VISHVESHWARAIAH TECHNOLOGICAL UNIVERSITY

BELGAUM-10

S.D.M COLLEGE OF ENGINEERING AND TECHNOLOGY

DHARWAD-02

A seminar report on

"4G WIRELESS SYSTEM "

Submitted by

SANGAMESHKUMAR.BANDI

2SD05CS066

8th semester

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

2009-10

VISHVESHWARAIAH TECHNOLOGICAL UNIVERSITY

BELGAUM-10

S.D.M COLLEGE OF ENGINEERING AND TECHNOLOGY

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

CERTIFICATE

Certified that the seminar work entitled "4G WIRELESS SYSTEM" is a bonafide work presented by SANGAMESHKUMAR.BANDI bearing USN NO:2SD05CS066 in a partial fulfillment for the award of degree of Bachelor of Engineering in COMPUTER SCIENCE of the Vishveshwaraiah Technological University, Belgaum during the year 2009-10. The seminar report has been approved as it satisfies the academic requirements with respect to seminar work presented for the Bachelor of Engineering Degree.

Staff in charge   **H.O.D CSE**

Name: SANGAMESHKUMAR.BANDI

USN:2SD05CS066

ABSTRACT

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 provide high spectral efficiency . The 4g wireless uses Orthogonal Frequency Division Multiplexing (OFDM), Ultra Wide Radio Band (UWB), and Millimeter 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.

CONTENTS

1. **INTRODUCTION**

Wireless mobile-communications systems are introduced in the early 1980s, first-generation (1G) systems were marked by analog-frequency modulation and used primarily for voice communications. Second - generation (2G) wireless-communications systems, which made their appearance in the late 1980s, were also used mainly for voice transmission and reception. The wireless system in widespread use today goes by the name of 2.5Gan in-between service that serves as a stepping stone to 3G. Whereby 2G communications is generally associated with Global System for Mobile (GSM) service, 2.5G is usually identified as being fueled by General Packet Radio Services (GPRS) along with GSM. In 3G systems, making their appearance in late 2002 and in 2003, are designed for voice and paging services, as well as interactive-media use such as teleconferencing, Internet access, and other services.

The problem with 3G wireless systems is bandwidth these systems provide only WAN coverage ranging from 144 kbps (for vehicle mobility applications) to 2 Mbps (for indoor static applications). Segue to 4G, the next dimension of wireless communication. The 4g wireless uses Orthogonal Frequency Division Multiplexing (OFDM), Ultra Wide Radio Band (UWB), and Millimeter wireless and smart antenna. Data rate of 20mbps is employed. Mobile speed will be up to 200km/hr. Frequency band is 2-8 GHz. it gives the ability for world wide roaming to access cell anywhere.

2. **HISTORY:**

The history and evolution of mobile service from the 1G(first generation) to fourth generation are as follows.

The 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), TDMA (time division multiple access); PDC (personal digital cellular) and CDMA (code division multiple access).These systems operate nationwide or internationally and are today′s mainstream systems, although the data rate for users in these system is very limited.

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.

During the 1990's 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. An interim step is being taken between 2G and 3G,

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.

3. ABOUT 4G:

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.

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. 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

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

Legend:

