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D5.3: 5G standardisation requirements

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Lead editor	Colin Willcock (5G IA)
Authors	Colin Willcock (5G IA)
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Abstract

This document is a report from the standardization activities associated with the 5G PPP phase 1 projects. The deliverable identifies relevant standardisation and regulatory bodies and describes the associated submissions and impact from the 5G PPP projects. The deliverable will also present a roadmap of relevant 5G standardization and regulatory topics and discusses the influences and meaning of these plans.

[End of abstract]

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Executive Summary

Standardization is a key aspect for defining the 5G mobile communication global standard. It is only through standardised interfaces that a truly global ecosystem with multiple players from many regions all producing compatible products can be developed and it is this global market scale that makes the technology commercially attractive to invest and get involved with.

For the 5G Infrastructure Association (5G IA) and the 5G PPP projects standardisation has been a clear focus area with significant investment in fundamental research leading to standardisation submission. This report highlights the standardization activities related to the 5G PPP phase 1 projects and related 5G IA activities associated with spectrum and Market Representation Partner (MRP) of the 3GPP.

In summary, the phase 1 5G PPP projects have had a significant impact on 5G standardization. This influence has been two-fold. Firstly, the projects have made a significant influence in building pre-standardization consensus across the major actors. This is a unique aspect of these projects and was enabled by the wide range of partners involved in these research efforts. The project partners encompassed not just vendor, operator, research institutes and SMEs from Europe but also many global players. This global reach was recognised at an international level with high awareness and interest with all things 5G PPP and in many ways this programme setting the tone and direction for 5G. As well as consensus building the phase 1 projects developed and submitted many specific technology proposals (highlighted later in this document). Although not all ideas and proposals have been accepted, as is the normal way with standardization, major impact on the 5G architecture ideas has clearly been achieved and many of the ideas generated by the phase 1 projects are still being discussed in the relevant standardisation bodies.

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1 Introduction

1.1 The role of standards for 5G

In the areas where the projects in 5GPPP are active there are a number of reasons for driving standards. The main role of standardization in the telecommunication industry is to ensure interoperability between equipment and networks from different vendors. In addition, standards also specify requirements on equipment to ensure that the use of them does not cause harm and that the equipment can be used safely. Moreover, taking into account a set of security, privacy and liability issues and addressing them directly in the standardisation processes will ensure a 5G network which is "Secure by Design".

Spectrum standardization is done to ensure that equipment in one system does not interfere with other systems, usually in other frequency ranges, but also in the same frequency range.

It should be noted that standards are not a complete product specification. There are many aspects that are deliberately left out of the standards work. There are many reasons for this. One reason is that there is a wish to keep the standards as simple as possible to reduce the work of ensuring compliance with the standard. Another reason is to allow for product differentiation and to allow for increase competition. A third reason is to allow for more innovation by placing fewer restrictions on the systems. So, in practice standards tend to specify the minimum requirements for interoperability, security and safety.

1.2 Strategic liaison of 5G PPP with standardisation bodies

Regarding liaison with standardisation bodies, the Pre-Standards WG has prepared a summary of 3GPP Phase 1 standardization activities, and was working on the document summarizing the standards activities performed by the projects during the first phase of 5G PPP, documenting the impact that 5G PPP has had on standards. This document served as the major input for this Deliverable. The WG has also supported the projects in their standards work by keeping track of and suggesting upcoming standards events and meetings that can be useful for exploiting their results.

Worth mentioning is that Euro-5G partner 5G-IA was accepted as a Market Representation Partner (MRP) of 3GPP in October 2016 and will thus have the opportunity to impact standards by e.g. offering advice to 3GPP in terms of market requirements (e.g. services, features and functionality), systems and scenarios, allowing to bring in views from 5G PPP.

Regarding ITU-R, the 5G-IA has successfully registered as one of the independent evaluation groups of IMT 2020 (5G) radio interface (under ITU-R WP 5D). The evaluations will start in 2018 and go on until 2020. The 5G-IA has decided to setup a dedicated “Evaluation WG”, to be chaired by Werner Mohr, which will coordinate the activities on behalf of the 5G IA. Strong contribution from 5G projects will be required. Preparations for a first ITU-R workshop to be held in Munich on 4 October 2017 have started.

2 Relevant Standardisation and Regulatory Bodies

2.1 Major standardization bodies targeted by 5G PPP

The 5G PPP projects are active in some of all the existing standards organisations (SDO). Here we list the SDOs which have seen most input from 5G PPP funded projects.

3GPP is the organization responsible for developing "cellular telecommunications network technologies, including radio access, the core transport network, and service capabilities - including work on codecs, security, quality of service - and thus provides complete system specifications"

IEEE is the standards organization responsible for the WiFi and WiMAX standards among many others. In addition to this, there are standards related to machine type communications. Currently work is ongoing to enhance the ability to manage WiFi networks and integrate them in cellular networks.

IETF covers all aspects 5G no-radio network segments as far network slicing is concerned.

ITU-R is developing the requirements that systems must meet in order to qualify as IMT2020 compatible. In addition they develop channel models that are used during evaluations of these systems.

ITU-T IMT2020 / SG13 covers all 5G no-radio network segments as far as overall 5G architecture, network softwarization, integrated network management, fixed mobile convergence is concerned

ETSI covers all aspects on Network Function Virtualisation (NFV), Mobile Edge Computing (MEC), Next Generation Protocols (NGP). ETSI has established its first Open Source Group OSG Open Source Mano. Moreover ETSI is also relevant about cybersecurity with a dedicated group, the TC CYBER.

Open Networking Forum (ONF) has developed an SDN architecture that may be relevant for SDN and NFV concepts. The ONF Services Area is responsible for both SDN architecture and security.

In addition to the organizations actually writing standards there are a number of organisations where some of the actors come together to join forces to have more impact in the standards bodies or to prepare topics that are related but not directly treated by the standards bodies. Examples of these organisations are GSMA and NGMN.

2.2 Position of Europe

One of the goals of 5G PPP is to increase the competitiveness of European industry. Standardisation plays a role in this, but it should be remembered that some topics are deliberately not standardised and these topics are also important for the competitiveness of Europe.

One benefit from standards is the license fees resulting from including patents (technologies) in the standard. At this stage it is difficult to judge how much license fees will end up in Europe for a number of reasons, e.g. accounting allocation for global players, unknown patent portfolio etc.

Another benefit is that the competence build-up happens during standardisation. The persons and organisations participating in standardisations activities learn about the new technology and this knowledge can be used when developing new products and when making new innovations.

3 Achievements and Activities

The projects in Phase 1 of 5G PPP have at the time of writing made numerous contributions to a number of groups/bodies working with standardisation of 5G technology or technology related to 5G. The main activities and achievements are discussed here:

3.1 3GPP

3GPP is busy standardising the first release of the next generation air interface (NR). The work started with a study item to establish the requirements running from mid-2015 to March in 2017. The corresponding work item will complete a first "drop" in the end of 2017 and the release (Rel-15) will be completed in mid-2018.

From the security point of view SA3 has started to work on TS33.501 since March 2017, aiming to deliver the first security specification by next March 2018. TS33.501 will be based on the content of the study Item TR33.899 that describes actual security measures for, among others, Architecture, Authentication, Slicing and Privacy of 5G.

One of the largest impacts of EU projects is setting the scope of this standardisation effort, the triad of eMBB, mMTC and URLLC was originally promoted by the first large 5G projects. As the standardisation process digs more into the details the things that projects influence also gets more detailed and this can be seen from the later sections in the document. Some examples of influences are:

- The architecture has support for splitting of user plane and control plane
- Support for slicing
- The channel models used for evaluations
- Scenarios and requirements
- Subscriber Privacy protection

3.2 IEEE

A variety of Societies within the IEEE are Sponsoring standards development activities that are directly related to the applications that will support the ultra-high bandwidth, ultra-low latency and ultra-low power requirements of next generation networking (aka 5G) applications such as networking vehicles, massive IoT and industrial automation.

