METIS-II Deliverable D2.1 Performance evaluation framework

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Introduction

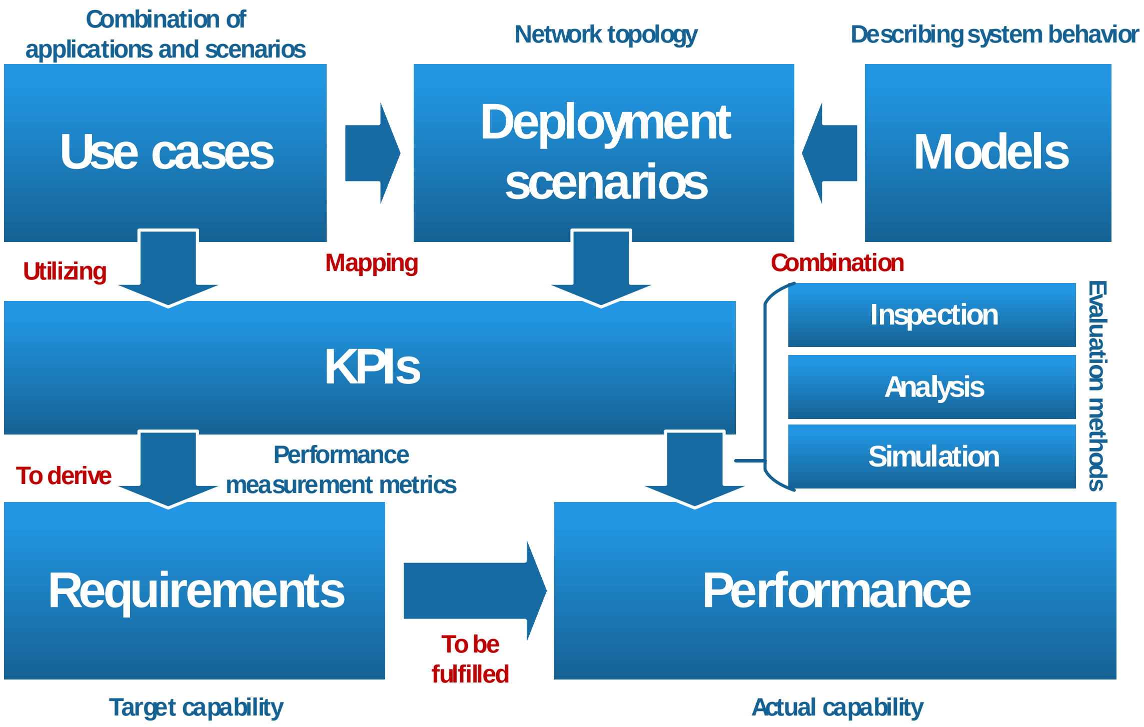
METIS-II Deliverable D2.1 contains a proposal for a performance evaluation framework that aims at ensuring that multiple projects within 5G-PPP wireless strand can quantitatively assess and compare the performance of different 5G RAN design concepts.

Deliverable collects the vision of several 5G-PPP projects and is conceived as a living document to be further elaborated along with the 5G-PPP framework workshops planned during 2016.

