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Key technology issues for LTE-Advanced

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Some key considerations

- The amount of spectrum identified for IMT (following WRC-07) is significantly less than the amount of spectrum predicted as needed for IMT
- Overall system capabilities and real world multi-user support have been key to the success of mobile communications
- Expected numbers and density of active users is increasing rapidly
- Backwards compatibility with LTE is essential
  - Legacy LTE terminals can operate in LTE-Advanced networks
  - Build on basic structure and design of LTE
- Mobility support is a key differentiator of 3GPP systems, and should not be sacrificed for the sake of support for high peak data rates

Spectrum aspects

- Increasing system bandwidth
  - LTE physical layer already supports deployment with a wide range of system bandwidths
    - The range of supported bandwidths will need to be increased
- Spectrum sharing and multi-band operation
  - Given the expected shortfall in available spectrum, and fragmented band plans:
    - Spectrum sharing technologies (between cells, between deployments, between systems) could be vital to the success of LTE-Advanced
    - Multi-band operation (simultaneous use of band-fragments in a coherent manner) seems necessary at the system level.
      - Not yet clear whether this is also necessary within individual terminals
      - But frequency agility between different bands will be essential for an individual terminal

Interference management/mitigation

- To combat both limited spectrum availability and increased numbers of active users
  - Techniques to combat interference (intra cell, inter cell and inter system) will make a significant difference to overall system performance
  - System costs (e.g. backhaul traffic for coordination) must also be understood
  - Interference cancellation at the terminal adds cost and complexity
    - But can be justifiable if the performance improvement is significant
    - The network can facilitate interference cancellation
      - Move from interference randomisation to interference co-ordination
      - Provide useful information to the terminal to improve cancellation
        - Signalling overhead may be justified by improved performance

Efficient control signalling design

- Control signalling needs to be efficient
- Support for wider bandwidths / non-contiguous bands
  - Control signalling overhead does not necessarily scale linearly with bandwidth
  - ensure low overhead regardless of system bandwidth
- Support for high user densities
  - Arising from:
    - increases in user numbers
    - increases in active periods (e.g. due to background traffic for context support and personalised services)
  - Need to ensure control signalling design / overhead is not the limiting factor for cell size or system capacity
    (as opposed to traditional limitations such as range/power or interference)

Downlink system performance improvements

- System performance is vital, not just peak data rate to a single user
  - Need to support high user densities in limited spectrum
- Multi User MIMO techniques aim to maximise system throughput, not peak per-user throughput
  - MU-MIMO gives an additional degree of freedom to the scheduler for improved total system performance
  - Techniques in LTE are relatively basic – enhancements are possible to increase system capacity
  - Improve availability and use of channel knowledge at eNB
- Code-division multiplexing may increase total capacity when combined with OFDM

Uplink data rate improvements

- UL data rate requirements will increase
  - UL and DL capacity is typically asymmetric in current systems
  - Therefore techniques for increasing uplink capacity are needed
- Consider support for flexible UL/DL bandwidth asymmetry
- Multiple antenna techniques
  - Terminal design likely to become more varied
    - More scope for multiple antennas with low correlation
  - UL transmit diversity
  - UL MIMO

Matching to system characteristics

- Increased system performance is not only a function of the RAN
- RAN techniques should complement important characteristics elsewhere in the system, e.g.
  - Video codecs
    - Uncompressed broadcast quality standard definition ~ 220 Mbps
    - MJPEG compression (same quality) ~ 30 Mbps
    - MPEG2 (same quality) ~ 5 Mbps
    - MPEG4 (same quality) ~ 2 Mbps
  - For video users, an increase in spectral efficiency of ~100x
- Questions:
  - What are the efficient service provision techniques which could be applied?
  - Which RAN technologies support these most effectively?

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