METIS-II Deliverable D2.3
Performance evaluation results

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5G PPP

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Introduction

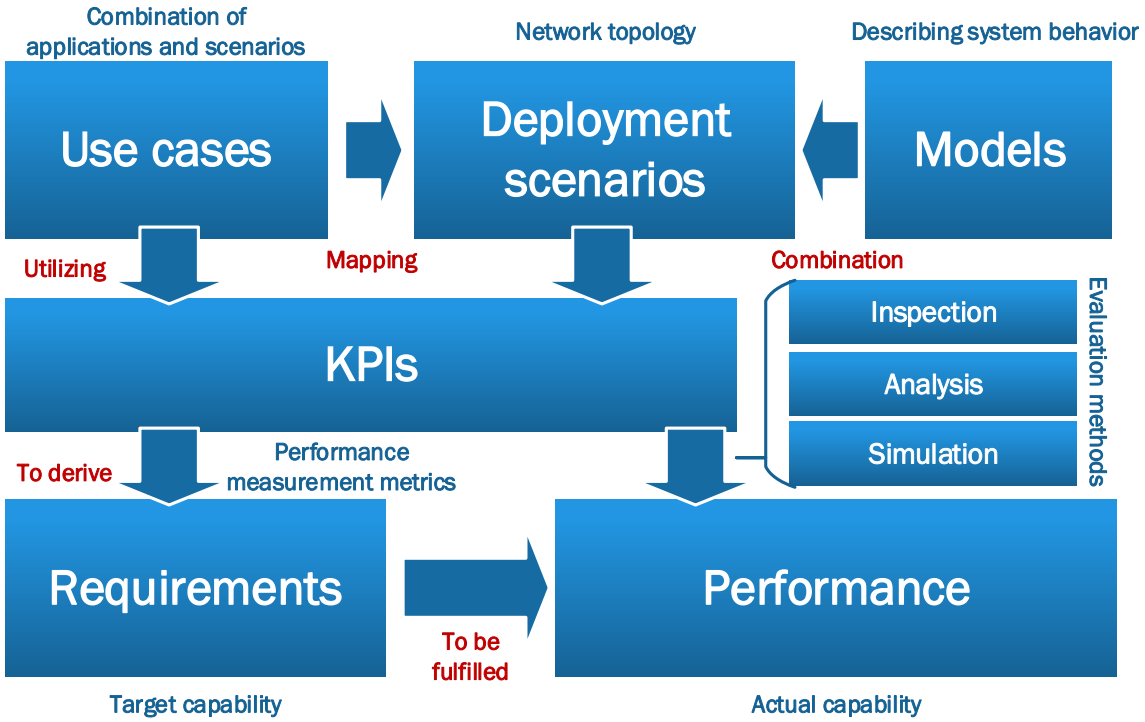
The objective of this document is threefold:

- Firstly, it provides an evaluation framework that can be used for a fair assessment of key performance indicators. This framework is expected to be similar as the one that will be issued by International Telecommunication Union (ITU) for “International Mobile Telecommunication for 2020 and beyond” (IMT-2020).
- Secondly, assessment of a hypothetical 5G RAN along proposed performance evaluation framework is done, taking into account expected advancements as well as technology components (TeCs) investigated in METIS-II.
- Finally, a crisp overview of selected TeCs developed in METIS-II is provided, showing their potential impact on the performance of 5G end users and network, mainly through system-level simulations.

