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Latest Considerations on the Overall Control Plane Design for the 5G RAN Architecture

METIS II

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Initial Conclusions on the CP design

- Single RRC connection to support tight interworking between LTE and new AIVs:
  - Dual connectivity and RAN-based mobility
  - There may be multiple RRC entities at the network and multiple transport configurations e.g. diversity/switching
- Connected Inactive state with optimized transition and UE-based mobility
  - Keep the context when sleeping and keep CN/RAN connection up
- Lean and beamforming will impact the design of mobility and initial access
  - Fewer “always on” signals and narrow beam coverage (support for analog/hybrid architectures)
- Initial access
  - Minimize BF usage of non-dedicated control information: Coverage vs. efficiency tradeoff
  - RACH multiplexing for service-tailored prioritization
- Mobility
  - Active: Beam management vs. beam switching
  - Inactive: UE-based mobility / cell reselection
  - Context awareness using data analytics
- D2D optimizations
  - Notion of UE grouping helping signaling optimization

Concepts with extremely high impact in early 5G standardization in 3GPP

RRC design

- Tight interworking between the LTE-A evolution and the new AIV(s):
  - RAN-based mobility and Dual Connectivity

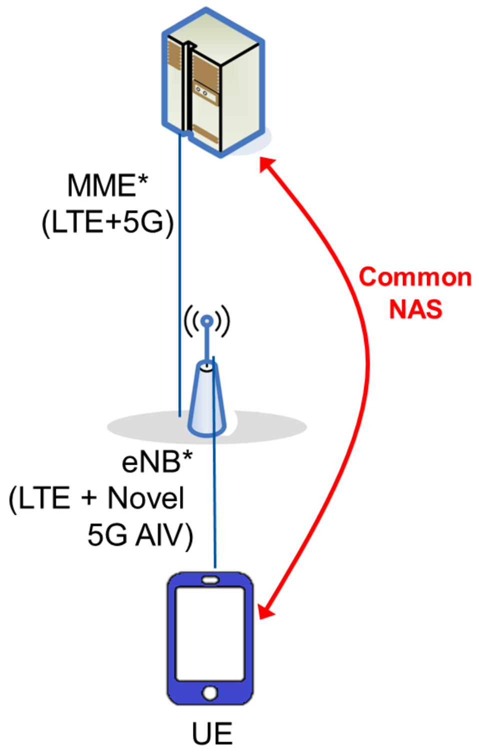
- A new RRC state model natively relying on a lightweight connection

- Support for a lean design where always on transmissions are minimized e.g. by new ways to distribute and encode System Information and/or new configuration mechanisms for reference signals

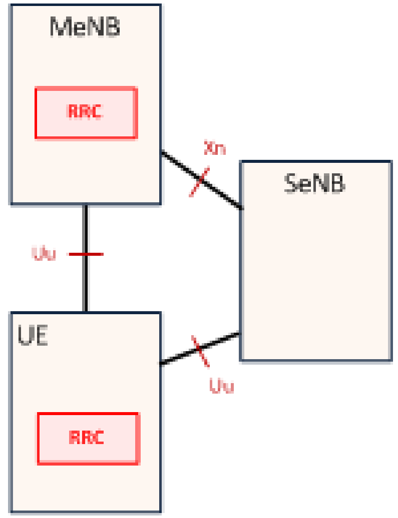
- Support for beam-based procedures, both for initial access and mobility.

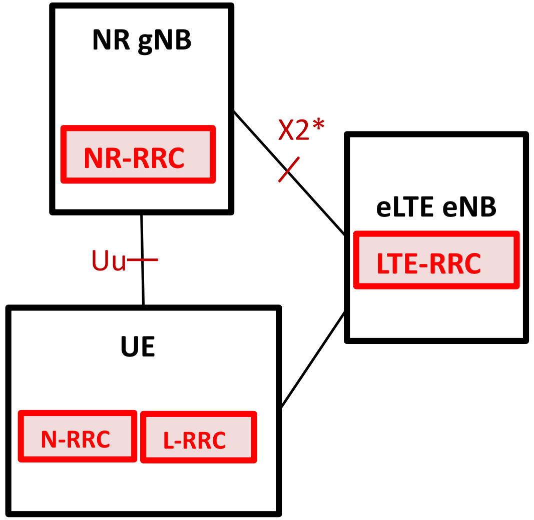
RRC for DC between LTE-A evolution and new AIV(s)

- Single CN connectivity (NAS)



- Single vs. Dual RRC state / connection
- Either LTE or new AIVs can be MeNB
- Two RRC entities at the network side can generate ASN.1

