METIS: Mobile Communications for 2020 and beyond

Mobile and wireless traffic volume is expected to increase a thousand-fold over the next decade. The traffic explosion will be driven by the massive increase in the number of the connected devices; forecasts predict 50 billion devices to be connected to the cloud by 2020 and all need to access and share data, anywhere and anytime [1-2]. Moreover, new machine-centric applications will be complementing the traditional human-centric applications in order to provide new types of services to the users and achieve the networked society vision. The wide range of expected applications will lead to a large diversity of requirements and use-cases that cannot be handled solely by existing technologies [3].
The future mobile and wireless communication systems beyond 2020 will have to respond to these societal challenges, by increasing capacity and by improving efficiency in energy, cost and spectrum utilization as well as by providing better scalability for handling the increasing number of the connected devices.

In this paper, we will describe the way METIS (Mobile and wireless communications Enablers for the Twenty-twenty Information Society) project intend to address the future challenges of the information connected society [4]. An overview of the project goals is first given before outlining the relevant technology components and the research topics investigated to build the overall architecture of the next generation system, "5G".

1. Objectives

METIS was set up by leading telecommunications companies, to lay the foundation of the mobile communication systems beyond 2020. The project envisions a future where access to information and sharing of data is available *anywhere* and *anytime* to *anyone* and *anything*. To enable the *all-communicating world* vision, METIS will develop a concept for the future mobile wireless communications system and will identify and research key building blocks of such a future system. As described in [4], The METIS overall technical goal is to provide a system concept that supports, relative to today's network:

- 1000 times higher mobile data volume per area,
- 10 times to 100 times higher number of connected devices,
- 10 times to 100 times higher typical user data rate,
- 10 times longer battery life for low power Massive Machine Communication (MMC) devices,
- 5 times reduced End-to-End (E2E) latency.

METIS will pursue a two-fold research approach: the *Horizontal Topics* will integrate the *Technology Components* into the future mobile and wireless communications system; and vertical Work Packages will research and develop the relevant *Technology Components* to respond to the expected future needs.
However, in order to capture these needs from an end-user perspective, METIS starts by identifying a set of challenging scenarios and test cases (TCs). In particular, specific assumptions regarding requirements and key performance indicators (KPIs) in 2020 and beyond are established in scenario definition work, to ensure consistent basic assumptions in the technical-research works and system concept-development work.

2. Scenarios

METIS will cover a wide area of technologies, which address different technical challenges generated by a diversity of applications and end-user requirements. Part of these requirements will probably be addressed through an evolution of today's networks whereas other possible futures, imposing new types of challenges such as extreme low-latency, very high data rate, or significantly reduced energy consumption, will require the development of new technology components to complement the existing Mobile networks, see Figure 1.1 [5].

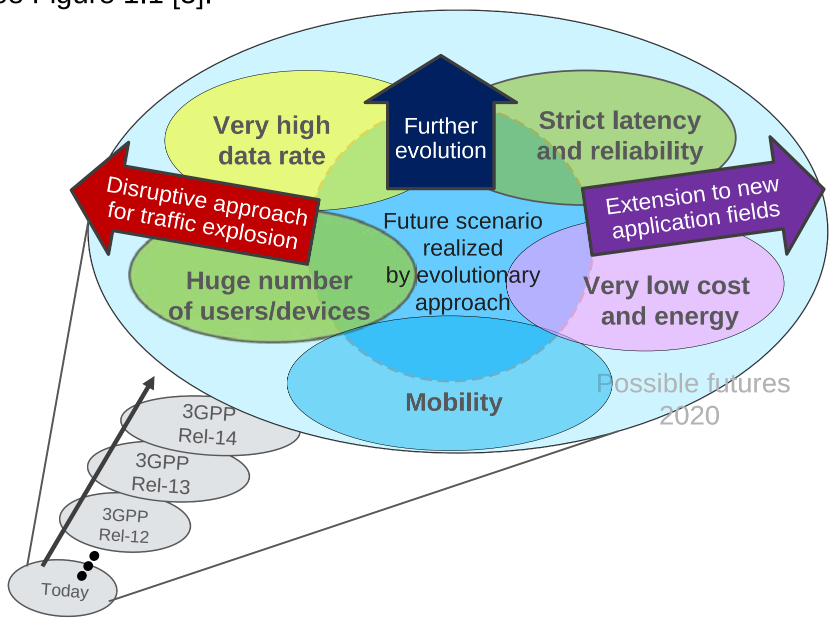

Figure 1.1: The METIS scenarios are selected so as to stretch out the space of possible futures and to cover the overall technical goals of METIS [4].

