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Further enhancements to CoMP and seamless mobility schemes

Intel Corporation

Rel-14 CoMP and seamless mobility enhancements Scope/objectives

Physical layer enhancements to support coordinated multi-point operation [RAN1]:

- Enhancements related to enabling of SU-MIMO transmission schemes with MIMO layers being independently transmitted from different transmission points
- Enhancement related to support the downlink transmission schemes with beamforming coordination on the TPs
- Enhancements related to interference and channel measurements for CSI with reduced overhead and reconfiguration for the measurement resources
- Enhancements related to support of the dynamic point switching for downlink LAA

Note: For evaluation of the enhancements two and four receive antennas at UEs, 1D/2D antenna port layouts at the TPs, and ideal backhaul links are assumed.

Rel-14 CoMP and seamless mobility enhancements Scope/objectives

Enhancements to minimize service interruption in mobility events (handover, TP switching, and SCG Change) for both ideal and non-ideal backhaul scenarios, including [RAN2/RAN1]：

- Minimize interruption time related to L1 and L2/3 reconfiguration and preparation during mobility events
- Minimize interruption time due to RACH procedure during mobility events

Existing CoMP schemes

In Rel-11 DL CoMP was introduced to support three types of the transmission schemes:

- Coordinated Scheduling Coordinated Beamforming (CS/CB)
- Joint Transmission (JT)
- Dynamic Point Selection (DPS)

For all considered CoMP schemes, it is typically assumed that UE receives all MIMO layers using quasi co-located (QCL-ed) UE-RS antenna ports, which implies that the precoding in e.g. JT-CoMP is performed jointly by all transmission points:

> *TS 36.213 Section 7.1.10 "A UE configured in transmission mode 8-10 for a serving cell may assume the antenna ports 7 – 14 of the serving cell are quasi co-located (as defined in [3]) for a given subframe with respect to delay spread, Doppler spread, Doppler shift, average gain, and average delay."*

In practical LTE-A deployments, however, such joint precoding is not always feasible due to:

- Different PDSCH RE mapping across the transmission points
- Lack of joint CSI-RS and CRS for QCL signaling with UE-RS antenna ports

Multi-point/cell SU-MIMO

For spatial multiplexing SU-MIMO, other DL CoMP transmission approaches based on independent transmission of the MIMO layers with per-point precoding from the transmission points should be considered:

- The additional MIMO layer(s) carrying independent signals may be transmitted to the UE from the one or more neighboring transmission points in addition to the MIMO layer(s) used at the serving transmission point

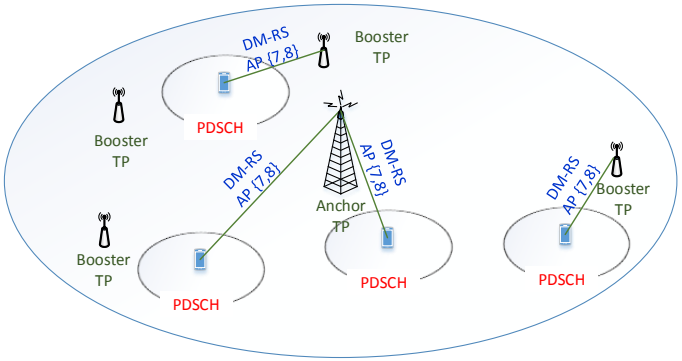
The user data throughput can be improved in the following scenarios:

- Dense deployment scenarios with LOS channels
- Small number of Tx antennas at the eNB at low bands

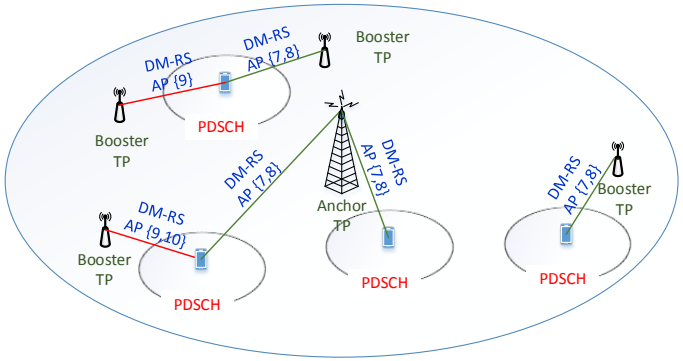
Other benefits:

