4G- A New Generation of Wireless Telecommunication

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***Abstract*—** The fourth generation wireless network systems will be fully IP-based wireless internet and is supposed to provide high data rate and all IP based multimedia services on an "anytime, anywhere, anyhow" basis with better visual technologies and higher bandwidth. The purpose of this paper is to provide an overview of the different aspects of 4G which includes its benefits, challenges in deployment, its proposed architecture and key technological enablers.

Keywords*—OFDM, MIMO, SDR, QoS*

I. INTRODUCTION

Each generation of wireless telecommunication has been a giant stride which revolutionized the field of mobile communication. After 2G and 3G network technologies, the 4G technology consists of all the basic standards of 2G and 3G with advanced modifications. In 1G and 2G communication systems, voice was considered to be the main traffic. Both 1G and 2G are based on circuit switched technology for data communication at low speed.

According to the ITU, the 4G network technologies must be capable of transmitting a data speed of approximately 100 Mbps in mobile phones and approximately 1Gbps in stationary local networks. 4G is also called as MAGIC (Mobile, Multimedia, Anytime Anywhere, Global mobility support, Integrated wireless solution and Customized personal service).

Some key features of 4G wireless network are as follows:-

- Interoperability and simple roaming
- Fast/Seamless handover across multiple networks
- High network capacity
- Support for multimedia services at low transmission cost
- High speed
- Autonomous network
- Software independence
- Ubiquitous mobile access

II. HISTORY AND EVOLUTION OF DIFFERENT GENERATIONS OF WIRELESS TELECOMMUNICATION

A. First generation (1G)

- Basic mobility
- Basic services
- Incompatibility
- Analog system

B. Second generation (2G)

- Advanced mobility (roaming)
- More services (data presence)
- Digital system
- Towards global solution

C. Third generation (2G)

- Seamless roaming
- Service concepts and models
- Global radio access
- Global solution
- High data rates

D. Fourth generation (4G)

- IP based mobility
- Very high data rates
- Complete telecom/datacom convergance

TABLE 1: NETWORK GENERATION

Generation	Data speed	Networks
1G	5-9 kbps	AMPS, NMT, TACS
2G	9.6-30 kbps	GSM, CDMA, TDMA, iDEN, PDC, PHS
2.5G+	20-130 kbps	GPRS, HSCSD, EDGE, CDMA2000 1XRTT
3G	300-600 kbps	WCDMA, CDMA2000 1 X EV-DO
3.5G	3.1-73.5 Mbps	HSDPA, HSUPA, UMTS TDD(TD-CDMA), TD-SCDMA, EV-DO Revision A

3.9G	100-200 Mbps	3 GPP LTE, 3 GPP2 UMB
4G	100-1000 Mbps	Undefined

III. NETWORK ARCHITECTURE

The architecture is based on Internet Protocol version 6 (IPv6) which operates at the transport layer enabling seamless communication across various heterogeneous networks and based on the key factors such as mobility, quality of service(QoS) and efficient resource management schemes.

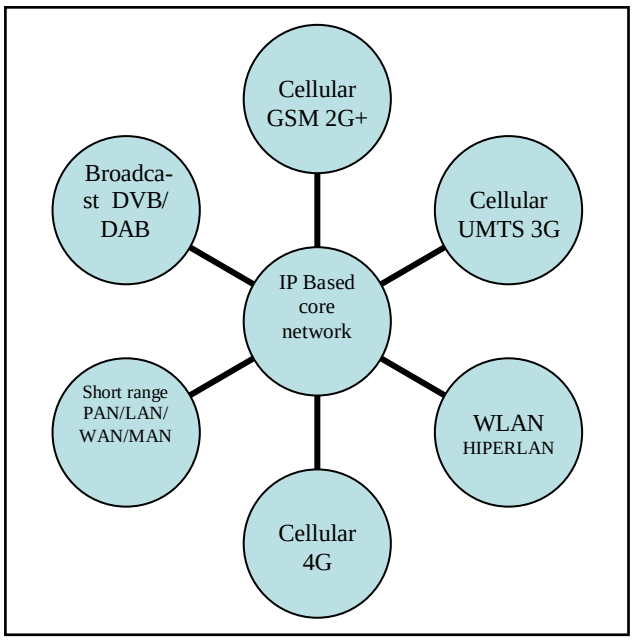

Fig.1; 4G Architecture Network

IV. SOME KEY 4G TECHNOLOGIES

There are several technologies suggested to deploy in the 4G. They are discussed as follows:-

