Satellite and Terrestrial Network for 5G

D6.5
Dissemination Activity Report

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<tr>
<td>Project Number</td>
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<tr>
<td>Project Acronym</td>
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<tr>
<td>Contractual Delivery Date</td>
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</tr>
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<td>Actual Delivery Date</td>
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<td>Dissemination Level</td>
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<tr>
<td>Contributors</td>
<td>AVA, UoS, SES, BT, ZII, BPK, GLT, IMEC, i2CAT, QUO</td>
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## Document History

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## Contributors

<table>
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<tr>
<th>Name</th>
<th>Organisation</th>
<th>Contributions include</th>
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<tbody>
<tr>
<td>Harri Saarnisaari</td>
<td>UOULU</td>
<td>Document Editor, Contributor</td>
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<tr>
<td>Konstantinos Liolis</td>
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<td>I2CAT</td>
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<tr>
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<td>IMEC</td>
<td>Contributor</td>
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<tr>
<td>Thierry Masson</td>
<td>Ekinops</td>
<td>Contributor</td>
</tr>
<tr>
<td>Leonardo Goratti</td>
<td>ZII</td>
<td>Contributor</td>
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<tr>
<th>Acronym</th>
<th>Description</th>
</tr>
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<tr>
<td>DoW</td>
<td>Description of Work</td>
</tr>
<tr>
<td>eMBB</td>
<td>Enhanced Mobile Broad Band</td>
</tr>
<tr>
<td>ESA</td>
<td>European Space Agency</td>
</tr>
<tr>
<td>EuCNC</td>
<td>European Conference on Networks and Communications</td>
</tr>
<tr>
<td>IEEC</td>
<td>The Institute of Electrical and Electronics Engineers</td>
</tr>
<tr>
<td>ICTON</td>
<td>International Conference on Transparent Optical Networks</td>
</tr>
<tr>
<td>KPI</td>
<td>Key Performance Indicator</td>
</tr>
<tr>
<td>MEC</td>
<td>Multi-access Edge Computing</td>
</tr>
<tr>
<td>MEO</td>
<td>Medium Earth Orbit</td>
</tr>
<tr>
<td>MPQUIC</td>
<td>Multipath QUIC</td>
</tr>
<tr>
<td>MPTCP</td>
<td>Multipath TPC</td>
</tr>
<tr>
<td>MWC</td>
<td>Mobile World Congress</td>
</tr>
<tr>
<td>NFV</td>
<td>Network Function Virtualization</td>
</tr>
<tr>
<td>NR</td>
<td>New Radio</td>
</tr>
<tr>
<td>PSBOL</td>
<td>Path Selection Based on Object Length</td>
</tr>
<tr>
<td>QoE</td>
<td>Quality of Experience</td>
</tr>
<tr>
<td>QUIC</td>
<td>Quick UDP Internet Connection</td>
</tr>
<tr>
<td>SDN</td>
<td>Software Defined Networks</td>
</tr>
<tr>
<td>TCP/UDP</td>
<td>Transmission Control Protocol / User Datagram Protocol</td>
</tr>
<tr>
<td>UK</td>
<td>United Kingdom</td>
</tr>
<tr>
<td>UPF</td>
<td>User Plane Function</td>
</tr>
<tr>
<td>VSAT</td>
<td>Very-Small-Aperture Terminal</td>
</tr>
<tr>
<td>5G</td>
<td>5th Generation Mobile Networks</td>
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<tr>
<td>5G-PPP</td>
<td>The 5G Infrastructure Public Private Partnership</td>
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**H2020 or ESA projects mentioned in the document**

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<tr>
<th>Project</th>
<th>Description</th>
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<td>Edge Network Computing Capabilities For Satellite Remote Terminals</td>
</tr>
<tr>
<td>FLAME</td>
<td>Internet of radio Light</td>
</tr>
<tr>
<td>IoRL</td>
<td>Demonstrator for Satellite-Terrestrial Integration in the 5G Context</td>
</tr>
<tr>
<td>SaT5G</td>
<td>Satellite and Terrestrial Network for 5G</td>
</tr>
<tr>
<td>5G-EVE</td>
<td>5G European Validation platform for Extensive trials</td>
</tr>
<tr>
<td>5Genesis</td>
<td>5th Generation End-to-end Network, Experimentation, System Integration, and Showcasing</td>
</tr>
<tr>
<td>5G CARMEN</td>
<td>5G for Connected and Automated Road Mobility in the European Union</td>
</tr>
<tr>
<td>5G-CORAL</td>
<td>A 5G Convergent Virtualised Radio Access Network Living at the Edge</td>
</tr>
<tr>
<td>5G-Media</td>
<td>Millimeter-Wave Edge Cloud</td>
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<tr>
<td>5G-TRANSFORMER</td>
<td>5G Mobile Transport Platform for Verticals</td>
</tr>
<tr>
<td>5G-VINNI</td>
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<td>5G-Xcast</td>
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Executive Summary

This document describes the dissemination and communications activities of the SaT5G project. The objective was to disseminate SaT5G project outcomes to relevant technical and non-technical bodies and fora, to ensure that the research and innovation results are communicated to the wider 5G community. The means of dissemination activities included SaT5G project's web page, social media and press releases. Quantitative measures were set for journal and conference publications as well as for white papers. Demonstrations played a big role in dissemination activities as well as cooperation with other 5G-PPP and related projects.