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
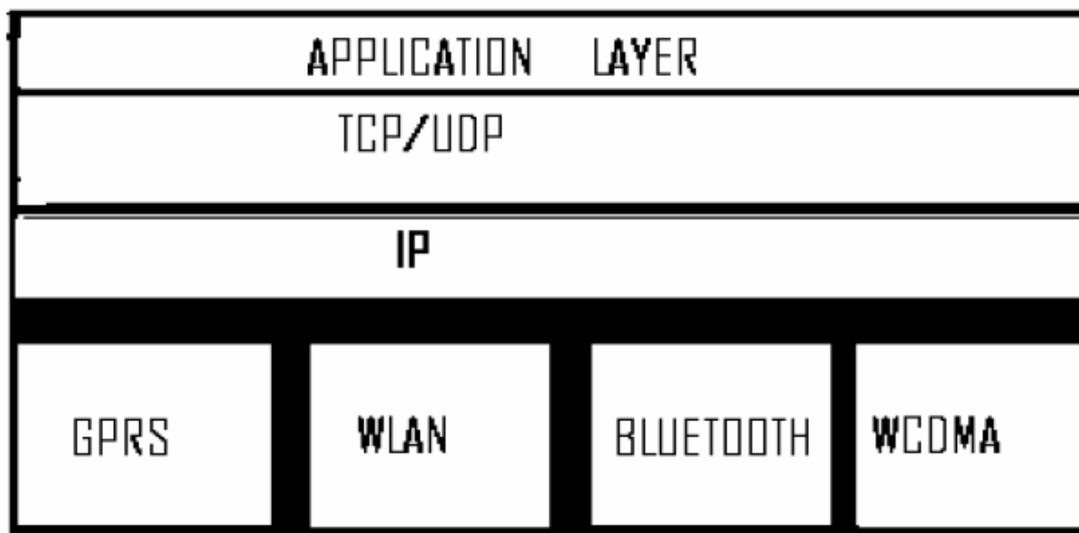WCDMA = wideband CDMA

4.FEATURES:

• Support for interactive multimedia, voice, streaming video, Internet, and other Broad band 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, Bluetooth, and Hyper LAN).

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

4G Wireless System

5. IMPLEMENTATION USING 4G

The goal of 4G is to replace the current core mobile networks with a single worldwide core network standard, based on IP for control, video, packet data, and voice. This will provide uniform video, voice, and data services to the mobile host, based entirely on IP.

```
┌─────────────────────────────────────────────┐
│           APPLICATION   LAYER                 │
├─────────────────────────────────────────────┤
│                TCP/UDP                        │
├─────────────────────────────────────────────┤
│                  IP                           │
├──────────┬──────────┬─────────────┬──────────┤
│          │          │             │          │
│  GPRS    │  WLAN    │  BLUETOOTH  │  WCDMA   │
│          │          │             │          │
└──────────┴──────────┴─────────────┴──────────┘
```

IP is assumed to act as an adhesive for providing global connectivity and mobility among networks. An all IP-based 4G wireless network has inherent advantages over its predecessors. It is compatible with, and independent of the underlying radio access technology.

An IP wireless network replaces the old Signaling System 7 (SS7) telecommunications protocol, which is considered massively redundant. This is because SS7 signal transmission consumes a larger part of network bandwidth even when there is no signaling traffic for the simple reason that it uses a call setup mechanism to reserve bandwidth, rather time/frequency slots in the radio waves.

