D7.2

Standardisation report

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Abstract:

D7.2 covers dissemination and contribution to standardisation bodies and technical platforms in order to support an anchoring of SANSA results. The main contributions are envisioned to 3GPP and ETSI working groups. This deliverable reflects the status of task 7.2 so far and its main focus is to present the standardisation strategy of the SANSA consortium, the targeted standardisation bodies, the work performed regarding standardisation contributions so far as well as the standardisation plans for the remainder of the project.

Document History

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List of Acronyms

3GPP	3rd Generation Partnership Project
5G-PPP	5G Infrastructure Public Private Partnership
CEPT	European Conference of Postal and Telecommunications Administrations
DECT	Digital Enhanced Cordless Telecommunications
EDGE	Enhanced Data rates for GSM Evolution
EFTA	European Free Trade Association
ESA	European Space Agency
ETSI	European Telecommunications Standards Institute
FDD	Frequency Division Duplex
Gbps	Gigabits per second
GHz	Gigahertz
GPRS	General Packet Radio Service
GSM	Global System for Mobile communications
HAPS	High Altitude Platforms
HNM	Hybrid Network Management
IBN	Intelligent Backhaul Node
ICT	Information and Communications Technologies
ISG	Industry Specification Groups
LPD	Low Power communication Device
LTE	Long Term Evolution
M2M	Machine to Machine
MAC	Media Access Control
QoS	Quality of Service
RAN	Radio Access Network
SA	System Architecture
SB	Standardisation Body (ies)
SDN	Software Defined Network
SES	Satellite Earth Stations and Systems
SNR	Signal to Noise Ratio
TDD	Time Division Duplex
TETRA	Terrestrial Trunked RAdio
UE	User Equipment
UTRA	Universal Terrestrial Radio Access
WI	Work Item

Executive Summary

Deliverable 7.2 is the interim document presenting the standardisation contributions so far, the standardisation plan and the targeted standardisation bodies.

This report presents the outcomes of the work done so far in SANSA WP7 Task 7.2. Specifically, task 7.2 covers dissemination and contribution to standardisation bodies and technical platforms in order to support an anchoring of SANSA results. The main contributions are envisioned to 3GPP and ETSI working groups.

The structure is based on three main pillars. The first is the standardisation contribution strategy that is followed by SANSA consortium along with a brief presentation of ETSI, 3GPP and 5G-PPP, which are the targeted bodies/institutes. The second pillar is the contribution to the standardization bodies so far; with ETSI work item “Seamless integration of satellite and/or HAPS (High Altitude Platform Station) systems into 5G system”, DTR/SES-00405 [6] being our first body to contribute SANSA use cases and key enabling components high level architecture. Finally, the third pillar is the future contributions to ETSI, 3GPP and 5GPPP along with the roadmap to achieve this goal. All targeted bodies along with the relevant project work that can be used as input have been identified.

1 Introduction

SANSA project aims at boosting the performance of mobile wireless backhaul networks in terms of capacity and resilience while assuring an efficient use of the spectrum. The recent global traffic forecasts foresee a significant mobile traffic increase within the next few years, and thus novel solutions are necessary to avoid the overload of future backhaul networks. The solution envisaged in SANSA is a spectrum efficient self-reconfigurable hybrid terrestrial-satellite backhaul network based in three key principles:

i. a seamless integration of the satellite segment into terrestrial backhaul networks;

ii. a terrestrial wireless network capable of reconfiguring its topology according to traffic demands;

iii. a shared spectrum between satellite and terrestrial segments.

Work Package 7 of SANSA is devoted to the dissemination and exploitation of SANSA outcomes, as well as the monitoring of and contribution to selected relevant standardization bodies and activities. In the context of WP7, this document, Deliverable 7.2, is a report of the activities regarding the dissemination and contribution to standardization bodies and technical platforms in order to support an anchoring of SANSA results.

In more detail, in D7.2 at first a description of the standardization strategy plan is given. Then, the identified technologies to be standardized are described. After that, the description of the targeted standardization bodies is given. In the following paragraphs the contributions of the SANSA project to the 3GPP, ETSI and 5G-PPP bodies are presented. Finally, a standardization roadmap is described, where the future plans for contributions and monitoring of the identified bodies will be seen.

2 Standardisation plan

2.1 Strategy plan

One of the major objectives of WP7 is to examine the possibility of disseminating the results through standardization bodies. The key action initially has been to identify the relevant standardization bodies with activities aligned to the ones of SANSA. The related activities of these selected standardization bodies were monitored and interaction with them has been established. It is noteworthy that some of the project partners, AVA and CTTC, have had interactions with known standardization bodies prior to SANSA and have been monitoring their activities. The identified standardization bodies are described in Section 2.3

The second important part of the standardization plan was the evaluation of the outputs of WP3 and WP4 in order to identify which of the project outputs can be considered for standardization. To that end, the industrial partners, OTE and AVA, have been continuously monitoring the project outputs and, based on the existing standards and the outputs of the standardization bodies, have been highlighting which items are worth standardizing. To decide if a project output is eligible for standardization or not, the following aspects are examined:

1. Does the project output rely on existings standards?
2. Is there a possibility of exploiting this output by organizations that are already using standards and their products or services?
3. Can the project output trigger the development of new products or services
4. Is it possible for the output to be the basis for creating compatible technologies by other organizations?
5. Will the output complete an area partially covered by an existing standard?

