access to new services.

OPERATORS:

- Respond to variations in traffic demand (load balancing).
- Incorporate service enhancements and improvements.
- Correction of software bugs and upgrade of terminals.
- Rapid development of new personalised and customised services.

MANUFACTURERS:

- Single platform for all markets.
- Increased flexible and efficient production.

PERSONAL MOBILITY:

- In addition to terminal mobility, personal mobility is a concern in mobility management.
- Personal mobility concentrates on the movement of users instead of users' terminals, and involves the provision of personal communications and personalized operating environments.
- Once the caller's agent identifies user's location, the caller's agent can directly communicate with his agent.

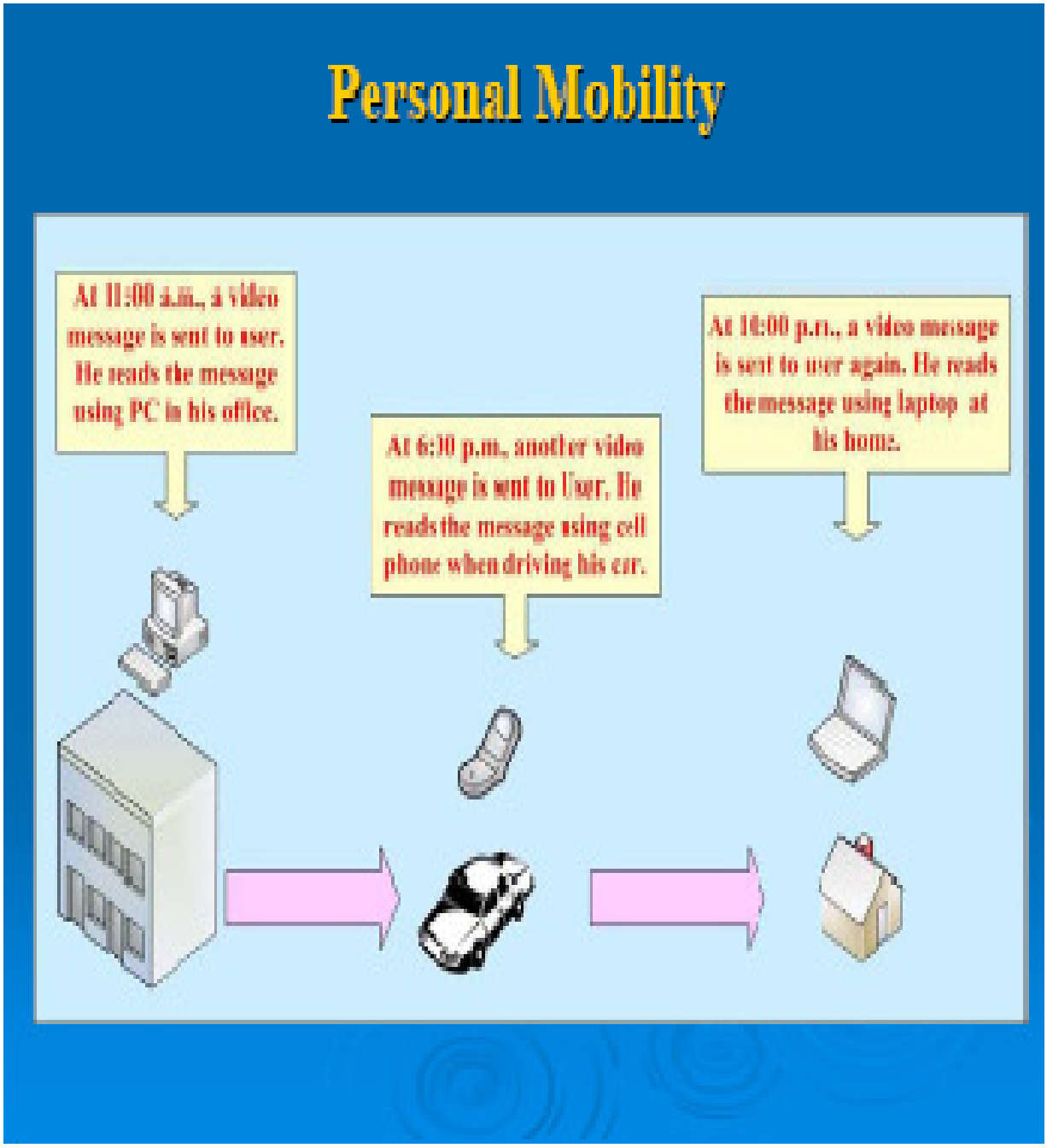

Figure 6. Personal Mobility

8.APPLICATIONS

8.1 VIRTUAL PRESENCE: This means that 4G provides user services at all times, even if the user is off-site.

8.2 VIRTUAL NAVIGATION: 4G provides users with virtual navigation through which a user can access a database of the streets, buildings etc.

8.3 TELE-GEOPROCESSING APPLICATIONS: This is a combination of GIS(Geographical Information System) and GPS (Global Positioning System) in which a user can get the location by querying.

8.4 TELE-MEDICINE AND EDUCATION: 4G will support remote health monitoring of patients. For people who are interested in life long education, 4G provides a good opportunity.

8.5 CRISIS MANAGEMENT: Natural disasters can cause break down in communication systems. In today's world it might take days or 7 weeks to restore the system. But in 4G it is expected to restore such crisis issues in a few hours.

8.6 MULTIMEDIA – VIDEO SERVICES

- 4G wireless systems are expected to deliver efficient multimedia services at very high data rates.
- Basically there are two types of video services: bursting and streaming video services.
- Streaming is performed when a user requires real-time video services, in which the server delivers data continuously at a playback rate.
- Bursting is basically file downloading using a buffer and this is done at the highest data rate taking advantage of the whole available bandwidth.

9.CONCLUSION

As the history of mobile communications shows,attempts have been made to reduce a number of technologies to a single global standard. Projected 4G systems offer this promise of a standard that can be embraced worldwide through its key concept of integration. Future wireless networks will need to support diverse IP multimedia applications to allow sharing of resources among multiple users. There must be a low complexity of implementation and an efficient means of negotiation between the end users and the wireless infrastructure. The fourth generation promises to fulfill the goal of PCC (personal computing and communication)—a vision that affordably provides high data rates everywhere over a wireless network.

4G is expected to be launched by 2010 and the world is looking forward for the most intelligent technology that would connect the entire globe.

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