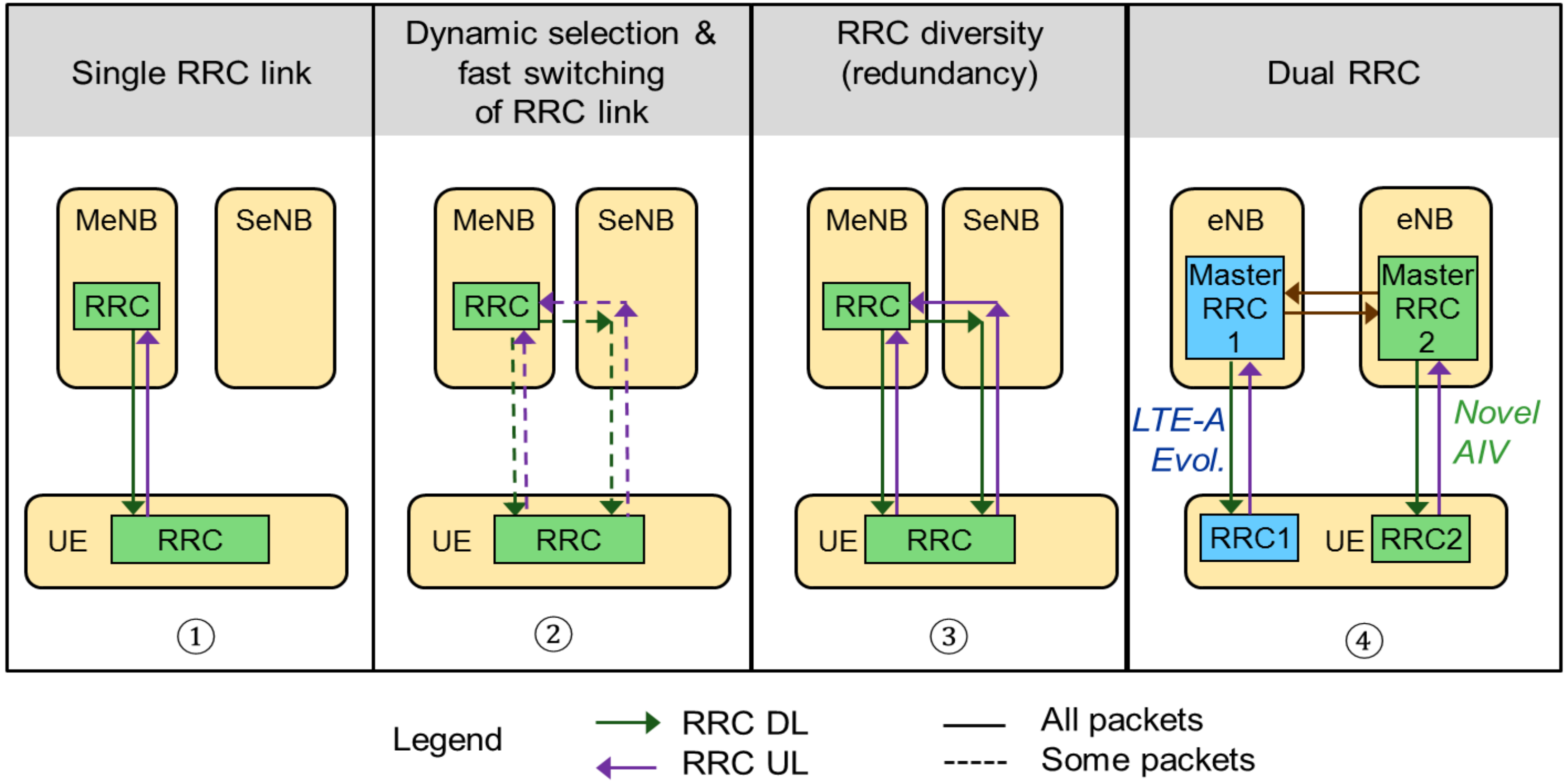




Dual state / connection

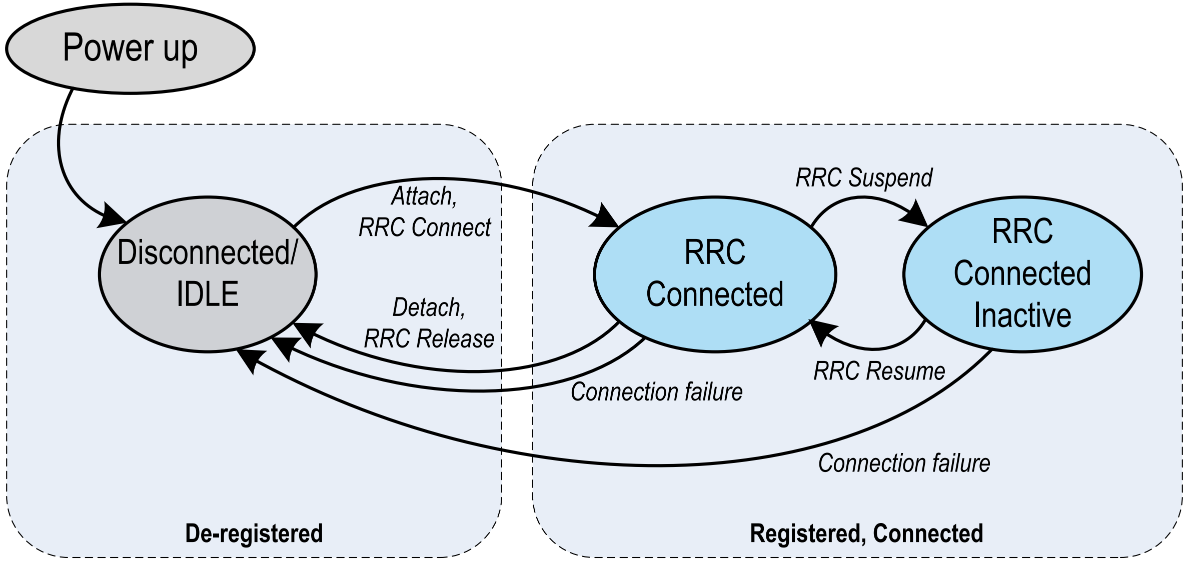
RRC for DC between LTE-A evolution and new AIV(s)

