Satellite and Terrestrial Network for 5G

D6.2
Standardisation Action Plan

Topic	ICT-07-2017
Project Title	Satellite and Terrestrial Network for 5G
Project Number	761413
Project Acronym	SaT5G
Contractual Delivery Date	August 2017 (M3)
Actual Delivery Date	02/10/2017
Contributing WP	WP6.2
Project Start Date	01/06/2017
Project Duration	30 months
Dissemination Level	PU
Editor	N. Chuberre / TAS
Contributors	AVA, ADS, SES, UOS, TNO, ZII, OA, GLT, i2CAT, QUO, BT, iDR

Document History			
Version	Date	Modifications	Source
0.00	June 17	Initial draft. Incorporation of comments from SES, AVA and UoS on the rationale for SatCom standardisation approach	TAS
0.54	15/06/17	Updated to template format	AVA
0.60	26/06/17	Incorporation of comments from ADS, SES on the standardisation approach Identification relevant SDO/groups and SaT5G participating partners in these SDO/groups from ZII, OA, TNO, GLT, i2CAT	TAS
0.70	07/08/17	Incorporation of comments from AVA and SES on the rationale for SatCom standardisation approach	AVA, SES
0.80	31/08/17	Full restructuration of the document complementing SatCom standardisation approach and defining a comprehensive standardisation action plan	TAS
0.84	10/09/17	Resolving of SES; ADS comments	TAS
0.85	18/09/17	Resolving of AVA, SES; ADS comments	TAS
0.86	20/09/17	Resolving comments from i2CAT, BT, AVA, SES, Airbus comments	TAS
0.88	27/09/17	Incorporating suggestions from SES, ZII, AVA, UoS	TAS
1.0	29/09/17	Incorporating inputs from OA and ADS + cleaning	TAS

Contributors		
Name	**Organisation**	**Contributions include**
N. Chuberre	TAS	Inputs to all sections (Editor)
Fabrice Arnal	TAS	Document review
Ray Sperber	SES	Inputs to sections 3
Alexander Geurtz	SES	Inputs to sections 3 and 4
Konstantinos Liolis	SES	Inputs to sections 3 and 5
Barry Evans	UoS	Document review
Ning Wang	UoS	Document review
Georgia Poziopoulou	AVA	Document review (Project manager)
Omar Iqbal	AVA	Document review
Simon Watts	AVA	Inputs to sections 3, 4 and 5.3
Oriol Vidal	ADS	Document review

Contributors		
Name	**Organisation**	**Contributions include**
Duc Pham Minh	ADS	Inputs to section 5.3
Macià Mut Vidal	ZII	Inputs to section 5.3
Denis Behaghel	OA	Inputs to section 3.3 and 5.3
Miodrag Djurica	TNO	Inputs to section 5.3
Avi Gal	GLT	Inputs to section 5.3
Pouria Sayyad Khodashenas	i2CAT	Inputs to section 3.3
Andy Hobbs	QUO	Inputs to section 5.3
Salva Diaz Sendra	BT	Inputs to sections 3 & 5

Table of Contents

List of Figures

List of Tables

List of Acronyms

3GPP	3rd Generation Partnership Project
AEEC	Airlines Electronic Engineering Committee
BSM	Broadband Satellite Multimedia
BSS	Broadcast Satellite Services
CSP	Communication Service Provider
DTH	Direct to Home
DVB	Digital Video Broadcast
ECC	Electronic Communications Committee
eMBB	Enhanced Mobile Broadband
ESOA	EMEA Satellite Operators Association
ETSI	European Telecommunications Standard Institute
E-UTRAN	Evolved Universal Terrestrial Radio Access Network
ESIM	Earth Station In Motion
FSS	Fixed Satellite Services
GERAN	GSM Edge Radio Access Network
IETF	Internet Engineering Task Force
IoT	Internet of Things
IP	Internet Protocol
ISG	Industry Specification Group
ITU	International Telecommunication Union
MPTCP	MultiPath Transmission Control Protocol
MANO	Management and Orchestration
MEC	Multi-Access Edge Computing
MSS	Mobile Satellite Services
NFV	Network Functions Virtualisation
NIS	Network Infrastructure and Security
NR	New Radio
OSM	Open Source MANO
RAN	Radio Access Networks
RDSS	Radio Determination Satellite Service
RP	Research Pillar
SA	Service and System Aspects
SaT5G	Satellite and Terrestrial Network for 5G
SatCom	Satellite Communications
SCN	Satellite Communication and Navigation
SDO	Standardisation Organisation
SES	Satellite Earth Stations and Systems (ETSI TC)
TBC	To Be Confirmed
TC	Technical Committee
TM	Technical Module
TR	Technical Report
TS	Technical Specification
TSG	Technical Specification Group
UTRAN	Universal Terrestrial Radio Access Network
VSAT	Very Small Aperture Terminal

Executive Summary

SaT5G aims to deliver the seamless integration of satellite into 5G networks to ensure ubiquitous 5G access everywhere.

This document corresponds to one of the outputs of SaT5G WP6.2 titled “Standardisation activities”, which defines the detailed standardisation action plan for the SaT5G project to ensure that 5G standards allow the full potential of an integrated satellite contribution and tracks its implementation.

The plan was developed analysing the SatCom and 5G standardisation context and taking into account the SaT5G focus derived from the use cases defined in WP2.1 and the work plan in the Grant Agreement.

For each standardisation group identified as relevant to support the integration of satellite communication systems as plug and play solution in 5G end to end system, specific objectives have been set and a responsible partner and contributors identified.

This plan may need to be revised during the course of the project to take into account the progress on the architecture and research pillars as well as the evolving 5G standardisation context.

1 Introduction

1.1 *Scope*

This deliverable proposes a general approach to standards for future SatComs integrated with 5G and then gives a standardisation action plan for the project SaT5G.

The document:

- Provides an overview of the SatCom systems, market segments and the focus of the SaT5G project;
- Presents the rationale for a new standardisation approach for SatCom based on the analysis of the current standardisation context in SatCom market and the on-going standardisation context for 5G;
- Proposes an approach to integrate satellite in the 5G related standards including the identification/justification of the standardisation requirements arising from SaT5G;
- Gives a standardisation action plan including the timeline, the Standardisation Organisations and groups where SaT5G plans to contribute and the SaT5G members involved;
- Proposes a consensus building approach for satellite related contributions to standards.

1.2 *Structure of the document*

In this document **Chapter 2** reviews the roles for SatCom in 5G within the context of the SaT5G project scope. **Chapter 3** then reviews the rationale for the appropriate standardisation approach for SaT5G by looking at both the current activities and then identifying the target standards organisations that might be considered.

From this the SaT5G phased approach is identified in **Chapter 4** and the resulting action plan defined in **Chapter 5**. Finally **Chapter 6** describes the need for a consensus building approach and details the process through pre-standardisation activities.

