NG Fronthaul Network Requirements and Architecture

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IEEE 1914
Next Generation Fronthaul Interface
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NGFI Network Requirements and Architecture

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Agenda

- 5G RAN Requirements and Network Architecture
- NG Fronthaul Requirements and Network Architecture
- Radio over Ethernet
5G Network Requirements

5G Key Capabilities

User experienced data rate (Gbps)

Connection density (10^4/Km^2)

Traffic volume density (Tbps/Km^3)

End to end latency (ms)

Mobility (Km/h)

Peak data rate (Gbps)

Energy efficiency

Cost efficiency

Spectrum efficiency

CAPEX

OPEX

Revenue

IMT 2020 5G Vision and Requirements
White Paper May 2014
5G RAN Network

- Highly Reliable
- QoE
- Bullet Train

Main scenarios and suitable technologies for 5G:

- Seamless wide-area coverage scenario
- Low-latency high-reliability scenario
- High-capacity hot-spot scenario
- Low-power massive-connections scenario
5G RAN Network – Network Slicing

Figure 9: 5G network slices implemented on the same infrastructure

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NG Fronthaul Key Requirements
China Mobile NGFI Workshop June 2015

- Transport Efficiency and Scalability
  - Decouple MIMO Traffic - Massive MIMO processed at RRH to reduce transport bandwidth
  - Traffic Load Adaptation - Dynamic Transport Bandwidth adaptive to User Traffic Load
  - Statistical Multiplexing - Tidal effect over large scale of RRHs

- RAN Network Efficiency
  - Centralize RAN Coordination Functions as much as possible

- RAN Networking and Virtualization
  - Dynamic Networking - Mesh Network, Load Balancing and vBBU switching

- RAN Interface Agnostic
  - Support CPRI and Radio over Ethernet (NGFI Packet, RF over Packet)
Transport and RAN KPI Tradeoff – 4G LTE

Symmetric Split Cases

Transport Efficiency

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<tr>
<th>Method</th>
<th>Down Link</th>
<th>Up Link</th>
<th>Delay (Magnitude, ms)</th>
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RAN Efficiency

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<th>Coordination</th>
<th>Method 1</th>
<th>Method 2</th>
<th>Method 3</th>
<th>Method 4</th>
<th>Method 5</th>
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</thead>
<tbody>
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<td>CS/CB, Non-coherent JT</td>
<td>CS/CB, JT</td>
<td>CS/CB, JT</td>
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<td>Up Link</td>
<td>CS/CB</td>
<td>CS/CB</td>
<td>CS/CB, Soft Information JR</td>
<td>CS/CB, JR</td>
<td>CS/CB, JR</td>
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China Mobile NGFI Workshop, June 4, 2015
5G Transport and RAN KPI Tradeoff
Dimensioning

TBD
5G Transport Network - UDN

- Fiber Rich within 1 km²
- vBBUs locally to cap FH capacity locally
- Easier to meet 5G RAN KPIs
- Packet DAS option
- Less Constraint on Transport Network Topology
- Transport Layers depending on Traffic Load
5G Transport Network – Low Latency

- vBBU at C-BBU site (FH Fiber 100us latency) meet E-2E 1ms latency
- Overlay over C-RAN topology with 5G RRU densification
- Transport Network Topology limited by Fiber Routes
- Transport Layers depending on Traffic Load
5G Transport Network – Dense M2M Network

- vBBU may be locally due to dense devices & smaller cells
- IoT Gateways needed to aggregate dense IoT devices to RRU
- Transport Network Topology may be limited by Fiber Routes
- Transport Layers depending on Traffic Load
5G Transport Network – 500+km/hour

- 5G network as WiFi backhaul
- mmWave frequency
- Backhaul for high speed train and Broadband service
- 1G to 10Gbps Backhaul speed
5G Transport Network – Highly Reliable

- Redundant vBBUs are the Norm
- Ring or Redundant Paths at the core Fronthaul network
- RRU-vBBU Switching
- Dual Node Interworking across two Rings at the optical layer
- Multi-Chassis LAG across two Rings at the packet layer
- Sub-50ms protection at the Optical Layer
- Sub-50ms protection at the Packet Layer
5G Transport Network – QoE

- Massive Network MIMO raises the throughput effectively
- Massive MIMO on the RRU can be distributed to achieve it
- Similar to Outdoor Packet DAS Model
- Digital RF over Ethernet from Distributed Antenna to RRU
5G Transport Network – Network Slicing

- Radio Frames ID visibility under SON Server Guidance
- Slices are assigned to V-LANs and Groups
- Each Slice can traverse different FH path
- Each Slice can traverse different BH path
- Protection Switching based on Each Slice
V-RAN

- New Gen. RRU and BBU will support L1 to L3 functional split options symmetrically & asymmetrical upon demand
- RRU may home to different vBBU and some RRU may be shutdown during off hour especially indoor
- Fronthaul Network will adapt to topology change and bandwidth demand dynamically upon SDN control
Radio over Ethernet

- From TDM to Statistical Multiplexing
- Agnostic to Air I/F Technology
- Low Delay & Jitter
- Higher Time Sync Accuracy (1588v2 ns time accuracy)

IEEE 8021.CM Profiles based on the following standards:
- 802.1ASbt Precise Timing Protocol Gen 2 (gPTP Gen 2)
- 802.1Qbu Preemption (collaborating w/ 802.3br Interspersing Express Traffic)
- 802.1Qbv Time Aware Shaper (TAS) — Scheduled Traffic
- 802.1Qca Shortest Path Control & Reservations
- 802.1CB Frame Replication & Elimination
- 802.1Qcc Stream Reservation Protocol Gen 1.1