3.3 IETF

Key impact was achieved by the acceptance of the Network Slicing BoF at the ETF 99 (July 2017). Two IETF side meetings dedicated to 5G non-radio network slicing have already taken place at IETF 97 and 98, with more than 100 attendees each. 5GEx and SONATA gave tangible contributions to the network slicing work of IETF, through authoring contributions to 5 drafts and 1 presentation:

- "Network Slicing - Revised Problem Statement", June 2017
- "Network Slicing Architecture, June 2017;
- "Network Slicing Use Cases: Network Customization and Differentiated Services", June 2017
- "Gap Analysis for Network Slicing", June 2017
- "Autonomic Slicing", March 2017

Relevant contribution and presentation on "Integration of Slice Networking in NFV" – IETF / IRTF NFVRG; have also been made at the March 2017 meeting

3.4 ITU-R

There are mainly two areas of influence. The first is on requirements and scenarios for IMT2020 and the second is the channel models for use in evaluations.

5G IA registered as an independent evaluation group for IMT-2020 (5G) in November 2016. The WG has been responsible for the activity from the 5G IA side, currently preparing for the first workshop to be held 4 October 2017, in Munich.

3.5 ITU-T

Key impact was achieved by the acceptance and release of ITU-T IMT2020 recommendations on 5G non-radio network standardisation gaps (Jan 2016), 5G framework (Jan 2017), 5G Network Management architecture (Jan 2017), 5G Network Management Requirements (Jan 2017); 5G Network Softwarisation (Jan 2017) (i.e. all recommendations contain acknowledges and references to 5GEx and SONATA projects)

3.6 ETSI

ETSI produces globally applicable standards for Information & Communications Technologies including fixed, mobile, radio, broadcast, internet, aeronautical and other areas. The ETSI Industry Specification Group for Network Functions Virtualization (ETSI ISG NFV) and Mobile Edge Computing (MEC) will play a relevant role to standardise the infrastructure aspects of 5G networks, that will be more and more virtualised and softwarised. ETSI TC CYBER, the Technical Committee dedicated to the cybersecurity, will coordinate all the security aspects carried-on within each TC operating under the ETSI umbrella. In particular the TC CYBER is working on Privacy and LI aspects and other strategic topics related to the security of the ICT.

4 5G PPP Phase 1 projects standards contributions

4.1 5G ENSURE

In the ETSI security work 5G Ensure has highlighted the importance of protecting IMSI in the mobile case by introducing the mobile use case. Such a use case describes the need to protect the IMSI to achieve true user privacy protection. Moreover 5G ENSURE strongly supported the works on the Attribute Based Encryption (ABE) public key cryptography, as a means to protect the Personally Identifiable Information (PII) not only in the mobile scenario, but also for cloud and IoT.

In 3GPP SA3 the project collaborated to the definition of the security areas for the TR33.899, by proposing the ideas developed within the project in the fields of (e.g.) privacy, slicing, architecture. In particular two actual mechanisms for the protection of the IMSI have been proposed and accepted.

Finally 5G ENSURE has raised the awareness of the need for addressing security topics in the standardisation process emphasising the concept of Security/Privacy by Design.

The table below shows the actions already started within 3GPP and ETSI TC CYBER, where project results has been proposed for possible standardisation actions.

Standardisation Organisation + Group		**Official deliverables target of 5G-ENSURE contributions**
3GPP	RAN	TR 38.913, Study on scenarios and requirements for next generation access technologies.
	SA3	TR 33.899, Study on Security Aspects of the Next Generation System TS 33.501, Security Architecture and procedures for 5G System
ETSI	TC CYBER	TR 103 304, *Personally Identifiable Information (PII) Protection in mobile and cloud services* TS 103 458, Application of Attribute-Based Encryption (ABE) for data protection on smart devices, cloud and mobile services DTS/CYBER-0025 (Provisional Identifier) “Attribute Based Encryption for Attribute Based Access Control” STF-529 (Specialist Task Force) Attribute Based Encryption - Common protocol for data access control for Cloud, Mobile and IoT

4.2 5GEx

5G Ex introduced the multi-domain concepts in the IFA028 work item in the ETSI NFV ISG.

5GEx proposed use case (NFV composition across multiple administrative domains Use Case) was approved by the NFV EVE group as a new ETSI NFV PoC, and is being incorporated in the latest release of the ETSI NFV001 document ("Network Functions Virtualization (NFV); Use Cases”).

4.3 5G NORMA

5G NORMA has contributed to 3GPP on slicing, e.g. how to isolate slices, how slices can be supported in the RAN, how slices should share resources and how QoS can be guaranteed. Other

topics that have been covered are paging and mobility management. Another important topic is session management.

Use cases and scenarios have been contributed to ETIS NFV and Broadband forum.

A new IEEE standards working group established on the Tactile Internet, the baseline standard (IEEE P1918.1) being "Tactile Internet: Application Scenarios, Definitions and Terminology, Architecture, Functions, and Technical Assumptions"

4.4 5G-CROSSHAUL

The architecture including control and data plane building blocks have been contributed in the ITU-T 2020 Focus Group and IEEE 1914 Working Group.

The requirements and data plane solutions have been contributed to IETF DETNET.

Transmission technologies, both optical and wireless (mmWave), have been contributed to relevant forums such as ITU-T SG15/SG13, FSAN, IEEE 802.11ay.

Information modelling (YANG model) for microwave and millimetre-wave technologies have been contributed to IETF CCAMP and ONF.

Virtualization enablers have been contributed in IRTF NFVRG and ETSI MEC ISG. Standardization gaps identified are agreed and will appear in an ETSI white paper led by 5G-Crosshaul.

4.5 5G-XHaul

In ITU-T SG15, the project has strongly impacted the development of the G.metro standard for "Multichannel bi-directional DWDM applications with port agnostic single-channel optical interfaces" by proposing solutions and providing measurements, especially on the system control and the management communication between the system terminals.

The project has contributed to ETSI White Paper No. 15 (mmWave semiconductors) and the pending white paper on Crosshaul.

In IEEE 802.11ay, the project has impacted the final channel model document with experimental results on mmWave channel measurements at V-Band for (1) large indoor scenario (entrance hall) and (2) Street canyon scenario. These are captured in the channel model specification "IEEE 802.11-15/1150r9".

In the ITU-T, a description of the project is captured in document "Draft Technical Report: Report on application of network softwarization to IMT-2020", IMT-O-041, published by Focus Group IMT-2020.

4.6 COHERENT

COHERENT has contributed in 3GPP RAN, RAN3 and SA1, in ETSI BRAN and in ECC PT1. The area of contributions extends from use cases in SA1, system requirements in RAN and RAN3 to detailed system architecture in RAN3, a new control framework for improving the WiFi-LAA coexistence in BRAN and flexible use of FDD spectrum in PT1.

COHERENT has impacted by mid-2017 (we expect an even stronger impact by the end of the project) the following activities

In 3GPP:

- 5G use cases in SMARTER;
- system requirements in TR 38.913, by adding in 3GPP TR 38.913 a requirement on UP/CP separation and scheduling coordination;

- Central RRM concept in TR 38.801;
- Description of the hierarchical control approach in TR 38.801;
- 3GPP RAN3: the Study Item on User Plane/Control Plane separation in the Central Unit reflects the principles contributed by COHERENT.

In ETSI BRAN:

COHERENT has opened the Work Item 'DTR/BRAN-0060022' having as scope "To review the architectures and the protocols supporting the central coordination of RLANs operating in the 5 GHz band, including the information to be provided by the wireless entities and the coordination of the operation of these entities" and has provided the COHERENT architecture and network graphs approach which are included in the draft TR 103 494.

In ECC PT1:

COHERENT has provided a contribution of flexible FDD duplexing in Sept. 2016. ECC has approved in Nov. 2016, within the document named "CEPT Roadmap for 5G", the action "A.5 Consider the impact of future "flexible duplex" on the management of existing FDD bands".