2 SatCom and 5G

2.1 *SatCom overview*

Satellite communications (SatCom) refers to a wide range of systems operating in various frequency bands allocated by International Telecommunication Union (ITU) to respectively Broadcast Satellite Services (BSS), Fixed Satellite Services (FSS) or Mobile Satellite Services (MSS).

It is possible to distinguish between two types of SatCom systems according to the type of terminals targeted:

- **Fixed or Mobile VSAT:** Systems serving directional Very Small Aperture Terminals (VSAT) that can be fixed or mounted on a moving platform (e.g. bus, train, vessel, aircraft, etc.). The service links typically operate in frequency bands allocated to satellite services (FSS, MSS) above 3 GHz and providing direct to home / office or backhaul services.
- **Handheld & IoT devices:** Systems serving terminals equipped with omni or semi directional antenna (e.g. handheld terminal). The service links operate typically in frequency bands allocated to MSS below 3 GHz providing backhaul services and/or service direct to user equipment.

The SatCom market can be typically segmented as follows:

Table 2-1: SatCom market segmentation

SatCom market segments	Supporting Satellite Network types	Targeted terminals
Direct to Home (DTH)	TV broadcasting	Fixed or Mobile VSAT (Rx only)
Consumer broadband	Fixed Broadband access	Fixed or Mobile VSAT (Tx/Rx)
Enterprise VSAT		
Backhaul		
Land	Mobile broadband access	
Aeronautical		
Maritime		
Land mobile	Mobile Satellite Systems	Handheld & IoT devices
Aeronautical		
Maritime		
Internet of Things (IoT)		

2.2 *SatCom roles in 5G*

The EMEA Satellite Operators Association (ESOA) has recently published a 5G White Paper on the SatCom services' role as an integral part of the 5G ecosystem [1]. The consensus and wider agreement on what satellite brings to achieving the 5G KPIs are:

- **Ubiquity:** Satellite provides high speed capacity across the globe using the following enablers: capacity in-fill inside geographic gaps, overspill to satellite when terrestrial links are over capacity, general global wide coverage, backup / resilience for network fall-back and especially communications during emergency.
- **Mobility:** Satellite is the only readily available technology capable of providing connectivity anywhere on the ground, in sea or air for moving platforms, such as airplanes, ships and trains.
- **Broadcast (Simultaneity):** Satellite can efficiently deliver rich multimedia and other content across multiple sites simultaneously using broadcast and multicast streams with information centric networking and content caching for local distribution.

One may note that all three of the above features are due to satellite's ability to serve coverages that are wider than those of most other wireless communications technologies.

The possible roles of satellite in the 5G system are acknowledged by the 5G ecosystem in a 3GPP technical report [2] currently being drafted:

- **Foster the roll out of 5G service in un-served areas** that cannot be covered economically by terrestrial 5G network (isolated/remote areas, on board aircrafts or vessels) and underserved areas (e.g. sub-urban/rural areas) to upgrade the performance of limited terrestrial networks in cost effective manner;
- **Reinforce the 5G service availability** by providing service continuity for Machine-to-Machine (M2M)/IoT devices or for passengers on board moving platforms (e.g. passenger vehicles - aircraft, ships, high speed trains, bus and cars) or ensuring service anywhere especially for critical communications, future railway communications or maritime communications;
- **Enable 5G network scalability** by providing efficient multicast/broadcast resources for data delivery towards the network edges or even user terminal.

2.3 *SaT5G Use Cases*

In [3], the SaT5G project identifies eMBB as the 5G Usage Scenario where satellite can most benefit to 5G system by supporting the objective of "Broadband access everywhere". In line with this focus, four use cases have been selected and are summarised below.

SaT5G Use Case 1: Edge delivery & offload for multimedia content and MEC VNF software

It refers to the provision of efficient multicast/broadcast delivery to network edges for content such as live broadcasts, ad-hoc broadcast/multicast streams, group communications, MEC VNF update distribution.

SaT5G Use Case 2: 5G Fixed backhaul

It refers to the provision of broadband connectivity where it is difficult or not (yet) possible to deploy terrestrial connections to towers, for example, maritime services, coverage on lakes, islands, mountains, rural areas, isolated areas or other areas that are best or only covered by satellites; across a wide geographic region.

SaT5G Use Case 3: 5G to premises

It refers to the provision of connectivity complementing terrestrial networks, such as broadband connectivity to home/office small cell in underserved areas in combination with terrestrial wireless or wireline.

SaT5G Use Case 4: 5G Moving platform backhaul

It refers to the provision of broadband connectivity to platforms on the move, such as airplanes or vessels.

3 Rationale for a new standardisation approach for SatCom

3.1 *Current standardisation organisations for SatCom*

SatCom system standards are mainly defined in two standardisation bodies namely DVB (DVBTM-RCS) and ETSI (TC-SES):

Table 3-1: SatCom standardisation bodies

Type of networks	Standardisation organisation: ETSI	Industry forum: DVB
TV Broadcasting	-	DVB-S/S2/S2x
Fixed/Mobile Broadband access	-	DVB-S2x/RCS2
Mobile Satellite Systems	SL family (also referred as BGAN system), GMR-1 family	DVB-SH, DVB-NGH

3.1.1 DVB (Digital Video Broadcast) : dvb.org

This industry forum was established initially to create a set of standards for the TV broadcasting industry via terrestrial, satellite or cable networks. DVB has successfully defined the DVB-S2 broadcast channel which is widely adopted around the world. A Return Channel (DVB-RCS/2) has been defined to support broadband telecommunication services via satellite. The DVB technical specifications are published by ETSI after being reviewed in the TC-BROADCAST.

3.1.2 SatLabs : satlabs.org

The SatLabs Group is an international, not-for-profit association whose members are committed to bringing the deployment of the DVB-RCS standard to large-scale adoption.

The main goal of the SatLabs Group is to ensure interoperability between DVB-RCS terminals and systems. The SatLabs Qualification Program was launched in April 2005 to achieve this goal by providing an independent certification process. When a terminal has successfully passed the tests defined in the SatLabs Qualification Program, a Certificate of Compliance is granted and the terminal is defined as a "Qualified Product".

3.1.3 ETSI (European Telecommunications Standard Institute): portal.etsi.org

Within ETSI, the Technical Committee Satellite Earth Stations and Systems (TC-SES) is responsible for all aspects related to satellite earth stations and systems of types of satellite communication systems, services and applications including fixed, mobile and broadcasting as well as satellite navigation systems and services. It is also the Primary Committee for co-ordinating the position of ETSI with relevant ITU Study Groups.

Lastly, ETSI TC-SES has established liaisons with 3GPP. This allowed the development of standards for Mobile Satellite as well as Broadband Satellite Multimedia systems which are largely based on 3GPP system architecture and radio protocols (at least the layer 2 and above). These standards entail a set of technical specifications and technical reports.

ETSI has defined several satellite radio interface among which GMR-1, SL, GMR-2, as well as WCDMA based families.

3.2 *Current standardisation approach*

Over the last several decades, terrestrial mobile networks have benefited tremendously from international standardisation efforts, notably in 3GPP, which has demonstrated its capability to incorporate various protocols/features from other SDOs such as IETF and ETSI. This has led to significant economies of scale and hence cost reductions.

