

SATELLITE AND SPACE COMMUNICATIONS

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SSC Newsletter

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The Satellite and Space Communications (SSC) Committee is a volunteer group actively involved in advancing satellite and space communication technologies within the IEEE. This committee is approved by the IEEE Communications Society and is governed by the constitution and bylaws of the IEEE as well as the other twenty-three Technical Committees in the Society. The committee belongs to the Technical Committee Clusters of Communication/Signal Processing (C/SP).

SATELLITE & SPACE

- JOIN US -

All conference attendees are welcome to join us in the SSC Committee meeting.

Location: ICC'18, Kansas City, US
Room: Roanoke
Westin Kansas City
at Crow Center

Date: Tuesday May 22, 2018
Time: 12:30-14:00

Future SSC Meetings

Dec. 2018, Abu Dhabi, UAE
May 2019, Shanghai, China

ICC 2018 SSC Committee Activities:

Symposium on Selected Areas in Communications:

Wednesday, May 23, 8:30 - 10:15

Room: Van Horn A

SAC-SSC.01: Satellite and Space Communication I

Chair: Peng Yu (Beijing University of Posts and Telecommunications, P.R. China)

Wednesday, May 23, 14:00 - 15:45

Room: Van Horn A

SAC-SSC.02: Satellite Networks

Chair: Ke Xiao (North China University of Technology, P.R. China)

Wednesday, May 23, 16:15- 18:00

Room: Van Horn A

SAC-SSC.03: Satellite and Space Communication II

Chair: Chunxiao Jiang (Tsinghua University, Beijing, P.R. China)



HOW TO JOIN SSC COMMITTEE AND MAILING LIST

If you like to join SSC Technical Committee: Please send your name and e-mail address to the SSC Secretary, optionally include your mail address, telephone and fax numbers.

If you like to join SSC Mailing List: Instructions on how to subscribe/unsubscribe are available at <https://comsoc-listserv.ieee.org/cgi-bin/wa?A0=ssc>.

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MESSAGE FROM THE CHAIR*Dr. Tomaso de Cola*

This message comes at the end of the term 2016-2018, in which important achievements have been recorded in terms of both editorial initiatives and number of submissions to the SSC track within ICC and GC editions. More emphasis on these numbers is given in the following. Before entering these details, however, I'd like to give some information about the next term, which will start already after ICC'18, i.e. in June. As most of you probably already now, I've decided to apply for another term in the position of chair of this TC, as permitted by ComSoc TC regulations. The main reason behind this decision has been to eventually implement some actions that I inherited from the previous chair (Dr. Igor Bisio), which stayed long in the TC agenda without however a clear roadmap. In particular, my "mission" is to revitalize the concept of working groups, wisely proposed by Dr. Bisio in the previous term in order to have a more programmatic organization of the SSC activities. In particular, I do think that support of the TC has to necessarily go through the inputs from standardization stages on the one hand and the outputs to the overall R&D agendas of academia and enterprises operating in the SatCom field. As such, the plan is give the TC a more concrete framework so as to allow an even broader visibility of the committee and hence enable the reachability of other relevant fora for the SatCom domain. Discussion about the very next actions to be undertaken will happen already during the ICC'18 meeting.

Participation to TC Meetings. The SSC TC last meetings have a quite satisfactory number of attendees. In the past ICC and GC conferences since 2016, we had about 30-40 attendees, hence testifying the increasing interest in the TC activities and also confirming the stability of our TC. Nevertheless, we have to continue to publicize our meeting and to invite members, past and new, to attend.

Operative Policies and Procedures (OP&P). In order to properly advertise and recognize the outstanding contributions to the SSC activities as well as the overall support to the SatCom initiatives, two awards are currently in place. The former is related to distinguished SSC service and is implemented since many years now, and assigned to the recipient during GC editions. The latter instead is related to technical contribution and is of more recent conception. The first assignment will be during ICC'18.

Membership Management. We proposed a two-fold approach: to continue with the acquisition of new members and, more importantly, to involve old and new members in the TC activities (as Symposium Chairs, Guest Editors, etc.). The former activity is proceeding at a slow pace, and we need more incisive action. For what concerns the second part, we deem it is producing adequate results: we nominate new representatives for IEEE ICC/GC and several members are working on interesting and prestigious editorial initiatives.