The project’s web page contains basic information of the project team, goals and research plans. It also contains links to public deliverables and a list of all deliverables. Furthermore, scientific publications and various presentations are listed as well as standardization activities and organized workshops and special sessions. The newsroom page shows the important project related news. Contact information and privacy policy are also provided in the web page.

Scientific journal and conference papers were published more than targeted and still some are under review and (potentially) published after the project’s end. The publication fora were relevant to the project’s research topics. One white paper introduced the developed integration architecture and another the results of project’s research pillars.

The project demonstrations showed selected features of research goals. Demonstrations were held at EuCNC2018 showing the first-of-its-kind over-the-air integration test and EuCNC2019 showing the enhanced one. In addition, the latter event demonstrated three more project results. In addition, a video demo was shown in MWC2019 at the 5G-PPP booth. Finally, an Industry Day was organized at the final part of the project to inform various invited stakeholders from several countries about the projects goals and achievements, and to show seven demonstrations.

Co-operation within 5G-PPP was in the form of contributions to various white papers, as well as via attending the regular meetings and contributing to the various discussions aiming to promote the satellite integration into 5G. Co-operation with other related projects was in terms of jointly organized workshops and special sessions as well as joint demonstrations. In total, three workshops and two special sessions were organized in EuCNC2018, EuCNC2019 and ICTON2019. The topics covered integration in technological sense, from verticals and business perspective as well as from validation and demonstration viewpoint.

Overall, the project partners are very satisfied with the dissemination activities and the impact created. The target KPIs set out in the SaT5G contractual baseline have been well achieved and even exceeded. The project was well visible in important events and the SaT5G Industry Day was a great success. Furthermore, demonstrations and publications showed very good progress that SaT5G provided to the integration of satellite and terrestrial networks into 5G ecosystem.
1 Introduction

The objective was to disseminate SaT5G project outcomes to relevant technical and non-technical bodies and fora, to ensure that the research and innovation results are communicated to the wider 5G community. The means of dissemination activities included SaT5G project’s web page that contains all the relevant information and dissemination material. Also social media and press releases were included into the toolkit. Quantitative measures were set for journal and conference publications as well as for white papers. Demonstrations played a big role in dissemination activities as well cooperation with other 5GPPP and related projects.

The following table summarizes the target KPIs set in the project contractual baseline (Description of Work – DoW). It also summarizes the achievements on these targets. The table forms a very illustrative picture about the dissemination activities in the project with respect the goals. It is easy to see that the goals were achieved and, in many times, exceeded. The next sections will provide the details of these dissemination activities.

Table 1: Summary of project’s dissemination target KPIs and achievements.

<table>
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<tr>
<th>Type of Dissemination Activity</th>
<th>Target KPI #</th>
<th>Achievements</th>
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<tr>
<td>Book Chapters</td>
<td>N/A</td>
<td>1 published (IET Book)</td>
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<tr>
<td>Workshops</td>
<td>N/A</td>
<td>3 successfully held (EuCNC 2018 together with other 5G PPP projects, EuCNC 2019 Business Modeling WS together with Global5G, ICTON 2019 Satellite 5G WS)</td>
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<tr>
<td>Special Sessions</td>
<td>N/A</td>
<td>2 successfully held (EuCNC 2018 together with ESA and ESA ARTES project, EuCNC 2019 together with ESA, 5G-PPP Phase 3 and ESA ARTES projects)</td>
</tr>
<tr>
<td>Type of Dissemination Activity</td>
<td>Target KPI #</td>
<td>Achievements</td>
</tr>
<tr>
<td>-------------------------------</td>
<td>-------------</td>
<td>-------------</td>
</tr>
<tr>
<td>Demos</td>
<td>2</td>
<td>15 successfully held (EuCNC 2018 OTA demo, MWC 2019 video demo, x2 EuCNC 2019 OTA demos, x1 EuCNC 2019 HW demo, x3 EuCNC 2019 video demos, x4 SaT5G Industry Day OTA demos, x2 SaT5G Industry Day HW demo, x1 SaT5G Industry Day video demo)</td>
</tr>
<tr>
<td>Press Releases</td>
<td>N/A</td>
<td>5 published (Project KO, MWC 2018, EuCNC 2018, EuCNC 2019, SaT5G Industry Day)</td>
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<tr>
<td>Project Flyers</td>
<td>N/A</td>
<td>5 published (MWC 2018, EuCNC 2018, MWC 2019, EuCNC 2019, SaT5G Industry Day)</td>
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<tr>
<td>White Papers</td>
<td>4</td>
<td>4 published (SaT5G WP3 Architecture White Paper, 5GPPP Architecture WG White Paper, 5GPPP Software Network WG White Paper, 5GInfraPPP Trials WG Roadmap) + 1 planned (WP4 Research Pillars)</td>
</tr>
<tr>
<td>Newsletters</td>
<td>2</td>
<td>2 published (IEEE ComSoc SSC Newsletter article, IEEE CTN Newsletter online article)</td>
</tr>
<tr>
<td>Collaboration with 5GPPP WGs</td>
<td>N/A</td>
<td>7 WGs (Pre-Stand, Architecture, Software Networks, Networks Management &amp; QoS, Vision &amp; Societal Challenges, Security, Trials WGs)</td>
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<tr>
<td>Website</td>
<td>N/A</td>
<td>SaT5G Project Website + SaT5G Entry in 5GPPP Website</td>
</tr>
<tr>
<td>Other</td>
<td>N/A</td>
<td>5GPPP Phase 2 Projects Brochure, EU 5GPPP Annual Journal 2018, EU 5GPPP Annual Journal 2019, etc</td>
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<tr>
<td>Industry Days</td>
<td>N/A</td>
<td>1 successfully held (NOV-2019 @ UoS) + 1 planned (JAN-2020 @ ZII)</td>
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<tr>
<td>Training Events</td>
<td>N/A</td>
<td>5 lectures given (x1 by SES to University Luxembourg PhD students, x1 by SES to University Luxembourg ISM - Interdisciplinary Space Master students, x3 by AVA to University of Surrey students) + 2 lectures planned (x1 by ZII to Technical University of Munich PhD students in OCT-2020, x1 by ZII to Technical University of Munich MSc students in FEB-2020)</td>
</tr>
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</table>
2 Scientific Papers