For more information related to standardization planning please refer to (https://www.w3.org) and (https://www.iprhelpdesk.eu/FS_How_to_reap_the_benefit_of_standardisation_in_RD). Some first technologies of SANSA that are eligible for standardization are presented in Section 2.2.

We close this section with a figure (Figure 2.1) that summarizes the plan followed for the standardization activities.

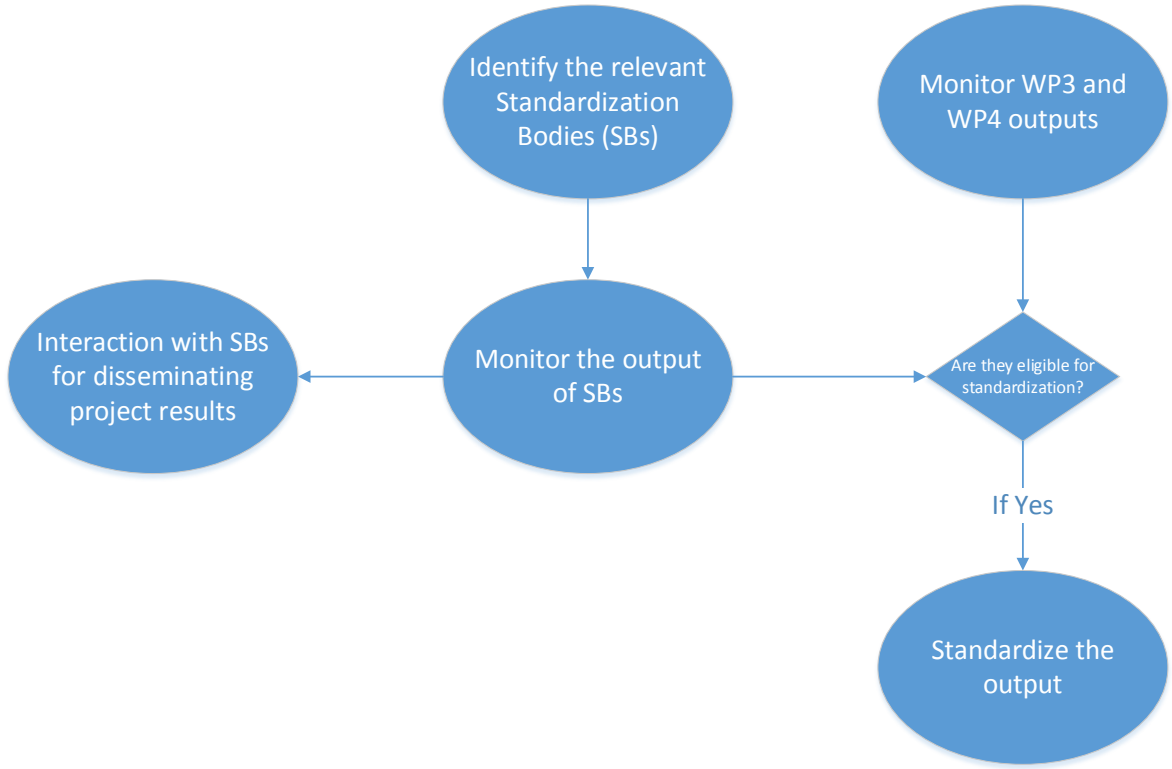

Figure 2.1: Plan of the Standardization activities.

2.2 Identification of technologies to be standardized

The SANSA project proposes a self-organizing hybrid terrestrial/satellite network as a solution for increasing the capacity, resilience, and energy and spectrum efficiency of current mobile backhaul networks. This solution is enabled by two large groups of technologies which correspond to SANSA's two main technical work packages.

In this sense, WP3 is devoted to the development of physical layer, MAC and radio resource management techniques enabling the topology reconfiguration of the terrestrial segment as well as an efficient use of the spectrum. Efficient use of spectrum is based on an aggressive frequency reuse between the terrestrial links, and also on the spectrum management coexistence between terrestrial and satellite terminals.

On the other side, WP4 is devoted to the seamless integration of the satellite segment on current backhaul terrestrial networks and on the dynamic operation of the resulting hybrid self-organizing backhaul network. All the functionalities required for the proper management of the hybrid

network have been mapped to the Hybrid network manager -Intelligent backhaul node (HNM-IBN) pair, which are the two innovative network components proposed by the project. The functionalities include backpressure hybrid routing algorithms, new topology calculators, traffic classification and network management, etc. Even the technologies developed in WP3 and mentioned before can be seen as a part of the HNM, since any topology reconfiguration implies a change on the interference landscape which is tackled by a module called radio-environment mapping, which includes all WP3 relevant technologies [1].

