Air interface design for 5G: a METIS-II perspective

EuCNC 2016 Special Session

"METIS-II views on 5G RAN design and architecture"

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Milos Tesanovic (Samsung), Venkatkumar Venkatasubramanian (Nokia Networks), Malte Schellmann (Huawei), Jamal Bazzi (DoCoMo), Miltiades C. Filippou (Intel), Daniel Calabuig (Universidad Politécnica de Valencia), Osman Aydin (Nokia Bell Labs), and Caner Kilinc (Ericsson)

Outline of the talk

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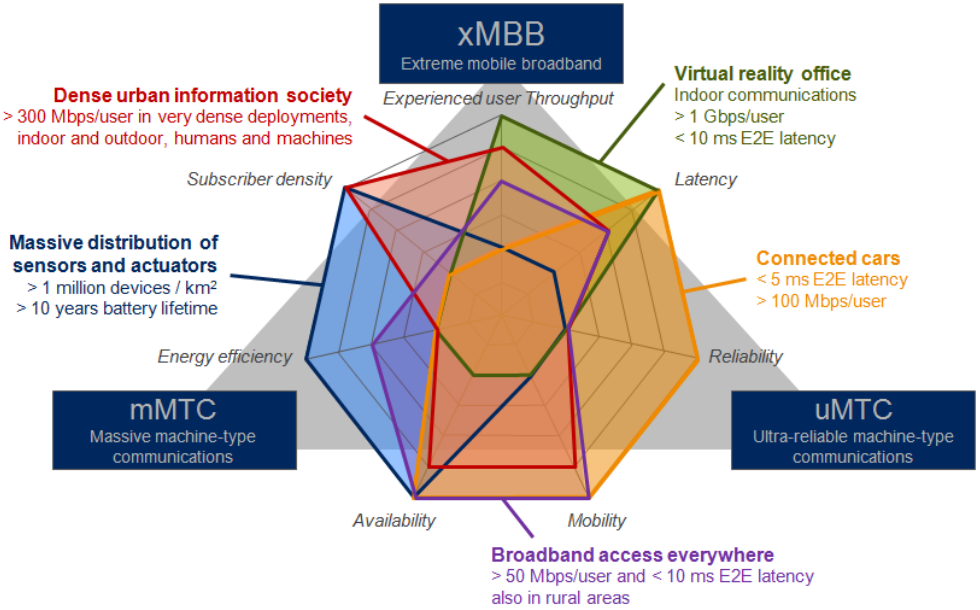
- Introduction and background
- 5G Air Interface: key requirements
- Design challenges
- The concept of AI harmonization
- Examples
- Conclusions and future work

Introduction and key requirements

- New radio is needed to fulfil all the 5G performance requirements of the envisioned new use cases
- Examples include:
  - extreme low latency use cases
  - ultra-reliable transmission
  - xMBB requiring additional capacity that is only available in very high frequencies
  - MTC with extremely densely distributed sensors and very long battery life requirements



METIS-II view of key 5G AI concepts

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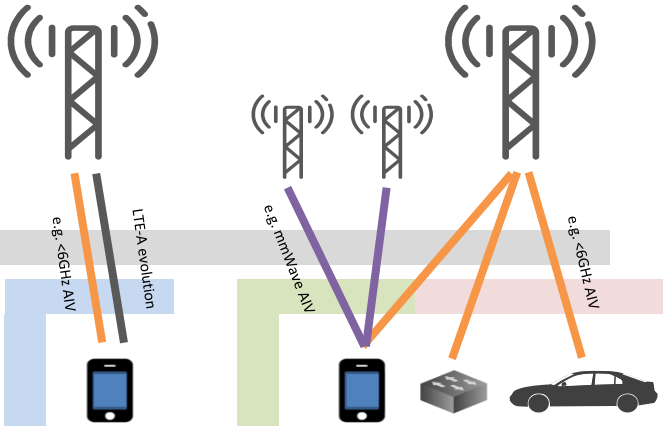
Harmonization

LTE-A evo. e.g. mmWave AIV e.g. <6GHz AIV

- Between LTE-A evo. and novel 5G AIVs, harmonization benefits have to be weighed against legacy constraints imposed towards novel AIVs
- Among novel 5G AIVs, maximum harmonization should be aimed for, but it is not sure whether full harmonization for all bands and services is possible

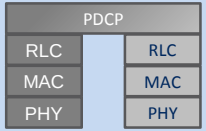


Service Multiplexing

- All novel protocol stack layers and related functions introduced in 5G should natively support service multiplexing for xMBB, mMTC, uMTC*

* Though some bands and related AIVs may be predestined for a subset of services (e.g. mmWave mainly for xMBB)

Integration among LTE-A evolution and novel AIVs

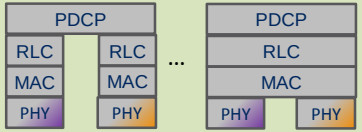


- RAN level integration should be supported
- PDCP is seen as a viable UP aggregation layer, though also MAC layer is investigated