This section provides a list of journal and conference articles as well as book chapters and posters. Also submitted papers are listed. The links, if available, point to the publishers’ pages and an access permission may be required to open or download full versions.

A few listed conference papers were non peer reviewed papers in special sessions and/or available only in the conference proceedings available to conference participants and, therefore, links are not available.

2.1 Journal Papers

Published/accepted:


Submitted:


2.1.1 Special Issue Editorships

Two SaT5G members are Guest Editors of the Special Issue "Satellite Networks Integration with 5G" in International Journal of Satellite Communications and Networking.

Guest Editors: Antonio Franchi (ESA), Konstantinos Liolis (SES), Barry Evans (University of Surrey)

- Extended Abstracts submission deadline: end November 2019
• Full paper submissions deadline: 15 March 2020
• Special Issue Publication scheduled for mid 2020


2.2 Book Chapters


2.3 Conference Papers

Published/accepted:

2018


2. A. Chiha, M. Van der Wee, S. Verbrugge, D. Colle, “Techno-economic analysis of the viability of integrating satellite communication in 4G networks to bridge the broadband digital divide”, 29th ITS European Conference, 2018


2019


12. P. Sayyad Khodashenas; H. Khalili; D. Guija; M. Shuaib Siddiqui, "TALENT: Towards Integration of Satellite and Terrestrial Networks", European Conference on Networks and Communications (EuCNC), 2019.

13. S. Watts, "Value Chain Analysis for Integrated Satellite-Terrestrial 5G Networks", European Conference on Networks and Communications (EuCNC), 2019, special session on "Validating and Demonstrating the Satellite Integration into 5G"

14. J. Cahill, R. Lord, “Satellite Ground Segment Integration into 5G: Softwarization, Virtualization and Orchestration of Satellite Ground Segment for Integration into 5G”, European Conference on Networks and Communications (EuCNC), 2019, special session on "Validating and Demonstrating the Satellite Integration into 5G"

15. K. Liolis, "Milestone Over-the-Air Demonstrations Showcasing Satellite’s Strategic Role in 5G", European Conference on Networks and Communications (EuCNC), 2019, special session on "Validating and Demonstrating the Satellite Integration into 5G"


17. H. Saarnisaari, C.M. de Lima, "5G NR over satellite links: Evaluation of synchronization and random access processes", 1st Workshop on Integration of Optical and Satellite Communication Systems into 5G Edge Networks in 21th International Conference of Transparent Optical Network (ICTON) (Invited paper)


Submitted:


2.4 Posters
The following table lists the posters provided by the project on various events.

<table>
<thead>
<tr>
<th>EVENT</th>
<th>POSTER</th>
</tr>
</thead>
<tbody>
<tr>
<td>MWC 2018</td>
<td>x1 Poster at Broadpeak's booth presenting the project (objectives, concept, testbeds and prototyping) as well as Broadpeak's contribution to SaT5G</td>
</tr>
<tr>
<td>NAB Show 2018</td>
<td>x1 Poster at Broadpeak's booth presenting the project (objectives, concept, testbeds and prototyping) as well as Broadpeak's contribution to SaT5G</td>
</tr>
<tr>
<td>EuCNC2018</td>
<td>x1 Poster at SaT5G booth showing the objectives of the provided demonstrations and as well as the project.</td>
</tr>
<tr>
<td>IBC 2018</td>
<td>x1 Poster at Broadpeak's booth presenting the project (objectives, concept, testbeds and prototyping) as well as Broadpeak's</td>
</tr>
<tr>
<td>Event</td>
<td>Description</td>
</tr>
<tr>
<td>---------------</td>
<td>--------------------------------------------------</td>
</tr>
<tr>
<td>contribution to SaT5G</td>
<td>x4 Posters at SaT5G booth showing the objectives of the provided demonstrations and as well as the project.</td>
</tr>
<tr>
<td>Industry day</td>
<td>Various Posters explaining the demos and results of the project.</td>
</tr>
</tbody>
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3 Public Presentations

The following tables provide annual list of presentations that SaT5G members have given in various events varying from scientific conferences to special satellite workshops, and from public events and technological fora.

Table 3: Presentations 2017.