5G performance evaluation framework

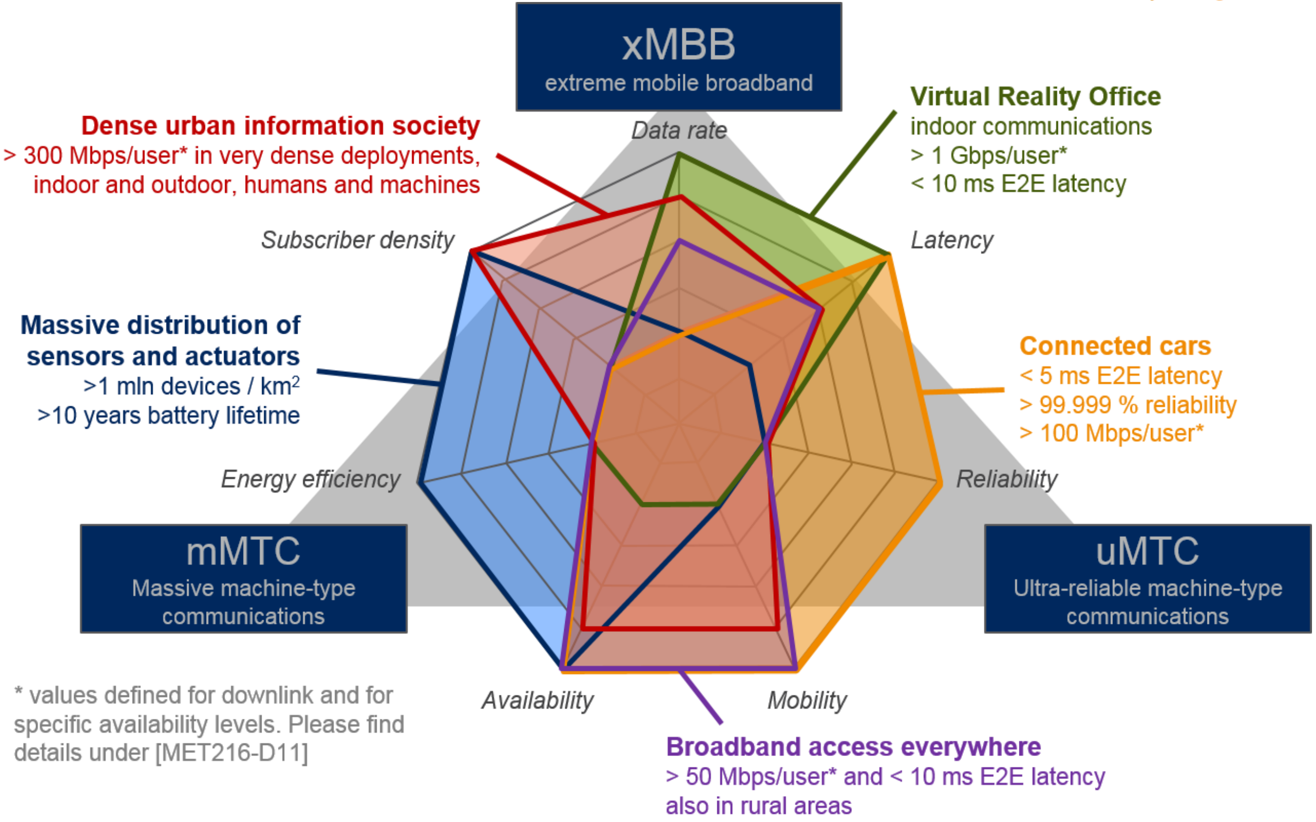
Four basic building blocks:

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



METIS-II use cases

METIS-II proposes five 5G use cases that are mapped to the basic use case families that 5G will embrace: xMBB, mMTC and uMTC. Each use case is represented by a set of a typical user requirements



Design goals of proposed 5G evaluation framework

- Simple (or not more complicated than necessary)
  - Should be easy to adapt by researchers who want to use it
- Fair
  - Shouldn’t favour any particular approach
- Reuse models that are widely endorsed
  - Minimization of implementation efforts
  - Well known limitations
  - Could be reused not only for the purpose of single project

KPIs and their evaluation methods

Inspection (yes/no):
- Bandwidth and channel bandwidth scalability
- Deployment in IMT bands
- Operations above 6 GHz
- Spectrum flexibility
- Inter-system handover
- Support for wide range of services

Analysis (calculation)
- Control plane latency
- User plane latency
- mMTC device energy consumption
- Inter-system HO interruption time
- 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

Exemplary evaluation via analysis

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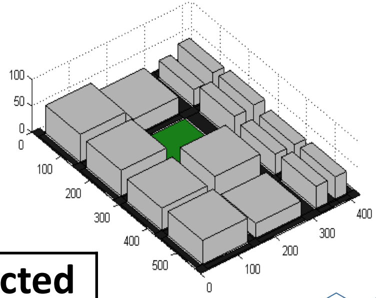
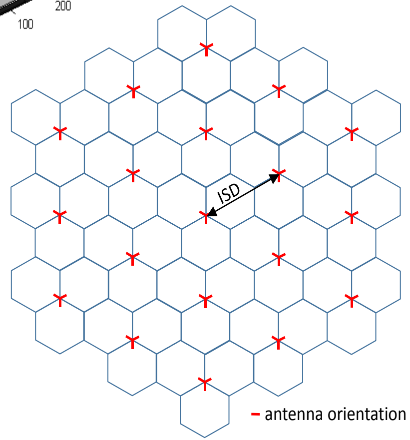
CP latency calculation procedure (first 3 steps out of 8)