In contrast, SatCom systems are characterised by the reliance on DVB technical specifications that are often associated with some proprietary features at architecture, protocol stack and radio access levels up to the point where basic satellite access network interoperability between different solution vendors was not granted.

Hence the current approach followed by the Satcom industry leads to loose integration with cellular system, a fragmented SatCom market with no interoperability between vendors and most SatCom systems supported by a single company.

3.3 *Rationale for a new approach to Standardisation*

The 5G ecosystem, system architecture and radio access technology that are currently being defined provide a broad range of design flexibilities and capabilities (e.g. deployment scenarios) that are of great potential benefit to SatCom market opportunities, provided effective and timely standardisation efforts are undertaken.

Integration of SatCom into the 5G heterogeneous network can take place at different levels, notably:

- Integration of the SatCom system into the 5G network management system supporting different access network technologies (e.g. 5G, 4G, Wifi…) which allows a Mobile Network Operator to configure and control the SatCom resources and to provide seamless service continuity. This also covers Virtualization of satellite communication elements as a non-conventional virtualized resources on 5G end to end services;
- Integration of the SatCom system into the 5G core network to provide 5G services to satellite terminals;
- Interoperability between SatCom terminals and SatCom hub from different SatCom vendors. This requires open standard and interoperability tests and enables keeping the same terminal when changing satellite operator and reducing cost of the terminal;

In the context of SaT5G which focuses primarily on backhaul via satellite, all such integration types will be addressed but putting priority on the integration of the SatCom system with the cellular network system. This requires the possible extension of 3GPP protocols to support the integration of SatCom with cellular network. This requires also the definition of interoperability tests with 5G terrestrial infrastructure.

With the development of 5G systems, SatCom systems can leverage open standards to reduce the deployment and operation cost of terminals (VSAT, ESIM) as well as other satellite network infrastructure equipment (gateway), and, very importantly, to facilitate a tighter operational integration (plug and play approach) into a heterogeneous “network of networks” under common network management.

The on-going standardisation efforts around 5G thus provide a unique opportunity to insert the satellite-specific “hooks” as may be required.

Considering the opportunities to leverage economies of scale and to foster acceptance of future SatCom solutions by all 5G ecosystem stakeholders, the project will spend efforts to standardise the full integration of satellite in 5G and enable multi-vendor deployment. The goal is to open more business opportunities for SatCom solutions as well as for terrestrial ones.

Hence it is opportune to contribute to standardisation organisations involved in the definition of the 5G system directly or indirectly aiming to define:

- Protocols and functions extensions or amendments to enable 5G to support satellite systems at access or transport levels in single or multi connectivity context in a plug and play manner;
- The architecture and protocols of future satellite communication systems featuring high technology commonalities with the 5G system;
- Virtualized satellite network functions as well as software defined satellite networks featuring high scalability, reconfiguration, multi tenancy;
- Tests and procedures.

The standardisation effort on 5G will span over 3GPP release 15, 16 and possibly beyond as well as in other bodies in parallel. Hence, the standardisation on the integration of satellite in 5G can take place in a phased approach taking into account the SDOs schedule constraints.

Meanwhile, it is anticipated that with the help of softwarization techniques, i.e. Network Function Virtualization (NFV) [4] and Software Defined Networking (SDN) [5], satellite communications will be able to support 5G features such as multi tenancy, reconfigurability, automation, scaling, resource slicing, etc. Therefore, it can be easier integrated into end to end 5G services. SaT5G project targets to investigate satcom softwarization techniques and based on that the project foresees possible contributions to the relevant standardization bodies, such as ETSI, IETF.

3.4 *Relevant Standardisation Organisations for the definition of 5G system*

The following standardisation groups are directly or indirectly responsible for standardisation activities related to the definition of the 5G system and therefore they are relevant for the integration of satellite in 5G networks.

3.4.1 3GPP

The overall objective of SaT5G activities in 3GPP is to define satellite friendly features to enable 5G to support the full integration of satellite access and transport solutions.

The standardisation work will take place in the Technical Specification Groups (TSG):

- Radio Access Networks (RAN);
- Service and System Aspects (SA).

3.4.1.1 *RAN*

Definition of the GERAN, UTRAN and E-UTRAN, including their internal structures and functions, of systems for evolved GERAN, UTRAN, E-UTRAN and beyond.

Within RAN there are the following groups:

- RAN WG1 Radio Layer 1 spec;
- RAN WG2 Radio Layer 2 spec, Radio Layer 3 RR spec;
- RAN WG3 lub spec, lur spec, lu spec, UTRAN O&M requirements;
- RAN WG4 Radio Performance Protocol aspects;
- RAN WG5 Mobile Terminal Conformance Testing;
- RAN WG6 Legacy RAN radio and protocol.

3.4.1.2 *SA*

Definition of the overall architecture and service capabilities of systems based on 3GPP specifications.

Within SA there are the following groups:

- SA WG1 Services;
- SA WG2 Architecture;

- SA WG3 Security;
- SA WG4 Codec;
- SA WG5 Telecom Management;
- SA WG6 Mission-critical applications.

3.4.2 ETSI

The overall objective of SaT5G activities in ETSI is to define the end-to-end SatCom system that can fully be integrated in 5G.

The standardisation work takes place in the following Technical Committees:

- Satellite Earth Stations and Systems (TC-SES);
- Network Function Virtualisation (ISG-NFV);
- OSG-Open-Source MANO;
- Multi-Access Edge Computing (TC-MEC).

3.4.2.1 *TC-SES*

Definition of the all aspects related to satellite earth stations and systems.

Within TC-SES, SCN working group (Satellite Communication and Navigation) covers radio and transmission aspects related to Fixed or Mobile Satellite Systems operating in any bands allocated to FSS, MSS or Global Navigation Satellite Systems operating in any bands allocated to RDSS.

In particular, this working group is responsible for:

- Producing and maintaining harmonised standards for satellite earth stations;
- Producing and maintaining technical specifications for satellite radio interfaces;
- Encouraging spectral efficiency on satellite links and harmonisation of satellite radio interfaces;
- Producing specifications that promote integration and inter-working between satellite and terrestrial networks.

3.4.2.2 *ISG-NFV*

Production of the technical specifications for the virtualisation of network functions.

3.4.2.3 *OSG-OSM*

Development of a software reference implementation of ETSI Management and Orchestration (MANO).

3.4.2.4 *ISG-MEC*

Production of the technical specification for realization of Multi-Access Edge Computing (MEC) in the context of content delivery (multicasting and caching).

3.4.3 IETF

3.4.3.1 *Transport Area (tsv) – Multipath TCP (mptcp)*

The Communication Service Providers (CSPs) want to extend the coverage and the bandwidth of the 5G services. They will face issues in some areas where the fixed network is not able to deliver enough bandwidth for the backhauling. So the network operators are currently working on standardisation with subcommittees of IETF on this deployment scheme of multipath including fixed and satellite for the backhauling of the 5G network. The Network – Assisted MPTCP deployment models are designed to facilitate the adoption of multipath communications without making any assumption about the support of the communicating peers.

