4G Technologies for Spectrum Efficiency

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Reviewing The History of Cellular Systems

- Aimed at the voice communications

  1G-3G (1984-) for high capacity and spectrum efficiency
- Applying frequency channel reuse techniques to increase the voice capacities
- In 1G: An analog system was used with FM (FDMA) and a bandwidth of 30 kHz. It worked for suppressing noise, interference, time delay spread and Doppler frequency shift

Reviewing The History Of Cellular Systems (Cont.)

- In 2G: A digital system with TDMA, such as GSM and NA-TDMA. GSM uses a bandwidth of 200 KHz with 8 time slots
- In 2.5 G: Using CDMA (spread spectrum) with a bandwidth of 1.25 MHz and 64 codes. Applied rake-receivers to acquire the desired channels, used power control to encounter the near-far situation. The frequency reuse pattern is K=1
- In 3G: Using CDMA with a 5 MHz bandwidth. The frequency reuse pattern K=1.

Spectrum Efficiency in Voice Systems

- Based on the number of voice channels/1 MHz/Sq Mi
- Only needs 8 kbps-13 kbps per voice channel
- CDMA is the candidate for voice systems

Selecting The Technology For High Speed Data Rates

- OFDMA will be the candidate
- It consists of a group of sub carriers
- Each sub carrier has a narrow bandwidth
- It can provide a high speed data rates in the mobile communication environment

The Spectrum Efficiency for Data Transmission

- ITU has issued the requirement for 4G data rates
  - 1 Gbps in a standstill condition
  - 100 Mbps in a moving condition
- No specific for the bandwidth
- No specific for the technology
- Who can apply a technology to meet the requirement with a least bandwidth becoming a winner

Choose The Technologies for 4G systems

- The criterions of challenging spectrum efficiency for voice and data are different
- Then, the chosen of technologies should be different
- It is very hard to select one technology to meet both criterions
- Therefore, we conclude that CDMA is for voice and OFDMA for data.

Summary

- CDMA technology is suitable for voice systems
- OFDMA technology is suitable for data transmission systems
- A dual-mode handset will be used for the 4G systems in the future