



LTE evolution

Asbjörn Grövlén
Ericsson

Overview



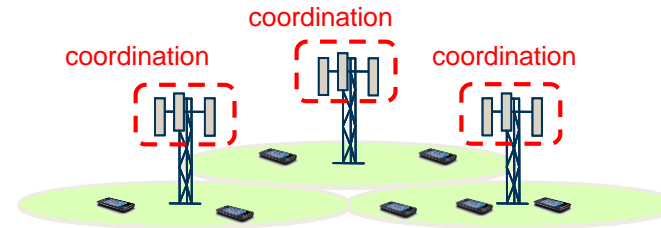
- LTE is submitted as part of the SRIT to IMT-2020
- What has happened in LTE since the IMT-Advanced submission?

➤ Lots!

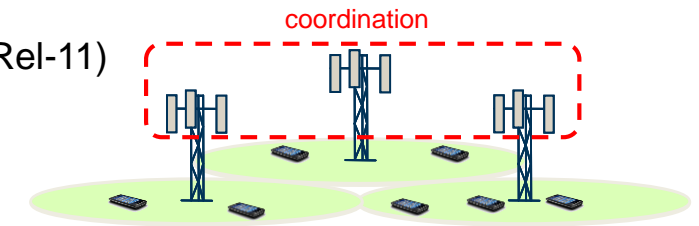


Coordinated Multi-Point Operation

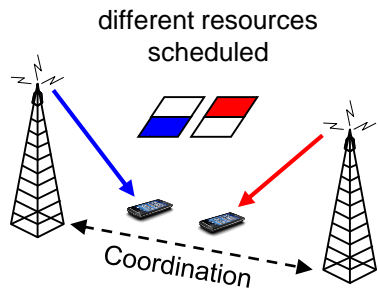
- Introduced coordination across antenna points
 - 📶 Reducing inter-cell interference, improving coverage
- Many coordination schemes require fast backhaul



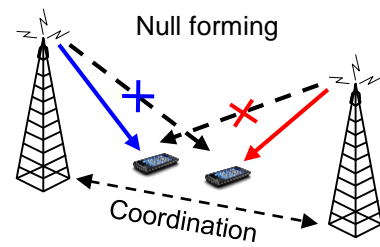
Intra-site coordination only (Rel-11)



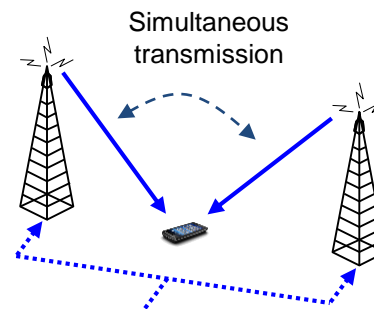
Inter-site coordination (Rel-12)