4.7 FANTASTIC-5G

FANTASTIC-5G's focus has been on technical enablers for the air interface of 5G related to the lower layers of the protocol stack (PHY, MAC and RRM). The relevant body for proposing those towards standardization is 3GPP (mainly RAN1, to some extent RAN2 and RAN4). The industrial partners of the project have submitted more than 60 contributions to those groups. In the following we provide the list of topics as discussed/agreed in 3GPP meetings being very much aligned to the proposals from FANTASTIC-5G. Additionally, we provide a list of items the project has worked on being not yet on the agenda of 3GPP and thus to be submitted in a later stage:

- FANTASTIC-5G has discussed various waveform options being based on OFDM and applying a filtering functionality (both per subcarrier and per sub-band). The latter has been proposed by various industrial partners to be included into the standard. 3GPP has decided to use CP-OFDM as baseline, including those filtering functionalities (per sub-band) as an option. RAN4 is to define the in-band transmission masks. Depending on those the need for those filtering functionalities is determined.
- mMTC is not yet on the agenda of 3GPP, however, early discussions indicate 3GPP to follow similar lines as proposed by the project contributions, e.g. related to access protocols (1-stage, 2-stage) and state handling (i.e. the introduction of a 3rd state to allow lean state transitions for battery constraint devices).
- The fundamental frame design considerations (e.g. sub-frame structure, slot configurations, resource block definitions, supported subcarrier spacings, etc.) are in general following the lines as given within the contributions of the industrial partners of FANTASTIC-5G.
- The project partners have proposed various enablers to efficiently implement URLLC services into NR (e.g. punctured/pre-emptive scheduling for DL mux of URLLC and eMBB transmissions).
- Several enhancements for HARQ (e.g. CB based reTx)
- Enhanced sequence design for PRACH based on modified m-sequences as investigated in the project are currently evaluated in 3GPP as candidate solutions.
- As proposed by the project contributions 3GPP follows the principle of in-resource control channels.
- Not yet on the agenda of 3GPP, but to be contributed in the second phase are enablers for massive MIMO (e.g. reference symbol design, grid-of-beams design, etc.).

- Similarly, aspects related to ICIC are not yet in the focus of 3GPP and thus later to be proposed.

4.8 FLEX5GWARE

3GPP RAN contributions:

– [R4-1700017] RF filters for mm-wave OOB blocking, noted

– [R4-1700604] UE reference architecture in mmWave, noted

– [R4-1702095] TP for TR38.803: Transceiver architecture for mmWave, approved

Contributions to ETSI RRS

– RRSWG1(17)037017r1 - Scenario proposal based on protocol download

– RRSWG1(17)037018r1 - Scenario proposal based on processing element selection

ETSI MEC (tba) by Intel

IEEE 802.11 related contribution from UC3M

4.9 METIS-II

The solutions for tight interworking between LTE and NR that has been agreed in 3GPP RAN2 and RAN3 was already discussed in the early phases of the project. In addition, details of the solutions were initially discussed before they were standardized, e.g. handover via a single CN and DC features.

4.10 mmMAGIC

Very early into the project, mmMAGIC started to send contributions on mmWave propagation to the 3GPP SI:CM. In February 2017, the SI:CM closed creating the TR38.900 document and since then the project findings regarding mm-wave channel were mainly sent to the ITU-R activity that define the requirements and evaluations methods for IMT-2020 (or 5G) but also to 3GPP in form of "request for change" to update the 3GPP channel model. The channel modelling is one area of standards that has been heavily influenced by the mmMAGIC activities.

Several concepts of the NR air interface have been discussed in mmMAGIC before entering the standard. The modulation schemes adopted are the same i.e. QPSK, 16QAM, 64QAM and 256QAM, the numerology is aligned i.e. :

a) scaling according to 2^n.

b) considering at-least 15 kHz to 480 kHz subcarrier spacing and

c) support for mixed numerology.

The reference signals PT-RS and DM-RS: front loaded DMRS and PT-RS are from mmMAGIC.

4.11 SELFNET

SELFNET has contributed to an NFVRG Internet-Draft, which targets the definition of a VNF orchestration framework for automated deployment of highly available VNF chains, providing VNF

resiliency and high availability concepts and functionalities within the Policy-Based Resource Management work item[2].

4.12 5G SONATA

Based on the results and papers of both projects a number of contributions were made as follows (i.e. all SDO's documents are explicitly acknowledging and referencing SONATA and 5GEx projects):

ITU-T IMT2020 Recommendations

- "ITU-T IMT2020 Gap Analysis (T13-SG13-151130-TD-PLEN-0208!!MSW-E) - accepted and released Jan 2016; lead contributor: UCL; in particular:
    - "5G High Level Architecture"
    - "5G Network Softwarization
- "Framework of IMT-2020 (5G) network architecture (O-043)"; accepted and released Jan 2017; lead contributor: UCL
- "Network Management Framework for IMT-2020 (O-047)" - accepted and released Jan 2017; lead contributor: UCL
- IMT-2020 network management requirements (O-046); accepted and released Jan 2017; lead contributor: UCL
- "Application of network softwarization to IMT-2020 (O-041) –accepted and released Jan 2017; lead contributor: UCL

IETF Drafts

- "Network Slicing - Revised Problem Statement", June 2017 - lead contributor: UCL, TID, UC3M, Huawei https://www.ietf.org/internet-drafts/draft-galis-netslices-revised-problem-statement-00.txt
- "Network Slicing Architecture; June 2017; - lead contributor: UCL, TID, UC3M , Huawei, https://www.ietf.org/internet-drafts/draft-geng-netslices-architecture-01.txt
- "Network Slicing Use Cases: Network Customization and Differentiated Services"; June 20170 lead contributor UCL, Huawei; https://www.ietf.org/internet-drafts/draft-netslices-usecases-00.txt
- "Gap Analysis for Network Slicing"; June 2017- lead contributor: UCL, Huawei https://tools.ietf.org/html/draft-qiang-netslices-gap-analysis-00
- "Autonomic Slicing" March 2017, https://tools.ietf.org/html/draft-galis-anima-autonomic-slice-networking-01; lead contributor UCL, Huawei
- Relevant contribution and presentation on "Integration of Slice Networking in NFV" – IETF / IRTF NFVRG; March 2017, lead contributor UCL, Huawei

[2] IRTF the Network Function Virtualization Research Group, „VNF Pool Orchestration For Automated Resiliency in Service Chains". Online available: https://tools.ietf.org/html/draft-bernini-nfvrg-vnf-orchestration-04

4.13 SPEED-5G

3GPP

- SA WG1 #74 (May 2016) 'S1-161308': contribution presented and noted on SPEED-5G use cases and scenarios.
- RAN WG2: contribution in preparation is on hold, due to RAN chairman de-prioritization of spectrum-related topics. The moratorium has been recently removed and SPEED-5G team is preparing to impact in the two remaining quarters of the year RAN2 work.

IEEE 1900.7

- A Project Authorisation Request (PAR) for an amendment to the IEEE 1900.7 standard to enable QoS support in Radio Interface for White Space Dynamic Spectrum Access Radio Systems' was accepted by IEEE 1900.7 WG and IEEE DySpan in March 2016.
- SPEED-5G tried to push forward the discussion related to MAC, but the group has been basically put on hold since few months, as some companies intend for internal reason to slow down the discussions related to MAC topics.

ETSI RRS

- SPEED-5G is co-proposer, together with the German funded project PMSE-xG, of the WI on "Feasibility study on temporary spectrum access for local high-quality wireless networks". The work is contained in the technical report DTR/RRS-0148, that reports relevant use cases of local high-quality wireless networks and identify most appropriate sharing frameworks, whether these are the current ones like Licensed Shared Access (LSA), Spectrum Access System (SAS), or enhancements or alternatives must be considered. The feasibility study is getting increasingly stable and in May 2017 it reached the internal version number 0.0.6. SPEED-5G has contributed to the ongoing discussion, presenting several ideas related to the work of the project on eDSA and its relations with LSA / SAS.

ITU-R, WP 5D

- SPEED-5G has asked the chairman for a slot in 2H 2017 to discuss the main outcome of the project for which the project is still waiting for a feedback.

Regulatory bodies

- Workshops organised with OFCOM (CH) and Ofcom (UK) in 2Q2016 where the eDSA approach proposed by SPEED-5G was discussed.
- CEPT: SPEED-5G made a presentation at CEPT meeting ECC PT1/2017/ECC PT1#55, held on 24-28 April 2017 in Berlin. The contribution focused on the eDSA concept, on the specification of the SPEED-5G architecture as well as on a discussion on the optimisation of resource efficiency (as reported in a project newsletter and available in the SPEED-5G website in the news section).

4.14 SUPERFLUIDITY

Standardization convergence: Harmonization of C-RAN and MEC over an Extended-NFVI that represents an evolution of the ETSI NFVI, supplemented by a converged management and orchestration (MANO) framework. Relevant contributions to the ETSI MEC ISG.