Extended Cooperation. It consists of strict co-operation with Industries, research institutes, standardization institutes (e.g., CCSDS, ETSI), and space agencies of several countries (NASA, JAXA, ESA, DLR). A first step is represented by the nomination of a Standardization Liaison coming from industry.

SSC Website and Mailing List. Maintenance and periodic update of mailinglist and website are performed by the committee secretary, in order to guarantee up-to-date material and possibly attract new members interested in SatCom-related topics.

Current Journals/Magazines. The IEEE Network special issue on the integration of Satellite and 5G received 29 submissions,

confirming the hype of satellite communications with good recognition also from IEEE publication point of view. The special issue will be published in September 2018. In parallel, another similar initiative about Space Networks is on the IEEE Wireless Communication magazine, whose deadline will be in June this year.

Conference Activities (ICC/GC and others). In ICC/GC is consolidated the SSC Track. In the recent years the SSC track has been quite successful. The SSC track of past ICC and GC editions showed a promising number of submission ranging between 40-60, with some relevant achievements as in the case of the

forthcoming GCC'18, where approximately 70 submissions were recorded. Concerning other conferences, the SSC TC has endorsed SPECTS, WiSee, and ASMS/SPSC conferences, to be held in the second quarter of 2018.

Standardization Activities. Since the meeting in Atlanta (IEEE GC'13), we have appointed the Standard Liaison, Dr. Henry Suthon, Principal Senior Engineer at Boeing (h.suthon@ieee.org), who has recently confirmed his commitment in this role.

*Dr. Tomaso de Cola, Chair
Satellite and Space Communications TC*

SCANNING THE WORLD

The first half of 2018 has witnessed a lot of exciting news on the satellite and space technologies, such as satellite network extension, optical modem, and deep-space relaying. Some representative news is summarized below.

Last December, SpaceX launched 10 satellites for mobile satellite services operator Iridium, achieving a personal best record of 18 launches in a single year. The first launch started in January 2017, and SpaceX is scheduled to launch a total of 75 satellites into orbit by the middle of 2018. Iridium, a mobile voice and data satellite communications network operator, which covers the entire globe, plans to provide services across oceans, airways, and polar regions. The company's ambition is, using low-Earth orbit satellites on track to fully replace the world's largest commercial satellite network, which may become one of the largest and highest "tech upgrades" in communication science.

In addition, Defense Advanced Research Projects Agency (DARPA), NASA and others, are discussing to extend the life of the critical satellites in space, instead of shipping them to the graveyard if out of the service time. The project allows agencies to build space robots with cameras and arms, to inspect, fix and refuel the space "patients", preventing them from the early retirement. More than that, the space ELFIN could help physically "update" the function of satellites. DARPA is focused on fixing satellites in GEO, which matches the rotation of Earth.

In late January, a technology company, LGS Innovations was selected to support the Laser Communication Relay Demonstration (LCRD) Low-Earth Orbit (LEO) User Modem and Amplifier (ILLUMA) project of NASA. A free space optical modem, which flies aboard

Chaofeng Zhang, Mianxiong Dong, Song Guo

the International Space Station, uses end-to-end optical communications system to encode and transmit data in space. Different from today's communications systems, ILLUMA is 10 to 100 times faster than today's communications equipment and requires significantly less mass and power than normal RF communications systems. The NASA LCRD satellite relays data from ISS to ground and back through innovations optical modem, which is on the track of geosynchronous equatorial orbit as well.

In late February, a modified sounding rocket was launched and soared into orbit, by Uchinoura Space Center in Japan. This rocket is originally designed for loft science instruments on high-altitude suborbital arcs, which is also the world's smallest satellite launcher. According to the Japan Aerospace Exploration Agency (JAEA), the mini-satellite took seven and a half minutes to get into orbit, and this solid-fueled booster has also become the smallest rocket to deliver an object to space.

In late May, two microsatellites are scheduled to be launched along with the relay satellite into moon orbit, according to the China National Space Administration (CNSA). "Queqiao", the name of the relay satellite, will be used in the country's Chang'e 4 mission to the moon's far side. It is able to communicate with both the Earth and the far side of the moon on an orbit at the Earth-Moon Lagrange Point L2, where is about 450,000 kilometers from the Earth and maintains a gravitational equilibrium. That mission is designed to bring lunar samples back to Earth. The relay satellite needs to help guide the landing, sampling, and return of the moon lander.