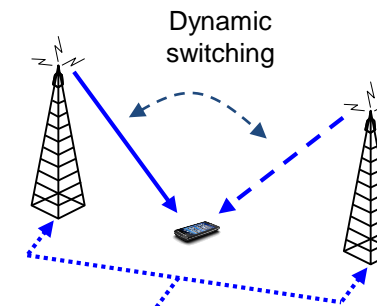
Dynamic Point Blanking



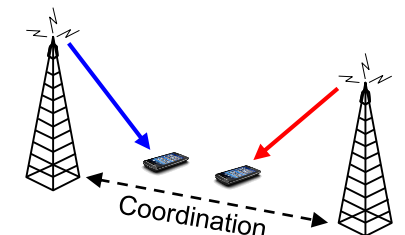
Coordinated Beamforming



Joint transmission



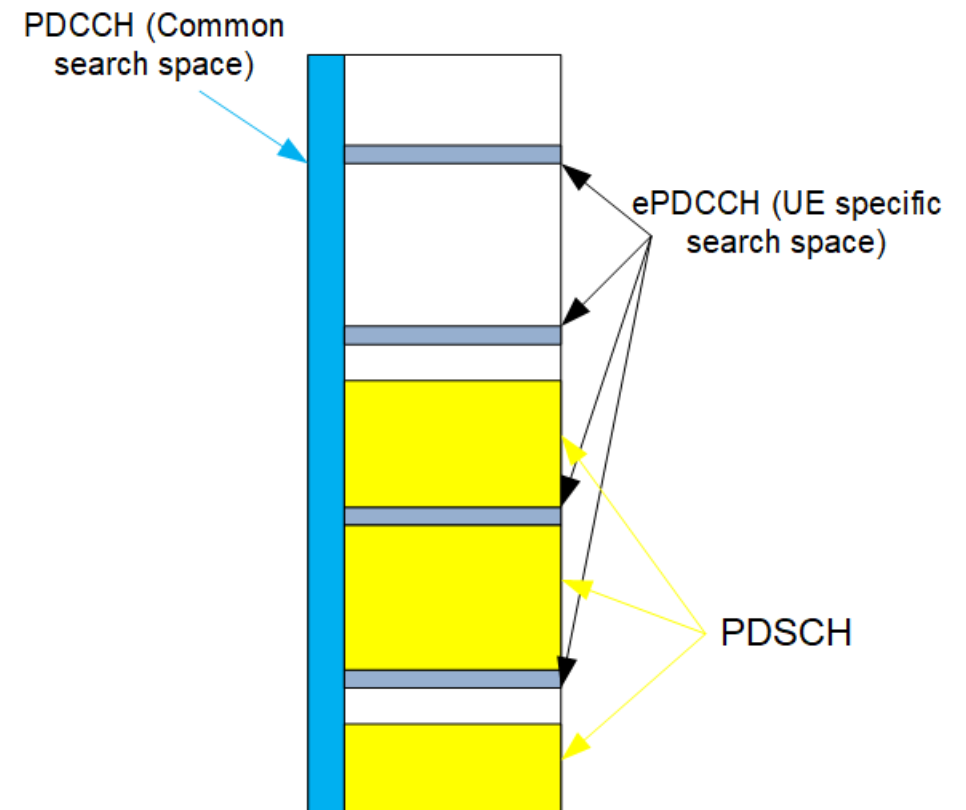
Dynamic Point Selection



Coordinated Link Adaptation

Enhanced downlink control channel

- 📶 PDCCH is
 - 📶 always full bandwidth
 - 📶 using common reference signal (CRS)
- 📶 EPDCCH introduced to support
 - 📶 increased control channel capacity
 - 📶 frequency-domain ICIC
 - 📶 improved spatial reuse of control channel resource
 - 📶 beamforming and/or diversity
- 📶 The EPDCCH can
 - 📶 be transmitted multiplexed with PDSCH
 - 📶 coexist with legacy UEs on the same carrier
- 📶 DMRS are used for demodulation



