E2E Network Slicing: A RAN Perspective

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5G/NR Architecture – Is it revolutionary or evolutionary?

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5GPPP Architecture Working Group

- Launched within the 5GPPP Initiative with participation of 5GPPP projects but input also from non-5GPPP projects
  
- ✓ 5G Architecture White Paper **June 2016**
- ✓ 5G Architecture White Paper v2.0 (Public Consultation) **Sept 2017**

https://5g-ppp.eu/white-papers/
https://5g-ppp.eu/5g-architecture-paper/
1. The Extent of Slicing in RAN
   - Utilization vs. Flexibility
   - Regulations

2. The Depth of Slicing in RAN
   - Shared Functionalities
   - Slice-specific Functionalities

3. Functional Implications
   - From QoS Fulfillment towards SLA Fulfillment

4. SLA Fulfillment
   - Stakeholders
   - Possible Extensions

- RAN Configuration Modes
- Based on 5G diverse Services & Use cases

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**RAN Support for Slicing**

**Functional Implications**

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- Slice-specific Functionalities

**From QoS Fulfillment towards SLA Fulfillment**

**SLA Fulfillment**

**RAN Configuration Modes**

**Based on 5G diverse Services & Use cases**

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1) The Extent of Slicing in RAN - I

Network Slicing is Business Driven

- Running multiple logical networks as virtually independent business operations
- Sharing one common physical infrastructure

Slicing in RAN is like Reversed Prism

- Each Network Slice Instance (NSI) can have dedicated CN instance with optimized stack
- RAN protocol stack optimizations are for network slice types (can be extended based on use cases)
1) The Extent of Slicing in RAN - II

- Limited number of 5G RAN Configuration Modes (RCMs)

<table>
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<th>RCM1: uMTC</th>
<th>RCM2: eMBB</th>
<th>RCM3: mMTC</th>
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<td><strong>Inter-RCM Traffic Steering and Resource Management</strong></td>
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<td>RCM Specific RRM</td>
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<td><strong>Common RRC functions (support for slice selection)</strong></td>
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<td>D2D mobility control</td>
<td>Multi-AIV aggregation for increased reliability</td>
<td>RCM specific RRC (connectionless, cell selection)</td>
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<td><strong>RCM specific RRC Functions</strong></td>
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<tr>
<td>RLC and PDCP Functions (ARQ, Segmentation, Re-assembly, Re-ordering, duplicate selection, ciphering)</td>
<td>RCM specific RRC (Measurements, inactive state included, Handover, cell-reselection)</td>
<td>RLC Functions (ARQ, duplicate selection)</td>
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<td>MAC (Mux/Demux, H-ARQ, RACH)</td>
<td>PDCP Functions (ROHC, Traffic Steering, Integrity, Duplicate Detection, Ciphering)</td>
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<td>MAC (Mux/Demux, H-ARQ, RACH)</td>
<td>Unified Scheduler (optional)</td>
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<td><strong>PHY Functions</strong></td>
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<td>PHY Functions – SOR (TTI bundling, Coding, Beamforming, MIMO, OFDMA, Modulation)</td>
<td>Cluster-based D2D comm. for mMTC</td>
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Cluster-based resource allocation for mMTC
2) The Depth of RAN Slicing

› Trade-off between Utilization & Flexibility

- The more separation the less sharing efficiency

There are cases that slices will be fully separated (if there are such regulations or needs)

If it is possible, sharing should be enabled for supporting the resource reuse
2) The Depth of RAN Slicing

- Stand-alone slice
- Slice with own spectrum
- Slice with shared resource

- Shared dynamic resources
- Dedicated static resources
3) Functional Implications - I

› Slice-Specific Functions: Initial Access
3) Functional Implications - II

- Inter-slice Function: Multi-slice Resource Management

Multi-Slice RM Gain
4) SLA Fulfillment

✓ Go from QoS-fulfillment towards SLA fulfillment, where the requirements of a slice (e.g., a customer) include the collective QoS requirements of various subscribers.

Derive dynamic weights based on SLA status

Update SLA metrics based on QCI KPIs

SLA control loop
4) SLA Fulfillment (METIS-II Demo on multi-slice RRM)
Stakeholders & Possible Extensions

› Telco Ecosystem: Network Slicing brings new business roles

› Slice-in-Slice

Two Towers

Bell Tower inside another

Software vendors (e.g. VNF, MANO, SDM-C/X software products)

Tenant A  Tenant B  Tenant C  Tenant D

Mobile Network Service Provider

Infrastructure Provider 1 (operator owned)
Infrastructure Provider 2 (non operator owned)
Infrastructure Provider n (non operator owned)

Resource brokering

End Users/Business customers

NaaS/PaaS

vs.

METIS-II, 5G-MoNArch, Architecture WG, Page 12
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5G-MoNArch Baseline Architecture

- D2.1 - Baseline architecture based on 5G-PPP Phase 1 results and gap analysis (Mo4: End of Oct 2017)
- D2.2 - Initial overall architecture and concepts for enabling innovations (Mo12: End of June 2018)
The 5G Infrastructure Public-Private Partnership

Thank You

https://5g-ppp.eu/white-papers/
https://5g-ppp.eu/5g-architecture-paper/

http://www.metis2020.com