

Fronthaul requirements of 5G mobile networks

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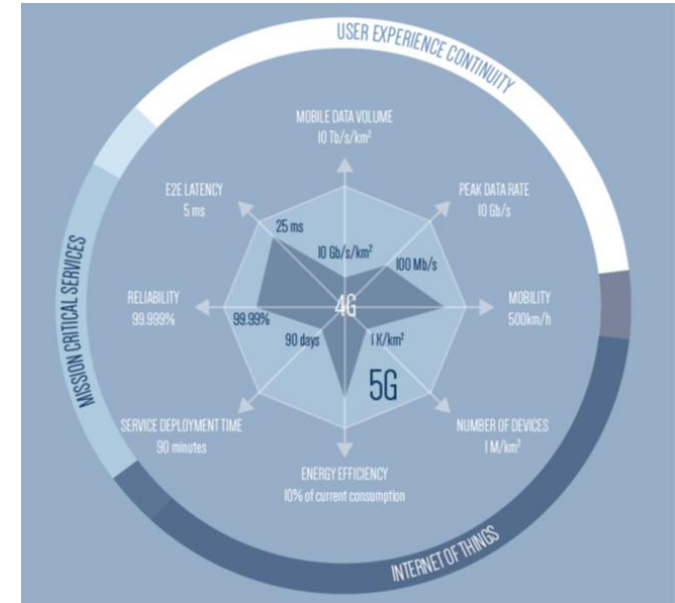
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Overview

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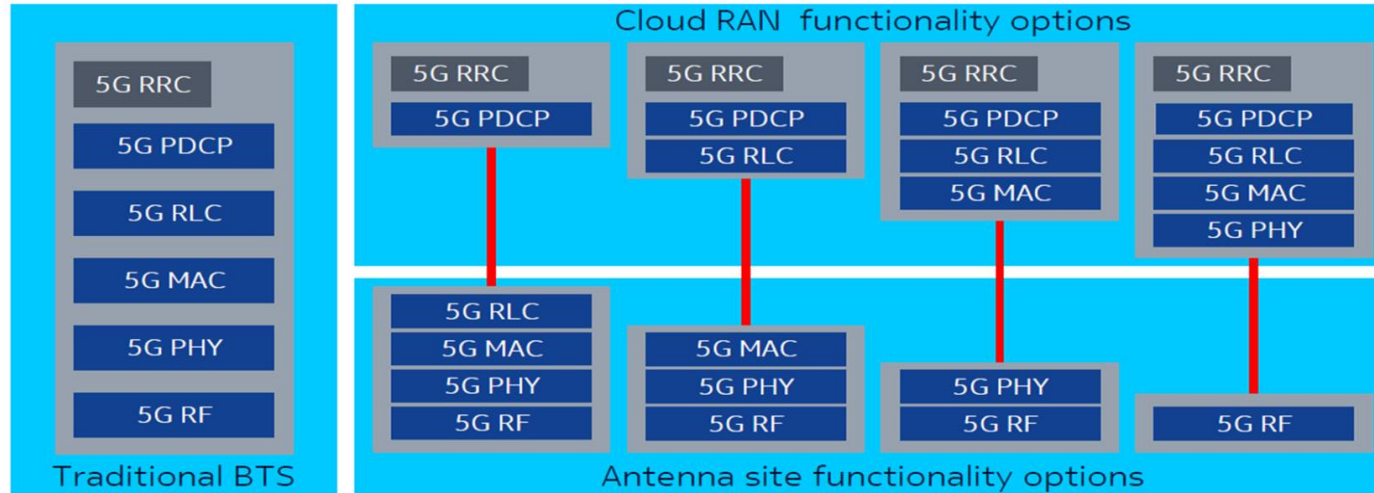
5G Requirements

- 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: ≤ 1 ms for e.g. industrial automation
 - end user datarate: ≥ 1 Gbps 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



NOKIA Vision & Priorities for Next Generation Radio Technology
3GPP RAN workshop on 5G, 17.-18. September 2015, Phoenix, AZ, USA

- 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

Issue	LTE-A	5G
TTI	1ms	0.2ms
HARQ	limiting TTI	
RTT	tens of ms	1ms

Issue	Bandwidth	Latency
MIMO	X	
Carrier aggr.	X	X
(e)ICIC		X
CoMP (dep. on scheme)	X	X

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

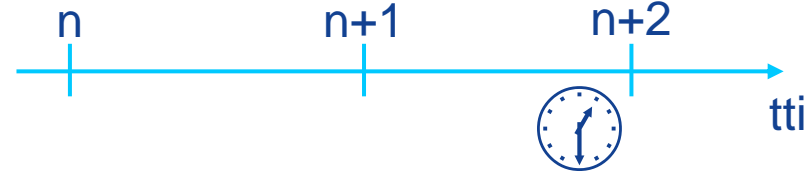
Flexible HARQ

- 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

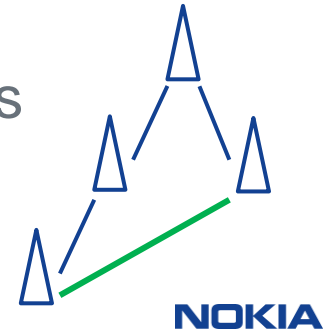
Flexible HARQ and TTI

- 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 $0.05 \cdot \text{TTI}$
 - 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

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