Taking this into account, SANSA needs to push the HNM-IBN architecture and functionalities into future standards in order to maximize its impact. For the time being, the relevant future standards related to backhaul networks are the 5G standards, in particular, those arising from the 3GPP RAN1 team. But so far, the community and industry has hardly considered spectrum sharing and satellite communications as an integral and required part of future 5G networks. Therefore, SANSA project is following a two-steps procedure in order to standardize specific techniques and solutions. The first step consists of identifying and advertising all scenarios and use cases which may benefit from the SANSA solutions, namely those enabled by the hybrid terrestrial/satellite communications. The goal here is to make these use cases become a real target for the relevant standardization bodies. Once this is accomplished, the second step will be devoted to the standardization of the specific techniques and solutions addressing the challenges of those use cases.

2.3 Targeted standardization bodies and groups

The major standardization bodies have been identified and are presented below.

2.3.1 European Telecommunications Standards Institute (ETSI)

The European Telecommunications Standards Institute (ETSI) is an independent, not-for-profit, standardization organization in the telecommunications industry (equipment makers and network operators) in Europe, headquartered in Sophia-Antipolis, France, with worldwide projection. ETSI was created by CEPT in 1988 and is officially recognized by the European Commission and the EFTA secretariat. ETSI produces globally-applicable standards for Information and Communications Technologies (ICT), including fixed, mobile, radio, converged, broadcast and internet technologies and is officially responsible for standardization of Information and Communication Technologies (ICT) within Europe.

ETSI publishes between 2,000 and 2,500 standards every year and has produced over 30,000 since its establishment in 1988. These include the standards that enable key global technologies such as GSM cell phone system, 3G, 4G, DECT, TETRA professional mobile radio system, and Short Range Device requirements including LPD radio, smart cards and many more standards success stories.

Significant ETSI technical committees and Industry Specification Groups (ISGs) include SmartM2M (for machine-to-machine communications), Intelligent Transport Systems, Network Functions Virtualisation, Cyber Security, Electronic Signatures and Infrastructures etc. ETSI inspired the creation of, and is a partner in, 3GPP and oneM2M. All technical committees, working and industry specification groups are accessible via the ETSI Portal.

ETSI technology clusters provide a simple, easy to grasp overview of ETSI's activities in ICT standardization. Each technology cluster represents a major component of a global ICT architecture and covers the work of a number of ETSI technical committees and working groups that share a common technological scope and vision. The work of a single Technical Committee may be represented in several clusters. Clusters facilitate easy identification of an area of interest based on business relevance or application domain rather than purely on specific technical work areas.

In 2013, ETSI's budget exceeded €23 million, with contributions coming from members, commercial activities like sale of documents, plug-tests and fora hosting (i.e. the hosting of forums), contract work and partner funding.

ETSI is a founding partner organization of the Global Standards Collaboration initiative.

The main targeted work group is ETSI Working Group on Satellite Communications and Navigation (SCN) and the Satellite Earth Stations and Systems (SES), specifically the Seamless integration of satellite and/or HAPS (High Altitude Platform Station) systems into 5G system work item.

2.3.2 3GPP

The original scope of 3GPP (1998) was to produce Technical Specifications and Technical Reports for a 3G Mobile System based on evolved GSM core networks and the radio access technologies that they support i.e., Universal Terrestrial Radio Access (UTRA) support both Frequency Division Duplex (FDD) and Time Division Duplex (TDD) modes).

The scope was subsequently amended to include the maintenance and development of the Global System for Mobile communication (GSM) Technical Specifications and Technical Reports including evolved radio access technologies, e.g. General Packet Radio Service (GPRS) and Enhanced Data rates for GSM Evolution (EDGE).

3GPP was created in December 1998 by the signing of the "The 3rd Generation Partnership Project Agreement". The latest 3GPP Scope and Objectives document has evolved from this original Agreement.

The discussions that led to the signing of the 3GPP Agreement were recorded in a series of slides called the "Partnership Project Description" that describes the basic principles and ideas on which

the project is based. The Partnership Project Description has not been maintained since its first creation but the principles of operation of the project still remain valid.

The 3rd Generation Partnership Project (3GPP) unites [Seven] telecommunications standard development organizations (ARIB, ATIS, CCSA, ETSI, TSDSI, TTA, TTC), known as "Organizational Partners" and provides their members with a stable environment to produce the Reports and Specifications that define 3GPP technologies.

The project covers 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. The specifications also provide hooks for non-radio access to the core network, and for interworking with Wi-Fi networks.

3GPP specifications and studies are contribution-driven, by member companies, in Working Groups and at the Technical Specification Group level.

The three Technical Specification Groups (TSG) in 3GPP are:

- Radio Access Networks (RAN),
- Services & Systems Aspects (SA),
- Core Network & Terminals (CT)

The Working Groups, within the TSGs, meet regularly and come together for their quarterly TSG Plenary meeting, where their work is presented for information, discussion and approval.

Each TSG has a particular area of responsibility for the Reports and Specifications within its own Terms of Reference (Details available in the Specification Groups pages).

The last meeting of the cycle of plenary meetings is TSG SA, which also has the responsibility for the overall coordination of work and for the monitoring of its progress.

The 3GPP technologies from these groups are constantly evolving through Generations of commercial cellular / mobile systems (see table below). Since the completion of the first LTE and the Evolved Packet Core specifications, 3GPP has become the focal point for mobile systems beyond 3G.

