Notes on Dahlmann, Parkvall, Skold's "5G NR" Chapter 4 – "LTE overview"

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LTE Release 8 – Basic Radio Access I

Spectrum flexibility introduced

- Carrier bw of 20 MHz for carrier frequencies of 1 GHz to 3 GHz
- Support for paired and unpaired FDD and TDD

Transmission scheme

- OFDM (robust to time dispersion and ease of exploiting time and freq. domains + MIMO)
- Subcarriers of 15 kHz and cyclic prefix of 4.7 μs – 1200 subcarriers in 20 MHz spectrum allocation
- Uplink: DFT precoded OFDM for low PAR and high power amplifier efficiency
- Time domain: 10 ms frames – 1 ms sub-frames – 14 OFDM symbols (smallest schedulable unit in LTE)

LTE Release 8 – Basic Radio Access II

Cell-specific reference signals

- The base station transmits one reference signal per layer
- Usage: downlink channel estimation (coherent demod.), channel state reporting (scheduling), correction of device-side frequency errors, etc

Scheduling

- Channel-dependent scheduling
- Fast hybrid ARQ – upon downlink reception, the devices reports back to the base station the outcome of the decoding operation, which can re-transmit if erroneously received
- For each 1 ms sub-frame, the scheduler controls which devices are to transmit or to receive and in what frequency resources
- Scheduling decisions provided through the Physical Downlink Control Channel (PDCCH)
- 1 PDCCH per UE

LTE Release 8 – Basic Radio Access III

- Uplink control signaling: HARQ acks, CSI for downlink scheduling through the Physical Uplink Control Channel (PUCCH)

Multi-antenna schemes

- SU-MIMO
- A number N_L of transmission layers are mapped to up to 4 antennas by means of a $N_A \times N_L$ precoder
- N_L is also known as transmission rank $\leq N_A$, the number of antennas
- closed-loop spatial multiplexing, possibility of open-loop spatial multiplexing
- Single-layer transmission – $N_A \times 1$ precoders – codebook-based beamforming

LTE Evolution

- Rel. 8 and 9 – foundations of LTE [2008, 2009]
- Rel. 10 – start of LTE evolution, would be fully compliant with IMT-Advanced requirements. Supports carrier aggregation, extended multi-antenna transmission, relaying and intercell interference coordination [late 2010]
- Rel. 11 – Coordinated multipoint (CoMP), etc [late 2012]
- Rel. 12 – semi dynamic TDD, device-to-device communication, etc [2014]
- Rel. 13 – LTE Advanced Pro "4.5G" – supports unlicensed spectra as a complement – many improvements in MIMO, carrier aggregation, etc [2015]
- Rel. 14 – V2V, V2X communications [spring 2017]
- Rel. 15 – [2018]

Spectrum flexibility I