- Transport alternatives → different from DC Rel-12
  - RRC diversity via UL/DL and/or UL-only, DL-only
  - Transparent vs. non-transparent (?)



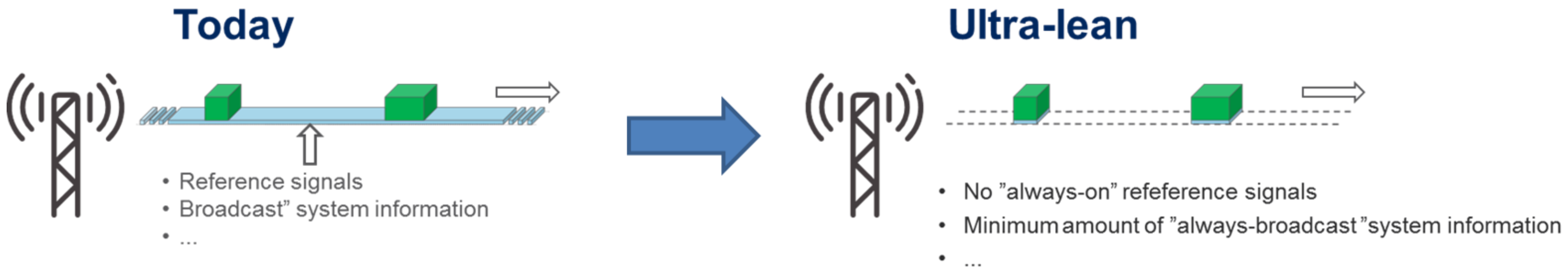
State Handling

- RRC Connected Inactive state
  - UE-based mobility
  - CN/RAN connection up when UE sleeps
  - Optimized state transition (latency/overhead)
  - High Configurability
  - RAN-based Paging
  - Tight interworking with LTE
  - Open question: Data transmission via state transition or accessible contention-based channel



Initial Access: Lean and beamforming

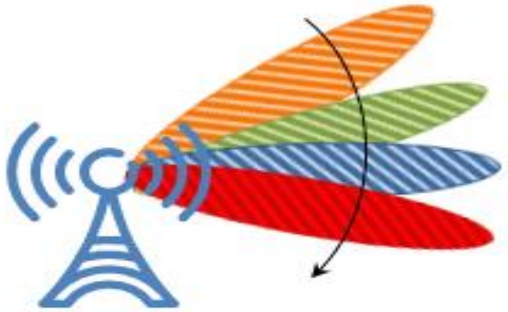
› **Lean design**: minimized “always on” signals for energy efficiency, efficient densification and future-proofness



› **Efficient usage of BF:** required in higher frequencies for coverage, highest efficiency for dedicated channels, very inefficient for broadcasting (common channels). Impact of Digital vs. Analog BF has also been assessed.

Table 4-2 – overhead estimation

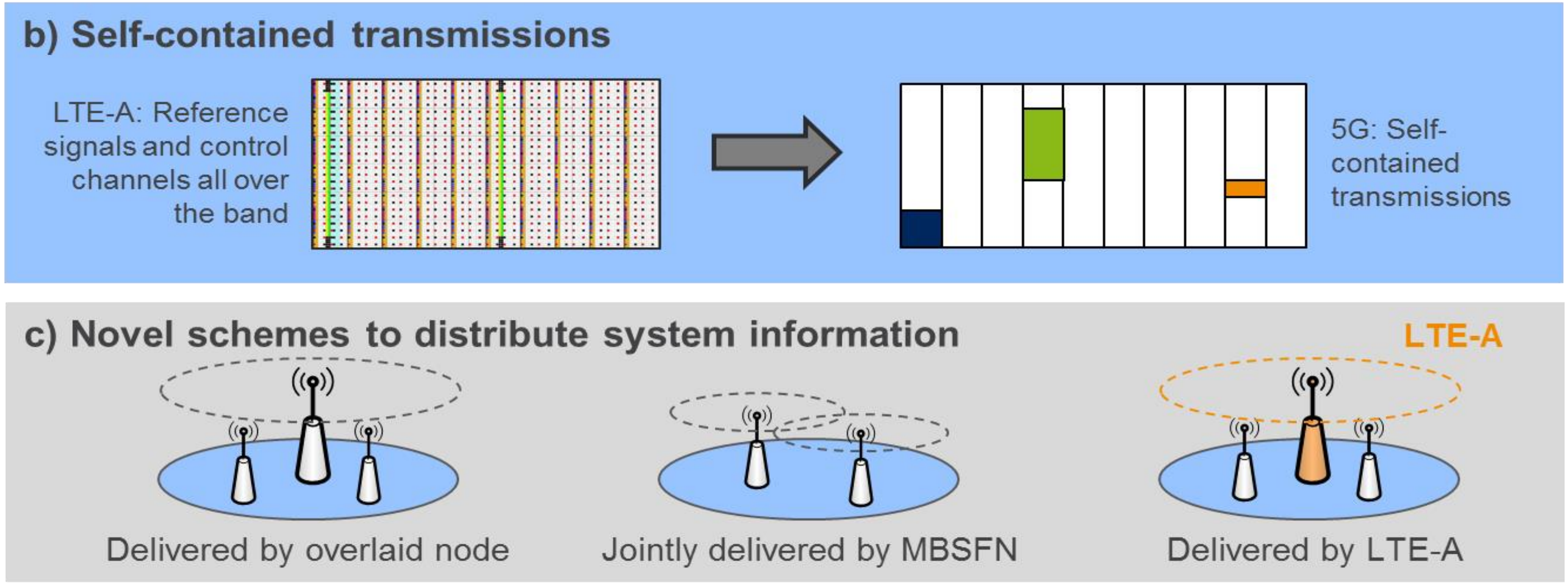
SYNC+RS+MIB	4 TTIs	4 %
SIB1	16 TTIs	4 - 8 %
SIB2	24 TTIs	3 %