- The scheme can provide load balancing by allocating additional resources to the UEs from less loaded transmission points (similar to DPS CoMP)

Single-point SU-MIMO

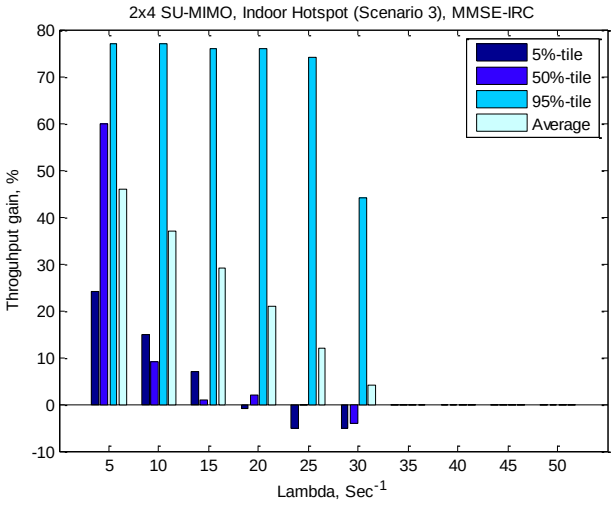


Multi-point/cell SU-MIMO

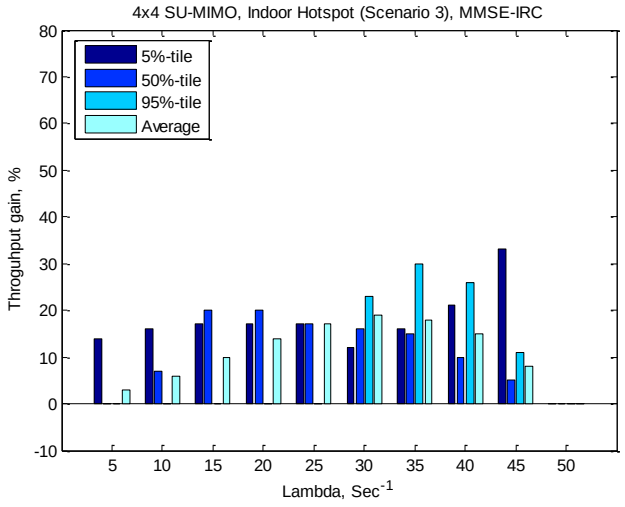


Multi-point/cell SU-MIMO - performance

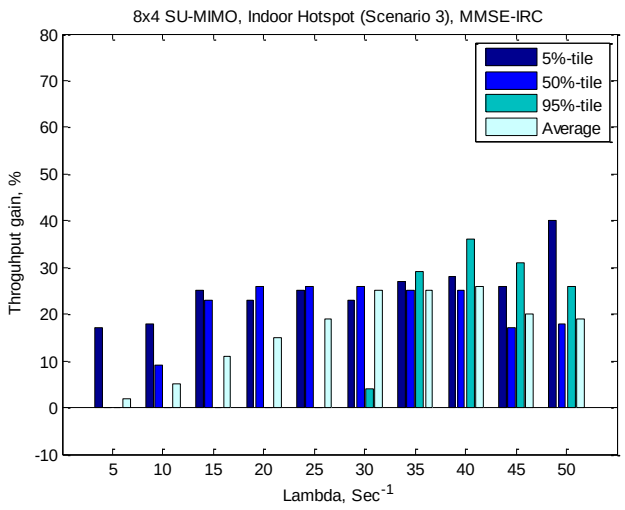
2x4 antenna configuration



4x4 antenna configuration



8x4 antenna configuration



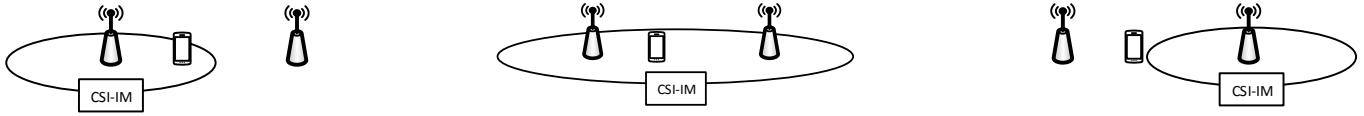
System level performance benefits are observed for all considered antenna configurations:

- For 2x4 antenna configuration the performance gains decreases with traffic loading factor, while for 4x4 and 8x4 antenna configuration the performance gains increases with traffic loading factor

CSI measurement enhancements

Interference measurements for CSI is performed on the CSI-IM resources

- Coordination of two transmission points requires at least three CSI-IM



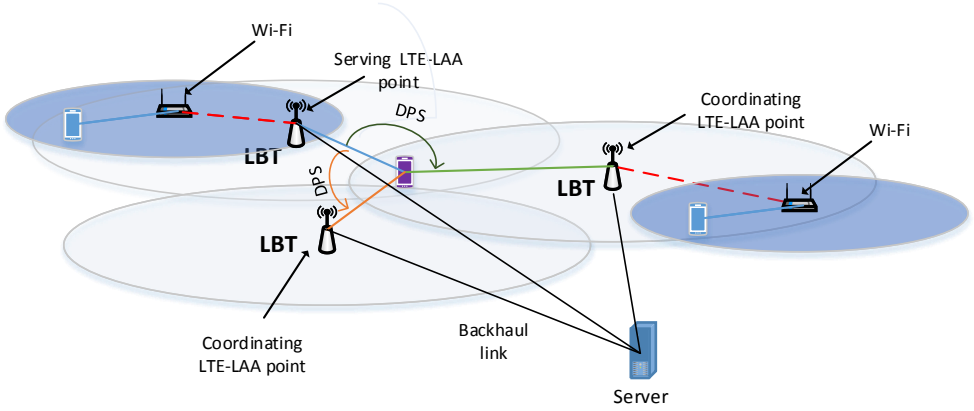
The need of supporting multiple CSI-IM resources can be relaxed if the interference emulation at the UE receiver is supported

- Only one CSI-IM can be configured for the UE
- The interference for CSI from the one TP can be emulated using channel measurements on NZP CSI-RS resource of the neighboring transmission point

Depending on the serving TP, eNB can indicate the NZP CSI-RS resource that should be used for interference emulation to support TP switching for CSI

Dynamic point switching for DL LAA

In the presence of Wi-Fi access points with high transmission activity in the close proximity to the serving LTE-LAA transmission point, dynamic point switching CoMP can be used to provide an additional LTE-LAA scheduling opportunity.

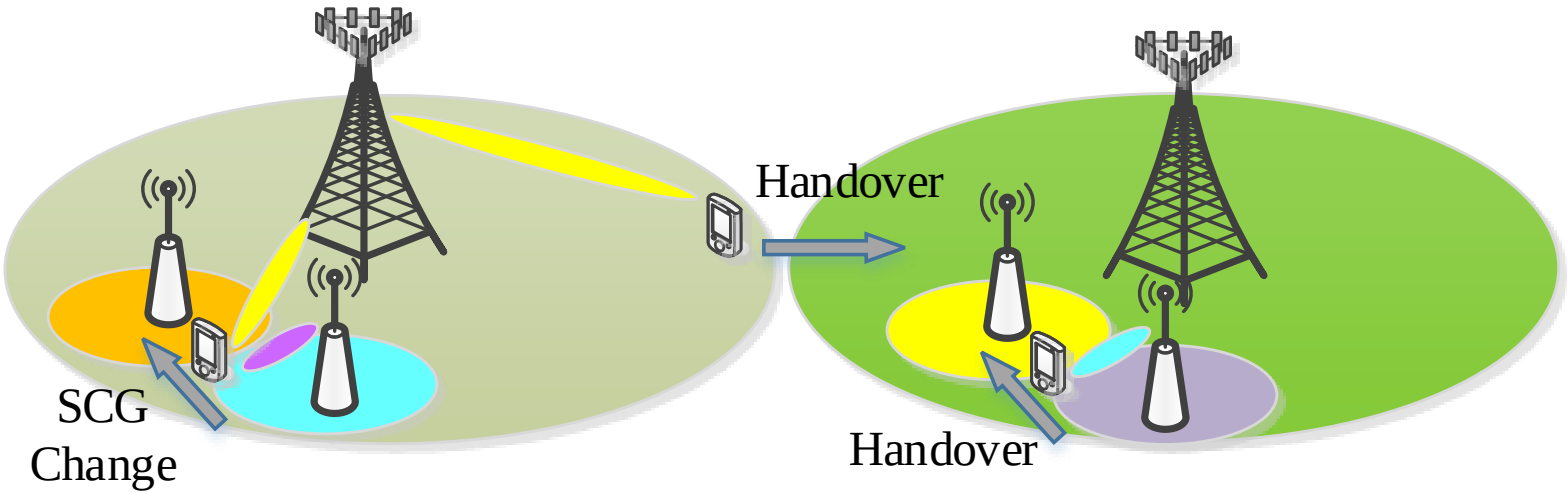


The additional scheduling opportunity is provided by possible transmission of the PDSCH from one of the neighbouring (non-serving) transmission points having a free downlink channel.