IP networks, on the other hand, are connectionless and use the slots only when they have data to send. Hence there is optimum usage of the available bandwidth. Today, wireless communications are heavily biased toward voice, even though studies indicate that growth in wireless data traffic is rising exponentially relative to demand for voice traffic. Because an all IP core layer is easily scalable, it is ideally suited to meet this challenge. The goal is a merged data/voice/multimedia network.
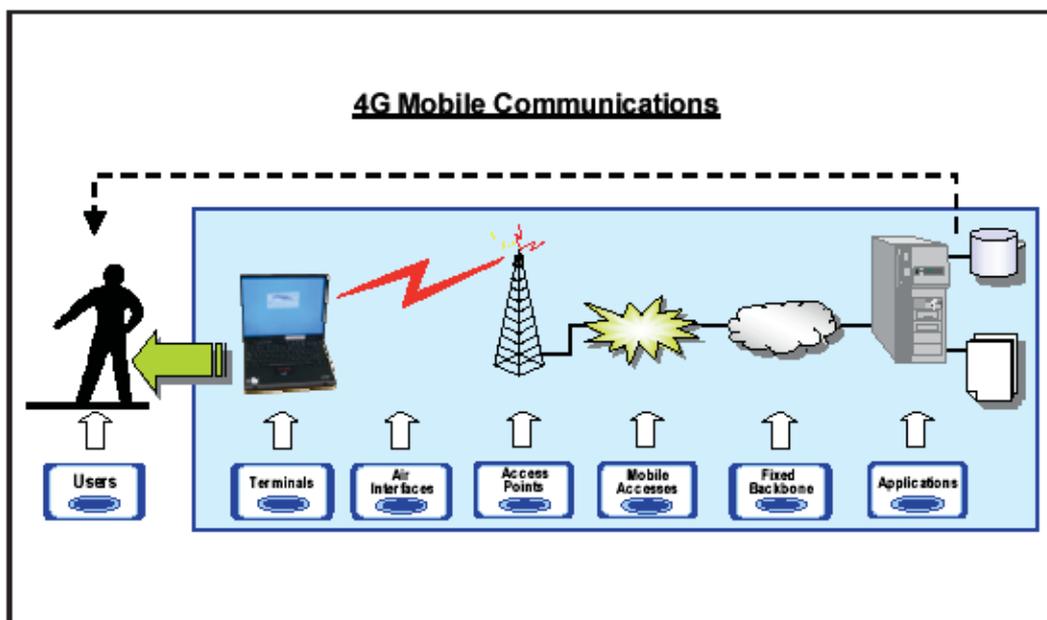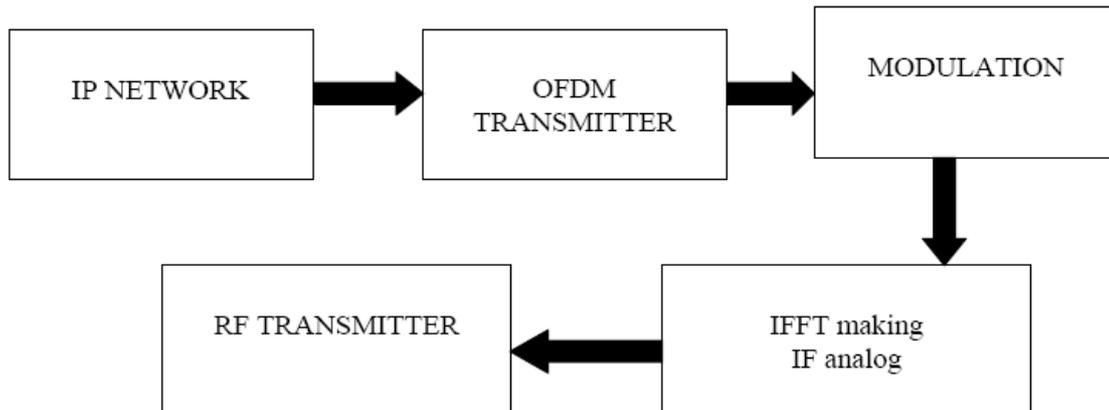

Figure 1. 4G Visions (Ref. 1)

6.TRANSMISSION

An OFDM transmitter accepts data from an IP network, converting and encoding the data prior to modulation. An IFFT (inverse fast Fourier transform) transforms the OFDM signal into an IF analog signal, which is sent to the RF transceiver. The receiver circuit reconstructs the data by reversing this process. With orthogonal sub-carriers, the receiver can separate and process

IP NETWORK
OFDM
TRANSMITTER
MODULATION
IFFT making
IF analog
RF TRANSMITTER
ODFM   provides better link and communication quality.

7.Wireless Technologies Used In 4G

1. OFDM
2. UWB
3. MILLIMETER WIRELESS
4. SMART ANTENNAS
5. LONG TERM POWER PREDICTION
6. SHEDULING AMONG USERS
7. ADAPTIVE MODULATION AND POWER CONTROL