Overhead in the order to 11-15% of beam sweeping of system information

Initial Access: Lean and beamforming

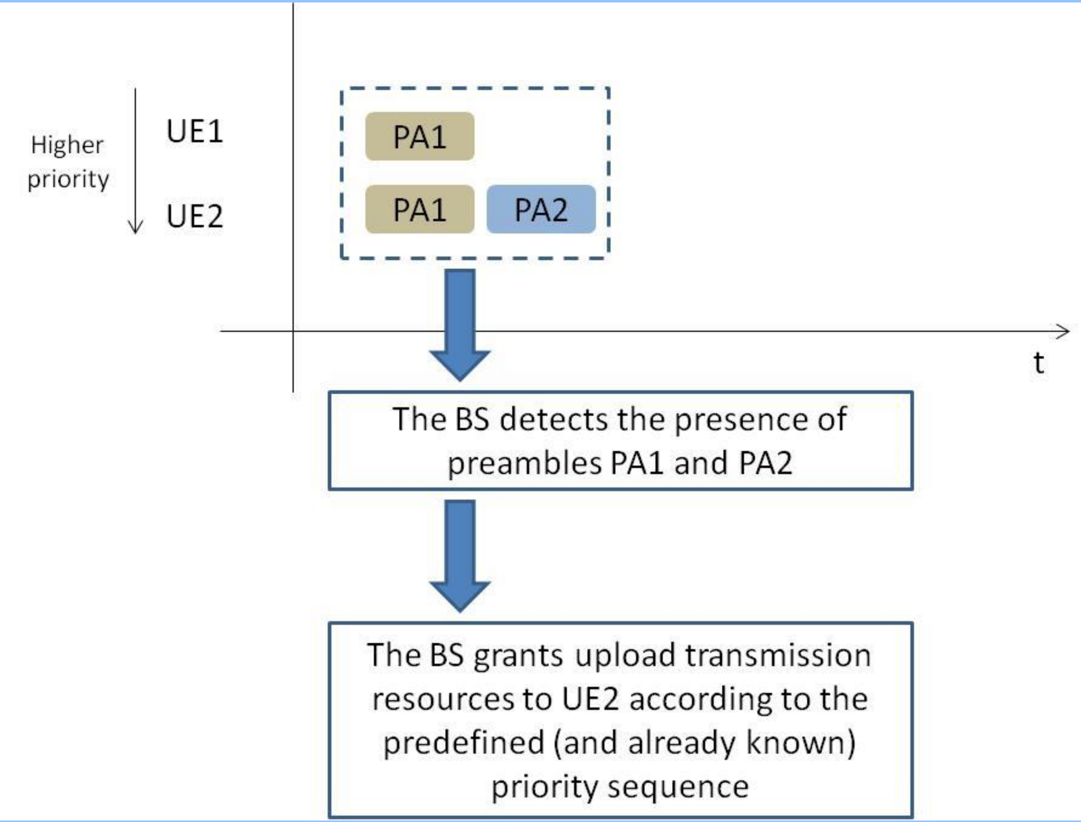
› **New ways to distribute System information**



New role of the Cell ID for flexible system information distribution

› **Random Access**: How much BF sweeping is needed until the Random Access Response? How to multiple services with different requirements?