Dual connectivity

Control and user plane separation

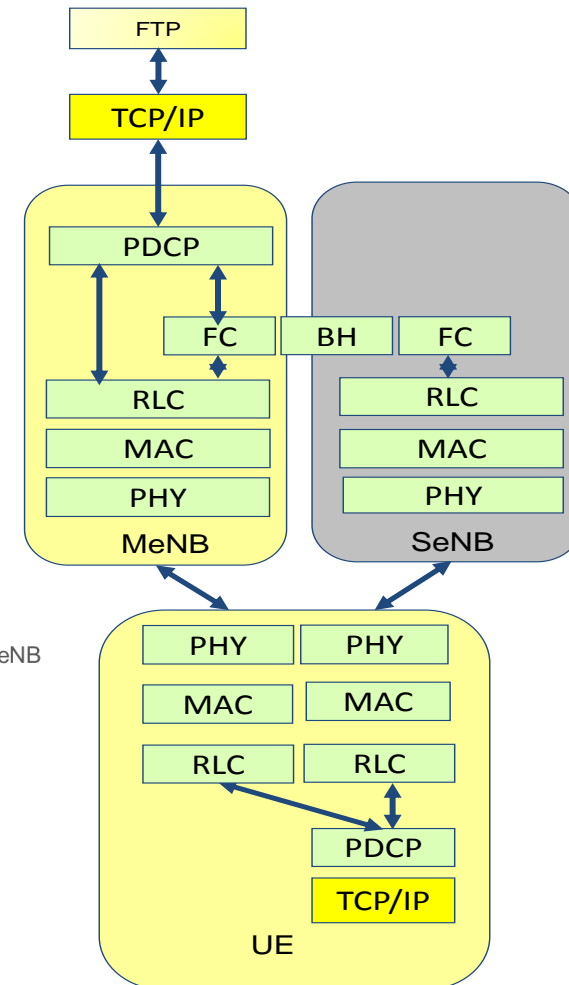
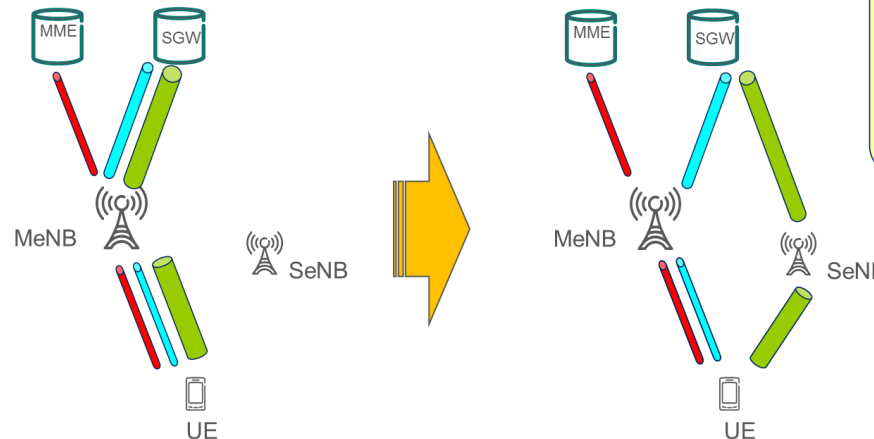
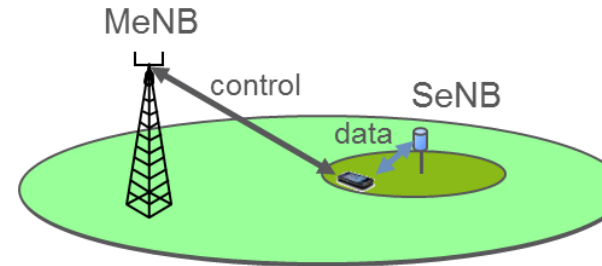
- DL (Rel-12)
- UL (Rel-13)

Benefits

- Increased mobility robustness
- Minimize UE context transfer
- Minimize re-establishment failures

Split bearer

- Data is split on the PDCP layer
- Transparent to higher layer protocols
- Service specific offloading



Small cells

Rel-11 →



Dynamic TDD (eIMTA)

Certain subframes within the radio frame can be dynamically switch between UL and DL

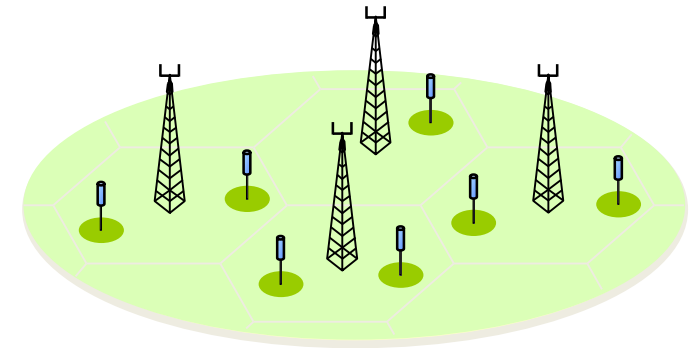
256QAM

1024 QAM also supported in DL

Allow small cells to be turned on/off with low latency

Discovery signal

Radio interface based inter-cell synchronization



Proximity services (ProSe) and vehicle-to-everything (V2X)

Rel-12→



➤ The introduction of the sidelink interface enables direct UE-to-UE communications