5G performance evaluation framework

Four basic building blocks:

1. **Use cases** reflecting predicted 5G applications
2. **KPIs** and their evaluation methods
3. **Deployment scenarios** reflecting expected 5G infrastructure deployment options
4. **Models** and parameters for performance assessment



KPIs and their evaluation methods

Inspection (yes/no):

- Bandwidth and channel bandwidth scalability
- Deployment in IMT bands
- Coexistence with LTE
- Interworking with 3GPP legacy networks and 802.11 WLAN
- Low cost requirements
- Operations above 6 GHz
- Spectrum flexibility
- Support for wide range of services

Analysis (calculation)

- Control plane latency
- User plane latency
- mMTC device energy consumption
- Mobility interruption time
- Peak data rate

Simulations:

- Experienced user throughput (bursty traffic)
- Traffic volume density (bursty traffic)
- Capacity (full buffer)
- E2E latency
- Reliability
- mMTC device density
- RAN energy efficiency
- Supported velocity

Where do we stand with 5G requirements?

KPIs evaluated by inspection (statements)

Bandwidth and channel bandwidth scalability ✓

Coexistence with LTE ✓

Deployment in IMT bands ✓

Interworking with 3GPP legacy technologies and 802.11 WLAN ✓

Operations above 6 GHz ✓

Spectrum flexibility and sharing ✓

Support of wide range of services ✓

Low cost requirements ✓

Where do we stand with 5G requirements?

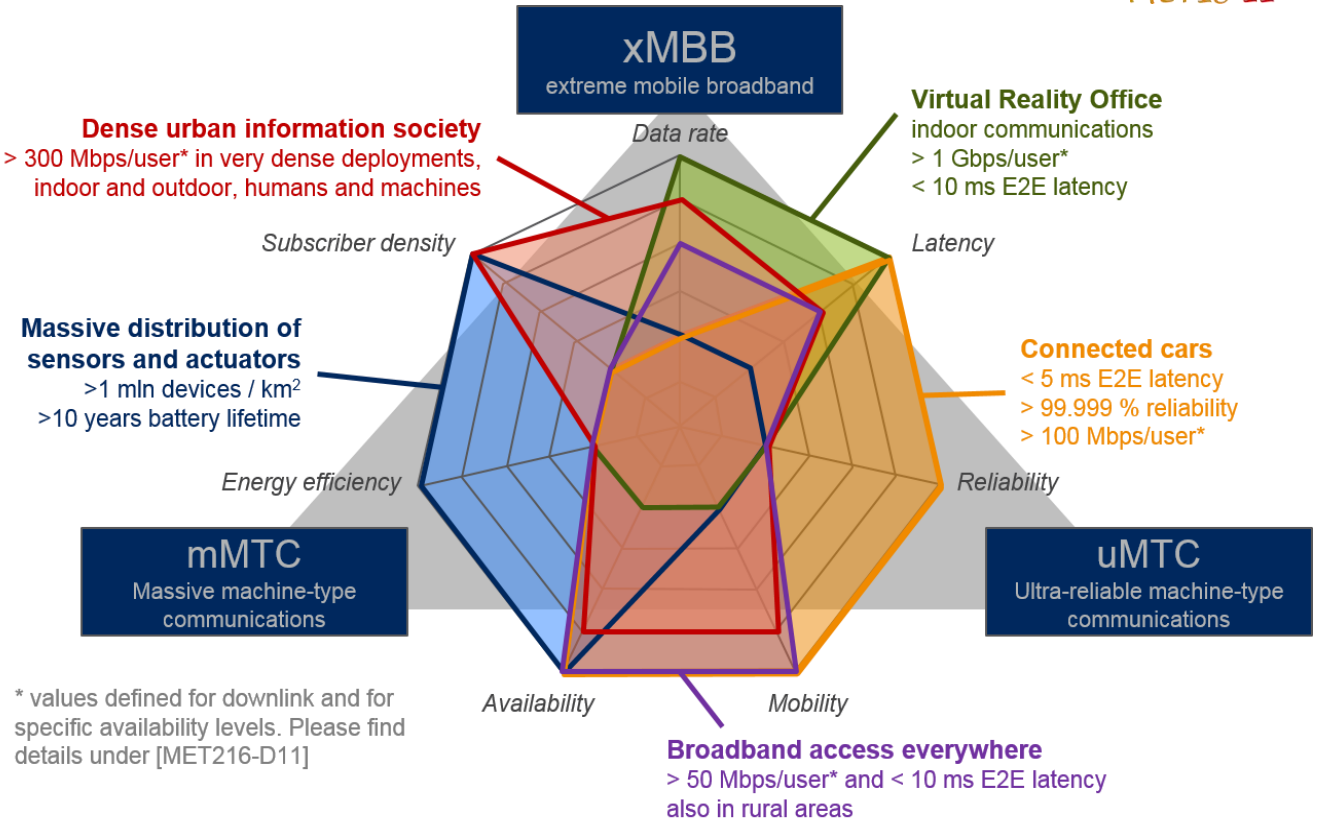
KPIs evaluated by analysis (pen and paper)