The Multipath TCP (MPTCP) working group develops mechanisms that add the capability of simultaneously using multiple paths to a regular TCP session. The key goal for MPTCP is to be deployable and usable without significant changes to existing Internet infrastructure. The working

group will explore whether an MPTCP-aware middlebox would be useful, where at least one end host is MPTCP-enabled. For example, potentially helping MPTCP's incremental deployment by allowing only one end host to be MPTCP-enabled and the middlebox acts as an MPTCP proxy for the other end host, which runs TCP; and potentially helping some mobility scenarios, where the middlebox acts as an anchor between two MPTCP-enabled hosts. The working group will detail what real problems an MPTCP-enabled middlebox might solve, how it would impact the Multipath TCP architecture (RFC6182), what proxy approach might be justified as compared against alternative solutions to the problems, and the likely feasibility of solving the technical and security issues.

This group is responsible for the production of the technical specification and document implementation advice for the realization of a standardized transport over a multipath network attachment.

3.4.4 AEEC

The Airlines Electronic Engineering Committee (AEEC) creates value for airlines and the aviation industry by developing engineering standards and technical solutions for avionics, networks, and cabin systems that foster increased efficiency and reduced life cycle costs for the aviation community.

The standardisation work will take place in the subcommittee Network Infrastructure and Security (NIS).

3.4.4.1 *Network Infrastructure and Security (NIS) Subcommittee*

The goal of the Network Infrastructure and Security (NIS) subcommittee is to develop standards for IP connectivity and security to the aircraft and enable fleet-wide solutions based on open standards for lower development cost, increased flexibility, higher reliability, reduced complexity, longer lifespan, and ease of configurability and maintenance.

One of their current drafts is ARINC Project Paper 848 - “Secure Broadband IP Air-Ground Interface (SBAGI)” which is intended to define a method for secure communications interface between IP networks contained within an aircraft and a ground network hosted within the aircraft OEM, airline or a 3rd party. Such secure interface, termed as the SBAGI interface, shall convey COTS radio network capabilities to upper network layers to assist with least-cost routing decisions. The ARINC Project Paper 848 would standardize this interface at the network level while taking into account the overall security context.

3.4.5 CEPT ECC

3.4.5.1 *WG FM 44 - Satellite Communications*

The Electronic Communications Committee’s (ECC) Working Group Frequency Management (WG FM) is responsible for developing strategies, plans and implementation advice for the management of the radio spectrum.

WG FM44 deals particularly with Satellite Communications and its terms of reference include the following:

- Maintain an oversight on satellite policy issues within the CEPT within the terms of reference of WGFM;
- Consider on the request of the WGFM how the spectrum identified for space radio-communication services should be arranged for use;
- Identify tasks on satellites (not covered by the permanent ECC working groups) which could be proposed to the WGFM;
- Maintain and update existing CEPT ECC Decisions, Recommendations and Reports on space radio-communication issues within the mandate of WGFM;
- At the request of WGFM, prepare responses to EC Mandates on space radio-communication issues;
- Seek, as appropriate, contributions and assistance from relevant ECC subordinate bodies and from the ECO;
- In agreement with WGFM, liaise with ETSI and other relevant bodies dealing with standardisation;

- Contribute, as appropriate, to the development of CEPT inputs to ITU-R Working Parties on space radio-communication issues in accordance with ECC working procedures;
- Report to each meeting of WGFM.

3.4.6 ITU-R

3.4.6.1 *Working Party 4B*

ITU-R Working Party 4B (WP 4B) carries out studies on performance, availability, air interfaces and earth-station equipment of satellite systems in the FSS, BSS and MSS. This group has paid particular attention to the studies of Internet Protocol (IP) related system aspects and performance and has developed new and revised Recommendations and Reports on IP over satellite to meet the growing need for satellite links to carry IP traffic. This group has close cooperation with the ITU Telecommunication Standardization Sector.

3.4.7 Other standards groups

Other standards groups and organisations may be relevant to the SaT5G findings. Standards activities related to integrating satellite in to 5G will also be monitored and managed in an ad hoc manner within SaT5G; for example work within:

- Broadband Forum (BBF) and
- the Small Cell Forum.

4 SaT5G Approach for the integration of Satellite in 5G Standards

In order to achieve the project standardization objectives and KPIs (see Section 5.2), SaT5G will develop a number of targeted, interrelated and closely coordinated standardisation activities in different standardisation bodies. These activities are derived from the Architecture aspects as well as the Research Pillars.

Figure 4-1 below illustrates the relationship between the main activities undertaken in this context.

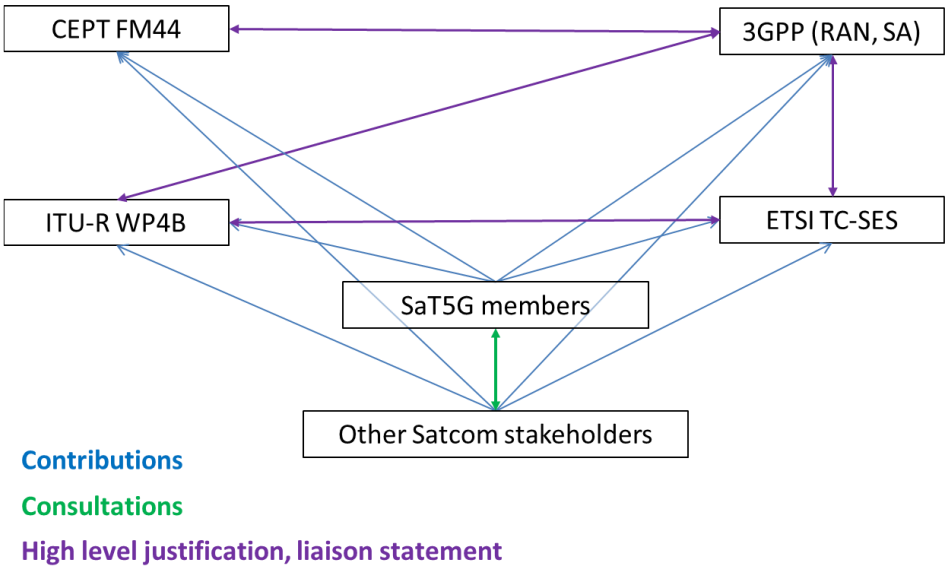

Figure 4-1: SaT5G standardisation activities and interrelations

4.1 *SaT5G focus related to standardisation activities*

The table below recalls the main features that are being researched in the SaT5G project and the planned standardisation impacts.