A. OFDM

OFDM can be used for the downlink transmission of the symbols for achieving high spectral efficiency. It facilitates the optimization between various layers of network for usage of radio link from multiple radios. OFDM is currently applied on various wireless and wireline standards such as Wi-Fi, wireless LAN, Wi-MAX, 3GPP UMTS AND 3GPP@ LTE.

B. Multiple-Input and Multiple-Output (MIMO)

It provides high spectral efficiency and link reliability facilitating significant increase in the data throughput and radio link usage without additional bandwidth and transmission power. This is currently used in WLAN-Wi-Fi-802.11n and digital home.

C. Software Defined Radio (SDR)

It is used for implementation of the multimodal, multi-band, multi-standard user terminals and base stations which allows accessibility across various wireless and wire line heterogeneous networks. It reduces the cost for development of multimodal, multiband and multi-standard user equipments. The current SDR technology is not capable of supporting the multiple networks. It should be enhanced to support multiple networks.

V. CHALLENGES IN INTEGRATING 4G WIRELESS SYSTEMS

Challenges are broadly classified into three categories namely mobile station, system and service.

A. Mobile Station

(i) Multimode User Terminal

Multimode user terminal is a device which supports a wide variety of 4G services and wireless networks by reconfiguring themselves to adapt to different wireless networks. They encounter several design issues such as limitation in size of the device, its cost and power consumption.

(ii) Discovery of wireless network

Service discovery is much more challenging in 4G due to the heterogeneity of the networks and their access protocols. By using software defined radio approach one can easily counter this challenge.

(iii) Selection of wireless network

4G will provide a choice to users to select a wireless network which provides optimized performance and high QoS for a desired service at a particular place and time. However it is difficult to choose an appropriate network for every communication session since network accessibility changes from time to time. Some possible considerations may be available network resources, network supported service types and cost and user performance.

B. System Challenges

(i) Terminal Mobility

Terminal mobility is responsible for anytime, anywhere feature of 4G. It allows the mobile users to room across the geographic boundaries of wireless networks. The main issues in terminal mobility are location and handoff management. Handoff process faces several challenges like maintaining the QoS and system performance across different systems, deciding the correct handoff time, designing the correct

handoff mechanism, packet losses, handover latency and the increased system load.

(ii) QoS support and network infrastructure

4G is an integration of IP and non-IP based system. In 4G networks QoS designs should consider the integration of different wireless networks to guarantee QoS for end-to-end services.

(iii) Security Issues

Most of the security measures and protocols were designed only for specific services. They are inflexible to be used across the architecture of 4G. Therefore, it is necessary for the organization to develop an effective series of tools that support most 4G security measures.

C. Services

(i) Billing System and Multiple Operators

In 4G networks, each user can avail to different services made available by different operators and thus complicates the billing system for both the service providers and the end users. Several frameworks are being studied based on the requirements of scalability, flexibility, accuracy and usability to cater the above issues.

(ii) Personal mobility

Personal mobility concentrates on users movement instead of their terminals and emphasizes on personal communication- ensuring message delivery to the user. Once the user moves from their home network, their agents can migrate to the new network.

VI. CONCLUSION

The evolution of 4G revolutionize the field of telecommunication which brings the wireless experience to a completely new level. The 4G mobile communication system will reduce number of different technologies to a single global standard. It would provide wealth of features and services making the world a smaller place to live. The user-centric approach towards 4G's development is the key to its success. The threat analysis model provided by ITU is very apt for the complete analysis and planning for security of 4G. It can be used as a reference framework for future research.

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