<table>
<thead>
<tr>
<th>Project Presentations</th>
<th>Event</th>
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<tbody>
<tr>
<td>SatT5G Project Overview</td>
<td>EuCNC 2017</td>
</tr>
<tr>
<td>SaT5G Project Overview</td>
<td>GVF Cellular Backhaul Conference</td>
</tr>
<tr>
<td>SaT5G Project Overview</td>
<td>Priorities for UK spectrum policy: competing demands, developing 5G, and the UK's international role</td>
</tr>
<tr>
<td>Satellite 5G trials &amp; testbed roadmap</td>
<td>Satellite Communications for 5G and beyond, WWRF39</td>
</tr>
<tr>
<td>Contribution to Panel Session as part of 15th BroadSky Workshop: One More Asset for the 5th Generation</td>
<td>Ka Band Conference 2017 - 15th BroadSky Workshop</td>
</tr>
<tr>
<td>Contribution to Panel Session &quot;SatCom in 5G and beyond: Opportunities and Challenges&quot;</td>
<td>WiSATS 2017 [9th EAI Internatio</td>
</tr>
<tr>
<td>SaT5G Project Overview Presentation (not delivered due to lack of time; focus on ESA activities)</td>
<td>ESA Technical Workshop &quot;Video delivery over integrated satellite terrestrial networks&quot;</td>
</tr>
<tr>
<td>SES - Satellites and 5G (incl. SaT5G Project Overview)</td>
<td>DLR 5G Workshop</td>
</tr>
<tr>
<td>5G IA Presentation (incl. SaT5G Project Overview)</td>
<td>IRG Heads' Workshop on 5G</td>
</tr>
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Who

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<tr>
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</tr>
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<tbody>
<tr>
<td>AVA</td>
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</tr>
<tr>
<td>AVA</td>
<td>Brussels,1 June 2017</td>
</tr>
<tr>
<td>SES, IDR, GLT</td>
<td>London, 21-22 June 2017</td>
</tr>
<tr>
<td>SES</td>
<td>London, 06 July 2017</td>
</tr>
<tr>
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<td>SaTSG Project Overview</td>
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<td>Research and validation activities for satellite backhaul in 5G</td>
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<td>Satellites and 5G A satellite operator’s perspective</td>
<td>CW Tec “5G Satellites &amp; Magic MIMO”</td>
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<td>5G coverage and satellite communications A satellite operator’s perspective</td>
<td>TNO “5G Satcom seminar”</td>
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<td>Integration of satellite with 5G networks</td>
<td>TNO “5G Satcom seminar”</td>
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<td>Satellite Integration with 5G and Edge Computing</td>
<td>10th FOKUS FUSECO Forum (FFF 2019)</td>
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<tr>
<td>Satellite Communications in the 5G Ecosystem</td>
<td>Lecture to University of Luxembourg PhD Students and SnT Partner Industry Members</td>
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<tr>
<td>Satellite Communications in the 5G Ecosystem</td>
<td>Lecture to Interdisciplinary Space Master (ISM) Students of the University of Luxembourg</td>
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<tr>
<td>Integration of satellite with 5G networks in the SaT5G project</td>
<td>UoS (Michael Fitch) presentation given at TNO 5G Satcom Seminar 2019 <a href="https://www.5gsatcom.nl/">https://www.5gsatcom.nl/</a></td>
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<tr>
<td>5G Coverage and satellite communications</td>
<td>AVA (Simon Watts) presentation given at TNO 5G Satcom Seminar 2019 <a href="https://www.5gsatcom.nl/">https://www.5gsatcom.nl/</a></td>
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<tr>
<td>Internet in Planes</td>
<td>ZII (Elisenda Temprado) presentation given at TNO 5G Satcom Seminar 2019 <a href="https://www.5gsatcom.nl/">https://www.5gsatcom.nl/</a></td>
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<td>Overview of SaT5G project</td>
<td>SaT5G Industry Day 2019</td>
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<td>SaT5G use-cases and techno-economics</td>
<td>SaT5G Industry Day 2019</td>
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<td>Architecture design of satellite integration with 5G terrestrial networks</td>
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<td>Implementation of integration of Satellite with 5G terrestrial networks</td>
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<td>SaT5G in standards</td>
<td>SaT5G Industry Day 2019</td>
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4 General Publicity Material

This section provides information about the project’s website and other related material like flyers, newsletters, white papers and press releases.

4.1 Website

The project website is at https://www.sat5g-project.eu/. It contains basic information such as partners and goals of the project. It shows dissemination activities like a publication list, white paper, videos provided by the project, all deliverables and download links to public ones. It also shows the project related news. The project website is maintained by AVA. Some screenshot below illustrates the contents.

![Figure 1: A screenshot of the front page.](image1)

![Figure 2: A screenshot about project details with the pages that contain dissemination material opened.](image2)
4.2 Press Releases
Totally five press releases were published. These were in the project kick off, MWC 2018, EuCNC 2018, EuCNC 2019 and the Industry Day November 27th 2019 where final demonstrations were shown to various stakeholders in the field. Links to the press releases are:

- Broadpeak® Leads Technology Innovation for Content Delivery Over 5G Networks
- SaT5G Consortium Members Showcase Satellite and 5G Integration Capabilities at EuCNC2018 Conference
- SES Showcases Satellite and 5G Integration as Part of SaT5G Consortium Live Demo
- EuCNC 2019 Special Session “Validating and Demonstrating the Satellite Integration into 5G”
- SaT5G Industry day

The press releases can be found at the project’s web page in the media part.