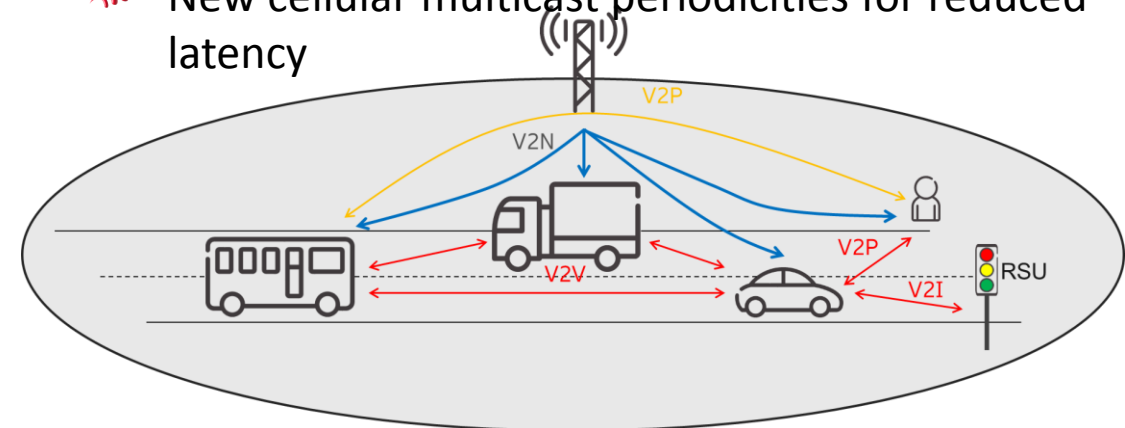
➤ The cellular interface was enhanced to handle efficiently unicast and broadcast traffic

➤ Use cases

- Mission critical push-to-talk for first responders (ProSe, Rels. 12-13)
- Discovery (ProSe, Rels. 12-13)
- Vehicular day-1 safety services such as CAM and DENM (V2X, Rel. 14)
- Truck platooning, advanced driving, vehicle sensor sharing (V2X, Rel. 15)

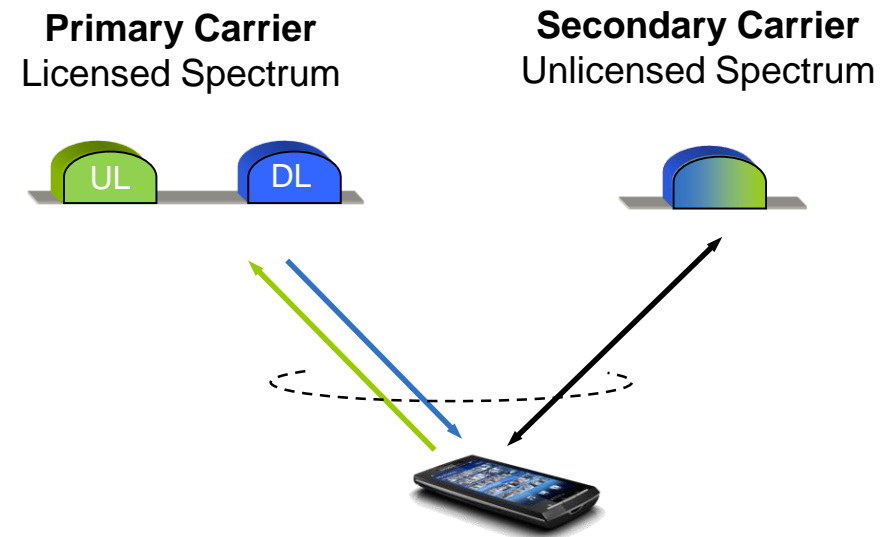
➤ Features

- UE-autonomous resource allocation and NW-managed resource allocation for sidelink
- Distributed synchronization for operation outside network coverage
- New physical layer format for high mobility scenarios (V2X)
- Aggregation of multiple sidelink carriers
- New cellular multicast periodicities for reduced latency



Licensed-Assisted Access

- 📶 **Rel-13 Licensed assisted access**
 - 📶 Enable gigabit throughput LTE via carrier aggregation framework
 - 📶 Downlink only access to 5 GHz unlicensed bands
- 📶 **Rel-14 Enhanced LAA**
 - 📶 Introduce scheduled uplink access to unlicensed bands
- 📶 **Rel-15 Further enhanced LAA**
 - 📶 Enhance uplink access throughput and latency with configured grants (aka “autonomous UL”)