METIS formulated the main technical challenges through the definition of a group of scenarios where each scenario deals with one main challenge, though it might have more challenges within its scope. The identified challenges are namely, "*Very low latency*", "*Mobility*", "*Very low cost and power*" communications, "*Very dense crowds of users*", "*Very high data rates*".
From a user-oriented perspective the challenging problems are then described as a set of 12 realistic and challenging Test Cases (TCs). By identifying the aspects of each TC, METIS identified the most challenging ones and thus grouped the TCs to generic problems described by scenarios,

Finally, the main challenges for each scenario are then used for the mapping between the overall METIS goals and their relevant scenarios.

3. Technology components and architecture

In order to provide a connectivity platform for a wide range of applications and requirements expected for beyond 2020, METIS will research the following technology components to outclass the state-of-the-art:

- *radio-links*, by investigation advanced transmission technologies, including the development of new transmission waveforms and new approaches to multiple access, MAC and RRM;

- *multi-node and multi-antenna transmissions*, by designing multi-antenna transmission/reception technologies based on massive antenna configurations and developing advanced inter-node coordination schemes and multi-hop technologies including wireless network coding to achieve better capabilities for future wireless;
- *network dimension*, by considering the demand, traffic and mobility management, and novel approaches for efficient interference management in complex heterogeneous deployments;
- *spectrum usage*, by considering extended spectrum-band-of-operation, as well as operation in new spectrum regimes to provide a complete system concept for new spectrum regimes that carefully addresses the needs of each usage scenario.

METIS will use the *horizontal topics* to build the overall system concept. Each horizontal topic (HT) will integrate a subset of the technology components to provide the most promising technology solution to one or more test-cases which have been identified in the scenario work. Potential overlaps between HTs, trade-offs and mutual interdependencies between technology components will be identified and analyzed with respect to their impact on the overall system design. Main HTs that have been identified so far in METIS are described below.

- *Device-to-Device (D2D) communications* refers to direct communication between devices allowing local exchange of user plane traffic without going through a network infrastructure. The goals of this HT are to extend coverage, to provide fall-back connectivity, and to increase spectrum usage and capacity per area.
- *Massive Machine Communications (MMC)* will form the basis of the Internet of Things with a wide range of application fields including the automotive industry, public safety, emergency services, medical solutions, etc. This HT addresses the characteristics and requirements associated with these applications and provide enablers for efficient support of machine-related communications.
- *Moving Networks (MN)* will enhance and extend linking together potentially large populations of jointly moving communication devices. A moving network node (e.g. vehicles or buses with advanced networking capabilities) or a group of such nodes can form a “moving network” that communicates with its environment, i.e., other fixed or mobile nodes that are inside or even outside the moving entity.
- *Ultra-dense Networks (UDN)* will be the main driver to address the traffic demands of beyond 2020, where the goals are to increase capacity, increase energy efficiency of radio links, and enable better exploitation of under-utilized spectrum. Infrastructure densification is a path that has already been taken within, e.g., existing cellular technologies with inter-site densities going down to the order of 200 m.
- *Ultra-reliable Networks (URN)* will enable high degrees of availability. In this context, METIS aims at providing scalable and cost-efficient solutions for networks supporting services with extreme requirements on availability and reliability.

In addition, METIS will develop new technologies which facilitate functionalities known from other relevant systems and also to efficiently enable integration of the HTs stated above in the overall METIS system concept.

METIS will research and introduce a novel, beyond-cellular architectural concept that can take advantage of the novel component technologies described previously in a scalable way. The goal is to provide a consistent architectural framework integrating different kinds of centralized and decentralized approaches.

4. Conclusion

METIS will lay the foundation of the next generation communication system, “5G”, and develop a concept that meets the requirements of future services, connect diverse devices and handle the increasing traffic demands. The project will research technology components such as network topologies, radio links, multi-node, and spectrum usage techniques. Horizontal topics such as Device-to-Device, Massive Machine Communications, Moving Networks and Ultra-dense Networks will be used to integrate the research results into a system concept that supports the connected information society at a low cost.

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References

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