4.3 Social Media
Dissemination of project results through social media was used especially related to demonstrations, special sessions and workshops. Examples are shown in corresponding place throughout this document. A list or related actions can also be found at the project’s web page in the media part.

4.4 Project Flyers
Project flyers were available at EuCNC2018, EuCNC2019, MWC2018, MWC2019 in SaT5G or its partners booths or sometimes in the 5G-PPP booth.

4.5 White Papers
The project provided two white papers. One was about the architecture aspects of the integration, and another about achievements with respect the project’s research pillars. These are available at the project’s web page.

- SaT5G Architecture white paper, June 2019
- SaT5G white paper on Research Pillars, planned to be published January 2020.

In addition, the project was involved to writing of the following three 5G-PPP white papers:
• 5G Infrastructure Association (5G-IA), “5G Pan-European Trials Roadmap”, version 3.0, a white paper.

4.6 Newsletters
Two newsletters authored by SaT5G were published in IEEE news fora.


In addition, news items were published in various satellite news associated with the project demonstration activities in various events, such as EuCNC2018, EuCNC 2019 and Industry Day. A non-exclusive list of such published news items is provided below:

- [The Integration of Satellite and 5G Showcased by SaT5G Member Companies @ EuCNC2018 Conference](http://www.ispreview.co.uk/index.php/2019/11/sat5g-project-finally-demonstrates-5g-data-over-satellite.html) was shown in satnews daily, June 19, 2018.
- [SaT5G Hit Milestone with Satellite-5G Integration Demonstration](https://www.ispreview.co.uk/index.php/2019/11/sat5g-project-finally-demonstrates-5g-data-over-satellite.html) was shown in ViaSatellite, June 19, 2018.
- [https://www.ispreview.co.uk/index.php/2019/11/sat5g-project-finally-demonstrates-5g-data-over-satellite.html](https://www.ispreview.co.uk/index.php/2019/11/sat5g-project-finally-demonstrates-5g-data-over-satellite.html)
- etc…
5 Organized Workshops and Special Sessions

This section describes the organized workshops and special sessions.

5.1 EuCNC 2018 Special Session: Satellite Solutions for the 5G Network of Networks

This special session was held in European Conference on Networks and Communications (EuCNC), 2018. It was organized together with ESA and ESA’s project SATis5. SaT5G had 3 presentations in the session.

The chairs were Georgia Poziopoulou (Avanti Communications, UK), Adam Kapovits (Eurescom GmbH, Germany) and Maria Guta (European Space Agency, France).

CONTENTS

- “The Connected Globe – Satellite’s Role for the Future”, Indran Sivarajah, Avanti Communications, SaT5G
- “ESA Satellite 5G initiative”, Maria Guta, ESA
- “Integration scenarios of satellite in 5G and standardisation impact” Nicolas Chuberre, Thales Alenia Space; SaT5G
- “Large scale experimental platforms and satellites”, Anastasius Gavras, Eurescom
- “Demonstrating satellite integration in 5G networks – SaT5G’s eMBB use cases”, Yogaratnam Rahulan, University of Surrey SaT5G
- “SATis5 – a satellite-terrestrial testbed showcasing different use cases”, Marius-Iulian Corici, Fraunhofer FOKUS
- “Japanese plans for satellite-terrestrial integration testing activities”, Naoto Kadowaki, NICT

This event was in the SaT5G news published in the project’s web page.
5.2 EuCNC 2018 Workshop on "Vertical Industries & Services for 5G"

This workshop was held in European Conference on Networks and Communications (EuCNC), 2018. It was organized together with H2020 projects 5G-Xcast, 5G-Media, 5GCity, IoRL and FLAME. SaT5G had one presentation and one member in a panel discussion.

The organizers were Woon Hau Chin (Toshiba Research Europe Limited, UK), Erik G. Ström (Chalmers University of Technology, Sweden), Chiara Buratti (University of Bologna, Italy), Laura Baracchi (Trust-IT Services, UK), Stephanie Parker (Trust-IT Services, UK), Mikael Fallgren (Ericsson Research, Sweden), Belkacem Mouhouche (Samsung Electronics Research, UK).