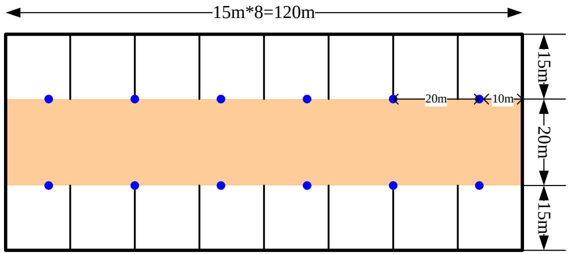
Step	Description	5G aspects for considerations
0	UE wakeup time	Wakeup time may significantly depend on the implementation (e.g., different for mMTC water meter sensor and for automotive uMTC device). Additionally, 5G may introduce intermediate states in addition to 4G LTE idle and connected, for the purpose of CP latency reduction and device energy consumption savings. The new introduced intermediate state might provide a widely configurable discontinuous reception (DRX) and thus contribute to different CP latency for different traffic patterns and battery requirement. Since UE can be configured by the network with different DRX in different situations, this delay component might be better reflected with simulation approach.
1	DL scanning and synch. + broadcast channel acquisition	This step includes also beam finding / sweeping procedures in the terminal side, if needed. On the other hand, 5G may introduce different forms of multi-connectivity which may allow skipping this step e.g., broadcast information for the idle AIV could be delivered over other AIV where UE is able to receive it. With different configuration of multi-connectivity, broadcast information for the idle AIV might be delivered in different ways. In case of CP/user plane (UP) decoupling between two or more cells, detection of UP cells discovery signals needs to be taken into account. Detection of UP cell should not be longer than duration of steps 2-7. Note also that in novel AIVs the periodicity of certain common signals/channels for access may vary. These details shall be included in the description of this step duration calculation.
2	Random access procedure	In case random access channel (RACH) preamble is used for the transmission of small payloads, it shall be specified these characteristics. In case where collision of random access occurs, (e.g., mMTC traffic) evaluation of this delay component can be more precise with simulation approach.

… and further steps i.e. UL sync, authorization …

Deployment scenarios







Use case	Dense urban inform. society	Virtual reality office	Broadb. access everywhere	Massive MTC	Connected cars
Synthetic deploym.	HetNet (UMa + outdoor small cells)	Indoor hotspot	Rural macro	Urban macro	(UMa + outdoor small cells)
Realistic deploym.	Madrid Grid	Indoor Office	n.a.	Madrid Grid	Madrid Grid

Both synthetic and realistic deployment scenarios are proposed

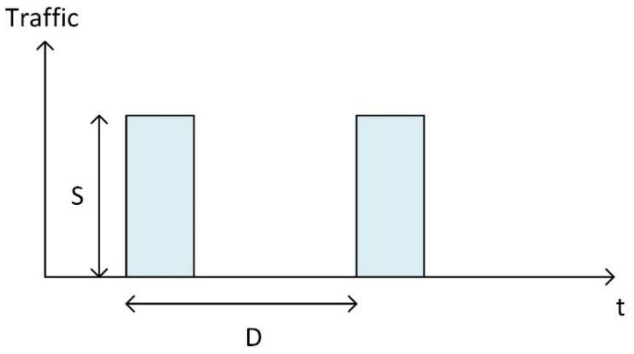
Synthetic deployment scenarios/parameters