Leading role in the establishment of a new Work Item, “End to end process descriptions”, within the ETSI ISG NFV. Also played a key role in the ETSI ISG NFV initiative to bring together the Information Models of many SDOs and industry groups.

The notion of Reusable Functional Blocks (RFBs) and the proposition that RFBs can be expressed in terms of other RFBs, in theory with no limits to the recursion levels. Relevant contributions to the ETSI ISG NFV, IRTF NFVRG (NEMO), as well as OASIS TOSCA.

OpenFlow extension EXT-562 proposed to ONF, for including state tables and state transitions in OpenFlow, and hence enable a stateful OpenFlow operation. Extension accepted for discussion; discussion currently in progress within ONF for possible inclusion in the incoming OpenFlow 1.6 version.

Contributions to the ETSI ISG MEC Work Item on End to End Mobility Aspects (DGR/MEC-0018E2EMobility).

Requirements for Open Source MANO (OSM), reference implementation of the MANO framework under the auspices of ETSI ISG NFV.

Contributions to (ISO/SC29/WG11) MPEG on a new Point Cloud Compression standard, relevant to the mobile video use cases of interest. Also to the draft MPEG requirements for Network Distributed Video Coding (NDVC).

In the above context, several SUPERFLUIDITY project participants have leadership roles: Vice Chair of Open Source MANO (OSM), Chair of the End User Advisory Group of the ETSI ISG NFV, Rapporteur for the ETSI ISG NFV “End to end process descriptions” Work Item, Chair of the IRTF NFVRG (Network Function Virtualisation Research Group).

4.15 VirtuWind

VirtuWind has contributed to the IETF DetNET group by adding the VirtuWind wind farm use case to the detnet-use cases draft.

5 5G Standardisation Roadmap

For 5G standardization there are two key roadmaps which should be considered. Firstly the 3GPP release timetable should be considered. This roadmap gives the current status of when and what the first 5G standards will be and as such the most important idea of what the first 5G systems will look like and be capable of. The second roadmap is related to the overall IMT2020 5G evaluation timetable. This gives the timetable for 5G technology candidate submission and evaluation which underlies the entire 5G process.

5.1 5G standardisation timetable

The current standardisation timetable is shown in figure 1. This shows the current plans for the 3GPP 5G standardisation. As can be seen there are two distinct releases planned in the near future non-standalone (NSA) and standalone (SA). The NSA is due to be fully functionally defined by December 2017. The NSA name refers to the fact that the 5G element can only provide a fully functioning system when combined with a 4G network. In this scenario, the LTE network provides many of the basic functionalities and the whole radio access network is connected to the existing 4G core. In effect the NSA can be seen as a hybrid version of LTE with a new radio interface. On the plus side however it will enable rapid deployment to handle limited areas with 5G while building on the existing LTE network for wide area coverage. Although the functional specification for NSA is due to be completed by December, this does not mean that the specification can at that point be made into products. After function freezing there is a further step necessary which in the formal specification of the protocols. For this formal definition, the Abstract Syntax Notation one (ASN.1) is used. The development and stabilization of these formal protocol specifications will require another 3 months and the aim is to complete these specifications for NSA by March 2018.

The second sub release is for the stand alone 5G system (SA). SA is the first 'full' 5G system which uses end-to-end 5G as it connects the 5G radio access network to the new 5G core. This specification should be functionally complete by June 2018 with the ASN.1 finished by 3 months later. The intension is that the physical layer for both NSA and SA should be identical and indeed SA will simply build on top of NSA to enable one common set of standards moving forward.

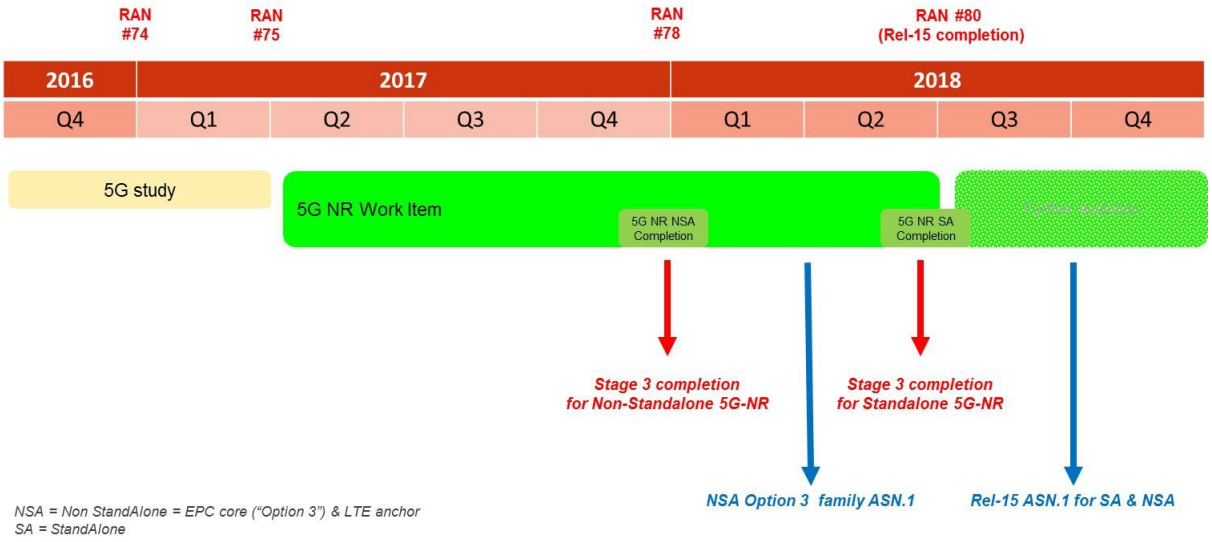

Figure 1: 3GPP TSG RAN official release 15 timescale

To enable this very aggressive timelines for NSA and SA to be completed on time a very streamlined approach to standardisation has been necessary. This means that this first specifications will not provide the full feature set or promise of 5G. For example the physical layer has been targeted mainly for mobile broad band applications, the other planned application areas such as IoT and ultra-reliable

and low latency communications have not been included explicitly in these first releases. However the hooks to enable these features to be added later are indeed already present and the hope is unlike previous generations we can develop 5G moving forward to meet the overall requirements and promise that the users have.

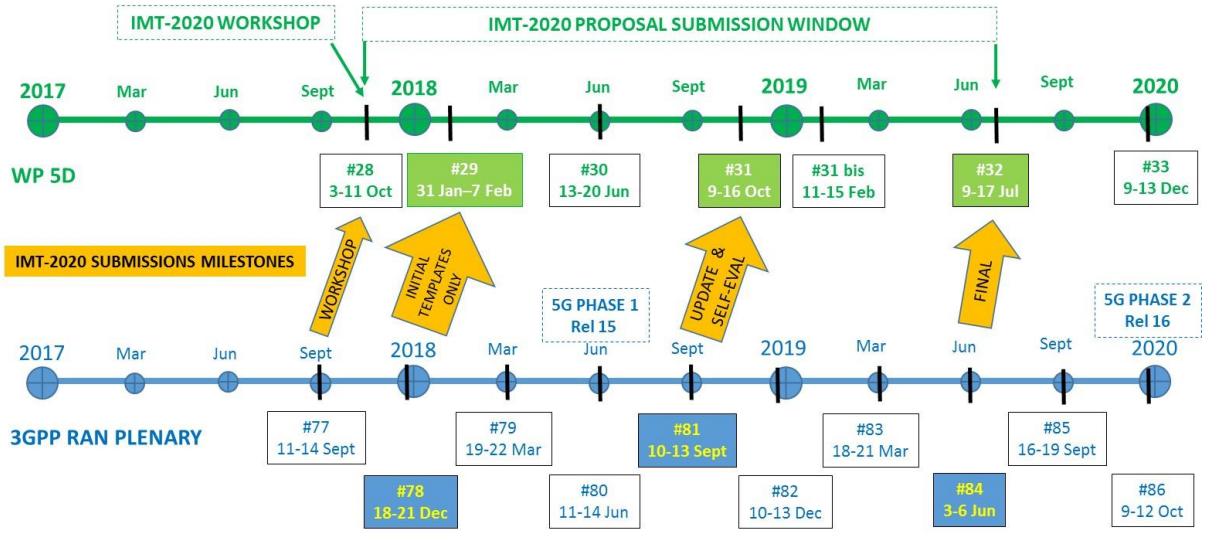

Figure 2: ITU-R IMT2020 submission timeline

5.2 ITU-R IMT2020 Timeline

That a technology is truly 5G will be decided by the ITU-R IMT2020 group. This group has set the requirements for 5G technology and will now go on to evaluate candidate technologies submitted to the process. 3GPP will not be the only organisation to submit 5G candidate technologies, but it is expected to be the most influential. Figure 2 shows the roadmap for technology submission and evaluation. It should be noted that 5G IA is an official technology evaluator in this process and will invest effort to assess various technology submissions to test 5G compliance.