CONTENTS

- Keynote 1 – “Future distribution of public service media content and services”, Darko Ratkaj (EBU, Switzerland)
- Keynote 2 – “Wireless Channel Models for 5G Verticals”, Claude Oestges (Université Catholique de Louvain, Belgium), Erik Ström (Chalmers Univ. of Technology/IRACON, Sweden)
- “A 5G Broadband Radio-Light Architecture for Media and Entertainment in Buildings”, John Cosmas (Brunel University, UK)
- “Transforming Cities into Hyper-Connected World”, Nicola Ciulli (Nextworks, Italy)
- “Boosting the Media Industry with 5G: the 5G-MEDIA project use cases”, Pasquale Andriani (Engineering Ingegneria Informatica Spa, Italy)
- “SaT5G Solution for eMBB Content Delivery in 5G Using Satellite Multicast”, Georgia Poziopoulou (Avanti Communications, UK) SaT5G
- “Insights into media service delivery using real-life 5G infrastructures”, Michael Boniface (IT Innovation, UK)
- Panel 1 – “Future Trends in Media Distribution”, Moderator: Andrea M. Michelozzi (Comunicare Digitale, Italy), Panellists: Darko Ratkaj (EBU, Switzerland), Adam Kapovits (Eurescom, Germany), Dirk Trossen (Interdigital, UK), Kumarendra Sivarajah (Avanti Communications, UK)
- Keynote 3 – “5G Automotive WG: 5G V2X Deployment”, Mikael Fallgren (Ericsson, Sweden)
- Keynote 4 – “Machine Type Multiple Access for Factories of the Future”, Hsuan-Jung Su (NTU, Taiwan), Mingzoo Wu (III, Taiwan) and Shih I Chen (III, Taiwan)
- “5G for Factories of the Future”, Haibin Zhang (TNO, Netherlands)
- “5G-Xcast for Public Warning Systems”, David Gomez-Barquero (UPV, Spain)
- “5G for Smart Energy”, John Davies (British Telecom, UK) & Miha Smolnikar (JSI, Slovenia)
- “5G for V2X”, Mikael Fallgren (Ericsson, Sweden)
- Panel 2 – “Impact of 5G on Verticals”, Moderator: Tommy Svensson (Chalmers Univ. of Technology, Sweden), Panellists: Mikael Fallgren (Ericsson, Sweden), Emery Jou (III, Taiwan), Leonardo Goratti (CREATE-NET, Italy) SaT5G, Antonino Albanese (Italtel, Italy), Philippe Cousin (EGlobalmark, France), Massimo Bertoncini (Engineering, Italy)
5.3 EuCNC 2019 Special Session "Validating and Demonstrating the Satellite Integration into 5G"

This satellite focused special session was held in European Conference on Networks and Communications (EuCNC), 2019. It was co-organised by SaT5G together with ESA, ESA projects SATis5, EdgeSAT and new 5G-PPP Phase 3 projects 5G-VINNI and 5Genesis. SaT5G had 3 presentations.

The session chairs were Maria Guta (European Space Agency, The Netherlands) and Konstantinos Liolis (SES, Luxembourg).

The special session was successful and managed to showcase that satellite integration into 5G is in fact getting closer to reality. The panelists and audience were composed of both satellite and terrestrial mobile stakeholders from industry, academia, research community, institutions, standardization and regulatory bodies. The estimated number of participants was 60, which made the room almost full. After all, nine presentations held in the special session, there was an interactive panel session with several questions raised from the audience and answered by the panelists, which proves the high interest and impact of the special session. There were also several offline positive comments after the special session, which highlights the relevant interest. In addition, the related LinkedIn post has reached on the 2019-07-05 more than 110 likes, 4 re-shares and 5980 views. This clearly showcases the success of the organized special session, the high impact on the relevant stakeholders, as well as the very good progress of satellite integration into 5G.

CONTENTS

- “Introduction” by Special Session Chairs Maria Guta and Konstantinos Liolis
- “Satellite Integration into 5G: Getting Ready”, Maria Guta, European Space Agency (ESA-ESTEC), Netherlands
- “Value Chain Analysis for Integrated Satellite-Terrestrial 5G Networks”, Simon Watts, Avanti Communications, UK SaT5G
- “Satellite Ground Segment Integration into 5G: Softwarization, Virtualization and Orchestration of Satellite Ground Segment for Integration into 5G”, Joe Cahill, VT iDirect, Ireland SaT5G
• “Milestone Over-the-Air Demonstrations Showcasing Satellite’s Strategic Role in 5G”, Konstantinos Liolis, SES, Luxembourg SaT5G
• “5G Experimentation Facility Supporting Satellite-Terrestrial Integration: The 5GENESIS Approach”, Harilaos Koumaras, NCSR Demokritos, Greece
• “MNO’s View and Use Cases on Satellite Integration into 5G”, Pål Gronsund, Telenor, Norway
• “Updates on Japanese Plans for Satellite-Terrestrial 5G Integration R&D Activities”, Naoto Kadowaki, National Institute of Information and Communications Technology (NICT), Japan
• “5G and Beyond: Research Challenges for Satellite Integration”, Marius Corici, Fraunhofer FOKUS, Germany
• “Satellites and 5G: What’s the Future?”, Hejia Luo, Huawei Technologies Co., Ltd., P.R. China
• “Panel Session – Q&A” All
Chairing the Special Session “Validating and Demonstrating the #Satellite Integration into #5G” at #EUCNC2019 in Valencia, Spain. Many thanks to all panelists and participants for interesting presentations and fruitful discussions as well as to the supporting #5GPPP and #ESA projects #SaT5G #5GVINNI #5Genesis #SAttss #EdgeSAT
Gouta Maria Simon Watts Joe Cahill Harilaos Koumaras, PhD Pål Grønsvand Naoto Kadomaki Merius Coridi Hejia Luo

https://lnkd.in/g/YQVS/kM

Figure 6: Promotion of EuCNC 2019 Special Session through LinkedIn.
Figure 7: Photos from EuCNC 2019 Special Session showing the presenters and co-chairs.

See also relevant news item at SaT5G project website.
5.4 EuCNC 2019 Workshop on “Emerging 5G Business Models: Opportunities for SMEs and large companies - lessons from 5G PPP”

The SaT5G participated in Business modelling workshop organized within the context of the EuCNC2019. The organizers were John Favaro (Trust-IT services and Vice-Coordinator of Global5G.org); Jacques Magen (Interinnov and Chair of NetWorld2020 SME) and Stephanie Parker (Trust-IT Services). The participants from SaT5G (Asma Chiha and Marlies Van der Wee from imec) presented the new business model involving a broker who is mediating between different network operators (e.g. MNOs, SNOs) in order to handle negotiations and simplify overall relationships. Supporting projects include: 5G City, 5G-CORAL, 5G-EVE, 5GENESIS, 5G-MIEDGE, 5G-TRANSFORMER, CARMEN, SAT5G. SaT5G has 1 presentation.