*Prof. Song Guo, Vice Chair
Satellite and Space Communications TC*

FORTHCOMING GLOBECOM AND ICC CONFERENCES

MILCOM 2018

October 29-31 2018, Los Angeles, USA

<http://www.milcom.org>

MILCOM 2018 celebrates the 37th anniversary of the premier international conference for military communications. At MILCOM, global military communications professionals face command, control, communications, computing, intelligence, surveillance and reconnaissance (C4ISR) challenges head on. They look at them from every angle and discuss them from end to end – research and development through future needs. The conference allows industry the opportunity to hear and understand the requirements, pace of change and state of play in a variety of C4ISR markets serving the military, federal agencies and multinational entities. Join military and industry communications professionals in this evolving conversation October 29-31 at the LAX Marriott in Los Angeles, CA. MILCOM features outstanding technical presentations, discussions and tutorials, as well as a nearly 30,000 square foot exhibit hall. Experts in C4I and cyber issues as well as science and technology developments will lead more than 200 unclassified and restricted sessions.

GLOBECOM 2018

December 9-13, 2018, Abu Dhabi, UAE

<http://globecon2018.ieee-globecom.org/>

IEEE GLOBECOM is one of two flagship conferences of the IEEE Communications Society (ComSoc), together with IEEE ICC. Each year the conference attracts about 3000 submitted scientific papers and dozens of proposals for industry events. A technical program committee of more than 1,500 experts provides more than 10,000 reviews, and from this a small fraction of the submitted papers are accepted for publication and presentation at the conference. The conference attracts

COSPONSORING / RELATED CONFERENCES AND WORKSHOPS

roughly 2000 leading scientists, researchers and industry practitioners from all around the world. IEEE GLOBECOM is therefore one of the most significant scientific events of the networking and communications community, a must-attend event for scientists, researchers and networking practitioners from industry and academia. IEEE GLOBECOM is a five-day event. Two days are dedicated to tutorials and workshops, while the remaining three days are dedicated to the IF&E program and the technical symposia. The program of the technical symposia includes oral or poster presentations of about 1000 scientific papers, grouped into 13 thematic symposia, and more than 15 parallel sessions. Themed "Gateway to a Connected World," GLOBECOM 2018 will offer five full days of original paper presentations, tutorials, workshops, keynotes, demonstrations, industry sessions and social events designed to further career opportunities and the in-depth understanding of the latest communications advancements worldwide.

ICC 2019

May 20-24, 2019, Shanghai, China

<http://icc2019.ieee-icc.org/>

The International Conference on Communications (ICC) is one of the two flagship conferences of the IEEE Communications Society, together with IEEE GLOBECOM. Each year the ICC conference attracts about 2-3000 submitted scientific papers, a technical program committee involving about 1500 experts provides more than 10000 reviews, the conference being finally attended by 1500 - 2000 professionals from all around the world. IEEE ICC is therefore one of the most significant scientific events of the networking and communications community, a must-attend forum for both industrials and academics working in this area. The vibrant city of Shanghai, China is proud to

host the 53rd IEEE International Conference on Communications (ICC 2019). Themed “Empowering Intelligent Communications,” this flagship conference of the IEEE Communications Society will offer five full days of original paper presentations, tutorials, work-

shops, keynotes, demonstrations, industry panels and social events designed to further career opportunities and the in-depth understanding of the latest communications advancements worldwide.