LTE-A evo. Novel 5G AIV, e.g. mmWave AIV

- Cases with single and dual RRC protocol instances above PDCP investigated (e.g. one for LTE-A evo. one for novel 5G AIV)

Integration among novel AIVs

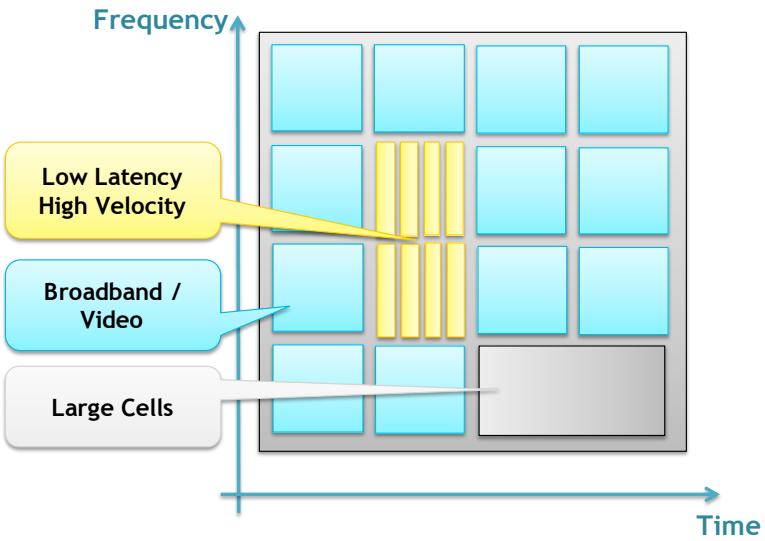


(for instance considering aggregation between mmWave and <6GHz AIV)

- User plane aggregation could take place on PDCP, RLC or MAC level
- Single RRC protocol instance envisioned above PDCP, RRC diversity, fast control plane switching etc. investigated

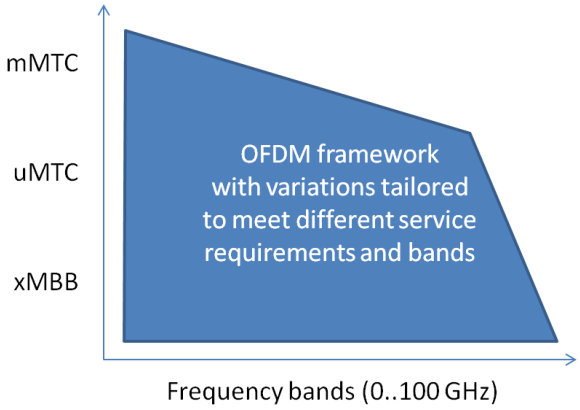
5G AI design challenges

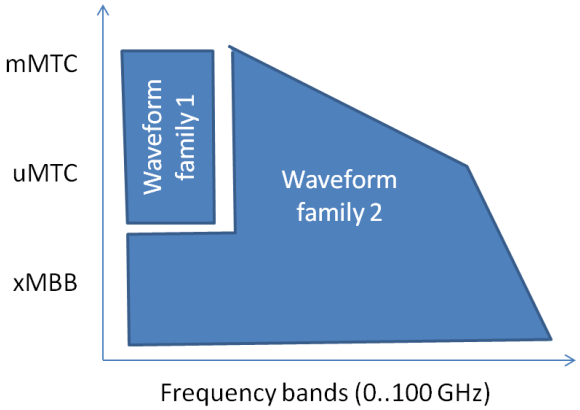
- We need to integrate different AI candidate technologies (including LTE-A evolution) is such a way as to support the wide landscape of services, bands, cell types etc.
- Additionally, both the complexity of the standard and that of the implementation are minimized
  - Performance of individual technologies should not be sacrificed
- An adaptable and flexible 5G AI design is therefore required to address these issues while efficiently multiplexing multiple services



Overall 5G AI landscape

- Current proposals differ in the technology components they are comprised of, and in the type (single-WF / multi-WF) and their inherent extent of harmonization
- A unified way of describing the 5G AI design proposals using a 5G service / frequency mapping is used in METIS-II:





METIS-II and 3GPP

- METIS-II 5G AI framework takes into account and expands the current considerations in 3GPP
  - While current 3GPP study and work items focus on specific aspects such as numerology details, in METIS-II we explore a comprehensive integrated system
- Assessment methodologies put forward in this talk are of broader scope than those developed within standardization activities, such as the ones in 3GPP
- Additionally, METIS-II studies a wider range of WF families and protocol functionalities

5G AI evaluation criteria

- The METIS-II AI candidate assessment is performed according to AI evaluation criteria classified into the following 4 categories:
  - The suitability of an AI proposal to meet the overall 5G KPIs and directly related UP design requirements;
  - Additional UP-related AI design principles, such as* flexibility by design, forward-compatibility, easy interworking with LTE-A evolution, minimising signalling overhead, beam-centric approach;
  - Requirements posed from CP considerations on the design of AIs;
  - The extent of harmonization across AIVs in overall AI considerations.