KPI	Requirement	METIS-II performance	Key contributor
C-Plane latency	< 10 ms	7.125 ms	RRC Connected Inactive, reduction of processing time in BS and UE
U-Plane latency	< 1ms	0.763 ms	Shortening of TTI, reduction of processing time in BS and UE
mMTC energy efficiency	> 10 years on a single 5 Wh battery	> 10 years on a single 5 Wh battery	Extension of DRX, C-Plane latency reduction, deep sleep energy conservation features
Peak data rates	> 20/10 Gbps for DL/UL	21.7/12.4 Gbps for DL/UL	MIMO spatial multiplexing (for lower frequencies), exploitation of mmW bands
Mobility interruption time	0 ms	0 ms	Multi-connectivity + make-before-brake

Where do we stand with 5G requirements?

KPIs evaluated by simulations – use cases

5G KPIs evaluated by simulations are assessed based on 5 use cases with certain deployment and corresponding user requirements

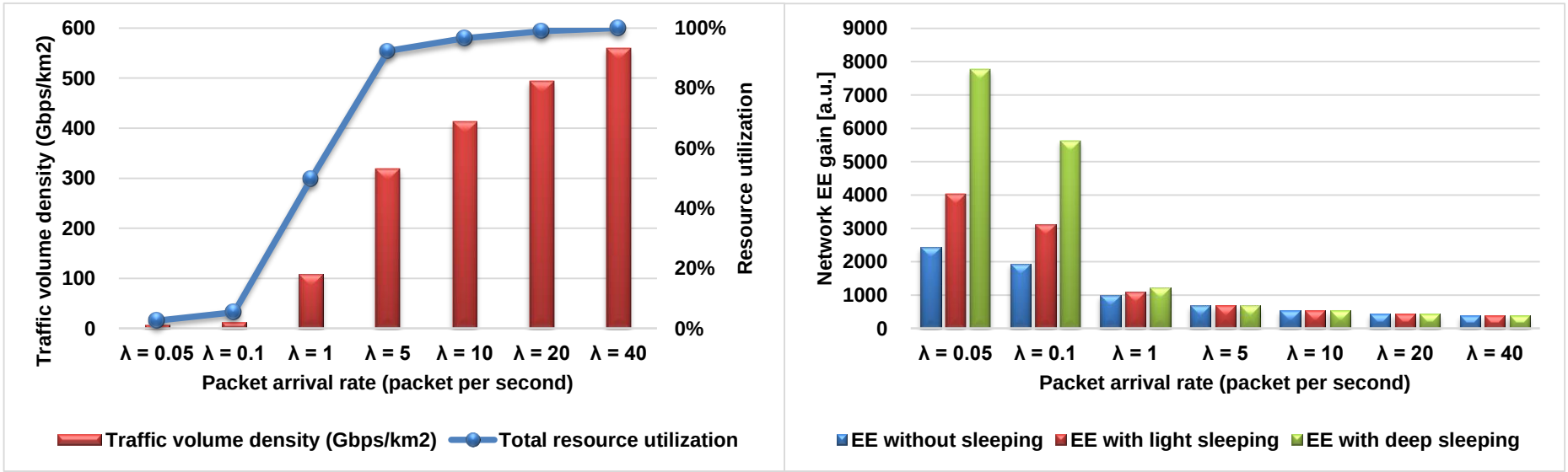


Where do we stand with 5G requirements?