CONFERENCES CALENDAR

CONFERENCE	DATE & LOCATION	INFORMATION
SPECTS 2018 International Symposium on Performance Evaluation of Computer and Telecommunication Systems	July 9-12, 2018 Bordeaux, France	http://atc.udg.edu/SPECTS2018/
ITC 2018 30 th International Teletraffic Congress	September 4-7, 2018 Vienna, Austria	http://itc30.org/
ICTS 2018 International Conference on Computer, Information and Telecommunication Systems	July 11-13, 2018 Colmar, France	http://atc.udg.edu/CITS2018/
ICL-GNSS 2018 International Conference on Localization and GNSS	June 26-28, 2018 Guimarães, Portugal	http://www.icl-gnss.org/2018/
PIMRC 2018 IEEE International Symposium on Personal, Indoor and Mobile Radio Communications	Sep. 9-12, 2018 Bologna, Italy	http://pimrc2018.ieee-pimrc.org/
Ka-Band/ICSSC 2018 The 24th Ka and Broadband Communications Conference and the 36th International Communications Satellite Systems Conference (ICSSC)	October 15-18, 2018 Niagara Falls, Canada	http://www.kaconf.org/
VTC-Spring 2018 2018 IEEE 87 th Vehicular Technology Conference (VTC-Spring)	June 3-6, 2018 Porto, Portugal	http://www.ieeevtc.org/vtc2018spring/
ASMS/SPSC 2018 9th Advanced Satellite Multimedia Systems Conference (ASMS) and 15th Signal Processing for Space Communications Workshop (SPSC)	Sep. 10-12, 2018 Berlin, Germany	https://www.asmsconference.org/front/index.php

To all SSC members: If your postal address, telephone or fax numbers have changed, please update them with the committee secretary. You can review our current records on our web page at <http://committees.comsoc.org/ssc/>.

Integration of 5G and Satcom: the SaT5G System

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Abstract —The current development of 5G networks represent huge potential for satcoms to address new business opportunities. Satcom can become a key technology cooperating with cellular and wireless technologies, with clear benefits for extending service ubiquity, service continuity and service scalability. To enable integration of satcom in 5G, the H2020 SaT5G R&D project, as presented in this article, develops technical enablers, considers the business aspects and contributes to the 3GPP standardization.

INTRODUCTION

The development of the next generation of wireless communications system, known as 5G, is expected to boost our mobile Internet services and day to day experiences. The ambition of 5G actually goes much further than data rate increase at the radio link. With the increasing diversity of potential Use Cases and applications (i.e. applications in industrial sectors, vertical markets, services for Vehicles, emergency and Public Safety...), the 5G system continues the development for mobile network services, in terms of applications, architecture solutions, and deployment options. Coexistence, interworking, or integration of non-native 3GPP systems is also a strong axis of targeted development, increase of user Quality of Experience (QoE), cost reductions, increase of system availability, and increase of coverage. This has been formalized by the definition of high-level 5G KPIs [1]. For several if not all of the above objectives, satellites can play a significant role thanks to their unique capacities: cost-effective broadcasting/multicasting; remote/isolated site access with minimal infrastructure deployment; mobility services.

THE SAT5G PROJECT

A. Context

The European Commission, through its 5G PPP work program within H2020, has launched and coordinated a number of 5G projects to support the development of 5G in Europe. A three phased approach has been set up. Phase 2, started in mid-2017, is aligned with the preparation of 3GPP Release16, has approved 23 proposals [2]. SaT5G (“Satellite and Terrestrial network for 5G”) is the unique Phase 2 running project explicitly addressing satcom and its integration with 5G system [3].

SaT5G benefits from several previous European initiatives in last years. The role of satellites in 5G has been extensively studied; including in the EU technology platform NetWorld2020 SatCom WG [4], as well as recently in two ESA projects, SPECSCI [5] and MEN-DHOSA [6]. Satcom has also been recognized [7] by

the 3GPP cellular community as providing service continuity, service ubiquity and service scalability. Further, other EU studies or ETSI position paper such as H2020 VITAL [8], FP7 BATS [9], ETSI TR 103 272 [10] paved the way of the development of 5G enabler technologies in satcom, including terrestrial convergence, SDN (Software Defined Networking), NFV (Network Function Virtualization), Content Delivery and Multi-Link data routing.

B. The SaT5G Consortium

SaT5G gathers the expertise of sixteen partners of recognized complementary skills (including academic institutions, research centers, and industrial telecom companies from terrestrial and satcom sectors), ensuring technical excellence of the project, with propositions and/or prototyping of technologies that will support tangible business cases and opportunities for 5G and satcoms.