Table 4-1: Link between the SaT5G research and the activities of standardisation organisations on 5G

SaT5G Research Pillar & architecture studies	SaT5G features being researched	Relevant SDO groups
Architecture aspects	Activity A1: Satellite use cases for eMBB	**3GPP SA1** for the identification of use cases and the related service requirements **CEPT WG FM44, ITU-R WP 4B** and **ETSI TC SES/SCN WG** for the identification of use cases
	Activity A2: Architectures integrating satellite links in 5G architecture (network functions updates & network topologies)	**3GPP SA2** for the inclusion of network functions updates and topology aspects

SaT5G Research Pillar & architecture studies	SaT5G features being researched	Relevant SDO groups
	Activity A3: NGc/NGu transport of satellite link or aggregation of satellite/terrestrial links (Cell(s) backhaul)	**3GPP RAN3** for the support of NGc/NGu over a satellite access link and the incorporation of Satellite access link in traffic steering for backhaul **3GPP SA2** (specific focus TBC)
	Activity A4: NGc/NGu dynamic relation for backhaul of cell(s) on board moving platforms (e.g. Passenger aircraft)	**3GPP SA2** for the definition of Dynamic Reselection of user path for a group of UEs on board a moving platform
	Activity A5: Mobile backhaul	**AEEC ARINC 848** for the extension of the secure broadband IP air-Ground interface to support 5G backhaul service
	Activity A5: scenarios and architectures for satellite use cases for eMBB	**CEPT WG FM44**, **ITU-R WP4B** and **ETSI TC SES/SCN WG** for the identification of technical features supporting the integration of satellite in 5G
RP1 – Implementing 5G SDN/NFV in Satellite Networks **and** **RP2 – Integrated Network Management and Orchestration**	Activity RP1&2.1: SatCom integration in the virtualised 5G architecture (including network slicing, orchestration etc.)	**ETSI ISG NFV** for the addition of Satellite network specific network functions in the MANO reference architecture **ETSI OSG OSM** for the update of the Open source MANO reference implementation with SatCom management function. More specific on new releases of the ETSI OSG OSM. **3GPP SA5** for orchestration in the 5G system
	Activity RP1&2.2: Flexible joint 5G-SatCom resource orchestration	**3GPP RAN3** for the incorporation of Satellite access network in the 5G RAN Radio Resource Management architecture
RP3 – Multi-Link and Heterogeneous Transport	Activity RP3.1: Performance enhancement protocols (PEP) for 5G to mitigate long latency link	No impact on standard because the objective of the PEP design is to achieve a transparent integration in the communication network
	Activity RP3.2: Link aggregation through traffic steering between network links of different QoS characteristics and capabilities (broadcast/multicast/unicast)	**IETF WG Mptcp** for the extension of MPTCP to address satellite and terrestrial network paths
RP4 – Harmonisation of Satcom with 5G User and Control planes	Activity RP4.1: 5G core network friendly Non 3GPP Satellite access technology	**ETSI TC SES/SCN WG** for the definition of an adaptation gateway to support the mapping of NR access/network layer over the physical/access layer of DVB or proprietary satellite radio interface

SaT5G Research Pillar & architecture studies	SaT5G features being researched	Relevant SDO groups
	Activity RP4.2 Satellite friendly New Radio protocols and access technology architecture	**3GPP RAN1, 2 & 3** for the definition of the enablers for a Satellite friendly New Radio protocols and access technology architecture
RP5 – Extending 5G Security to Satellites	Activity RP5.1: Extension of the security architecture to local caching/MEC fed by a broadcast component	**3GPP SA3** for the extension of the 5G security framework with local caching/MEC
	Activity RP5.2: Efficient key management and authentication over fixed or mobile satellite transport	**3GPP SA3** for the extension of the 5G security framework to include satellite links **IETF Security Area** – Keying and Authentication for Routing Protocols (karp)
RP6 – Caching and multicast for Optimised Content & NFV Distribution	Activity RP6.1: Efficient multimedia content/MEC NFV delivery over a satellite link	**ETSI ISG MEC** for the support of content delivery operations through satellite backhaul links (unicast/multicast and broadcast)

4.2 SaT5G phased approach towards standardisation

It is important to underline that such standards-compliant integration will follow a phased approach and that satellite communication systems can be integrated in the 5G system even if some satcom elements are proprietary (e.g. proprietary satellite air interface or resource manager).

Relevant aspects of these features will be introduced in the appropriate standardisation organisations as explained in the next chapter. The table below identifies the target date for definition of SaT5G features that would be used as inputs for standardisation contributions:

Table 4-2: Identification and description of 2 phases (preliminary)

SaT5G Features	Phase A (end of 2018)	Phase B (end of 2019)
Architectures	A1: Satellite use cases for eMBB A2: Architectures integrating satellite links in 5G architecture (network functions updates & network topologies) A3: NGc/NGu transport of satellite link or aggregation of satellite/terrestrial links (Cell(s) backhaul)	A4: NGc/NGu dynamic relation for backhaul of cell(s) on board moving platforms (e.g. Passenger aircraft) Activity A5: Mobile backhaul
Research Pillars	RP1&2.1: SatCom integration in the virtualised 5G architecture RP3.2: Link aggregation through traffic steering between network links of different QoS characteristics and capabilities (broadcast/multicast/unicast) RP4.1: 5G friendly Non 3GPP Satellite access technology RP5.1: Extension of the security architecture to broadcast component RP5.2: Efficient key management and authentication over fixed or mobile satellite transport RP6.1: Efficient multimedia content/MEC NFV delivery over a satellite link	RP1&2.2: Flexible joint 5G-SatCom resource orchestration RP3.1: Performance enhancement protocols (PEP) for 5G to mitigate long latency link RP4.2: Satellite friendly New Radio protocols and access technology architecture

Note that some of the features in phase A may be extended in phase B.

5 Standardisation action plan

Considering the opportunities to leverage economies of scale enabled by the on-going standards efforts and to foster acceptance of satcom solutions by all 5G eco system stakeholders, the proposed standardisation plan for SaT5G is as follows.

5.1 *Timeline of 5G standardisation*

3GPP which is responsible for the definition of 5G system following a two-step approach as presented in Figure 5-1:

- The publication of a first set of technical specifications mid-2018 and focusing on core aspects of the New Radio Access Technology mainly to support enhanced Mobile Broadband (eMBB).
- The publication of a second set of technical specifications end of 2019 and adding new features.

Note that each 3GPP release lasts 15 months.

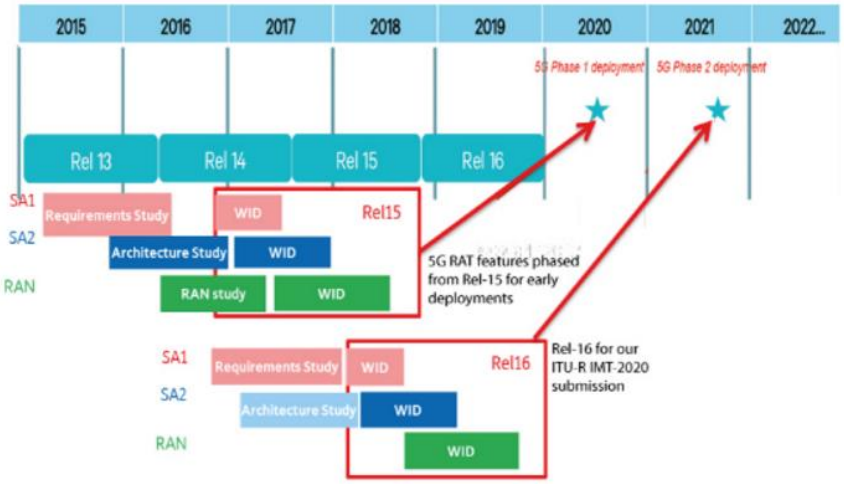

Figure 5-1: 3GPP Standardisation Schedule [Source: www.3GPP.org]

As illustrated below, the project timeline fits well with the overall 3GPP schedule for the definition of the 5G system. This enables us to contribute to study items as part of the Release 15 and to the work items as part of the Release 16 (5G phase 2) and beyond.

