

4G Technologies for Spectrum Efficiency

By

Dr. William C.Y. Lee
Professor, Peking University
Chairman, Treyspan Inc.

**World Wireless Congress
4G Mobile Summit
Fairmont Hotel, San Jose, CA
May 14-15, 2008**

Why Spectrum Efficiency

- On the planet –We have not found another kind of transmission medium beside EM wave
- The vast extension of using wireless communications in multi-media applications needs a wide range of EM wave below 40 GHz
- The spectrum becomes a very precious commodity
- The demand and challenge in managing spectrum efficiency becomes critical

How Spectrum Efficiency

- The evaluation of spectrum efficiency should be based on different environments (fixed or moving) and different applications (voice, data or video).
- The cellular system is the first system considering spectrum efficiency for voice channels in the history

Reviewing The History of Cellular Systems

- Aim at the voice communications 1G-3G (1984-1998) for high capacity and spectrum efficiency
- Apply frequency channel reuse techniques to increase the voice capacities
- In 1G: An analog system was used with FM (FDMA) and bandwidth of 30 kHz. It works for suppressing noise, interference, time delay spread and Doppler frequency shift

Reviewing The History Of Cellular Systems

- 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. Apply rake-receivers to acquire the desired channels, power control to encounter the near-far situation. The frequency reuse pattern is $K=1$
- In 3G: Using CDMA with 5 MHz bandwidth. The frequency reuse pattern $K=1$.

Spectrum Efficiency in Voice Systems

- Based on the number of multiple access channels
- Calculated by the voice channels/1 MHz/Sq Mi
- Only needs 8 kbps-13 kbps per voice channel
- Among all the multiple access schemes, CDMA is the candidate for voice systems