Although these Generations have become an adequate descriptor for the type of network under discussion, real progress on 3GPP standards is measured by the milestones achieved in particular Releases. New features are 'functionality frozen' and are ready for implementation when a Release is completed. 3GPP works on a number of Releases in parallel, starting future work well in advance of the completion of the current Release. Although this adds some complexity to the work of the groups, such a way of working ensures that progress is continuous & stable.

The main focus for SANSA is on TSG **RAN1** and **SA2.**

Within the scope of TSG RAN, RAN WG1 is responsible for the development of specifications dealing with UTRA, Evolved UTRA, and beyond.

RAN WG1 is also responsible for the specification of the physical layer of the radio backhaul links [12][13]. The work in RAN WG1 includes especially:

- Specification of physical channel structures
- Specification of the mapping of the transport channels onto physical channels
- Specification of the physical layer multiplexing, and channel coding and error detection
- Specification of the spreading and modulation
- Specification of the physical layer procedures
- Specification of definition of measurements and their provision by the physical layer to the upper layers. RAN WG1 also carries out work related to handling of the physical layer related UE capabilities and to physical layer related parameters used in UE tests developed in TSG RAN. [2]

SA WG2 Architecture is in charge of developing the Stage 2 Architecture of the 3GPP network. Based on the services requirements elaborated by SA WG1, SA WG2 identifies the main functions and entities of the network, how these entities are linked to each other and the information they exchange. The output of SA WG2 is used as input by the groups in charge of the definition of the precise format of messages in Stage 3 (Stage 2 for the Radio Access Network is under TSG RAN's responsibility). The group has a system-wide view, and decides on how new functions integrate with the existing network entities [3].

Results from work in WP4 "Hybrid terrestrial-satellite backhaul adaptive network" and in WP5 "Key enabling components" presenting the system architecture and the key enabling components (HNM and IBN) are relevant to the requirements of SA WG2 group. These build on the foundation work of WP2 "Scenario and Requirements Definition".

2.3.3 5GPPP

The 5GPPP is a Public Private Partnership aiming to provide technical solutions, architectures and standards for the next generation of communication infrastructures, i.e. 5G [4] . The public part of the partnership is the European Commission while the private counts with a selected group of manufacturers, telecom operators, service providers, SME and research institutes which form the 5G Infrastructure Association. The overall objective of this initiative is to strengthen the leadership of European companies in the telecom sector as well as in new markets such as smart cities, e-health, intelligent transport, education or entertainment & media. The specific research objectives are very ambitious, including drastic improvements in terms of capacity, energy efficiency, latency, number of connected devices, etc. Interestingly, some of them coincide with the specific objectives of the SANSA project.

The 5GPPP is not a standardization body, but it will have a major role in the definition of 5G in Europe. All major European players, including the EU Commission are working together in order to propose novel solutions for 5G, and to promote them through the relevant standardization and regulation bodies. Therefore, it is of vital importance to be able to include SANSA technologies in the 5GPPP ecosystem since it will be the most straightforward way to reach the relevant standardization bodies.

The research activities of the 5GPPP are carried out by the 5GPPP projects which are granted by the H2020 work programme. 19 projects were granted in phase I which started in July 2015, while the call for projects for phase II closed in November 2016. All these projects must share results and collaborate by contract. As a result of this collaboration and following the initial work of the 5G Association, the cross-project initiatives have been organized in 9 working groups [4]: Pre-Standardization, Spectrum, 5G Architecture, SDN / NDF, NetMgmt / QoS / Security, Vision and Societal Challenges, Security, SME, and Trials.

Based on the identified SANSA technologies to be standardized in Section 2.2, the most relevant working groups are the Spectrum and 5G Architecture. Therefore, the objectives of the SANSA project in this regard will be twofold: (i) to promote the spectrum sharing use cases and enabling technologies through the Spectrum working group; and (ii) to promote the hybrid network architecture based on the HNM-IBN pair and their functionalities through the 5G Architecture group.

It must be noted that the collaboration between 5GPPP projects is closed to 5GPPP projects by contract, and there is no way for an external project like SANSA to be included in such agreements. In order to overcome this barrier, 5GPPP decided to organize specific open workshops in order to incorporate solutions and visions of external projects to their common 5G framework. Alternatively, SANSA could also have an impact on the 5G working groups through the 5G steering board, of which CTTC is an elected member.

3 Standardisation contributions

As already mentioned in section 2 SANSA has targeted bodies and institutes mentioned in section 2 to present its results and try to influence standards through the project results. In this section the contribution to each of these bodies is presented.

3.1 Contribution to ETSI

SANSA members have participated at ETSI in the SES/SCN (the technical committee SES being "Satellite Earth Stations and Systems" and the working group SCN being "Satellite Communications and Navigation"). In particular, SANSA is contributing to the ETSI Work Item DTR/SES-00405: "Satellite Earth Stations and Systems (SES) Seamless integration of satellite and/or HAPS (High Altitude Platform Station) systems into 5G system". The scope of ETSI SES SCN WI DTR/SES-00405 is to identify 5G systems architecture integrating satellite and/or HAPS systems (communication and/or navigation) for relevant use cases. The intent is to prepare the necessary standardisation activity in relation to relevant satellite (communication and/or navigation) technologies. SANSA has already contributed to the early draft that is currently available (version 0.0.1). More specifically, SANSA use cases and scenarios already presented in D2.3 [1] as well as the key enabling components and their high level architecture are an integral part of this early draft. The details of this WI schedule are presented in Table 3-1. Progress in the specific group is not as fast as scheduled. One of SANSA challenges is to speed up processes and contribute to the completion of the WI schedule.