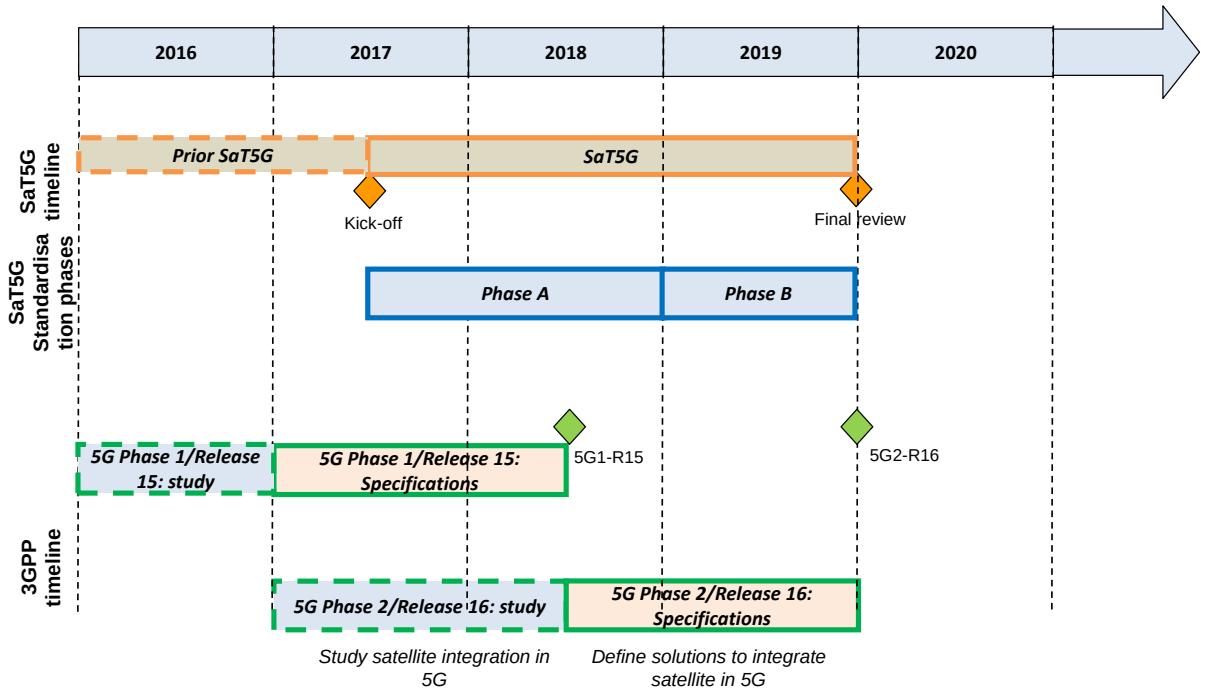

Figure 5-2: 3GPP schedule on 5G definition versus SaT5G project timeline

While Release 15 may not incorporate new satellite related specifications, SaT5G will make concrete contributions to integrate satellite into 5G for the subsequent 3GPP Releases 16 and beyond, in accordance with phases identified in Table 4-2.

5.2 *Overview of SaT5G Standardization Targets and KPIs*

In the SaT5G Description of Work in the Grant Agreement, the following Standardization targets and KPIs have been identified in terms of quantity.

- At least **10** project contributions incorporated in the targeted 3GPP and ETSI documents (Technical Reports and Technical Specifications) during the project
- At least **2** standardization Technical Reports during the project

5.3 *Status of 3GPP Contributions by SaT5G Partners To Date*

Since the beginning of 2016, several partners of the SaT5G project (e.g. TAS, ADS, SES, and TNO) have submitted several contributions to 3GPP presented in Table 5-1 and obtained the support from satcom stakeholders worldwide (HNS, Dish networks, Inmarsat, Ligado, Fraunhofer IIS, Eutelsat). To date, further contributions have been prepared/submitted to ensure the forward compatibility of the Phase 1 features with satellite solutions. All this effort paves the way for maximum impact of SaT5G "satellite" related contributions to 3GPP.

Table 5-1: Impacts of recent contributions in 3GPP by SaT5G partners

Reference	Document Title	Impact	Status
3GPP TR 22.891	Feasibility Study on New Services and Markets Technology Enablers; Stage 1 (Release 14)	Use case "5G Connectivity Using Satellites" added (clause 5.72)	Done in SA1
3GPP TS 22.261	Service requirements for next generation new services and markets; Stage 1 (Release 15)	Basic capability "Satellite Access" added (Clause 6.3.2.3)	SA1#75 decision (8/2016)
3GPP TR 38.913	Study on Scenarios and Requirements for Next Generation Access Technologies; (Release 14)	Deployment scenario "Satellite extension to Terrestrial" added (Clause 6.1.12)	RAN#72 decision (6/2016)
3GPP TR 23.799	Study on Architecture for Next Generation System (Release 14)	Key issue 22 added: Support of "5G connectivity via satellite" use case	SA2#116bis decision (9/2016)
3GPP TR 38.811	Study on NR to support Non-Terrestrial Networks (Release 15)	Study Item creation in RAN	RAN#75 decision (3/2017)

5.4 *SaT5G objectives in the relevant standardisation groups*

Here under are detailed the standardisation objectives of SaT5G partners in the various groups of the relevant SDOs.