6 Conclusions

Standardisation is a key building block for 5G technology enabling a common global ecosystem with scale reach and ubiquitous access. As shown in this document the 5G PPP phase 1 projects have had a major influence on the 5G standardisation process and continue to effect and direct 5G standardisation moving forward. With the first versions of the 5G standard due to be available in the near future the job of 5G research is not over. As explained this first version of the 5G standard will by design be streamlined to a subset of the required features and capabilities. It is only though continued focused research and associated standardisation submissions that 5G can grow to become the promised all-encompassing communication technology capable of meeting the direct users' needs in addition to many new vertical markets.

Appendix A List of input documents to standardisation bodies

3GPP-SA3	1 – 5 February 2016	Study on Architecture and Security for Next Generation System	S3-160278	5G-ENSURE
3GPP-RAN	March 7 - 10, 2016	pCR on Section “Security and Privacy” of TR38.913 - Requirements on user identity	RP-160154	5G-ENSURE
3GPP-RAN	March 7 - 10, 2016	pCR on Section “Security and Privacy” of TR38.913 - Requirements on security visibility	RP-160157	5G-ENSURE
3GPP-RAN	March 7 - 10, 2016	pCR on Section “Security and Privacy related requirement relevant for Radio Access” of TR38.913 – Requirements on radio signaling messages	RP-160506	5G-ENSURE
3GPP-RAN	Nov. 16 - 20, 2015	Fast UL evaluation for Mission Critical / Real Time applications	R2-156695	FANTASTIC-5G
3GPP-RAN	Nov. 16 - 20, 2015	Fast UL evaluation for Uu based V2V	R2-156706	FANTASTIC-5G
3GPP-RAN	Feb. 15 - 19, 2016	Considerations for SA resource selection for V2V in mode 2	R1-160485	FANTASTIC-5G
3GPP-RAN	Feb. 15 - 19, 2016	Methods to estimate the SA pool load	R1-160486	FANTASTIC-5G
3GPP-RAN	Feb. 15 - 19, 2016	Capacity analysis for UL Uu based V2V	R2-161108	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	5G Waveforms for the Multi-Service Air Interface below 6 GHz	R1-162890	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Uplink contention-based access in 5G New Radio	R1-162892	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	On Hybrid ARQ functionality for 5G New Radio	R1-162900	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Scheduling framework and related requirements	R1-162891	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	On the forward compatibility of the 5G New Radio	R1-162884	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Basic frame structure principles for 5G new radio	R1-162893	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Motivation of 5G new FEC	R1-162160	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Considerations on vehicular communications for 5G	R1-162167	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Ultra-reliability with low-latency support in 5G new radio interface	R1-162189	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Channel coding for 5G new radio interface	R1-162181	FANTASTIC-5G
3GPP-RAN	April 11 - 15, 2016	Waveform and Multiple Access for 5G New Radio Interface	R1-162177	FANTASTIC-5G
3GPP-RAN	7-10/03/2016	Changes to 5G SI related to new architecture	RP-160168	COHERENT
3GPP-RAN	7-10/03/2016	General description of NG Architecture	RP-160527	COHERENT
3GPP-RAN	7-10/03/2016	Coverage requirement in TR 38.913	RP-160174	COHERENT
3GPP-RAN	7-10/03/2016	Deep-indoor deployment scenario for mMTC and eHealth	RP-160175	COHERENT
3GPP-RAN	28-29/01/2016	A proposal for changes to ToC	RPa160029	COHERENT
3GPP-RAN	28-29/01/2016	Requirements for the architecture of 5G cellular networks	RPa160028	COHERENT

3GPP-RAN	28-29/01/2016	A deployment scenario for utility meters	RPa160027	COHERENT
3GPP-RAN	7-8/12/2015	Prioritization of higher-layer 5G technology studies	RP-151762	COHERENT
3GPP-RAN	15-18/9/2015	COHERENT Vision on Software Defined Networks for 5G	RWS-150086	COHERENT
3GPP SA1 on SMARTER	19-21/10/2015	Spectrum use case	S1-153034	COHERENT
3GPP SA1 on SMARTER	19-21/10/2015	SDN concepts applied to lower layers of 3GPP system	S1-153033	COHERENT
3GPP SA1 on SMARTER	19-21/10/2015	Update of clauses 5.45 and 5.46 (Industrial Automation)	S1-153032	COHERENT
3GPP SA1 on SMARTER	19-21/10/2015	Update of use case 5.34 “Mobility on demand”	S1-153031	COHERENT
3GPP SA1 on SMARTER	19-21/10/2015	Update of clause 5.33 “Connected vehicles”	S1-153030	COHERENT
3GPP SA1 on SMARTER	19-21/10/2015	Update of use case 5.2 “Network slicing”	S1-153029	COHERENT
3GPP SA1 on SMARTER	19-21/10/2015	Up-date of use case 5.1 Ultra-reliable communications	S1-153028	COHERENT
3GPP RAN2#93-BIS	11-14/4/2016	High level view of 5G access architecture	R2-162231	COHERENT
3GPP RAN2#93-BIS	11-14/4/2016	Network graphs supporting central coordination as 5G design target	R2-162230	COHERENT
ETSI MEC IEG	17-18/03/2016	Changes to MEC Metrics: delay	MECIEG(16)000020r1	Flex5Gware
ETSI MEC IEG	17-18/03/2016	Changes to MEC Metrics: footprint	MECIEG(16)000022r1	Flex5Gware
ETSI RRS WG1	42434	Reconfigurable Radio Systems (RRS); Feasibility Study of a Radio Interface Engine	RRSWG1(16)033e003	Flex5Gware
3GPP-SA3	9-13/05/2016	pCR - New security area for subscriber privacy	S3-160498	5G-ENSURE
3GPP-SA3	9-13/05/2016	pCR - New key issue for subscriber identifier protection	S3-160499	5G-ENSURE
3GPP-SA3	9-13/05/2016	pCR to draft-TR 33.899 on New security area for AAA	S3-160493	5G-ENSURE
3GPP-SA3	9-13/05/2016	pCR to draft-TR 33.899 on Core Network Control Plane Security	S3-160504	5G-ENSURE
3GPP-SA3	9-13/05/2016	pCR to draft-TR 33.899 on New security area for network virtualization security	S3-160682	5G-ENSURE
3GPP-SA3	9-13/05/2016	pCR to draft-TR 33.899 on Radio Access Network security	S3-160781	5G-ENSURE
ITU-T focus	27-30 October 2015	DYNAMICALLY RECONFIGURABLE OPTICAL-WIRELESS	-	5G-XHaul