Table 3-1: WI DTR/SES-00405 schedule [6]

Code	Status	Milestone	Action	Action Nb	Target	Achieved	Version
0	**Creation of WI by WG/TB**	Creation of WI by WG/TB			15/12/2015	15/12/2015	
0 p	**WI proposed to TB**	WI proposed to TB			15/12/2015	15/12/2015	
0 a	**TB adoption of WI**	TB adoption of WI			18/12/2015	21/12/2015	
1	**Start of work**	Start of work			21/12/2015	18/05/2015	
2	**Early draft**	Early draft			02/05/2016	02/05/2016	0.0.1
8	**TB approval**	TB approval			15/12/2016		
8 A	**Draft receipt by ETSI Secretariat**	Draft receipt by ETSI Secretariat			29/12/2016		
12	**Publication**	Publication	PU		26/01/2017		1.1.1

Inside ETSI SANSA project was also presented at the *ETSI Workshop on Future Radio Technologies focusing on Air Interfaces* [5] which took place on 27-28th of January 2016, in Sophia-Antipolis, France. The objective of this workshop was to discuss future air interfaces as well as their impact on network system architectures. It included presentations of many 5GPPP projects, as well as other H2020 projects, FP7 projects and presentations from different companies in the telecommunications sector. Regarding the SANSA project, a project overview was given highlighting the target use cases and the key enabling components. On the round table after all presentations, potential follow-up activities where discussed. The possibility to start an *X-haul* initiative devoted to study the different front- and backhaul technologies to be used in future networks was of special interest to SANSA. However, these discussions did not go through and the consortium decided to focus their efforts on the ETSI SES SCN activity explained above.

3.2 Contribution to 3GPP

As already mentioned in section 2.3.2, SANSA will focus its contribution to two working groups. No SANSA specific contributions have yet been made directly to 3GPP. Various SANSA members have contributed to an ad hoc report [9] "Integration of satellite and other non-terrestrial components in the Next Generation system architecture" that was submitted to the 3GPP TSG SA2 Meeting #116bis in Sanya, China, held between 29th August and 2nd September 2016. This work was initiated by Dish Networks and the following 3GPP members - Thales, Fraunhofer IIS, DISH Network, Inmarsat, SES S.A., Hughes Network System Ltd, Eutelsat S.A were quoted as source; from within Avanti made some inputs.

Work performed in WP3 in SANSA is suitable for RAN WG1 where they are considering the requirements for wireless backhaul connections. Within this WP SANSA partners have started working with the objectives being to enable the spectrum coexistence of terrestrial and satellite backhauling links through a hybrid system operating in Ka-band and using the system architecture as already defined in WP2, to study mitigation techniques for the intra-system interference (satellite to terrestrial and terrestrial to satellite) and select the most promising one, to study the dynamic radio resource management in terms of power and carrier allocation and select the most promising technique, to study and evaluate the feasibility of database-assisted spectrum access techniques taking also into account incomplete or inaccurate data and study MAC layer mechanisms and propose adaptations needed for hybrid terrestrial-satellite backhauling networks.

Work in WP 4 is relevant to working group SA WG 2, where system architecture results as well as key enabling components requirements and specifications will be provided as input. In WP 4 the hybrid satellite terrestrial system architecture of the SANSA system is designed with the objectives regarding the outcome of the WP being able to identify the necessary interoperability building blocks between terrestrial and satellite networks, to produce the high level specification to address the seamless inclusion of the satellite component in the terrestrial wireless network, to define the hybrid network manager that will be able to plan the best configuration topology, to allow decisions in intervals of days, which will result in a satellite network segment configuration

topology update to dynamically adjust to service or network status change, to make an efficient use of the network resources in order to make the most suitable load distribution amongst the terrestrial mesh and satellite networks, and to attain an even load distribution within the nodes forming the terrestrial mesh backhaul.

3.3 Contribution to 5GPPP

As explained in Section 2.3.3, the objectives of SANSA with regard to the 5GPPP initiative are:

- To promote the spectrum sharing use cases and enabling technologies to the 5G Spectrum working group.
- To promote the SANSA's hybrid network anagement management scheme and the use cases benefiting from it to the 5G Architecture working group.

The Sections below document the activities carried out so far towards the accomplishment of these objectives.

3.3.1 Spectrum working group

In the first two years of the SANSA project, the Consortium has been monitoring the discussions of the 5G Spectrum working group with the objective of pushing the spectrum sharing technologies whenever possible. The monitoring started with the attendance to the *5G Workshop between Regional initiatives* which took place on 20th of October 2015, in Lisbon, in the framework of the EU ICT Lisbon conference. In this event, Europe, US, China and Korea shared their visions on 5G standards and spectrum. Interestingly, some controversy aroused with regards to the use of the 28GHz band for 5G. This band is being considered for 5G by regions such as US or Korea, but not by Europe, which is protecting its satellite industry which can operate its uplink Ka band links at this frequency. Although SANSA also preserves the current exclusive satellite bands in Ka band for satellite use, we are already considering spectrum coexistence between terrestrial and satellite segments in the current bands assigned to terrestrial fixed services, and also aggressive frequency reuse between terrestrial links which results in an important improvement on the spectrum usage.