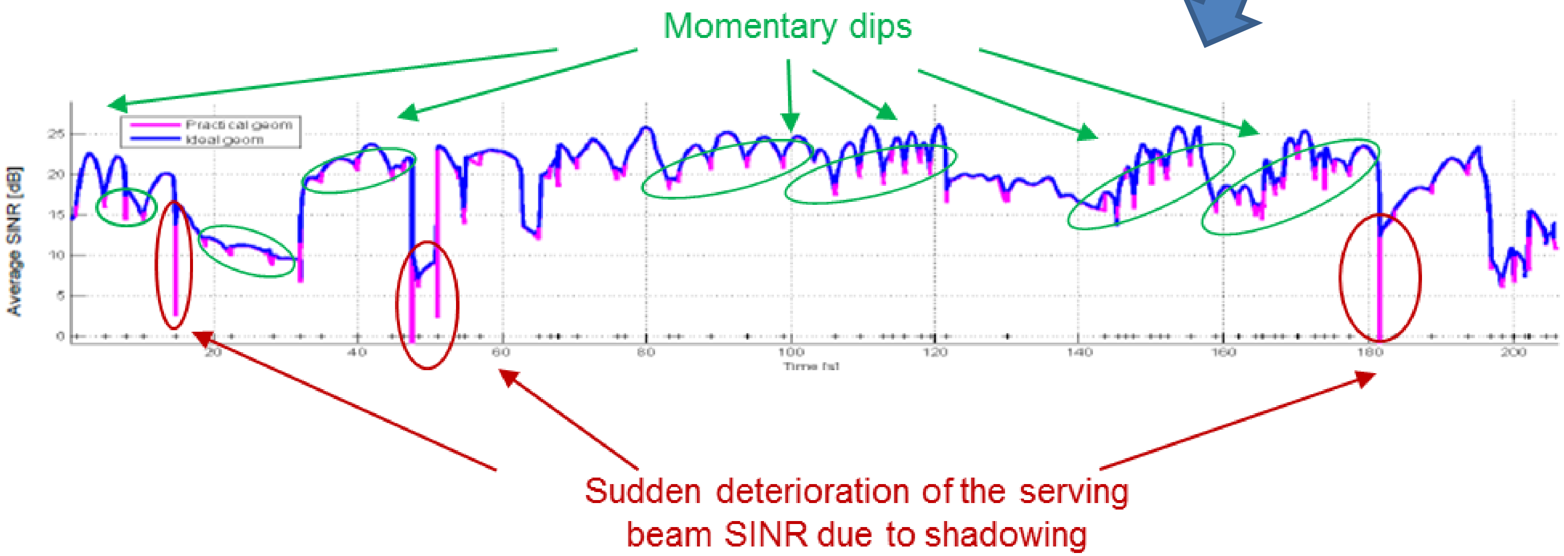
Initial Access: RACH multiplexing in support to diverse access requirements



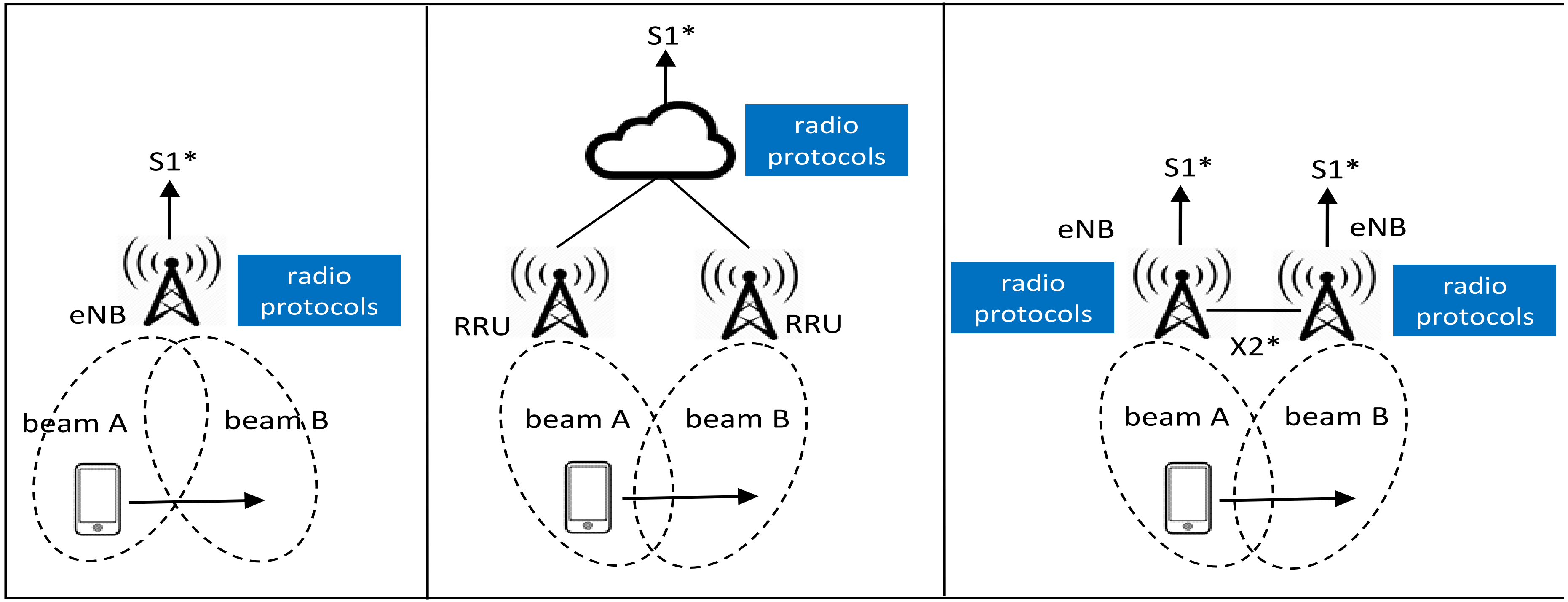
- The **<u>prioritized terminal/service</u>** uses a **<u>combination of the preambles</u>** at one random access time slot to “overwrite” the other preambles.
- Similar approaches could be followed for **<u>more than 2 priority levels</u>**; in this case the device transmitting the higher number of preambles will have higher priority in the transmission request.
- The preambles may be combined in **<u>time</u>**, **<u>frequency</u>**, or even **<u>both domains</u>**.