group IMT-2020		BACKHAUL/FRONTHAUL WITH COGNITIVE CONTROL PLANE FOR SMALL CELLS AND CLOUD-RANS		
tech-UK, UK spectrum policy forum	42354	Applying 60 GHz WiGig to Backhaul: Update on Recent Developments	-	5G-XHaul
ITU-T Q.6/SG15	12.-15.10.2015	Communication Channel in G.metro	WD06-03	5G-XHaul
ITU-T Q.11/SG15	12.-15.10.2015	Communication Channel in G.metro	WD11-10	5G-XHaul
ITU-T Q.14/SG15	19.-22.10.2015	Communication Channel in G.metro	WD14-08	5G-XHaul
ITU-T Q.6/SG15	15.-26.2.2016	Analysis of cross gain modulation caused by pilot tones	C-1528	5G-XHaul
ITU-T Q.6/SG15	15.-26.2.2016	Application code proposal in G.metro	C-1608	5G-XHaul
ITU-T Q.14/SG15	15.-26.2.2016	Communication channel in G.metro	C-1663	5G-XHaul
3GPP RAN1 #84-BIS	11-15 April 2016	Discussion on blockage modelling for above 6 GHz channel model	R1-162720	mmMAGIC
3GPP RAN1 #84-BIS	11-15 April 2017	o Discussion on spatial consistency for above 6 GHz channel model	R1-162721	mmMAGIC
3GPP RAN1 #84-BIS	11-15 April 2018	Discussion on large antenna array modeling	R1-162722	mmMAGIC
3GPP RAN1 #84-BIS	11-15 April 2019	o Initial 60 Ghz channel sounding results from the mmMAGIC project for corner diffraction and surface scattering	R1-162872	mmMAGIC
3GPP RAN1 #84-BIS	11-15 April 2016	On the frequency dependence of LSPs	R1-163254	mmMAGIC
3GPP RAN1 #AH CM	14-16 Mar 2016	o Measurements of path and penetration losses at multiple carrier frequencies	R1-161688	mmMAGIC
3GPP RAN1 #AH CM	14-16 Mar 2016	o Indoor and outdoor to indoor channel measurements	R1-161691	mmMAGIC
3GPP RAN1 #AH CM	14-16 Mar 2016	o Frequency-dependent LSP modelling	R1-161698	mmMAGIC
3GPP RAN1 #AH CM	14-16 Mar 2016	o mmMAGIC white paper	R1-161700	mmMAGIC
3GPP RAN1 #AH CM	14-16 Mar 2016	o Discussion on blockage modeling	R1-161707,	mmMAGIC
3GPP RAN1 #AH CM	14-16 Mar 2016	o Discussion on spatial consistency	R1-161708	mmMAGIC
3GPP RAN1 #84	15-19 Feb 2016	Street microcell channel measurements at 2.44, 14.8, and 58.68 GHz	R1-160846,	mmMAGIC

3GPP RAN	23.-27. May 2016	Punctured Scheduling for Latency Critical Transmissions	R1-165381	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Network-based inter-cell interference coordination	R1-165379	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	On the forward compatibility of New Radio	R1-165356	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Uplink contention-based access in 5G New Radio	R1-165022	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Scheduling framework and related requirements	R1-165023	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	New radio waveforms for the Multi-Service Air Interface below 6 GHz	R1-165012	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Initial uplink performance results for the New Radio Waveforms below 6GHz	R1-165013	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Subband-wise filtered OFDM for New Radio below 6GHz	R1-165014	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Performance of Interleave Division Multiple Access (IDMA) in Combination with OFDM Family Waveforms	R1-165021	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Improved LTE Turbo codes for NR	R1-164635	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Flexibly Configured OFDM	R1-164619	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	Performance evaluation of FC-OFDM	R1-164620	FANTASTIC-5G
3GPP RAN	23.-27. May 2016	On future D2D SI – further discussion	R2-163401	FANTASTIC-5G
ETSI TC CYBER	15-17 June	Access control mechanisms and policy rules for PII protection on smart devices, cloud and mobile services	CYBER(16)007029	5G-ENSURE
ETSI TC CYBER	15-17 June	PII Protection in mobile and cloud services	CYBER(16)007028	5G-ENSURE
3GPP RAN plenary	March 7 - 10, 2016	Next Generation Radio Access Technology Transport Network	RP-160255	5G-Xhaul
ITU-T Q.6/SG15	20.-22.6.2016	Message channel in G.metro	WD06-02	5G-Xhaul
ITU-T Q.6/SG15	20.-22.6.2016	Measurements of the impact of pilot tones in G.metro	WD06-03	5G-Xhaul
ITU-T Q.6/SG15	20.-22.6.2016	Considerations on pilot tones in G.metro	WD06-04	5G-Xhaul
ETSI	42552	mmWave Semiconductor Industry Technologies: Status and Evolution	ETSI White Paper No. 15	5G-Xhaul
3GPP-SA3	25.-29.07.2016	Enhancing the concealment of permanent or long-term subscriber identifier	S3-160995	5G-ENSURE
3GPP-SA3	25.-29.07.2016	Deletion of key issue #7.1 on subscriber identifier privacy	S3-160963	5G-ENSURE
3GPP-SA3	25.-29.07.2016	New privacy key issue on transmitting permanent subscriber identifiers only when needed	S3-160962	5G-ENSURE
3GPP-SA3	25.-29.07.2016	New privacy key issue on transmitting permanent identifiers in secure interface	S3-160961	5G-ENSURE

3GPP-SA3	25.-29.07.2016	New privacy key issue on using effective temporary or short-term subscriber identifiers	S3-160960	5G-ENSURE
3GPP-SA3	25.-29.07.2016	New privacy key issue on concealing permanent or long-term device identifier	S3-160959	5G-ENSURE
3GPP-SA3	25.-29.07.2016	New privacy key issue on concealing permanent or long-term subscriber identifier	S3-160958	5G-ENSURE
3GPP-SA3	25.-29.07.2016	Update of key issue #7.2 on refreshing of temporary subscriber identifier	S3-160957	5G-ENSURE
3GPP-SA3	25.-29.07.2016	Split of key issue #7.1 on subscriber identifier privacy	S3-160956	5G-ENSURE
3GPP RAN3	May 23-27 2016	5G access architecture with UP/CP separation	R3-161474	COHERENT
3GPP RAN3	May 23-27 2016	New functions of 5G access architecture with UP/CP separation	R3-161119	COHERENT
3GPP RAN3	May 23-27 2016	Some definitions and acronyms for 5G access architecture	R3-161118	COHERENT
3GPP RAN3	August 22-26 2016	Additional NR RAN specific functions	R3-161686	COHERENT
3GPP RAN3	August 22-26 2016	RAN-based solution for LTE tight interworking with NR	R3-161685	COHERENT
3GPP RAN3	August 22-26 2016	Distributed and centralized gNB-gNB mobility scenarios	R3-161684	COHERENT
3GPP RAN3	August 22-26 2016	5G access – a heterogeneous deployment scenario	R3-161683	COHERENT
3GPP RAN1	August 22-26 2016	Simulation assumptions related to new measurements and LTE architecture	R1-167088	COHERENT
3GPP RAN3	August 22-26 2016	Response to contributions R3-161805 and R3-161574	R3-161947	COHERENT
3GPP RAN1	18th February 2016	Considerations of DMRS Enhancement in the High Doppler Case for V2V Services based on LTE Sidelink	R1-160663	METIS-II
3GPP RAN1	April 11, 2016	General consideration on evaluation work for 5G new radio study	R1-162147	METIS-II
3GPP RAN1	April 11, 2016	Draft Report of 3GPP TSG RAN WG1 #AH Channel Model v1.0.0	R1-162190	METIS-II
3GPP RAN1	April 11, 2016	DM-RS Enhancement to Sidelink Physical Layer Structure in the High Doppler Case for V2V Services based on LTE sidelink	R1-162990	METIS-II
3GPP RAN1	April 11, 2016	Initial considerations on system access in NR	R1-163237	METIS-II
3GPP RAN1	May 23, 2016	Support for flexible backhauling for NR	R1-164053	METIS-II
3GPP RAN1	May 23, 2016	Enhancement to Sidelink Physical Layer Structure in Super High Doppler Case for V2V	R1-164932	METIS-II
3GPP RAN1	22 August 2016	Support for flexible backhauling for NR	R1-166115	METIS-II
3GPP RAN2	April 11, 2016	Tight integration of the New Radio interface (NR) and LTE: Control Plane design	R2-162753	METIS-II
3GPP RAN2	April 11, 2016	Tight integration of the New Radio interface (NR) and LTE: User Plane design	R2-162754	METIS-II