* Further details can be found in Deliverable D 4.1, “Draft air interface harmonization and user plane design”, May 2016.

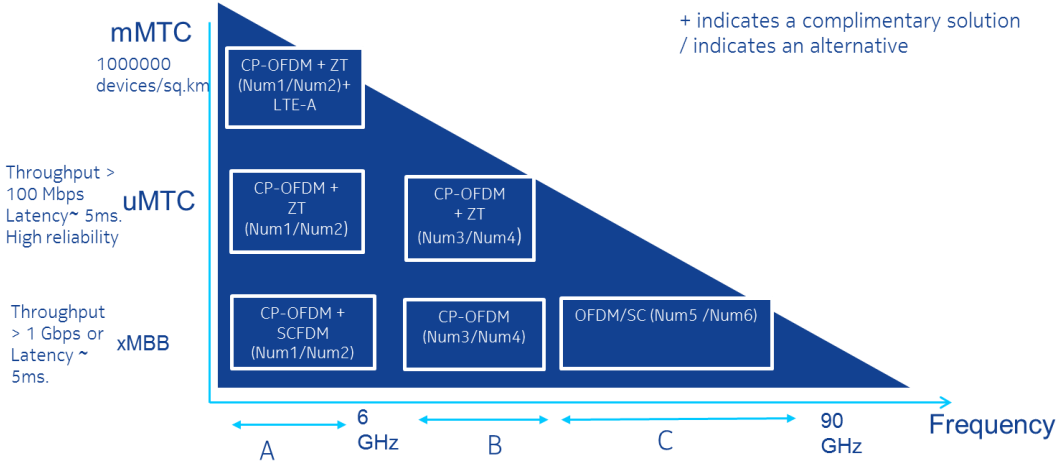
Spotlight on harmonization KPIs

1. Standardization effort and product development of AI proposals (time to market): This KPI assesses the amount of work needed to standardize and develop the different AI proposals.
2. Ability to integrate new AI proposals with LTE-A: This KPI assesses the ability a proposal has to integrate with LTE-A.
3. Forward compatibility: This KPI assesses the ability of efficiently introducing new features and services in the future without the need for re-designing the AI.

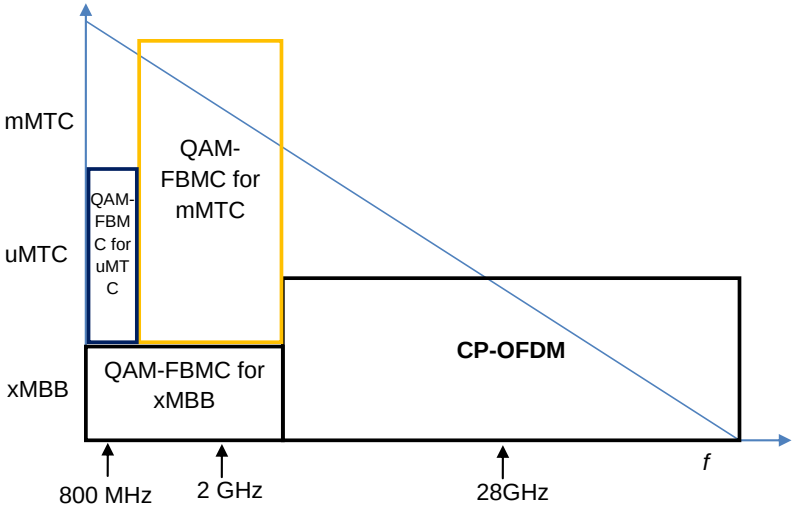
Spotlight on harmonization KPIs

3. Ability to dynamically utilize radio resources: This KPI assesses in which time scale the proposed AI can utilize the frequency bands in a given location.
4. Support of User Plane (UP) aggregation: This KPI assesses the degree of ability to aggregate multiple AI components on different layers of the protocol stack to support UP aggregation.
5. Ability to reuse SW and HW components among components of new AI: This KPI assesses the ability to reuse SW and HW components by the different AI components / instantiations, for both the UE and the network equipment.

Example AI Frameworks Considered*



Single-waveform solution



Multi-waveform solution

*note that these are only two examples out of many studied in METIS-II. Further details can be found in Deliverable D 4.1, “Draft air interface harmonization and user plane design”, May 2016

Conclusions

- METIS-II approach to 5G AI design presented
- Key focus was on the extent of harmonization across underpinning components in overall AI considerations
  - Defined as a combination of features such as utilization of radio resources, implementation complexity, standardization effort, forward compatibility, and interaction with legacy systems
- The case was argued that these harmonization KPIs are essential when assessing new 5G AI technologies
- Additional criteria include UP-related design principles, and requirements posed from CP considerations

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Thank You

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