The monitoring activity continued with the attendance of the first face-to-face meeting of the 5GPPP spectrum group in Brussels, on 25th of April 2016. The meeting was devoted to the identification of the spectrum needs for 5G and the identification also of pioneering bands for the first 5G trials in Europe. Several 5GPPP projects presented their visions on the spectrum needs and 5G services. Interestingly, COHERENT project [11] highlighted the need for a flexible spectrum management for 5G including novel spectrum sharing techniques. However, since this face-to-face meeting, none of the regular telco meetings held by the group addressed spectrum sharing aspects. Indeed, the group has been focused on the identification and recommendation of pioneering bands for first 5G trials. In this sense, the 24.25-27.5 GHz has been identified as one of the potential bands for 5G deployments addressing high capacity links in urban or suburban

hotspots. It must be noted that these bands share most of the design challenges of the 28 GHz band which is being addressed in SANSA. Thus, most of the technology developed in SANSA would fit in this pioneering band.

A direct contact to the Spectrum working group leader has been made in order to trigger a specific discussion on spectrum sharing aspects. Although such a discussion was not already planned it was agreed that the best option is to participate in the open spectrum workshop that is being organized for Q2 2017. Therefore SANSA will focus its efforts in the presentation of SANSA solutions on spectrum sharing at this workshop.

3.3.2 5G Architecture working group

In the case of the 5G Architecture working group, SANSA was invited to present our views on the 5G architecture in the 1st 5G Architecture Workshop, organized by the 5GPPP and opened to non-5GPPP projects. The workshop took place in Brussels on 6th of April 2016.

We took the opportunity to present the SANSA concept based on a self-organizing hybrid terrestrial-satellite backhaul network. We focused on the benefits enabled by the seamless integration of the satellite and the self-organization of the hybrid network. The use cases enabled by the SANSA solution such as extended coverage, terrestrial traffic offloading, content delivery networks or improved network resilience where discussed. Besides, we presented the enabling architecture based on the Hybrid network manager and intelligent backhaul node functional split. Finally, we addressed a possible integration of these functionalities with the current 5G architecture based on softwarisation and virtualisation.

SANSA was not the only project presenting satellite communications as an integral part of 5G, but also ESA projects, other H2020 such as VITAL or even telecom operators such as AVANTI addressed this point. However a controversy aroused between the vision of these projects and the vision of the 5GPPP working group which is formed almost exclusively by terrestrial segment players. In particular, the relevant role of satellite communication was not acknowledged by the 5GPPP group which considered that the satellite could not support the extreme data rates that the terrestrial segment is targeting. However, in the discussion it was agreed that satellite can play a role for extending coverage and in the quick rollout or 5G services in regions not densely populated. The conclusions of the discussion were collected in the first 5G architecture white paper [7] which was issued in July 2016. It finally included the satellite communication as a 5G backhaul candidate for some use cases, though the weight of satellite technologies in the document is still low. The paragraph below, extracted from [7] collects almost all information about satellite technologies:

"There are discussions ongoing on the benefits of using the satellite link as backhaul base station in specific scenarios like redundant infrastructure for disaster recovery or for coverage in emerging markets. As the capacity of the radio-based uplink to the satellite is limited by the available

spectrum and SNR, the achievable capacity is not higher than the one for terrestrial radio links which is between 1-10 Gbps today. Basic research has reached already 100 Gbps terrestrial in spectrum above 100 GHz and commercial systems may be available during the next decade. As radio link capacity is similar, fixed satellite backhaul of mobile base stations could be considered as a candidate to be integrated into the 5G network as another access branch for some 5G use cases."

Moreover, the integration of satellite and terrestrial services has not been explicitly considered. Indeed, the paper only considered satellite networks as one of the physical resources available to be used by the 5G resource orchestration as depicted in Figure 3.1.