KPIs evaluated by simulation in METIS II use cases

KPI	Requirements	METIS-II performance	Comments
User throughput (use case 1, UC2 and UC3)	UC1: 300 Mbps UC2: up to 5 Gbps UC3: 50/25 Mbps for DL/UL	UC1: 1 Gbps+ UC2: up to 7.85 Gbps UC3: 50/25 Mbps for DL/UL	Only DL values for UC1 and UC2 Different methodology applied for UC3 evaluation
mMTC device density (UC4)	> 1 mln/km^2	4 mln/km^2	Depends heavily on the traffic/report periodicity of mMTC devices. 1 upload of 1000 bits every 100 s was used in METIS-II
Reliability (UC5)	99.999% at 50/1000m for urban/highway	99.999% at 45/150m for urban/highway	For highway scenario, requirements seems very difficult to meet (revision needed?)
Network energy efficiency (UC1, UC3)	Should follow (at least) capacity improvement	For the capacity x1000, network energy efficiency improvements of 350-7500 were reported	Evaluation done only for Dense Urban environment. Savings depend on the load level in LTE-A/5G network

KPIs evaluated by simulation in METIS II use cases - example



TeCs for improved 5G performance

METIS-II D2.3 introduces several TeCs developed in METIS-II technical work packages. Description captured in D2.3 highlights numerical evaluation results and impact of a given TeC on 5G RAN design.

TeCs for improved 5G performance

Table 4-1. Overview of TeCs captured in Section 4.

Service family	Section	Functional description	Key highlights and 5G RAN design implications
xMBB	4.1.1	Integration of LTE-A and 5G using Dual Connectivity	Common LTE-A and 5G interface between core network (CN) and RAN (S1*) for smooth introduction of 5G
	4.1.2	Intercell interference management using Frequency Quadrature Amplitude Modulation (FQAM)	Data rates of edge users can be improved by FQAM operations with info exchange between neighbouring BSs (X2* or multi-connectivity signalling)
	4.1.3	Interference management using joint transmission based on zero forcing precoding	To achieve maximum gains in terms of data rates, BSs need to obtain information on symbols, gains and phases of transmitting radio links in proximity
	4.1.4	RRM enhancements via context awareness	For proactive scheduling, acquisition and signalling of context messages between UEs and BSs is needed
	4.1.5	RRM in networks enhanced by nomadic nodes	Interference management and backhaul link measurements have a

… + 13 more from uMTC, mMTC and mutli-service support domains

Key concepts coming from evaluation of individual TeCs

- tight integration of 5G with LTE-A very useful in initial deployments
- new roles of user equipment as nomadic nodes, mobile relays, etc.
- the dynamic cell switch off to increase energy efficiency
- grouping of accesses, preamble multiplexing for optimized mMTC
- advanced RRM approaches including traffic steering and network slicing to improve QoS support of different services
- harmonization of air interfaces for optimal RRM

Summary

Deliverable D2.3 has presented the final METIS-II **performance evaluation framework**. The most novel feature and one of the major achievements of this framework is the final version of the RAN energy efficiency evaluation methodology.

A set of **inspection KPIs** was evaluated positively.

Analytical **evaluation of KPIs** concluded the ability of the 5G RAN designed by METIS-II to fulfil the 5G system requirements.

Simulation-based evaluation for the five METIS-II 5G UCs has been conducted based on METIS-II and 3GPP performance evaluation framework.

Where to find more info?

- https://metis-ii.5g-ppp.eu/ - official METIS-II page
- https://metis-ii.5g-ppp.eu/documents/deliverables/ - METIS-II public deliverable
- https://5g-ppp.eu/ - official 5G-PPP website

Thank you!