Mobility and beamforming

- **Signals used for measurements**
  - DL Reference signals
    - Possibly swept, beamformed, possibly on demand / periodic
  - UL reference signals
    - UE-specific, exploit TDD deployments, overhead optimization
- **Measurement configuration and reporting**
  - Measurements current take too long
  - Quick drop of SINR in higher frequencies



Mobility and beamforming



Beam management (lower layers)

Beam switching (higher layers, RRC driven)

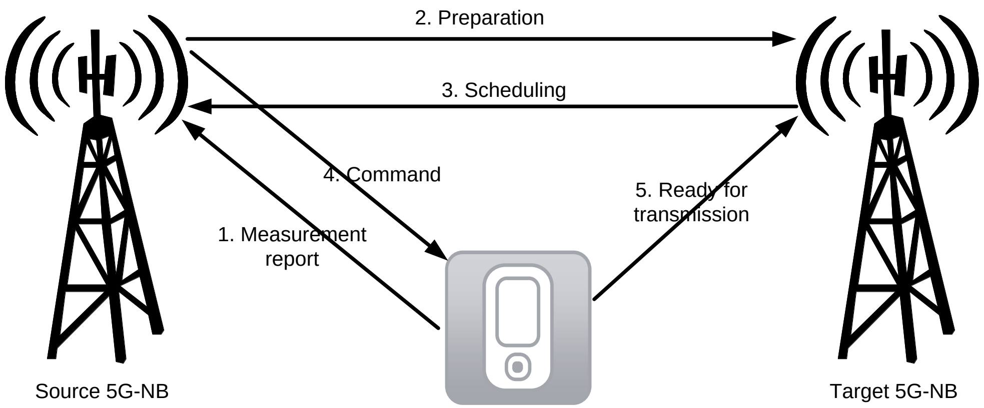
Do we need a “Cell” in Connected mode for 5G?

Seamless mobility

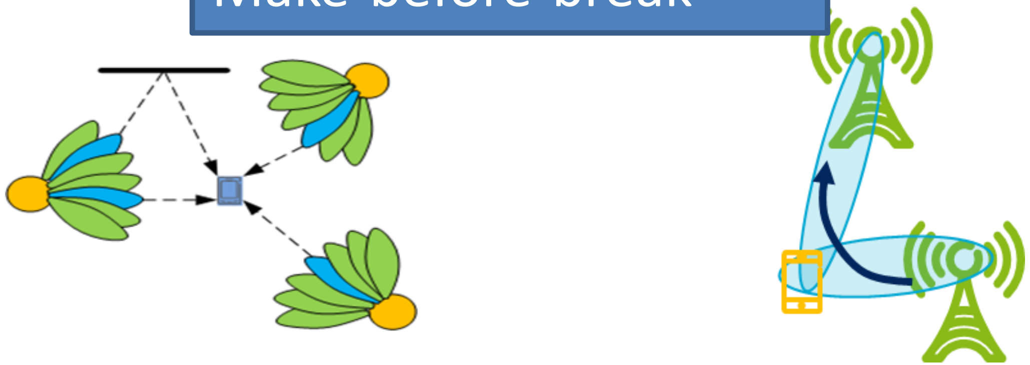
- Support of handovers via the source (as in LTE) and/or target (including make-before-break)

- Make-before-break mobility
  - Access the target link without receiving handover command
  - Random access preamble jointly with beam selection
  - Leverage on Multi-connectivity capabilities