3GPP RAN2	April 11, 2016	RAN support for network slicing	R2-162758	METIS-II
3GPP RAN2	April 11, 2016	Active Mode Mobility in NR: future proofness and energy efficiency	R2-162761	METIS-II
3GPP RAN2	April 11, 2016	Active Mode Mobility in NR: SINR drops in higher frequencies	R2-162762	METIS-II
3GPP RAN2	April 11, 2016	Initial considerations on NR system access	R2-162763	METIS-II
3GPP RAN2	April 11, 2016	CN / RAN aspects of NR integration	R2-162765	METIS-II
3GPP RAN2	23 May 2016	Discuss on the NR user plane protocol design	R2-163737	METIS-II
3GPP RAN2	23 May 2016	Initial access in NR	R2-163923	METIS-II
3GPP RAN2	23 May 2016	NR/LTE tight interworking: CP requirements on Mobility and Dual Connectivity	R2-163993	METIS-II
3GPP RAN2	23 May 2016	Future proofness and energy efficiency	R2-163994	METIS-II
3GPP RAN2	23 May 2016	Operation in higher frequencies	R2-163995	METIS-II
3GPP RAN2	23 May 2016	Mobility measurements and procedures	R2-164001	METIS-II
3GPP RAN2	23 May 2016	RAN support for network slicing	R2-164004	METIS-II
3GPP RAN2	23 May 2016	Tight integration of NR and LTE: User Plane design	R2-164027	METIS-II
3GPP RAN2	23 May 2016	Control plane aspects of higher frequency support in NR	R2-164165	METIS-II
3GPP RAN2	22 Aug, 2016	QoS-aware initial access	R2-165362	METIS-II
3GPP RAN3	April 11, 2016	Tight integration of the New Radio interface (NR) and LTE: User Plane design	R3-160849	METIS-II
3GPP RAN3	23 May 2016	Tight integration of the New Radio interface (NR) and LTE: User Plane design	R3-161293	METIS-II
3GPP RAN	7 March, 2016	Summary of [5G-AH-03] Resolve square brackets for the deployment scenarios and KPI values in the TR	RP-160354	METIS-II
3GPP RAN	7 March, 2016	Revised Work Item proposal: Multi-Band Base Station testing with three or more bands	RP-160063	METIS-II
3GPP RAN	7 March, 2016	Revision of WI UE Conformance Test Aspects - LTE DL 4 Rx antenna ports	RP-160078	METIS-II
3GPP RAN	7 March, 2016	UE Conformance Test Aspects - AWS-Extension Band for LTE (Band 66)	RP-160079	METIS-II
3GPP RAN	7 March, 2016	Realistic Environmental Model for Next Generation Radio Access Technology evaluation	RP-160254	METIS-II
3GPP RAN	7 March, 2016	Realistic Environmental Model for Next Generation Radio Access Technology evaluation	RP-160557	METIS-II
3GPP RAN	13 June, 2016	Summary of 3GPP RAN reflector discussion: [RAN#71-06] Energy Efficiency	RP-160884	METIS-II
3GPP RAN	13 June, 2016	pCR on Security Requirements for NR	RP-161208	METIS-II

3GPP RAN	28 January 2016	Requirement for next generation access	RPa160063	METIS-II
3GPP RAN	28 January 2016	Scenario and requirements for eHealth verticals for inclusion in TR38.913	RPa160074	METIS-II
3GPP RAN	28 January 2016	Scenario and requirements for Smart Energy verticals for inclusion in TR38.913	RPa160075	METIS-II
3GPP RAN	28 January 2016	Report of 3GPP TSG RAN ad hoc on Next Generation Access	RPa160084	METIS-II
3GPP RAN	17 September 2015	5G Vision and Priorities	RWS-150007	METIS-II
3GPP RAN	17 September 2015	Initiatives for 5G	RWS-150059	METIS-II
3GPP RAN	17 September 2015	Draft Report of 3GPP RAN workshop on "5G"	RWS-150074	METIS-II
3GPP RAN2	22 Aug, 2016	Consideration to Network Energy Efficiency for NR	R2-165163	METIS-II
3GPP-SA3	07-11 .11. 2016	pCR on Updating solution #7.3	S3-161853	5G-ENSURE
3GPP-SA3	07-11 .11. 2016	pCR on Encrypting IMSI based on ECIES	S3-161856	5G-ENSURE
3GPP-SA3	07-11 .11. 2016	pCR on New privacy solution for concealing permanent subscriber identifier	S3-162108	5G-ENSURE
3GPP-RAN 4		PA model using Memory Polynomial was included in TR 38.803	R4-167263	Flex5Gware
3GPP-RAN 4		TP for 38.803: Overview of PA models for NR, approved.	R4-168952	Flex5Gware
3GPP-RAN 4		NR RF parameters and template for WP5D, noted.	R4-1609122	Flex5Gware
3GPP-RAN 4		NF values in ITU-R WP5D related coexistence simulations, noted.	R4-1609123	Flex5Gware
3GPP-RAN1	22.-26. Aug. 2016	Enhanced Turbo Codes for NR: Implementation Details	R1-167413	FANTASTIC-5G
3GPP-RAN1	22.-26. Aug. 2016	Enhanced Turbo Codes for NR: Performance Evaluation	R1-167414	FANTASTIC-5G
3GPP-RAN1	22.-26. Aug. 2016	Discussion on sensing operation for P-UE	R1-167869	FANTASTIC-5G
3GPP-RAN1	22.-26. Aug. 2016	Downlink network coordination for New Radio	R1-167293	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	On-demand power boost and cell muting for URLLC in the 5G New Radio	R1-1610278	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	Non-coherent multi-node transmission for URLLC in the 5G New Radio	R1-1610255	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	Input to control channel design from a scheduler perspective	R1-1609741	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	Punctured scheduling for low latency transmissions	R1-1609747	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	Early Hybrid ARQ Feedback for the 5G New Radio	R1-1609745	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	FEC performance comparison for short frame sizes for NR	R1-1610314	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	WF on channel coding observations for short block size	R1-1610931	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	On NR physical downlink control channel	R1-1609539	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	Reference signal design for NR control channel	R1-1609540	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	On transmission schemes of NR physical downlink control channel	R1-1609541	FANTASTIC-5G

3GPP-RAN1	10.-14. Oct. 2016	FC-OFDM discussion based on RAN1#86 waveform agreements	R1-1610404	FANTASTIC-5G
3GPP-RAN1	10.-14. Oct. 2016	Details of partial sensing by pedestrian UEs	R1-1608899	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	Enhanced Turbo Codes for NR: Performance Evaluation for eMBB and URLLC	R1-1612938	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	WF on channel coded for NR short block length eMBB data	R1-1613347	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	On the number of OFDM symbols for NR downlink control channel	R1-1611990	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	NR downlink control channel and DMRS design	R1-1611991	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	On the NR control subband	R1-1612166	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	Partial sensing for pedestrian UEs	R1-1611266	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	Pause-Resume Scheduling for Low Latency Uplink Transmissions	R1-1612248	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	Punctured Scheduling for Low Latency Transmissions	R1-1612247	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	Enriched feedback for adaptive HARQ	R1-1612243	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	Early Hybrid ARQ Feedback for the 5G New Radio	R1-1612249	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	On demand power boost and cell muting for URLLC in the 5G New Radio	R1-1612874	FANTASTIC-5G
3GPP-RAN1	14.-19. Nov. 2016	Non-coherent multi-node transmission for URLLC in the 5G New Radio	R1-1612841	FANTASTIC-5G
3GPP-SA1	19.-21. Oct. 2015	Service requirement on charging for multi RAT connections	S1-153008	5G-NORMA
3GPP-SA2	23.-26. Feb. 2016	Solution: QoS Framework	S2-161188	5G-NORMA
3GPP-SA2	23.-26. Feb. 2016	Key Issue on Policy Framework	S2-161238	5G-NORMA
3GPP-RAN3	11.-15. Apr. 2016	Key principles for RAN – CN Interface	R3-160733	5G-NORMA
3GPP-RAN3	11.-15. Apr. 2016	Key Requirements and Principles for Network Slicing	R3-160734	5G-NORMA
3GPP-RAN3	11.-15. Apr. 2016	Considerations for RAN architecture	R3-160737	5G-NORMA
3GPP-SA2	11.-15. Apr. 2016	Application Awareness in an End-to-End QoS Framework	S2-161622	5G-NORMA
3GPP-SA2	11.-15. Apr. 2016	Solution: shared and Dedicated Network Functions for Network Slicing	S2-161785	5G-NORMA
3GPP-RAN2	23.-27. May 2016	Considerations for Ultra Reliable Low Latency Communications (URLLC) with High Mobility, May 2016	R2-163686	5G-NORMA
3GPP-RAN2	23.-27. May 2016	Multi-connectivity in standalone NR	R2-163687	5G-NORMA
3GPP-RAN3	23.-27. May 2016	Flexibility of RAN functions through configuration and deployment	R3-161099	5G-NORMA
3GPP-RAN3	23.-27. May 2016	Requirements of Isolation between Network Slices	R3-161358	5G-NORMA
3GPP-SA2	23.-27. May 2016	Update to Solution 2.3: Content Aware QoS Framework	S2-162706	5G-NORMA
3GPP-SA2	23.-27. May 2016	Session Management to Enable (Re-)selection of Efficient User plane path	S2-162507	5G-NORMA
3GPP-SA2	23.-27. May 2016	Solution for Mobility levels	S2-162526	5G-NORMA