Deployment scenario	Indoor hotspot	Urban macro	HetNet Outdoor small cells	Rural macro
BS antenna height	3 m, mounted on ceiling	25 m, above rooftop	10 m on the lamppost / below the rooftop	35 m, above rooftop
Number of BS antennas elements (TX/RX) (FFS)	Up to 256/256 >6 GHz, up to 16/16 <6 GHz	Up to 32/32	Up to 256/256 >6 GHz, up to 16/16 <6 GHz	Up to 32/32
Number of BS antenna ports (FFS)	Up to 8	Up to 16	Up to 8 < 6GHz	Up to 8
BS antenna gain	5 dBi (per element)	17 dBi	5 dBi (per element)	17 dBi
Maximum BS transmit power	40 dBm EIRP for >6 GHz (in 1 GHz), 21 dBm for 6 GHz (in 20 MHz)	49 dBm per band (in 20 MHz)	40 dBm EIRP for >6 GHz (in 1 GHz), 30 dBm <6 GHz (in 20 MHz)	49 dBm per band (in 30 MHz)
Carrier center frequency for evaluation (per BS)	3.5 GHz and 70 GHz	2 GHz for UC4 and UC5, 3.5 GHz for UC1	25 GHz in UC1, 5.9 GHz for RSU in UC5	800 MHz
Carrier bandwidth for evaluation (per BS) [1]	100 MHz at 3.5 GHz and 1 GHz at 70 GHz	Up to 10 MHz at 2 GHz for UC4 and UC5, up to 100 MHz at 3.5 GHz for UC1	1 GHz at 25 GHz in UC1, 10 MHz at 5.9 GHz for RSU in UC5	30 MHz at 800 MHz, assuming Carrier Aggregation with other bands
Inter-site distance	20 m	200 m for UC1, and 500 m for UC4 and UC5	> 20 m	1 732 m

[1] The spectrum information used in this document on carrier center frequencies and carrier bandwidth sizes per each base station and access point are given as examples to be used only for 5G radio technology performance evaluation purposes. The amount of spectrum needed for 5G and what spectrum bands would be used for 5G are still under study.

Models - traffic

- mMTC: transmit 125 B payload up to once per second
- uMTC (URLLC): CAM and DENM messages as proposed in 3GPP TR 36.885 or METIS-II Deliverable D1.1
- xMBB:
  - Bursty: 3GPP FTP 3: fixed file size of 3.5 MB, varying packet interarrival time
  - Full buffer



Models - channel

- < 6GHz – reuse 3GPP models (3D UMa for Dense urban xMBB and mMTC, 2D for anything else)
- > 6GHz – recommending models from white paper on "5G Channel Model for bands up to100 GHz" http://www.5gworkshops.com/5GCM.html
- Pathloss traces available for realistic deployment scenarios for selected frequencies https://www.metis2020.com/documents/simulations/