7.1 Orthogonal Frequency Division Multiplexing(OFDM):

OFDM, a form of multi-carrier modulation, works by dividing the
data stream for transmission at a bandwidth B into N multiple and parallel bit streams, spaced B/N apart (**Figure**). Each of the parallel bit streams has a much lower bit rate than the original bit stream, but their summation can provide very high data rates. N orthogonal sub-carriers modulate the parallel bit streams, which are then summed prior to transmission.
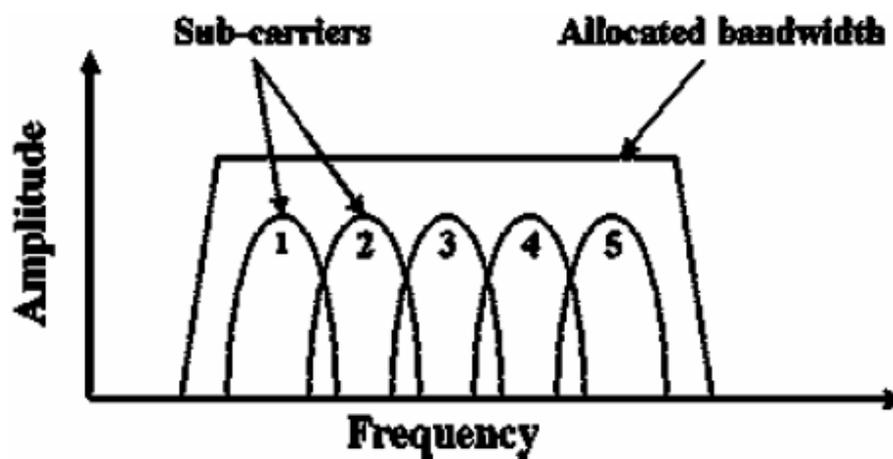
An OFDM transmitter accepts data from an IP network, converting and encoding the data prior to modulation.An IFFT (inverse fast Fouriertransform) transforms the OFDM signal into an IF analog signal, which is sent to the RF transceiver. The receiver circuit reconstructs the data by reversing this process. With orthogonal sub-carriers, the receiver can separate and process each sub-carrier without interference from other sub-carriers. More impervious to fading and multi-path delays than other wireless transmission techniques, ODFM provides better link and communication quality.

7.1.1Error Correcting:

4Gs error-correction will most likely use some type of concatenated coding and will provide multiple Quality of Service (QoS) levels. Forward error-correction (FEC) coding adds redundancy to a transmitted message through encoding prior to transmission. The advantages of concatenated coding over convolutional coding are enhanced system performance through the combining of two or more constituent codes into one concatenated code. The combination can improve error correction or combine error correction with error detection

For example: For implementing an Automatic Repeat Request if an error is found. FEC using concatenated coding allows a communications system to send larger block sizes while reducing bit-error rates.

7.4 Smart Antennas:

A smart antenna system consists of multiple antenna elements with signal processing to automatically optimize the antennas radiation (transmitter) and/or reception (receiver) patterns in response to the signal environment. One smart-antenna variation in particular, MIMO, shows promise in 4G systems. MIMO (Multi-Input Multi-Output) is a smart antenna system where smartness is considered at both transmitter and the receiver. MIMO represents space-division multiplexing (SDM)—information signals are multiplexed on spatially separated N multiple antennas and received on M antennas. **Figure** shows a general block diagram of a MIMO system. Multiple antennas at both the transmitter and the receiver provide essentially multiple parallel channels that operate simultaneously on the same frequency band and at the same time. This results in high spectral efficiencies in a rich scattering environment (high multi-path), since you can transmit multiple data streams or signals over the channel simultaneously.
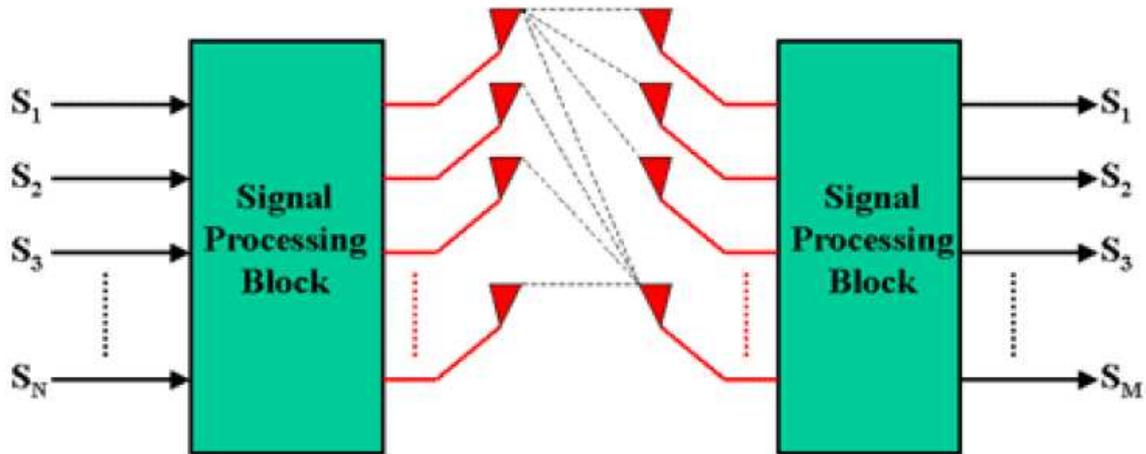
7.6 Scheduling among Users:

