Mobile Communication – An overview

Lesson 06

Introduction to 3G+ (Pre-4G), 4G and 5G Data Communication

pre-4G Mobile

- IP
- OFDMA
- WiMax (IEEE 802.16e)
- [WiMax (worldwide interoperability for microwave access)]

Broadband Fixed Wireless Access (BFWA) systems

- Broadband data services to provide Internet access for applications such as E-mail, web-browsing, file downloading and transfer, audio and video services over Internet

BFWA Multipaths and Turbo Equilization

- Radio signal multi paths from transmitter to receiver antennas
- Multipath propagation causing inter-symbol interference and degrade the system performance
- Turbo equalization used a powerful technique to remove the effect of inter-symbol interference

Multi Input Multi Output Antennae (MIMOs)

- Use MIMO space-time coding to increase the capacity
- Signals from different antennas separated through orthogonal design (Alamouti algorithm)
- When used over frequency selective channels, a channel equalizer has to be used at the receiver along with the space-time decoder

MIMO

- OFDM and the frequency selective channel converts into a set of independent parallel frequency-flat sub-channels

WiMax

- Defines a specification for new generation innovative technology
- Delivers high--speed broadband, fixed, and mobile services wirelessly to large areas with much less infrastructure using the IEEE 802.16 standard

WiMax 802.16e

(a) Up to 2048 sub-carriers scalable, and a single channel OFDMA

(b) 128, 256, 512, 1024, and 2048 FFT (fast Fourier Transform)

(c) Adaptable number of channels (closer to cell more channels and farther from cell less channels)

(d) Sub-channelisation for subscriber links (This reduces interference from multiple paths)

WiMax 802.16e

(e) 64-QAM, 16-QAM, QPSK and BPSK adaptive modulation (64-QAM for strong signals and BPSK for weak signals)

(f) MIMO antennae (giving higher bandwidth)

(g) Beamforming Antennae

(h) Advanced Antenna Systems (AAS)

(i) DES or AES encryption

WiMax 802.16e

(j) Dynamic

(k) Fast hybrid Automatic Repeat reQuest (ARQ)

(l) MAC sublayers for IP, Ethernet, Handover mechanisms and classification of data

(m) Idle and sleep modes for Power saving

(n) Allocation of channel by Base station to the subscriber station

LTE Pre-4 G evolution and standards

- LTE (Long Term Evolution)
- 3GPP High Speed OFDM Packet Access (HSOPA)
- 1.25 MHz to 20 MHz bandwidth
- 100Mbps downlink and 50 Mbps uplink for voice
- Support for IPTV with full mobility, high-speed video

4G Features

- Enable multimedia newspaper, mobile TV of high resolution, IP telephony and 100 Mbps data rates
- Uses mobile WiMax IEEE 802.16m standard and LTE Advanced
- 4G [1000 Mbps (1 Gbps) data rates]

LTE Advanced

(a)MT Advanced Multi-carrier OFDMA in downlink and Hybrid of OFDMA and SC-FDMA (single carrier FDMA) in uplink

(b) Scalable bandwidth support between exceeding 20 MHz up toand 100 MHzMHz. Supports and 100 MHz downlink bandwidth

LTE Advanced

(c) Adaptable spectrum usage

(d) 1000 Mbps fixed systems and 100 Mbps mobile data rates for multimedia newspapers and for and high resolution TV

(e) Supports 100 Mbps for mobile

(f) Faster switching between different power levels

LTE Advanced

(g) Cell edge handover improved performance during Cell edge handover

(h) Use of relay nodes

(i) Single user MIMO, coordinated MIMOs and diversified MIMOs

(j) Dual transmission [CDMA, HSPA Support Node **GGSN** to the packet data network]

(k) Automatic (j) autonomous network operations

(l) Interference management and suppression

LTE Advanced

(m) Advanced networks topology,

(n) OptimisedOptimized heterogeneous networks

(o) Both high and low data rates 40 Mbps and 154 Mbps per nodes

(p) Use of picocells (very short region cells) and femtocells (tiny region cells) [http://qualcomm.com/technology]

WiMax IEEE802.16m

(a) Wireless MAN (Metropolitan Network)

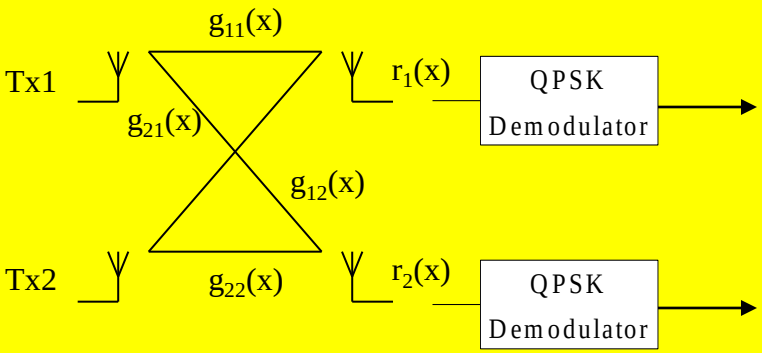
(b) WiMax 802.16e enhanced to multicarrier support (two different channels not necessary in adjacent bands)

(c) multi-hop relay

(d) enhanced multi-cast broadcast, increased

(e) Single -– User and Multi-User MIMO

MIMO



WiMax IEEE802.16m

(f) Up to 120Mbps downlink and 60Mbps uplink using a 4 × 2 MIMO/TDD 5:3 (self-configuration for the FDD and TDD , configuration) to users

(g) adaptable to 20 ms superframes to give 20 MHz, 30 MHz and 40 MHz bandwidths two, three and four times data transfer rates two carriers

(h) Interference compression

(i) Reduced latency of a link

WiMax IEEE802.16m

(j) 1000 Mbps fixed and 100 Mbps mobile— That enables video conferencing, videos, high resolution TV and , multimedia newspapers (http://www.ieee802.org/16/tgm/docs/80216m-08_003r1.pdf)

5G

- Satisfy ITU IMT-2020 requirements and 3GPP Release 15
- High throughput, low latency, high mobility and high connection density
- Additional spectrum in the existing LTE frequency range (600 MHz to 6 GHz) and millimeter wave bands (24-86 GHz)

5G

- Support data rates of up to 20 gigabits per second (Gbps)
- Massive MIMO (Multiple Input Multiple Output) Infrastructure for significant increase in network capacity

5 G – eMBB Network Services

ITU three categories of Network Services

1. Enhanced Mobile Broadband (eMBB) handsets. Initial 5G deployments will focus on eMBB·

5 G– URLLC and MMTC Network Services

2. Ultra-Reliable Low-Latency Communications (URLLC), which includes industrial applications and autonomous vehicles, and
3. Massive Machine Type Communications (MMTC) from sensors.

5 G Use Cases (Projected)

- 10- to 100-fold increase in the number of 5G-connected devices over the number of 4G devices
- The Internet of Things (IoT) —5G's virtualized, radio technology-agnostic core, published predictions estimate as many as 20 billion IoT connections by 2020

5 G Use Cases (Projected)

- Drive smart buildings and smart cities
- 1,000 times the bandwidth of 4G
- Up to five times the density
- 5G speeds driverless cars to coordinate over the network, enable augmented reality and virtual reality, and expand the horizons of remote surgery

Summary

- Pre-4G LTE
- Pre-4G WiMax IEEE 802.16e
- 4-G Multimedia newspaper, mobile TV of high resolution, IP telephony and 1000 Mbps data rates.
- LTE Advanced
- WiMAx 802.16m

End of Lesson 06

Introduction to 3G+, 4G and 5 G Data Communication