3GPP-SA2	23.-27. May 2016	Network Slice abbreviation	S2-162957	5G-NORMA
3GPP-SA2	23.-27. May 2016	Update to QoS framework solution	S2-162901	5G-NORMA
3GPP-SA2	23.-27. May 2016	Guidelines for defining network function granularity	S2-163151	5G-NORMA
3GPP-RAN	13.-16. Jun. 2016	Security Requirements for New Radio	RP-161208	5G-NORMA
3GPP-SA2	11.-15. Jul. 2016	Relationship between Mobility Management and Session Management	S2-163605	5G-NORMA
3GPP-RAN2	22.-26. Aug. 2016	Upper layer aggregation for NR-NR multi-connectivity	R2-164787	5G-NORMA
3GPP-RAN2	22.-26. Aug. 2016	NR Multi-connectivity in DU/CU architecture	R2-164956	5G-NORMA
3GPP-RAN2	10.-14. Oct. 2016	RAN Slicing in NR	R2-166170	5G-NORMA
3GPP-RAN2	10.-14. Oct. 2016	Radio resource isolation requirements	R2-166171	5G-NORMA
3GPP-RAN3	10.-14. Oct. 2016	Paging and Mobility in Inactive State	R3-162406	5G-NORMA
3GPP-RAN3	10.-14. Oct. 2016	Isolation using dedicated radio resources	R3-162404	5G-NORMA
3GPP-RAN3	10.-14. Oct. 2016	Definition for RAN support of slicing	R3-162401	5G-NORMA
3GPP-RAN3	10.-14. Oct. 2016	Generic QoS Framework over NG interface	R3-162400	5G-NORMA
3GPP-RAN3	10.-14. Oct. 2016	NG-U principle for QoS differentiation function	R3-162398	5G-NORMA
3GPP-SA2	14.-18. Nov. 2016	Interim agreement on Routing of NAS signalling and on How the AMF can select the proper SMF instance for a PDU session	S2-166351	5G-NORMA
3GPP-RAN2	14.-18. Nov. 2016	Radio resource isolation requirements	R2-167650	5G-NORMA
3GPP-RAN2	14.-18. Nov. 2016	Paging and location tracking in RRC_INACTIVE	R2-167708	5G-NORMA
3GPP-RAN2	14.-18. Nov. 2016	Discussion on Connectionless	R2-167714	5G-NORMA
3GPP-RAN3	14.-18. Nov. 2016	Paging and Mobility in Inactive State	R3-162948	5G-NORMA
3GPP-RAN2	13.-17. Feb. 2017	QoS flow relocation	R2-1700814	5G-NORMA
3GPP-SA2	27.-31. Mar. 2017	Coexistence among network slices	S2-172230	5G-NORMA
IEEE	17. Nov. 2015	Standard for Tactile Internet	0	5G-NORMA
IEEE P1918.1	28. May 2016	Multi-connectivity architectures supporting Tactile Internet services	0	5G-NORMA
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IETF	01. May 2016	RFC 7864: Proxy Mobile IPv6 Extensions to Support Flow Mobility	0	5G-NORMA
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BBF (WWC)	Jun. 2016	5G Enablers and Requirements	SD-373	5G-NORMA
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ITU-T focus group IMT-2020	42577	Introduction to the Horizon 2020 5G PPP 5G-XHaul Project	-	5G-XHaul
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ITU-T Q.6/SG15	19.-30.09.2016	Impact of pilot tone and message channel on the payload in G.metro	C-1919	5G-XHaul
ITU-T Q.6/SG16	19.-30.09.2016	Appendix on Principles of Operation for G.metro	C-1942	5G-XHaul
ITU-T Q.6/SG15	19.-30.09.2016	Parameters for pilot tones and message channel for G.metro	C-1943	5G-XHaul
ITU-T Q.6/SG15	19.-30.09.2016	Wavelength Plan Proposal for G.metro	C-2000	5G-XHaul
TechUK	12.10.2016	5G Millimetre Wave FWA 'Wireless is the new Wired?'	0	5G-XHaul
3GPP RAN1	22-26.8.2016	Discussion on transmission schemes for NR DL MIMO	R1-167198	5G-XHaul
IEEE 802.11az	42626	Efficient Positioning Method Applicable in Dense Multi User Scenarios	IEEE 802.11-16/1249r1	5G-XHaul
ITU-T Q.6/SG15	16.-19.1.2017	Proposed 10G application code for G.metro	WD06-03	5G-XHaul
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ETSI NFV ISG - SOL005	20.-24.2.2017	Self-Organized Management in Virtualized and Software-Defined Networks - Presentation to ETSI NFV SOL005	NFVSOL(17)000104r1	Selfnet
3GPP-SA3	06-10/Feb/2017	Updating solution #7.14 "Privacy protection of permanent or long-term subscription identifier using ABE"	S3-170343	5G-ENSURE
3GPP-SA3	06-10/Feb/2017	Updating solution #7.3	S3-170080	5G-ENSURE
3GPP-SA3	27-31/March/2017	Updating solution #7.14 "Privacy protection of permanent or long-term subscription identifier using ABE"	S3-170784	5G-ENSURE
3GPP-SA3	27-31/March/2017	Comments to "pCR to TR 33.899 – evaluations and conclusions in clause 7"	S3-170877	5G-ENSURE
3GPP-SA3	27-31/March/2017	Updating solution #7.3	S3-170776	5G-ENSURE
3GPP-SA3	16-19/May/2017	pCR on Updating solution #7.14 "Privacy protection of permanent or long-term subscription identifier using ABE"	S3-171100	5G-ENSURE
3GPP-SA3	16-19/May/2017	pCR on Evaluations and conclusions in clause 7	S3-171101	5G-ENSURE
3GPP-SA3	16-19/May/2017	pCR on Questions - KI #7.2 - permanent subscription identifier privacy	S3-171137	5G-ENSURE

		solution types		
3GPP-SA3	16-19/May/2017	pCR on Dynamic pseudonyms as short-term subscription identifiers	S3-171361	5G-ENSURE
3GPP-SA3	16-19/May/2017	pCR on Question and Agreement - KI #7.2 - permanent subscription identifier privacy in Phase 1	S3-171511	5G-ENSURE
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3GPP RAN plenary	6th – 9th March, 2017	Justification & vision of NR low layer split	RP- 170435	5G-XHaul
ITU-T Q.6/SG15	19.-30.6.2017	G.metro wavelength pairing	C-0010	5G-XHaul
ITU-T Q.6/SG15	19.-30.6.2017	Message example in G.metro	C-0018	5G-XHaul
ITU-T Q.6/SG15	19.-30.6.2017	Appendix replacing the editor note in Clause 10.2, Output power setting during tuning, of G.metro	C-0019	5G-XHaul
ITU-T Q.6/SG15	19.-30.6.2017	Proposed 40 channels application parameters for G.metro	C-0174	5G-XHaul
3GPP-SA3	16-19/May/2017	Updating LI aspects for solutions #7.3 and #7.15	S3-171143	5G-ENSURE
3GPP-SA3	16-19/May/2017	Question and Agreement for issue #7.1 and #7.4	S3-171139	5G-ENSURE
3GPP-RAN 4		On mm-wave technologies for NR	R4-164226	Flex5Gware
3GPP-RAN 4		RF filters for mm-wave OOB blocking	R4-1700017	Flex5Gware
3GPP-RAN 4		UE reference architecture in mmWave	R4-1700604	Flex5Gware
3GPP-RAN 4		TP for TR38.803: Transceiver architecture for mmWave	R4-1702095	Flex5Gware
3GPP-RAN 4		Further elaboration on mm-wave phase noise modelling	R4-1703087	Flex5Gware
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