To optimize the system throughput, under specified QoS requirements and delay constraints, scheduling will be used on different levels:

7.6.1 Among sectors:-In order to cope with co-channel interference among neighboring sectors in adjacent cells, time slots are allocated according to the traffic load in each sector .Information on the traffic load is exchanged infrequently via an inquiry procedure. In this way the interference can be minimized and higher capacity be obtained. After an inquiry to adjacent cells, the involved base stations determine the allocation of slots to be used by each base station in each sector.

The inquiry process can also include synchronization information to align the transmission of packets at different base stations to further enhance performance.

7.6.2 Among users:-Based on the time slot allocation obtained from inquiry process, the user scheduler will distribute time-frequency regions among the users of each sector based on their current channel predictions. Here different degrees of sophistication can be used to achieve different transmission goals.

8.ISSUES:

1)The first issue deals with optimal choice of access technology, or how to be best connected:
User may be offered connectivity from more than one technology at any one time, one has to consider how the terminal and an overlay network choose the radio access technology suitable for services the user is accessing. There are several network technologies available today, which can be viewed as complementary.
For example, WLAN is best suited for high data rate indoor coverage. GPRS or UMTS, on the other hand, are best suited for nation wide coverage and can be regarded as wide area networks, providing a higher degree of mobility. Thus a user of the mobile terminal or the network needs to make the optimal choice of radio access technology among all those available. A handover algorithm should both determine which network to connect to as well as when to perform a handover between the different networks. Ideally, the handover algorithm would assure that the best overall wireless link is chosen. The network selection strategy should take into consideration the type of application being run by the user at the time of handover. This ensures stability as well as optimal bandwidth for interactive and background services.

2)The second issue regards the design of a mobility enabled IP networking architecture:
This includes fast, seamless vertical (between heterogeneous technologies) handovers (IP micro-mobility), quality of service (QoS), security and accounting.
Mobility in IPv6 is not optimized to take advantage of specific
mechanisms that may be deployed in different administrative domains. Instead, IPv6 provides mobility in a manner that resembles only simple portability.
To enhance Mobility in IPv6, 'micro-mobility' protocols have been developed for seamless handovers i.e. handovers that result in minimal handover delay, minimal packet loss, and minimal loss of communication state.

3)The third issue concerns the adaptation of multimedia transmission across 4G networks:
Multimedia will be a main service feature of 4G networks, and changing radio access networks may in particular result in drastic changes in the network condition.
In cellular networks such as UMTS, users compete for insufficient and expensive bandwidth. Variable bit rate services provide a way to ensure service provisioning at lower costs. In addition the radio environment has dynamics that renders it difficult to provide a guaranteed network service. This requires that the services are adaptive and robust against varying radio conditions.

High variations in the network Quality of Service (QoS) leads to
significant variations of the multimedia quality. The result could sometimes be unacceptable to the users. Avoiding this requires choosing an adaptive encoding framework for multimedia transmission. The network should signal QoS variations to allow the application to be aware in

real time of the network conditions. User interactions will help to ensure personalized adaptation of the multimedia presentation.

9.APPLICATIONS

9.1 4G Car
With the hype of 3G wireless in the rear view mirror, but the reality of
truly mobile broadband data seemingly too far in the future to be visible yet on the information super highway, it may seem premature to offer a test drive 4G.
But the good news is, 4G is finally coming to a showroom near you.