Mobility enhancements

An area leveraging from multi-site/multi-point coordination is mobility enhancements. The following mobility events are considered

- Fast TP switching
- Handover between cells connected with ideal or non-ideal backhaul
- SCG Change in dual connectivity



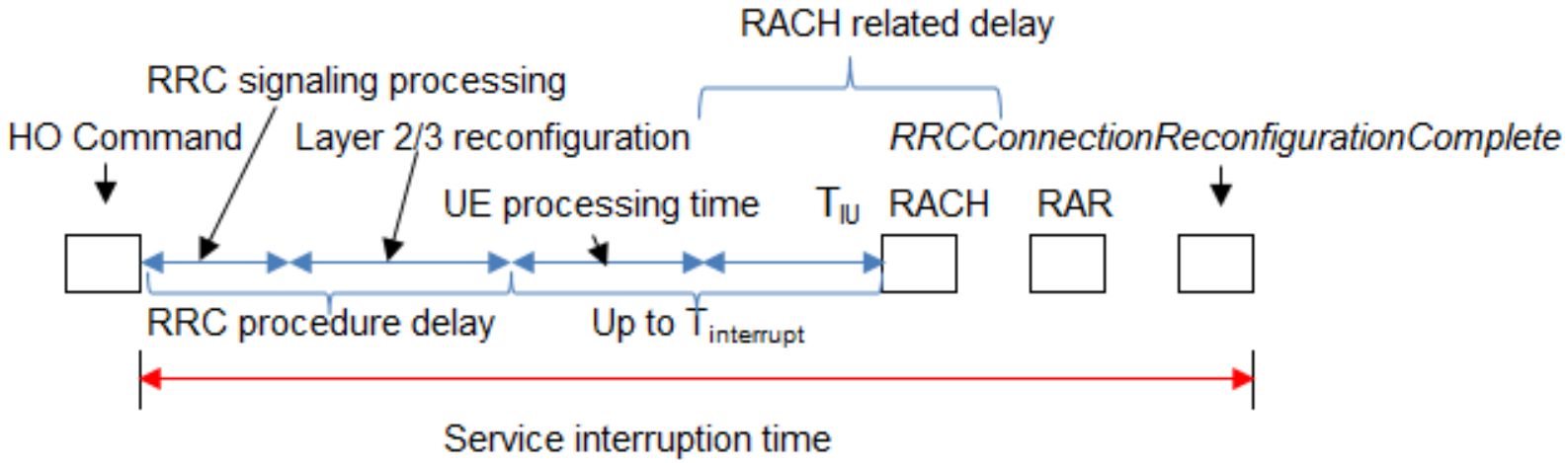
Existing service interruption due to handover

Service interruption time in handover lasts at least several tens of milliseconds, and is mainly due to

- Reconfiguration (including associated UE processing time) of physical layer and layer 2/3
- RACH procedure towards target eNB

For SCG Change in dual connectivity, there is similar service interruption.

- Note that for split bearer, the help from MeNB during SCG Change might be rather limited since the resource provided by MeNB might not be sufficient.



Potential enhancements for seamless mobility

There are two main benefits to reduce service interruption time:

- Satisfy the QoS requirements of the latency sensitive services.
- Improve TCP performance: large interruption time can trigger congestion avoidance algorithm and TCP data rate can be reduced dramatically even after the link is resumed after mobility.

It is necessary to study enhancements to minimize service interruption in mobility events by further multi-site/multi-point coordination. Potential enhancements include:

- Efficient support of fast TP switching
- Minimize/reduce re-configuration of physical layer and L2/3 parameters during mobility events
- Potential new control/user plane architecture to reduce the interruption during mobility events
- Minimize interruption time due to RACH procedure during mobility events