Table 5-2: SaT5G objectives in each targeted standardisation groups

SDO	Group	SaT5G objectives	Relevant SaT5G Activity and RP	Related work items
ETSI	TC-SES	Definition of future satcom architecture and performance assessment for 5G Definition of functions/protocols to handle the specifics of satellite payload/systems' management and operation. Definition of 5G friendly Non 3GPP Satellite access technology. Definition of performance, signalling and protocols and interoperability tests.	Architecture	DTR/SES-00405: "Seamless integration of satellite and/or HAPS (High Altitude Platform Station) systems into 5G system"
ETSI	ISG-NFV	Incorporate satcom management functions.	RP1/2	3rd version of MANO specifications
ETSI	OSG-OSM (MANO)	Add SatCom management and orchestration feature	RP1/2	Open-source MANO reference implementation
ETSI	ISG-MEC	Support of content delivery operations through satellite backhaul links	Architecture & RP6	As part of phase 2, possible revisions of Terminology, technical requirements,

SDO	Group	SaT5G objectives	Relevant SaT5G Activity and RP	Related work items
				Framework and Reference Architecture
IETF	WG mptcp	Ease the deployment of 5G services in low density areas to extend the coverage and bandwidth through aggregation of multi network links including satellite exploiting MPTCP protocols	RP3	Update of a Draft internet "Extensions for Network-Assisted MPTCP Deployment Models" with the aim to finalise an RFC
AEEC	NIS (Network Infrastructure and Security) Sub committee	Identify recommendations from this standards group in defining next generation of Broadband Satellite connectivity to aircrafts and in particular, on critical matters like End-to-End security, virtualized interfaces and QoS optimization. ZII will monitor this sub-committee and provide relevant inputs to the project team.	Architecture	ARINC Project Paper 848
CEPT	ECC WG FM 44 - Satellite Communications	Define the role and use cases of satellite in IMT2020 networks. The intent is to promote the satellite in IMT-2020 context.	Use cases	FM44/ECC PT1 Work Item: ECC "Report on satellite solutions for 5G"
ITU-R	Working Party 4B	Identify technical features to support the integration of satellite in IMT-2020 ("5G") networks for different integration scenarios/use cases and identify possible related ITU regulatory/standardisation requirements.	TBC	ITU-R.M (NGAT_SAT) Report: Key lements for the integration of satellite systems into Next Generation Access Technologies
DVB	TM-RCS	TBC	TBC	TBC
3GPP	RAN1 (Radio layer 1)	Ensure that satellite terminals support the 5G radio interface's physical layer	RP4	FS_NR_nonterr_nw: "Study on NR to support Non-Terrestrial Networks"
3GPP	RAN2 (Radio layer 2 and Radio layer 3 RR)	Ensure that satellite terminals can be controlled by the 5G Radio Interface's Protocols (MAC, RLC, PDCP, Radio Resource Control)	RP4	New study item
3GPP	RAN3 (Iu, Iub, Iur, S1, X2 and UTRAN/E-UTRAN)	Enable orchestration of satellite networks resources by 5G core network. Support of satellite for multi-link/homing and broadcast/multicast for backhaul	Architecture	New study item
3GPP	RAN4 (Radio performance	Ensure satellite performance is considered in 5G as well as	RP4	New study item (TBC)

SDO	Group	SaT5G objectives	Relevant SaT5G Activity and RP	Related work items
	and protocol aspects)	define test or EMC specification.		
3GPP	SA1 (Services)	Identify/analyse use cases of satellite access in 5G in order to complete/consolidate the service requirements covering satellite access (Non 3GPP or 3GPP)	Use cases	FS_5GSAT "Feasibility Study on using Satellite Access in 5G" study item, to identify updates of TS 22.261 "Service requirements for the 5G system; Stage 1"
3GPP	SA2 (Architecture)	Ensure that the architecture requirements cover satellite use cases. It includes Dynamic Reselection of user path for a group of UEs on board a moving platform	Architecture	New SA study item
3GPP	SA3 (Security)	Extend 5G security framework to integrate Satellite access (Non 3GPP or 3GPP)	RP5	New SA study item
3GPP	SA5 (Telecom Management)	Ensure provisioning and management of the virtualized satellite access is included in 5G	RP1/2	New SA study item

5.5 *Participation of SaT5G partners in the SDOs*

Table 5-3: SaT5G partner participation plan in standardisation groups (preliminary)

SDO groups	Scope	Lead participant for SaT5G in the meetings	Participant to the SDO meetings	Participant only taking part in the drafting of contributions*
ETSI TC-SES	Satellite systems	TBC	TAS, ADS, SES, iDR	GLT
ETSI TC-SES/SCN WG	Satellite Communication & Navigation	TBC	AVA, ADS, SES, TAS, iDR	ZII
ETSI ISG-NFV	Network Function Virtualisation	TBC		i2CAT, SES
ETSI OSG-OSM	Open-Source Management and Orchestration	TBC		AVA, GLT, SES, i2CAT
ETSI ISG-MEC	Multi-access Edge Computing	iDR		UoS, QUO, ZII, GLT, SES
IETF tsv mptcp Group	Transport Area – Multipath TCP	OA		
IETF art cdni Group	Applications and Real-Time Area - Content Delivery Networks Interconnection	TBC		
ARINC848	Secure Broadband IP Air-Ground Interface (SBAGI)	ZII		
DVB Forum	Broadband and broadcast satellite systems	TBC	ADS, SES, TAS	
CEPT ECC WG FM 44	Satellite solutions for 5G	SES	TAS, AVA	BT, ADS
ITU-R WP4B	Integration of satellite-based solutions into IMT-2020 networks	SES	TAS, AVA	ADS
3GPP RAN (Plenary)	Radio Access Network	TAS	AVA, SES	GLT
3GPP RAN1	Layer 1	TAS		BT
3GPP RAN2	Layer 2 & 3	TAS		TNO, BT
3GPP RAN3	RAN architecture	TAS		TNO, BT
3GPP RAN4	Radio performance and protocol aspects	TBC		BT, TAS
3GPP SA (Plenary)	Service & System Aspects	TAS	AVA, SES, TNO	ZII, GLT

* We identify here the SaT5G members that will not participate to the meeting but will draft all or part of contributions.

SDO groups	Scope	Lead participant for SaT5G in the meetings	Participant to the SDO meetings	Participant only taking part in the drafting of contributions*
3GPP SA1	Services	TAS	SES, TNO	AVA, QUO
3GPP SA2	Architecture	TAS	SES	AVA, QUO, TNO, ADS, BT
3GPP SA3	Security	TBC	TBC	TNO
3GPP SA5	Telecom management	TBC	TBC	AVA

6 Consensus building approach for satellite related contributions to standards

6.1 *Pre-Standardisation Co-Ordination*

The project plans to drive standardisation in various SDOs and contribute to the definition of enablers for the integration of satellite in 5G system. Early coordination with the stakeholders can be carried in the following groups. Any stakeholder can share planned contributions to seek broader views, additional inputs and supports before submitting it to the targeted standardisation bodies.