9.2 4G and public safety
There are sweeping changes taking place in transportation and intelligent highways, generally referred to as "Intelligent Transportation Systems" (ITS). ITS is comprised of a number of technologies, including information processing, communications, control, and electronics. Using these technologies with our transportation systems, and allowing first responders access to them, will help prevent - or certainly mitigate - future disasters. Communications, and the cooperation and collaboration it affords, is a key element of any effective disaster response. Historically, this has been done with bulky handheld radios that provide only voice to a team in a common sector. And this architecture is still cellular, with a singular point of failure, because all transmissions to a given cell must pass through that one cell. If the cell tower is destroyed in the disaster, traditional wireless service is eliminated. 4G wireless eliminates this spoke-and-hub weakness of cellular architectures because the destruction of a single node does not disable the network. Instead of a user being dependent on a cell tower, that user can hop through other users in dynamic, self roaming, self-healing rings. This is reason enough to make this technology available to first responders. But there is more: mobility, streaming audio and video, high-speed Internet, real-time asset awareness, geo-location, and in-building rescue support. All this at speeds that rival cable modems and DSL. Combining 4G with ITS infrastructure makes both more robust. In 4G architectures, the network improves as the number of users increases.

ITS offers the network lots of users, and therefore more robustness.
Think of every light pole on a highway as a network element, a "user" that is acting as a router/repeater for first responders traveling on those highways. Think of every traffic light as a network element, ideally situated in the center of intersections with a 360-degree view of traffic. This is the power of the marriage between 4G networks and ITS

9.3 Sensors in public vehicle

Putting a chemical-biological-nuclear (CBN) warning sensor on every

government- owned vehicle instantly creates a mobile fleet. As these vehicles go about their daily duties of law enforcement, garbage collection, sewage and water maintenance, etc., municipalities get the added benefit of early detection of CBN agents. The sensors on the vehicles can talk to fixed devices mounted on light poles throughout the area, so positive detection can be reported in real time. And since 4G networks can include inherent geo-location without GPS, first responders will know where the vehicle is when it detects a CBN agent.

9.4 Cameras in traffic light

Some major cities have deployed cameras on traffic lights and send

those images back to a central command center. This is generally done using fiber, which limits where the cameras can be hung, i.e., no fiber, no camera. 4G networks allow cities to deploy cameras and backhaul them wirelessly. And instead of having to backhaul every camera, cities can backhaul every third or fifth or tenth camera, using the other cameras as router/repeaters. These cameras can also serve as fixed infrastructure devices to support the mobile sensor.

9.5 First responder route selection

Using fiber to backhaul cameras means that the intelligence collected

flows one way: from the camera to the command center. Using a 4G network, those images can also be sent from the command center back out to the streets. Ambulances and fire trucks facing congestion can query various cameras to choose an alternate route. Police, stuck in traffic on major thoroughfares, can look ahead and make a decision as to whether it would be faster to stay on the main roads or exit to the side roads.

9.6 Traffic control during disasters

4G networks can allow officials to access traffic control boxes to change

inland traffic lanes to green. Instead of having to send officers to every box on roads being overwhelmed by civilians who are evacuating, it can all be done remotely, and dynamically.

10.ADVANTAGES

1. 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.

2. 4G in principle will allow high-quality smooth video transmission.

3. In 3G only very short music clips can be downloaded. 4G is likely to enable the download of full length songs or music pieces which may change the market response dramatically. Music rights will be a major issue to solve.

4. 3G and 4G Mobile operators have demanded products that will offer PC capabilities in a PDA form factor.

5. Fourth-generation (4G) cellular services, intended to provide mobile data at rates of 100Mbits/sec or more.

11.CONCLUSION

- 4G provide with a very efficient and reliable wireless communication system for seamless roaming over various network including internet which uses IP network.

- It will be implemented in the coming years which are a miracle in the field of communication engineering technology.

- It will dominate the wireless communications, and its converged system will replace most conventional wireless infrastructure.

12. REFERENCES

1) Communication Systems

2) www.comsoc.org

3) www.techonline.com

4) www.ieee.org