The outcomes of the workshop have been published as a positioning paper to Cloudscape Brazil 2019 (link to the paper [here](#)).

CONTENTS

- Welcome Address with Tour de Table by Organisation Type: Nicola Ciulli, Head of Research and Development and Co-Chair of the NetWorld SME Working Group
- Darko Ratkaj, Senior Project Manager, “European Broadcasting Union (EBU): 5G for the media industry”
- Josep Matrat, Atos: “Business Opportunities from open source”
- Nicola Ciulli, Nextworks: “5G new opportunities for verticals and technology providers: an SME viewpoint”
- Aitor Zabala, Telcaria: “Enabling new SME business models by leveraging novel federation and zero-touch technologies, through network softwarization in 5G CORAL”
- Maurizio Cecchi, Innovazione PIIIU: “Prizes for SMEs: Call of Ideas on how to exploit 5GPPP trials facilities in 5G-Eve”
- Riccardo Ferrari, Azcom: “Converged RAN to the Edge and Fog: Azcom path to the future”
- Krzysztof Rocki, MIRANTIS: “5G & OpenSource can create Unlimited Opportunities”
- Panagiotis Demestichas, WINGS ICT: “Creating businesses on top of advanced wireless infrastructures: an opportunity and challenge for SMEs”
- Panel Discussion: “Large meets Small”
- Asma Chiha Ep Harbi, UGENT: “Cutting across Verticals - New business models for non-terrestrial networks”; SaT5G
- Valerio Frascolla, Intel: “Merging MEC and mmWave in 5G & beyond use cases”
- Simon Fletcher, Real Wireless: “Techno-economics for 5G solutions”
- Panel discussion: “Pragmatic Steps Moving forward”
5.5 ICTON 2019 Workshop on “Integration of Optical and Satellite Communication Systems into 5G Edge Networks (OSCto5G)”

i2CAT organised 1st Workshop on Integration of Optical and Satellite Communication Systems into 5G Edge Networks (OSCto5G) in ICTON 2019. SaT5G had 2 presentations.

The chairs were Pouria Sayyad Khodashenas and Hamzeh Khalili.

The session was successfully organized and managed. It received very good amount of attention/feedback and papers. Presenter and audience were composed of both satellite and optical fields from industry, research and academic sectors. There were many discussions in the session around the satellite, terrestrial and optical connectivity and amount of value that satellite can bring to the 5G. Due to success of the 1st workshop, it was planned to continue with the second workshop in ICTON 2020.

CONTENTS

- “Integration of optical and satellite communication technologies to improve the cache filling time in future 5G edge networks” (Invited) A. Dowhuszko, M. Shaat, and A. Pérez-Neira
- “A use case of shared 5G backhaul segment planning in an urban area” (Invited) J. L. Romero-Gázquez, F-J. Moreno-Muro, M. Garrich, M-V. Buenaga, P. S. Khodashenas, and P. Pavón Mariño"
- “Introducing terrestrial satellite resource orchestration layer” (Invited) H. Khalili, P. S. Khodashenas, D. Guija, and S. Siddiqui SaT5G
- “5G NR over satellite links: Evaluation of synchronization and random access processes” (Invited) H. Saarnisaari and C. Morais de Lima SaT5G
- “Optimized beam size of optical ground-to-satellite link over turbulence and beam-wandering”, N. Alshaer, T. Ismail, H. Seleem, and M. E. Nasr
5.6 Lectures at Universities

Konstantinos Liolis (SES) gave a lecture to University Luxembourg PhD students on 11 September 2019 and a lecture to University Luxembourg ISM (Interdisciplinary Space Master) students on 11 November 2019. Both lectures titled “Satellite Communications in the 5G Ecosystem” used material from SaT5G project, among others.

Simon Watts (AVA) gave a lecture “VSATs and broadband” that included information on SaT5G and related work in a satellite communications course, University of Surrey. It was given Dec 2017, Apr 2018 and Apr 2019.

Leonardo Goratti (ZII) will provide a lecture to the PhD school inside the Technical University of Munich in February 2020, and another one in January 2020. The first lecture is part of Broadband communications networks course to the school of Master students. The second lecture is for PhD students. They will include satcom inside 5G technology evolutions.
6 Demonstration Events

The project provided several demonstrations in EuCNC 2018 and 2019 and in the Industry day, where stakeholders were invited to see the project’ results and various demonstrations. This section provides summaries of these demonstration events. Technical details of the demonstrations are given in deliverable D5.6.

6.1 EuCNC 2018 Demo

The EuCNC 2018 demo was a SaT5G success story. This extended promotional and marketing campaign resulted in high publicity. Highlights of the event were:

- Event attended by ~600 participants
- SaT5G demo booth #25 (AVA)
- Project flyers, poster, demo infographics (SES, iDR, ADS)
- Demo pitch corner (SES)
- Promotional video with on-site interviews (Interinnov)
- Press-releases (SES, iDR)
- Social media campaign (SES, iDR, AVA)
- Blog posts (SES, iDR)
- Related news articles in online magazines
- References in follow-up press interviews (SES, iDR)
- Intranet article (SES).

