Fronthaul requirements of 5G mobile networks

Thomas Deiß, Bertold Dickhaus
thomas.deiss@nokia.com, bertold.dickhaus@nokia.com
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8. Summary
5G Requirements

- 5G mobile networks will offer disruptive network and service capabilities
- Use cases envisioned by 5G PPP, NGMN and Metis envision disruptive end user SLAs
  - e2e Delay: <= 1ms for e.g. industrial automation
  - end user datarate: >= 1Gbps e.g. for virtual reality office
- However, not all requirements have to be satisfied simultaneously
- SDN and NFV will enable fast deployment of new services and flexible allocation of physical resources
- The radio access network is particularly challenging for NFV/SDN due to its stringent real-time requirements
- New splits of the radio stack enable more flexible deployment of functions in the physical radio access networks

Source: 5GPPP 5G Vision document
Fronthaul Requirements and 5G RAN Functional Splits

- Initiatives around new Fronthaul interface(s) include NGFI, …, and …
- 5G should be deployable regardless of the fronthaul technology, latency or capacity

- Many functional splits are possible – resulting in different requirements for the fronthaul
Radio Feature Impact

- Beside end user service requirements, radio and radio coordination features have significant impact on the fronthaul.
- 5G will tighten radio parameters compared to LTE-A to shorten system delay and increase throughput.
- LTE and LTE-Advanced introduced coordination features.
- For virtualization, these features need to work with significant increased latencies, delay variations and packet drop rates.
  - Internal interfaces become external interfaces.

<table>
<thead>
<tr>
<th>Issue</th>
<th>LTE-A</th>
<th>5G</th>
</tr>
</thead>
<tbody>
<tr>
<td>TTI</td>
<td>1ms</td>
<td>0.2ms</td>
</tr>
<tr>
<td>HARQ</td>
<td></td>
<td>limiting TTI</td>
</tr>
<tr>
<td>RTT</td>
<td>tens of ms</td>
<td>1ms</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Issue</th>
<th>Bandwidth</th>
<th>Latency</th>
</tr>
</thead>
<tbody>
<tr>
<td>MIMO</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>Carrier aggr.</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>(e)ICIC</td>
<td></td>
<td>X</td>
</tr>
<tr>
<td>CoMP (dep. on scheme)</td>
<td>X</td>
<td>X</td>
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</table>
Flexible scheduling framework

• TTI as small as 0.2ms proposed for low latency 5G-users
  - Small TTIs may decrease coding gains
  - Small TTIs increase resource usage of scheduler (more scheduling decisions) and control channels (more grants)
  - mobile broadband would benefit from longer TTI

• 3GPP investigate different TTIs per bearer
  - no decision by 3GPP yet

• ➡ stringent RTT requirements for a part of the traffic only
Flexible HARQ

- LTE has rigid HARQ scheme
  - Number of HARQ processes, timing of ACK/NACK
- 5G might have different TTIs per bearer and even for UL/DL
- Adapt HARQ configuration to air interface
  - TTI configuration, latency, ...
- Allow different HARQ schemes
  - E.g. retransmission until ACK received, ...
- HARQ impact on latency is limited to a part of the traffic
- No decision by 3GPP yet
Flexible HARQ and TTI

• If such flexibility will be designed into the system, some use cases will not require stringent latency requirements,
  - Low latency application: 1ms RTT, 0.5ms latency
  - Mobile broadband: 8ms RTT, 4ms latency
  - Latency measured among 5G PDCP of UE and BTS, 3GPP 38.931
• only a small part of the traffic requires this low latency
• some part of the traffic can be prioritized over other parts
  • ➔ fronthaul equipment has to support prioritization
  • ➔ remaining traffic has to cope with increased jitter or even congestion
Impact of small TTI on virtualization and network topology

- BBU – RRH communication
  - BBUs and RRHs synchronize on TTIs and compute within a TTI
  - Real time computing at a time-granularity of one TTI
  - Timers have to be more accurate, e.g. as accurate as 0.05*T Ti
    - 10us accuracy for 0.2ms TTI
  - No problem with rtOS on dedicated hardware, but difficult for virtualization

- Inter BBU communication bound to one or a few TTIs
  - physical mesh topology among BBUs may be needed
Summary

• Still a lot of discussion ongoing, 5G radio not defined yet
• 5G requirements will be more stringent than 4G
  - Flexible solutions discussed in 3GPP to require stringent latency only where needed
• Be aware of impact on network topology and implementation technologies