AVANTI, with a main role of Project Coordinator for SaT5G, provides its accurate knowledge of the whole satcom domain and deployment experience of mobile cellular backhauling with satcom, as a main satellite and service operator;

THALES ALENIA SPACE, as a leader satellite communication vendor, acts a project Technical Coordinator. Largely involved in the promotion of the project outcome to the 5G standards, it also studies integrations/convergence options at the lower 5G layers;

UNIVERSITY OF SURREY brings a significant experience in 5G and satellite systems and via the 5G Innovation Centre. Its main role in the project is to prototype an integrated 5G testbed to be used in the demonstration and trials;

SES, as a unique satellite and service operator positioned to offer combined GEO-MEO service capabilities for the future 5G infrastructure globally, is working on the Positioning of Satellite Scenarios for eMBB (Enhanced Mobile Broadband); it also leads all dissemination activities;

AIRBUS DEFENSE AND SPACE, as a leader satellite communication vendor, is active in 5G EC initiatives and 5G Infrastructure association. In SAT5G, ADS mainly leads the Integrated Network Architecture design activity;

ONE ACCESS, as a network equipment vendor for satcom, mobile, and fixed access networks, is involved in the definition and prototyping of multi-link and hetero-

geneous Transport solutions for hybrid terrestrial/satcom 5G deployments.

NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK (TNO) brings its specific expertise and research capabilities on networking architectures, technologies and protocols for a future 5G satellite system. TNO also leads Security Extension activities;

BRITISH TELECOMMUNICATIONS (BT) as a main established telecom operator and experience with satellite 4G backhauling deployments in Europe, BT leads the definition of scenarios while driving the 5G requirements for satcom and supports the business review;

ZODIAC INFILIGHT INNOVATION (ZII) is a world leader for product and services in aeronautical in-flight entertainments and connectivity, with strong interests for service delivery in 5G aeronautical environments. ZII leads the activities of the aeronautical testbed;

IDIRECT as a leading supplier of satcom ground segment, drives the implementation of SDN/NFV satcom products, to be integrated and demonstrated in the satcom/terrestrial 5G network;

BROADPEAK as a product supplier of CDN and Video delivery services, brings its expertise to extend the SAT5G system with efficient multicast and CDN solutions in a 5G context;

GILAT SATELLITE NETWORKS, as a leading supplier of satcom ground segment, participates in SaT5G in the development of virtualized satcom components, including the satellite hub, to be integrated within a 5G architecture. Gilat also leads activities related to roadmap for satcom in 5G integration;

INTERUNIVERSITAIR MICROELECTRONICA CENTRUM (IMEC), as a research institute, leads the business modeling work item, and contributes to the definition of SAT5G scenarios;

FUNDACION PRIVADA I2CAT, (INTERNET I INNOVACIO DIGITAL A CATALUNYA), as a research center with strong expertise on management and orchestration framework and SDN/NFV technologies in virtualized 5G networks, develop the SAT5G MANO system, aligned with 5G industry orchestration software.

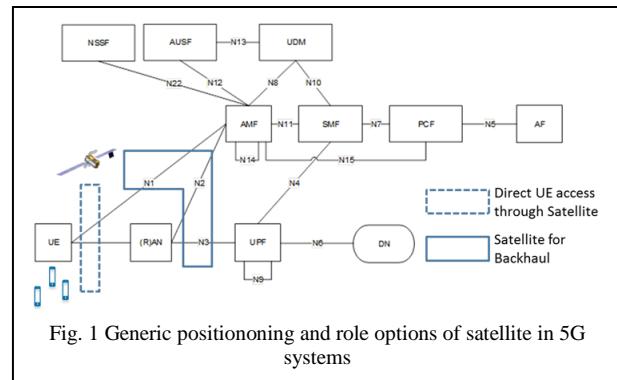
UNIVERSITY OF OULU has been in the forefront of cellular system development since 1990. In the project, they investigate integrations/convergence options at the lower 5G layers and targets to prototype and demonstrate this approach on a 5G testbed.

QUORTUS as a mobile software core network vendors, provides the 5G Core Network for the integrated SaT5G testbed.

C. Technical approach

The SaT5G project's ambitions is to make satcom technologies ready for integration in 5G. For this, it follows a work logic addressing different use cases: (i) Edge Delivery and offload for Multimedia content, (ii) 5G fixed backhaul, (iii) 5G to premises, and (iv) 5G moving platform backhaul. Further details can be found in [11].