Break-before-make

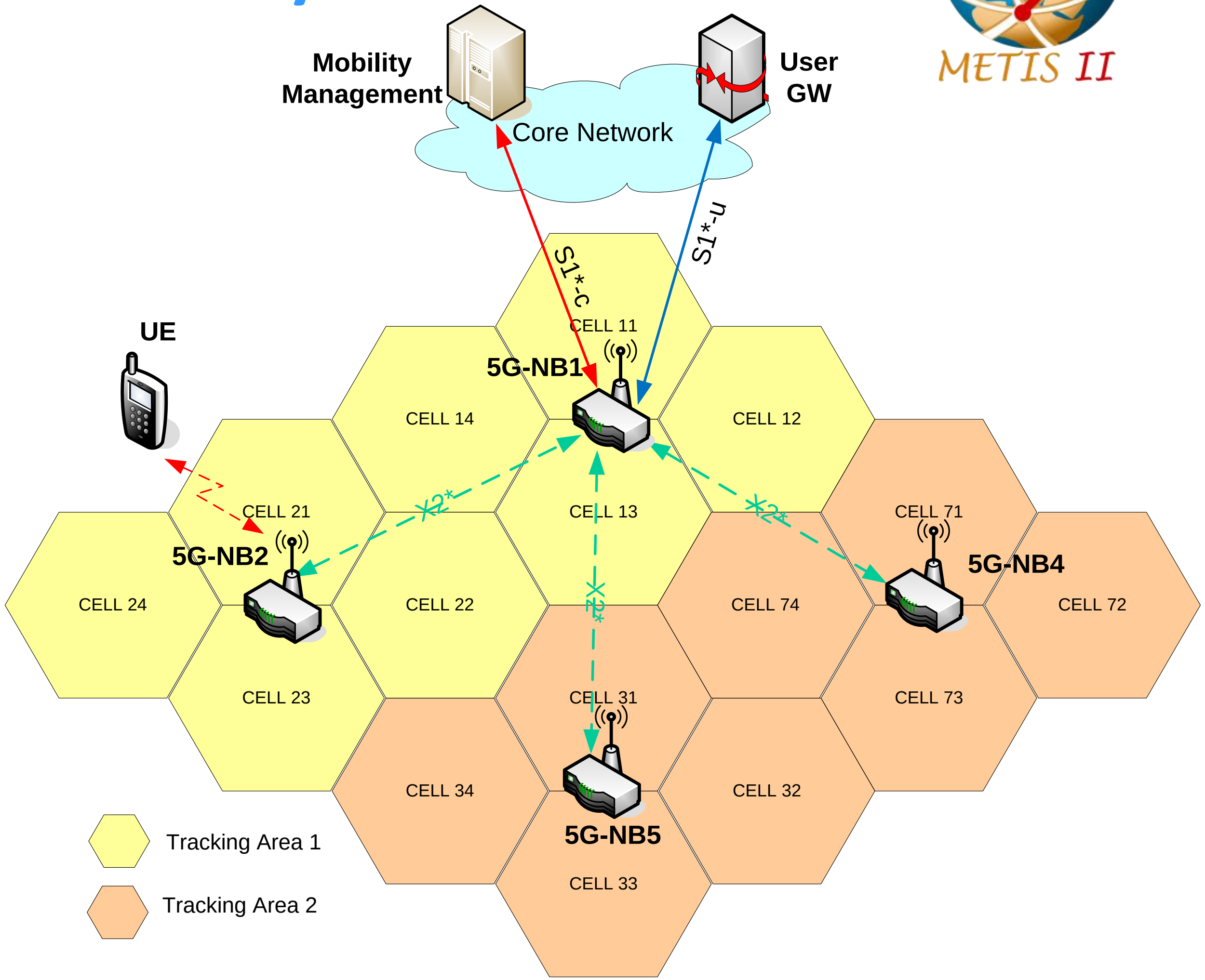


Make-before-break



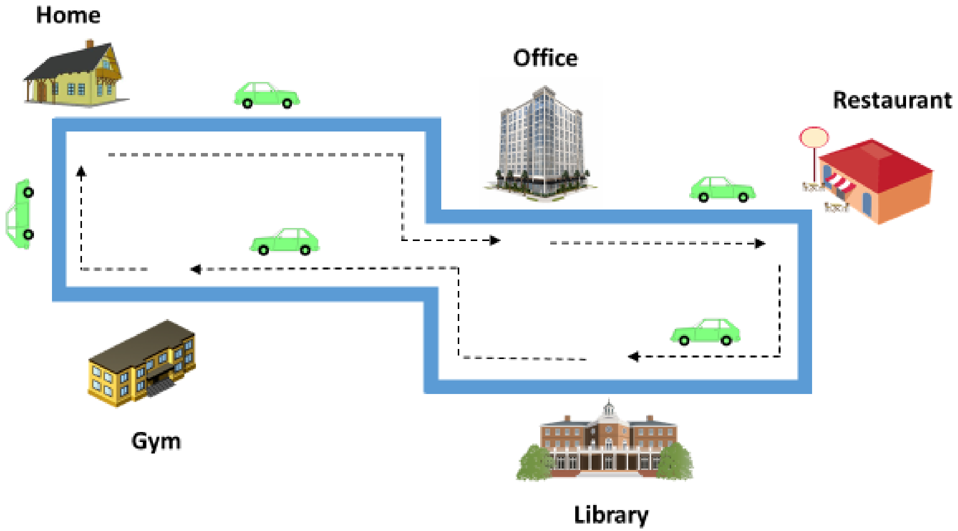
Connected Inactive Mobility

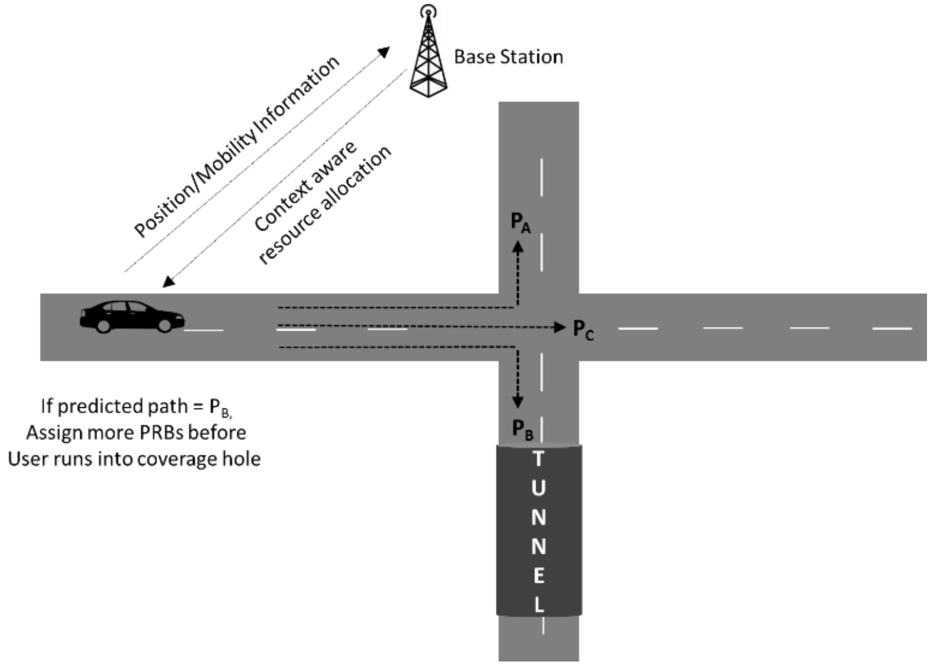
› UE-based mobility to support paging and camping
› Cell reselections and Tracking area updates, possibly defined within the RAN
› Transparent mobility across the evolution of LTE and the new AIVs



Other functions to improve mobility

- Common Mobility Control - Data analytics for signaling minimization
- Diurnal Mobility Prediction to Assist Context Aware RRM