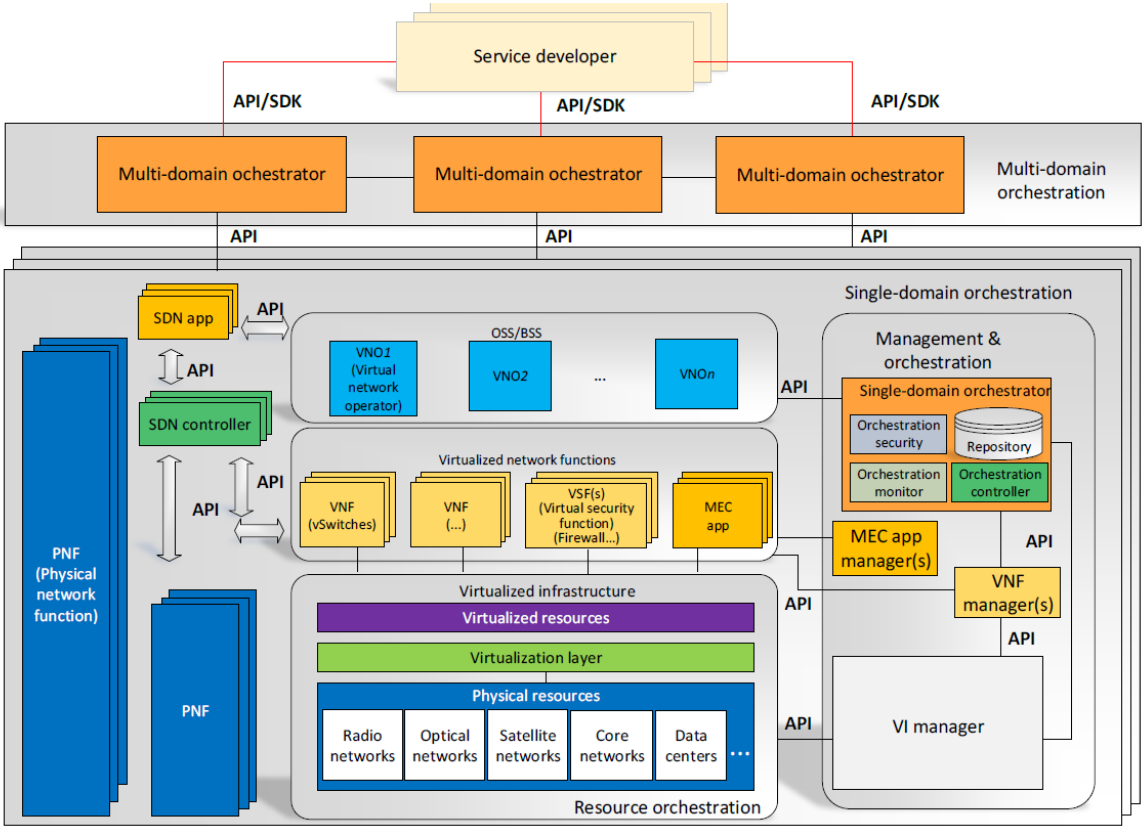

Figure 3.1. 5G network architecture from [7]

Summarizing, 5GPPP is considering satellite communications as a feasible alternative to terrestrial technologies for some special use cases, but a lot of effort is still needed to enlarge those use cases, strengthen their relevancy and promote seamless integration of terrestrial and satellite resources.

4 Standardisation Roadmap

After 2 years of producing results SANSA has already provided inputs to standardisation bodies and will continue providing its results to become part of industrial standards and further exploit the SANSA concept. Moreover, results will be used as input for other bodies as described below.

4.1 ETSI SES/SCN WG

As mentioned in section 3.1 SANSA has already provided inputs to ETSI and more specifically to Satellite Communications and Navigation group and ETSI WI SES/DTR 405 "Satellite Earth Stations and Systems (SES); Seamless integration of satellite and/or HAPS (High Altitude Platform Station) systems into 5G system group".

The WI SES/DTR 405 progress is now behind than scheduled. The main target for the SANSA project is to keep the working item alive and contribute more technical results in order to fulfill the technical expectations of this WI. The next WI meeting is scheduled for 7th of February 2017 in Toulouse where the timetable will be re-assessed and dates set.

4.2 3GPP RAN1 and SA2

Work in WP 3 and WP 4 in SANSA matches requirement and contributions to RAN WG 1 and SA WG2. The target of SANSA is to be included in the 3GPP in order to introduce SANSA innovations as a Study Item (if approved by the SANSA team, discussion planned at the SANSA meeting in late February 2017).

The focus of SANSA is to promote the role of satellite in 5G networks and the benefits brought by the use of satellite as well as the use of aggressive frequency reuse techniques for terrestrial backhauling links. More specifically, satellites can play a key role in unserved or underserved areas where mobile backhauling infrastructure cannot support the provision of applications and services demands in terms of bandwidth. Latency can be an obstacle for some end user applications when satellite connections are used. Hybrid solutions, combining heterogeneous terrestrial and satellite links, especially in underserved areas where terrestrial infrastructure exists but terrestrials links do not have the required bandwidth and capacity to support the provisioning of services with high bandwidth requirements, along with a mechanism that classifies applications and selects the appropriate link based on service requirements (work performed in WP4) offer a solution to problems such as maximizing Quality of Experience (QoE) for users. Of course, for users in unserved areas, satellites can be the only option for mobile connectivity. The System Architecture group is the intended target for SANSA's results regarding hybridisation.

This system design is in conjunction with the key enabling components that do support, manage and coordinate such a system. As far as frequency reuse techniques (WP3) are concerned, the idea

of developing techniques to have more bandwidth available with an acceptable cost in terms of increased interference levels as developed within the SANSA self-organising network can be very interesting for 3GPP RAN group.