Models - parameters

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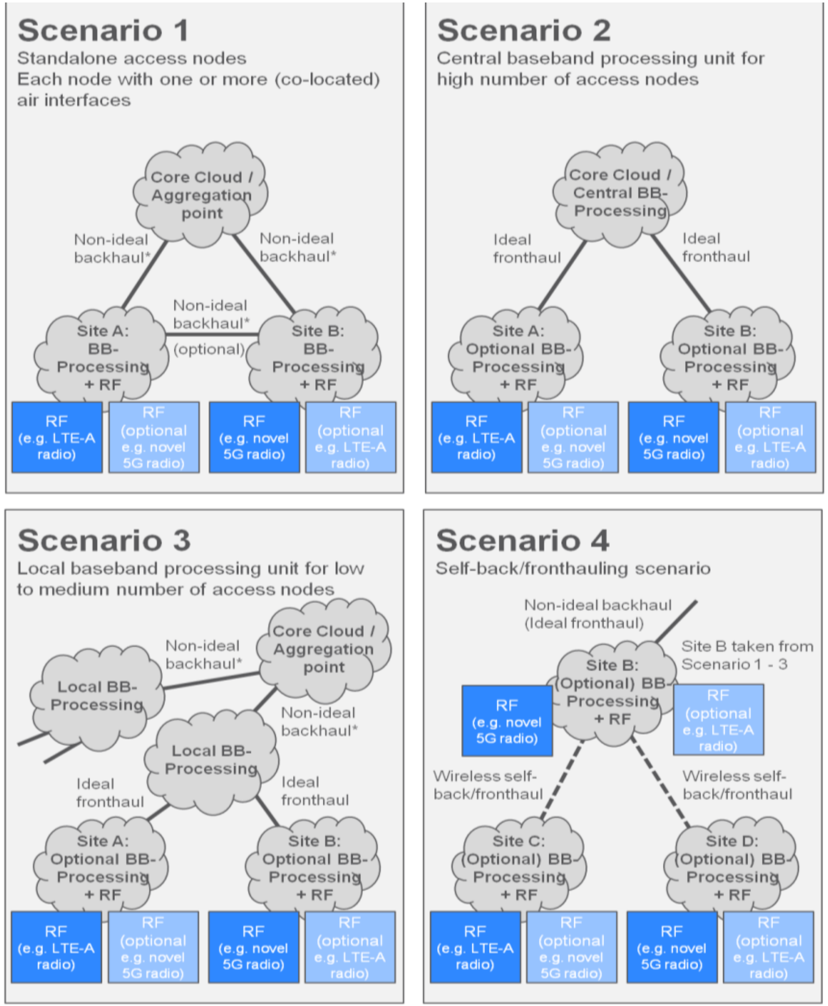
Use case	UC1 Dense urban information society	UC2 Virtual reality office	UC3 Broadband access everywhere	UC4 Massive distribution of sensors and actuators	UC5 Connected cars
UE deployment	10 UEs per macro cell and 5 UEs per small cell	cf. Section 4.2.2	10 UEs per cell	24000 per cell	< 1000/100cars per square km (Urban/Motorway)
UE height	cf. D2.1 Section 4.1.2	1.5 m	1.5 m	cf. D2.1 Section 4.4.2	1.5 m
Number of UE antenna elements (TX/RX) (FFS)	16/16	16/16	8/8	2/2	2/4
Number of UE antenna ports (TX/RX)(FFS)	8/8 for <6 GHz, 4/4 for >6 GHz	8/8 for <6 GHz, 4/4 for >6 GHz	4/4	1/1	1/2
UE maximum transmission power	24 dBm	24 dBm	24 dBm	21 dBm	23 dBm
UE speed for fast fading calculation	3 km/h in OSC and 30 km/h in UMa	3 km/h	120 km/h	3 km/h	60 km/h for Urban and 140 km/h for Motorway
UE position	Fixed	Fixed	Fixed	Fixed	Explicitly modelled
Min 2D UE-BS distance	10 m for OSC BS and 35 m for UMa BS	10 m	35 m	35 m	35 m
Indoor / Outdoor ratio	80/20	100/0	0/100	80/20	0/100
Channel model	< 6 GHz 3GPP UMa 3D, >6 GHz 5GCM	< 6 GHz 3GPP InH 2D, >6 GHz 5GCM	3GPP RMa 2D	3GPP UMa 3D	cf. D2.1 Section 4.5.5
Traffic model	Full buffer and bursty traffic	Full buffer and bursty traffic	Full buffer and bursty traffic	Bursty traffic (periodic)	Bursty traffic (periodic+event)

General models

For non-ideal fronthaul/backhaul [1, 5 and 30 ms] and [0.05, 0.5 and 10 Gbps] one way latency and throughput, respectively, are recommended.



General models

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- Link to system
  - Recommend to use Eb/No to packet error rate mapping curves obtained using mutual information effective SINR mapping (MIESM) method
- RAN energy efficiency
  - Spatial (whole network) and temporal (e.g. 24h) needs to be considered
  - First concepts for evaluation assume 3-4 averaged load levels and ‚density' areas mapped to basic use cases (dense urban, urban, rural)
  - KPI for entire RAN

Summary

Models described in METIS-II D2.1 will be used to evaluate different 5G technical solutions and it is possible that some aspects will be a subject to fine tuning. Corrections, if any, and further parametrization of 5G KPIs assessment methods will be available along with the evaluation results in METIS-II deliverable D2.3 'Performance evaluation results' that will be issued in February 2017.

Full version of METIS-II D2.1 is available at https://metis-ii.5g-ppp.eu/documents/deliverables/

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Thank You

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