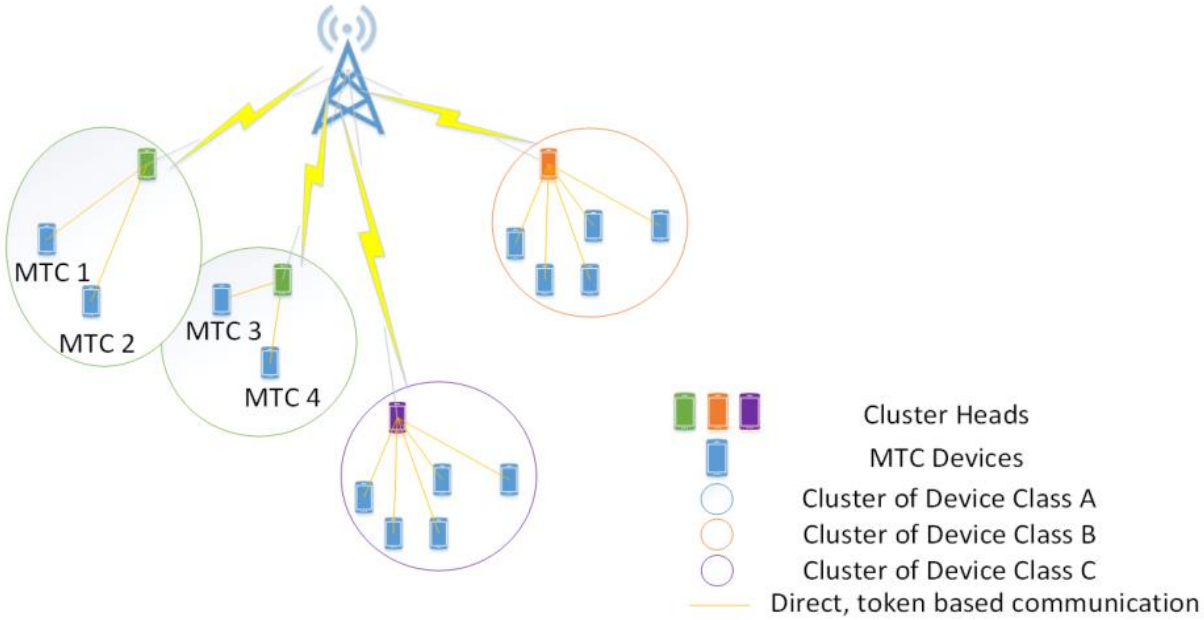




Native D2D Support

- D2D 5G communication scenarios
  - Grouping of devices in proximity with similar communication needs
  - Deep coverage extension for mMTC services
  - D2D communication in the context of mobility
  - Wireless self-backhauling in very dense 5G deployments

- Corresponding enabler
  - Control signaling among devices
  - Cooperative D2D communications
  - D2D discovery and communication



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Thank You

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