To address these use cases, several architecture options, referring to the different strategies of network and system integrations, have been discussed in [12]. Technical, operational, and business requirements, all collected from representative stakeholders (satcom operators, satcom providers, terrestrial mobile network operators, network providers, and academic researchers) have been considered. Two parallel approaches are targeted: Direct UE Access through satellite, where the 5G New Radio (NR) is implemented over the satellite segment, and Satellite Backhaul services through indirect Access (with several flavors), where 5G backhauling and relay functions are implemented within the local UE Radio Access Network (possibly in the satellite terminal). In both cases, the satellite terminal hosts some 3GPP UE management functions requiring the VSAT terminal to be interfaced with the 5G Core Network (through the Non Access Stratum (NAS) protocols). These approaches set the satellite in distinct possible roles in the 3GPP system architecture, as shown in Fig 1.



The second main development is Management and Orchestration (MANO) in a virtualized network context, to achieve a successful integration with terrestrial networks. Much effort is currently made towards the support of SDN and NFV to achieve full automation of network service deployments, high flexibility in the management of the network functions and related IT infrastructure and the so called slicing (as one of the key function appearing in 5G). This is expected to be fully functional in operators' networks by 2020, for the beginning of the commercial deployment of 5G. Further, the definition of frameworks such as ETSI MANO [13] is expected to provide guidance to ensure minimal compatibility between implementations of different network vendors.

STANDARDIZATION ACTION PLAN

Over the last decade, terrestrial mobile networks have benefited tremendously from international standardization efforts, notably in 3GPP, that has demonstrated its capability to incorporate various protocols/features from other leading standardization bodies such as IETF and ETSI. This has led to significant economies of scale and hence cost reductions. In contrast, current Satcom systems and technologies show a lesser degree of standardization, particularly at the system level. 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 could be of great benefit to Satcom market opportunities, provided effective and timely standardization efforts are undertaken. Hence, by inserting satellite-specific “hooks” as may be required, Satcom systems can leverage the 5G standard standards to reduce the deployment and operation costs of satellite terminals as well as other satellite network infrastructure equipment (gateway), and, very importantly, to facilitate a tighter operational integration into a heterogeneous “network of networks” under common network management. Therefore the project plans to submit concrete and reasonable propositions to relevant groups, including ETSI TC-SES SCN; 3GPP SA1/SA2; and 3GPP RAN1/RAN2/RAN3).

INVESTIGATED TOPICS

Taking these trends into account, we identify in the SaT5G project three main required topics for satcom to demonstrate they can successfully achieve convergence and integration in 5G:

1) *Management and Orchestration solutions* of the satcom system will present the same standardized interfaces to third parties (Service Providers, MNOs, ISPs) with the same level of features, so that the particularities of the satellite RAN system can be concealed when executing the complete chain of the service provisioning. This overall requirement is seen as essential to prove satcom networks are mature enough for use with of terrestrial state-of-the-art network technologies, and can achieve equivalent functions with low integration efforts demanded by Cloud and Terrestrial network providers.

2) *Virtualization of specific satellite functions* to be deployed in the ground segment of the satcom domain need to be upgraded to expose the necessary NFV virtualization interfaces to be managed (or, more dynamically, controlled) by an internal or external Cloud network orchestrator. This applies to most internal satcom functions (modems, radio resource managers, encapsulators) at Gateway and terminal ends, and also for the network infrastructure. Support of SDN-type interface could further be targeted, in a later stage, in order to broaden the possible set of service configuration to achieve flexible capabilities required within flexible payload systems. SaT5G shall therefore investigate the definition of new VNF data models (YANG, TOSCA...) extending the existing models.

3) *Full compatibility with existing 3GPP system architecture and procedures* is being tackled to support all the various integration options. QoS, security, and mobility solutions shall be designed in that perspective, as well as efficient content delivery architecture and algorithms supporting aggregation of satellite and a terrestrial links; multicasting; and Content caching to the Edge.

In addition to these technical requirements, live demonstrations will showcase, in June 2018, a first integration of a pre-5G system including a pre-5G Core Network and a satcom ground segment, both interfaced with the MANO system. A more refined integration including virtualized satcom functions and additional features will be demonstrated in Q4 2019 at the end of the project. Both demos will include operations over real satcom links. The achievement is finally assessed as critical towards the 5G terrestrial community.

ACKNOWLEDGMENTS

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