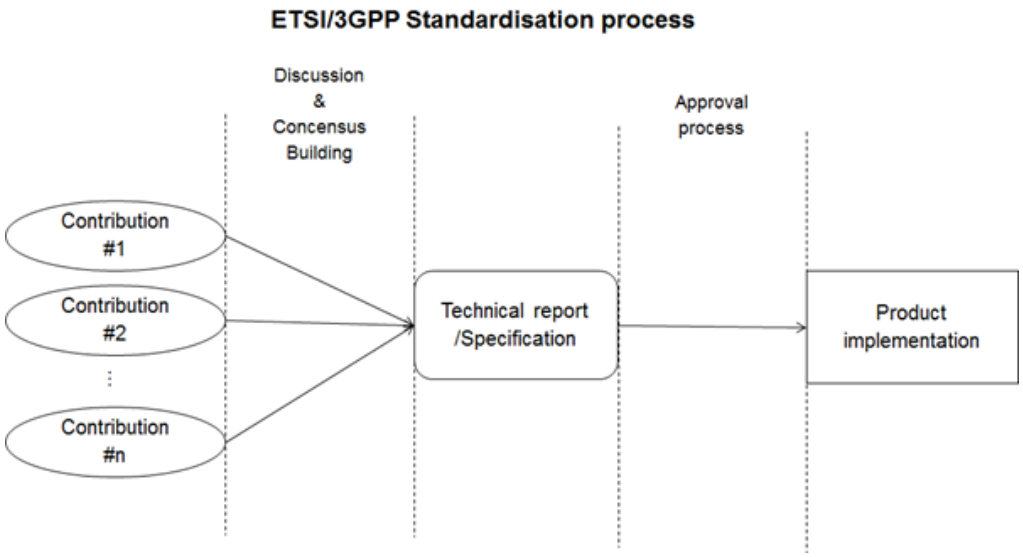

Figure 6-1: Example of standardisation process in ETSI and 3GPP

Depending on the topic, the contributions prepared by individual SaT5G partners will build consensus to enlarge the support to maximise impact in SDOs using all or part of the following groups:

- SaT5G interested partners;
- SatCom industry stakeholders through Networld2020 Satcom pre stand WG (see description below) and/or ETSI SES;
- European non satcom industry stakeholders through 5G IA pre stand WG (see description below);
- ESA 5G initiative task force
- Worldwide non satcom industry stakeholders within 3GPP.

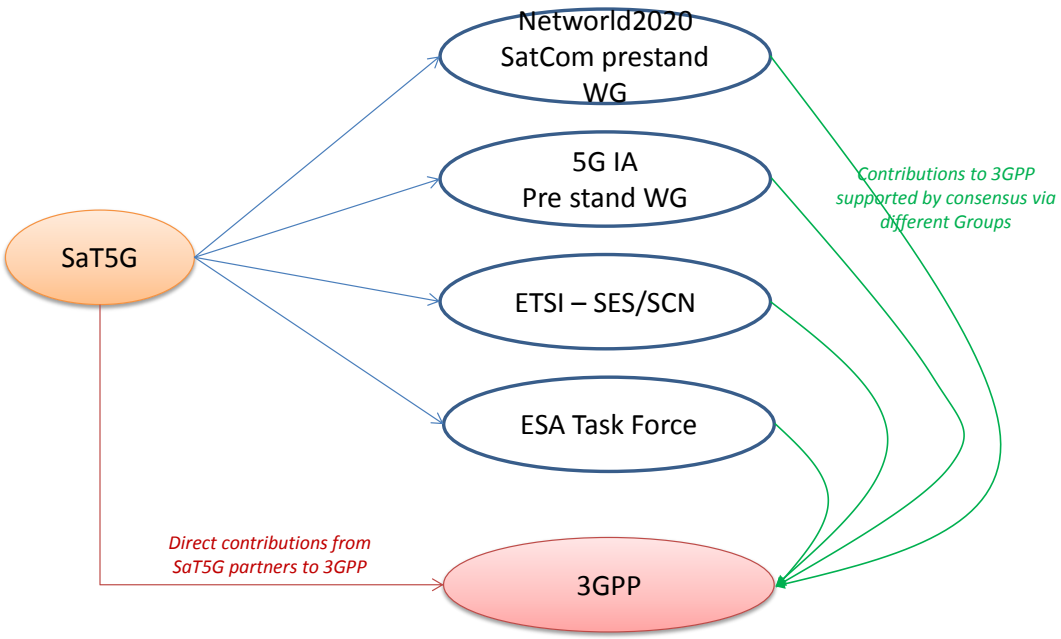

Figure 6-2: Illustration of the flexible consensus building approach towards 3GPP

In the event that seeking a wide consensus within SaT5G, results in particular initiative being detrimentally delayed, the issues shall be escalated to the SaT5G technical committee and if required to the steering committee to establish a suitable way forward.

6.1.1 Pre-Stand SatCom Working Group of the Networld2020 European Technology Platform

This working group is a Forum to

- Discuss possible joint contributions to relevant Standardisation Organisations and related preparation activities between stakeholders having interest in satellite related solutions for 5G
- Identify standardisation bodies and groups where Satellite related contribution should be valuable to be proposed, and prepare/agree on these contributions. Discuss/review also Non satellite contribution which have an impact on satellite
- Identify persons who are representatives of the organisations interested in the Pre-stand satcom group's activities able to attend the meetings and defend the joint contributions.

6.1.2 Pre-Standardization Working Group of the 5G Infrastructure Association

This working group:

- Identifies standardization and regulatory bodies to align with e.g. ETSI, 3GPP, IEEE and other relevant standards bodies, & ITU-R (incl. WPs) and WRC (including e.g. ECC PT1);
- Develops a roadmap of relevant standardization and regulatory topics for 5G: Evaluate existing roadmaps at international level;
- Proposes own roadmap for 5G being aligned at international level;
- Potentially proposes where topics should be standardized

This is what is reflected is the terms of reference. In practice the WG identifies (post-facto) what different 5G-PPP projects have contributed to standardization. In addition, it triggers some high level discussions on overall standardization progress and strategy.

6.1.3 ETSI SES 5G ad hoc group

During the last ETSI TC-SES meeting (SES #91, 30may-1rst June 2017), Airbus Defence and Space together with other industrials has proposed to create a sub working group dedicated to 5G matters. This group, which has strict procedures and is experienced in the publication of Technical Reports and Specifications, could be used to consolidate the consensus building approach proposed by SaT5G. Liaisons could be sent to interface officially with 3GPP. Currently 5G activities are being carried out by the established SCN WG which has sent several liaisons to 3GPP.

7 Conclusion

This document constitutes a first standardisation action plan for the project SaT5G. It will be updated with the findings of the project and as the 5G standardisation context evolves.

In particular, the priorities to contribute in relevant groups may be updated to optimise the SaT5G impact on the integration of satellite in 5G.

8 References

[1] ESOA 5G White Paper, “Satellite Communications Services: An integral part of the 5G Ecosystem,” ESOA, 2017. [Online]. Available: https://www.esoa.net/cms-data/positions/ESOA%205G%20Ecosystem%20white%20paper.pdf.

[2] 3GPP RAN1, “3GPP TR 38.811 V0.1.0 (2017-06), "Study on New Radio (NR) to support Non Terrestrial Networks (Release 15)",” 2017.

[3] H2020 ICT 5GPPP SaT5G, D2.1 “Satellite Reference Use Cases and Scenarios for eMBB”, August 2017.

[4] "Network Functions Virtualisation— Introductory White Paper" European Telecommunications Standards Institute (ETSI), 2012.

[5] Evangelos Haleplidis, Kostas Pentikousis, Spyros Denazis, Jamal Hadi Salim, David Meyer, Odysseas Koufopavlou, “Software-Defined Networking (SDN): Layers and Architecture Terminology,” RFC 7426, IETF, ISSN 2070-1721, January 2015.