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

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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-tailed 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
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

![Diagram showing today and ultra-lean approaches]

Today
- Reference signals
- Broadcast" system information
- ...

Ultra-lean
- No "always-on" reference signals
- Minimum amount of "always-broadcast" system information
- ...

› **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>
<thead>
<tr>
<th>Table 4-2 – overhead estimation</th>
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<tbody>
<tr>
<td>SYNC+RS+MIB</td>
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<td>SIB1</td>
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<td>SIB2</td>
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Overhead in the order to 11-15% of beam sweeping of system information
Initial Access: Lean and beamforming

- **New ways to distribute System information**

  b) Self-contained transmissions
  
  LTE-A: Reference signals and control channels all over the band
  
  5G: Self-contained transmissions

  New role of the Cell ID for flexible system information distribution

  c) Novel schemes to distribute system information

  Delivered by overlaid node
  
  Jointly delivered by MBSFN
  
  Delivered by LTE-A

- **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 prioritized terminal/service uses a combination of the preambles at one random access time slot to “overwrite” the other preambles.
• Similar approaches could be followed for more than 2 priority levels; 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 time, frequency, or even both domains.
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
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 enablers
- Control signaling among devices
- Cooperative D2D communications
- D2D discovery and communication
Thank You

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