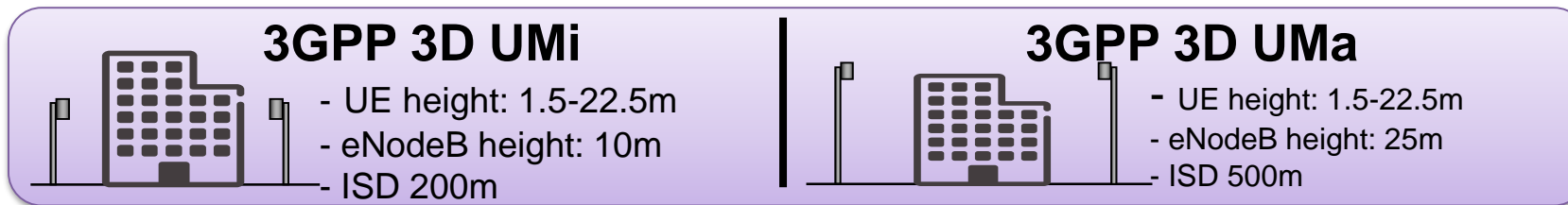
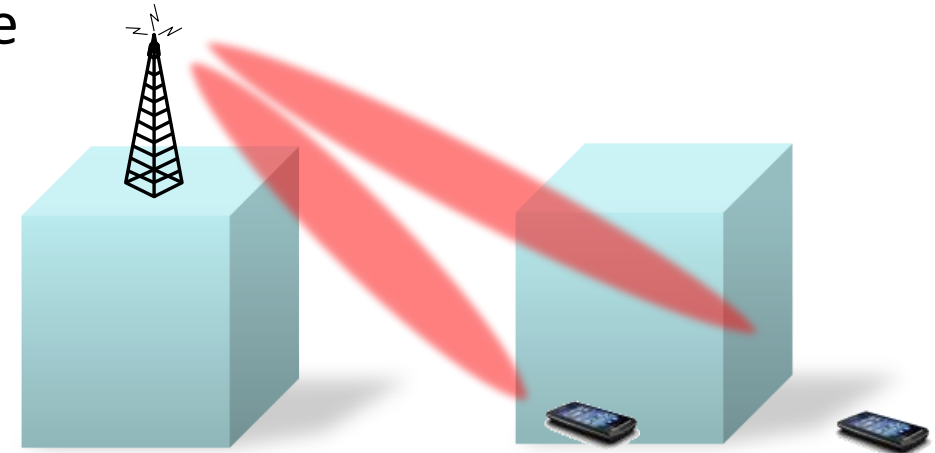


Elevation Beamforming/ Full-Dimension MIMO

Rel-13→

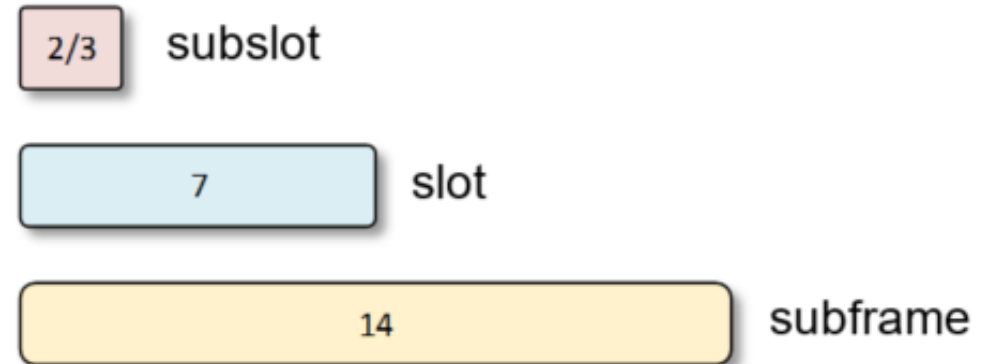


- With the introduction of advance antenna systems with more antenna elements, exploiting all three dimensions for MIMO becomes possible
- A 3D channel model was developed
- Feature components
 - Increased number CSI-RS ports to 12 and 16
 - Beam selection
 - SRS enhancements for low delay spread channels
 - DMRS enhancements to increase the number of co-scheduled UEs



Shortened TTI and processing time

- Shortened TTI and processing time for LTE introduces the possibility for subslot- (2 or 3 symbols long) and slot-based transmission, each associated with a short processing time.
- A shortened processing time of $n+3$ (compared to $n+4$) has also been introduced for subframe-based transmissions
- DL and UL control channels have been redesigned (SPDCCH and SPUCCH for UL and DL respectively) ensuring backwards compatibility with existing LTE operation
- Higher layer improvements to latency have also been introduced



Summary



- Continuous enhancements have improved LTE meeting the IMT-2020 requirements of a component RIT