What is the definition of 5G?

Should a vision of 5G address the entire network, including new and evolved radio access technologies, new RAN and core network architectures and fundamental changes to business models and eco-systems or "only" the definition of a new RAT complementing LTE to address a specific set of new requirements? Is it possible to initially limit consideration in 5G standards to a narrow issue of the definition of new RAT or is there a danger that this approach introduces design assumptions that will impact the long term 5G vision?

Set in the scope of pre-standardization, this affects which standardization bodies become relevant.

What are the main target standards bodies?

Telecommunication: 3GPP, ITU-R, ITU-T, ETSI and other regional standards bodies, IETF/IRTF, IEEE, ONF, BBF, Open source projects (Open Daylight, OPNFV, Open Stack), oneM2M, ...?

As 5G architectures are intended to integrate different domains (mobile/fixed/satellite, licensed/ unlicensed, IoT) it may become an issue how the standards development organisations related to these specific domains will work together to define 5G.

Verticals: Every vertical industry has its own standards bodies. What is a suitable level of involvement in the different verticals? The purpose for telecom industry is to understand requirements affecting the communication, not necessarily to become active contributors to the verticals standardization bodies. How do we engage verticals? What can we learn from oneM2M's experience in this respect?

There is an inherent trade-off between the economy-of-scale provided by e.g. 3GPP systems and the specific requirements of the verticals. The verticals must reassess which requirements are crucial and which are "nice-to-have". The telecom community must then evaluate which requirements can be supported without unacceptable increase of cost. Cost increases should be expected since significant improvements of reliability or reduction in latency will require different resource allocation, and possibly also different network elements. Latency reduction affects the air interface and the network function placement. Network slicing is an enabler for this. What do the different verticals want to control in their network slices? Security and reliability issues related to this.

Automotive vertical: All 5 regions represented at the Workshop have an international automotive industry. Does this lead to an opportunity for the 5 regional forums to have a joint approach in this vertical industry? C-ITS, ETSI, CEN and ISO are together developing specifications. In this area we see an example of joint work between ISO TC204 WG18 and CEN TC278 WG16. There is also global cooperation with IEEE and SAE standardization. In addition to radio interfaces, information models and some architecture for C-ITS need to be standardized.

Factory vertical: This is another industry with many actors represented in several of the 5 regions represented at this workshop. Is there therefore a potential for a common approach? Some relevant industry organisations include IEEE (802.11 mobile/Wi-Fi integration, ITS G5 802.11p V2X, 802.15 Zigbee, wireless HART automatic control), ISA100 Factory Automation Working Group, Industrie 4.0.

What are the road maps/milestones/time frame?

5G initiatives have to take into account at least ITU-R and 3GPP if they want to impact the 5G standardisation efforts. Three phases have been identified so far: a phase that has already started and will continue for another 1-2 years, in which various aspects or 5G are or will be studied, an 'early 5G' specification phase for prioritised 5G features, with main focus in 2017-2018 and a 'full 5G' specification phase in 2018-2019.

Right now, there is an opportunity to contribute in 3GPP to identification of 5G use cases (SA1) and 5G channel modeling (RAN). Starting from December there will also be an opportunity to impact the 5G architecture study (SA2) and 5G RAN study (RAN).

The timing of contributions to or impact on verticals standardisation poses a larger issue. Before determining of the large number of potentially relevant SDOs the 5G PPP projects will actually interface, it is hard to determine a consolidated time-line.

What are key issues to address over the next two years

Use cases: Three major use case categories have been identified for 5G: (1) Enhanced Mobile Broadband; (2) Massive Machine Type Communications; and (3) Ultra-reliable and Low Latency Communications. There is no consensus yet on prioritisation of one of the use case categories over the others. Although a significant number of companies proposed to target Enhanced Mobile Broadband with priority, another large number of companies want to wait for the results of studying all use case categories first.

3GPP SA1 has identified over 50 use cases. Have all relevant use cases been identified? The 5G Forums have been identifying visions and requirements, and therefore are expected to have use cases in mind. Now is the time to contribute those to 3GPP, if not already done.

The regional 5G forums may be able to play a role in identifying some priority based on their work, e.g. by identifying urgent individual use cases instead of these broad categories.

Channel modeling: The research community has been working on channel models before. Maybe 5G Forums can therefore quickly produce relevant inputs to the 3GPP study for channel modeling for above 6GHz spectrum?

RAN technologies: After identification of requirements for all use cases, 3GPP RAN Working Groups will start evaluations of technology solutions from March 2016. The following technologies were mentioned most frequently in contributions to the 3GPP 5G Workshop. 5G forums therefore have a good chance to impact 3GPP if they start to develop results on these technologies:

- New Carrier
- New waveform/Numerology

- Massive MIMO enhancements
- Latency reduction techniques
- mmWave communications
- Non-Orthogonal Multiple Access
- Adaptive/flexible frame structure
- Cell virtualization (C-RAN)
- User-centric (NFV/Slicing, RAN virtualization)
- Ultra Dense Network
- Advanced MIMO/beamforming
- Focus on TDD
- Less network broadcast, reduced or no periodic transmission
- Flexible Duplex
- Symmetric UL/DL PHY (e.g. MC-OFDM)
- eD2D
- Small cells
- Dynamic TDD
- Wireless Mesh (D2D)

Security and privacy: The mechanisms for virtualization and slicing open many different ways for providing access (not only to network services, but also to control and management interfaces) and sharing (infrastructures, functions, services…) In these scenarios the real identity of the users, partners and providers will be much more difficult to establish. It is necessary to agree on security standards to allow for a proper identification and enforcement of technical and business requirements, addressing different levels of assurance depending on the criticality of the services being supported. This include as well the direct legal requirements on identifying the parties in a certain communication or even performing legal interception when required by the courts of justice.

Besides this, a highly pervasive broadband network like 5G will pose additional privacy concerns to the already existing ones, and it is essential to address user concerns about their privacy while guaranteeing a proper meta-information flow that facilitates network monitoring and management.

Forward Compatibility: What does this imply for the work? Radio forward compatibility will be used to allow later deployment of additional services. The exact forward compatibility requirement needs to be defined and captured in the 3GPP technology study that is expected to be approved in March. Could 5G forums think of smart ways to define forward compatibility and how to achieve it?

How can the regional 5G forums cooperate in a pragmatic way?

Many MoUs have been signed, but how can the regional 5G forums work pragmatically together? F2F meetings like this workshop can probably only take place occasionally. How about regular (e.g. quarterly?) exchanges by electronic means to share major project results, blocking topics, identified priorities, etc.? Maybe the 5G forums can adopt some of the ways of cooperation that the telecom SDOs have been using to exchange information?

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