4.3 5G PPP

The roadmap of standardization activities of SANSA project with regard to 5GPPP is a straightforward continuation of the activities that have been carried out in the first two years and explained in Section 3.3. Therefore, SANSA consortium will keep on monitoring the activities of the Spectrum working group with the main objective of promoting the spectrum sharing techniques developed in the project. In particular, SANSA Consortium is willing to participate in the 1st open 5G spectrum workshop that 5GPPP is planning to organize for Q2 2017. The main objective of this presentation will be to demonstrate to the 5GPPP the improved spectrum usage that spectrum sharing techniques could enable. On one side, we will focus on the spectrum coexistence of satellite and terrestrial backhaul services which follow a win-win collaboration scheme in order to improve both the capacity of the hybrid networks and the efficient use of the spectrum. On the other side, we will report on the techniques enabling an aggressive spectrum reuse on terrestrial links, which results in an improved network spectral efficiency with respect to traditional conservative spectrum rules based on per-link licensing. Remarkably, SANSA will not be alone in proposing flexible spectrum management techniques since a 5GPPP project like COHERENT is already promoting spectrum sharing solutions. Moreover, recent studies show that the amount of spectrum required for 5G would become prohibitive unless spectrum sharing is considered. As an example, the paragraph below is extracted from the 3g4g blog (http://blog.3g4g.co.uk/2016/09/how-much-spectrumwould-5g-need.html):

"*Real Wireless has done some demand analysis on how much spectrum is required for 5G. A report by them for European Commission is due to be published sometime soon. As can be seen in the slide above, one of the use cases is about multi gigabit motorway. If the operators deploy 5G the way they have deployed 4G then 56 GHz of spectrum would be required. If they move to a 100% shared approach where all operators act as MVNO and there is another entity that deploys all infrastructure, including spectrum then the spectrum requirement will go down to 14 GHz.*"

Besides the spectrum sharing techniques, the SANSA Consortium will keep on promoting the key role of satellite networks in mobile backhauling, including the seamless integration of satellite and terrestrial segments and the efficient management and operation of dynamic hybrid backhaul networks. The promotion of these assets will implicitly result in the promotion of the HNM-IBN architecture and functionalities. Inside 5GPPP, the proper way of carrying out these promotion activities is the 5G Architecture working group. However, it will be only possible if new open workshops are organized in a short time frame. It is worth mentioning that the EU Commission and the 5G Infrastructure Association already acknowledged the lack of Satellite projects and

partners inside 5GPPP phase I. Indeed, the 5GPPP Association included a Target Activity devoted to the *integration of satellite communications and aerial platforms* in 5G in the pre-structuring model of 5GPPP phase II [10].

Therefore, it can be foreseen that some projects addressing this issue will be granted which can force a revision of the current vision of the 5G Architecture, enlarging the presence and relevance of satellites and aerial platforms. SANSA project will follow this potential activity and contribute with its project outcomes whenever possible.

4.4 Networld2020

NetWorld2020 [8] is the European Technology Platform for communications networks and services. It is formed by about 100 member organizations including industrial leaders, SME and research and academic institutions. Its mission is to close the gap between research and innovation and the expectations from the European society, by developing an agreed Strategic Research and Innovation Agenda (SRIA) for Europe in the communication networks sector. The goal is to guide the long-term research actions as well as the impact on global standards assuring the leadership of Europe in networking technology and services.

SANSA did not consider following the Networld 2020 discussion from the beginning because it is closely related to the 5GPPP and it was expected that the major standardizations outcomes could come through the 3GPP. However, recently, the Satellite communications Working Group inside Networld2020 has created a pre-standardization working group with the objective of coordinating standardization contributions to relevant standardization bodies between satellite stakeholders, with the focus on 5G satellite activities. The first meeting of this group was held on 25/01/2017, and the discussion included the revision of the 5G satellite use cases already defined in the draft of the technical report ETSI DTR/SES-0405, as well as the revision of on-going 3GPP Study Item descriptions to 3GPP.

This group is willing to concentrate all discussions relative to the ETSI and 3GPP explained in previous Sections. Therefore, SANSA consortium will contribute in this group in order to promote its results to ETSI and 3GPPP. Avanti. U. Luxembourg and CTTC are already members of the pre-standardization WG of the Networld 2020 Satcom group.

5 Conclusions

In this deliverable we have detailed the standardization strategy of the SANSA project, we identified the main standardization bodies to be targeted, and we revised the standardization activities performed so far by the SANSA consortium as well as the plans for the last year of the project.

Since the future communication standards are being dominated by 5G, it is of crucial importance to promote the SANSA results as enablers for real 5G deployments. However, so far, 5G has been mainly considered as a terrestrial technology and the satellite community has been somehow excluded.

In order to overcome this, in the first two years, SANSA project collaborated with many other satellite stakeholders in order to promote 5G scenarios and use cases enabled or improved by the inclusion of satellite solutions. This was done through ETSI SES SCN WG, 3GPP, Networld 2020 satellite working group and the architecture and spectrum working groups of the 5GPPP.

This activity of defining the 5G satellite use cases is still open and SANSA will continue contributing to it through the above mentioned working groups which. It must be noted that the specific push of project outcomes from WP3 and WP4 to 5G standards will be only possible once the corresponding uses cases are acknowledged and accepted. Thus SANSA Consortium is mainly focused on the promotion of use cases and will start dealing with specific SANSA techniques whenever possible.

Additionally, in order to promote the spectrum sharing techniques, SANSA is participating in the discussions of the 5GPPP spectrum working group. Although, so far, spectrum sharing has been hardly discussed, it is expected that SANSA will be able to show the benefits of its techniques in the first open workshop on 5G spectrum to be organized in Q2 2017.The objective there will be to demonstrate the need of spectrum sharing in 5G backhaul and to trigger specific standardization spectrum sharing activities.

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