SaT5G had a demo booth titled “SaT5G (Satellite and Terrestrial Network for 5G): Demonstration of Satellite Integration Towards 5G”, which hosted a live over-the-air demo. This demo corresponds to the first-of-its-kind over-the-air live demo towards satellite integration into 5G. It successfully demonstrated the key benefits of satellite integration with an SDN/NFV/MEC-enabled pre-5G construction testbed, with an SES’ GEO in-orbit satellite system as a proof-of-concept for integration of those features into a full 5G network. Its successfully met objectives were:

- Satellite integration into standard 3GPP network architecture
- SDN and NFV integration into satellite communications
- Efficient edge content delivery over satellite
- Multi-access Edge Computing (MEC).
The following SaT5G project partners contributed to the success of this demo:

- SES: Provided end-to-end managed services, powered the space segment with its existing ASTRA 2F geostationary satellite system (28.2°E), and delivered seamless connectivity between the remote and the hub platform located at its teleport in Betzdorf, Luxembourg.
- VT iDirect: Provided the pre-5G enabled satellite hub platform and satellite terminals which incorporate SDN/NFV and MEC capabilities and enabled the satellite integration into a 3GPP core network architecture.
- University of Surrey: Provided the 5GIC testbed and the related virtualized 5G infrastructure.
- Broadpeak: Provided multicast headend for efficient content delivery and a MEC enabled platform for CDN caching.
- i2CAT: Provided input into the orchestration of the MANO system on the SES teleport site.
Figure 11: The SaT5G demo booth at EuCNC 2018.

Figure 12: The EuCNC 2018 booth team.

The event was also visible in social media through the SaT5G partners as shown in the examples in the following few figures.
The reality of 5G draws nearer with the successful SaT5G Consortium live demo showcased at EuCNC2018 today! Together with our partners, we seamlessly integrated satellite within 5G networks, and achieved yet another milestone. ...see more

Figure 13: Promotion of EuCNC 2018 Demo through LinkedIn (SES).
Figure 14: Promotion of EuCNC 2018 Demo through LinkedIn (iDR).

Figure 15: Promotion of EuCNC 2018 Demo through Twitter (Interinnov).
The event was announced also in news items (one and two) and press releases that can be found from the SaT5G project's web page.

6.2 MWC 2019 Demo

The video about demonstrating “5G NR over satellite links” was shown in the 5G-PPP booth. It demonstrated what changes are needed in the uplink random access process such that 5G NR can be used over long propagation distances exceeding the terrestrial cell size. The video can be seen here at the project’s web page.
6.3 EuCNC 2019 Demos

SaT5G had a demo booth presenting our demonstrations and posters. It showed extended over the air demonstration, videos from inflight wireless services based on satellites and extended 5G NR over links demonstrations as well as link selection between a terrestrial and an emulated satellite link to an edge MEC. The live demo over satellite was building upon EuCNC 2018 demo success story and was a joint demo with 5G-XCAST. Brief descriptions of the demonstrations can be found below. A video about the SaT5G booth is available in YouTube and a press release in the project’s web page.

Over-the-air MEC-based layered video streaming over a 5G multilink satellite and terrestrial network
The demonstration showcases a network which integrates 5G over parallel satellite and terrestrial delivery paths to provide enhanced Quality of Experience (QoE) for users consuming 4K video content. The innovative demonstration highlights how a Multi-access Edge Computing (MEC) proxy can incorporate bit-rate adaptation, link selection and enhance layered video streams for future satellite and terrestrial integrated networks. The demonstration is undertaken in partnership with Avanti’s high-throughput HYLAS 4 GEO satellite capacity, University of Surrey’s 5G Innovation Centre testbed network and VT iDirect’s 5G-enabled satellite hub platform and satellite terminals.

Over-the-air multicast over satellite video for caching and live content delivery
The demonstration showcases over-the-air satellite multicast technology for the delivery of live channels using a MEC platform for Content Delivery Network (CDN) integration with efficient edge content delivery. The demonstration highlights the benefits, in terms of bandwidth efficiency and delivery cost, of using a satellite-enabled link for provisioning live content in a 5G system. The demonstration is undertaken in partnership with Avanti’s high-throughput HYLAS 4 GEO satellite capacity, Broadpeak’s CDN, University of Surrey’s 5G Innovation Centre testbed network and VT iDirect’s 5G-enabled satellite hub platform and satellite terminals.

Video demonstration of 5G New Radio (NR) over satellite networks
The video was an extended demonstration about “5G NR over satellite links”. It demonstrated what changes are needed in the uplink random access process such that 5G NR can be used over long propagation distances exceeding the terrestrial cell size. In addition, it was connected to the external 5G test bed (5GTN at UOULU) to show that end to end data can be transmitted through the system.
Demonstration of Hybrid 5G Backhauling to extend services for rural markets and large-gathering events
Ekinops demonstrated the SaT5G hybrid backhaul operations. Comparing different splitting technologies, MPTCP and MPQUIC protocols distributions were compared to highlight the benefits of a path selection algorithm based on the length of the exchanged objects that applies to all the transport connections (TCP/UDP) even encrypted at transport layer. PSBOL is also efficient in situations where the connection behaviour varies from interactive to download. This algorithm avoids the impairments of the satellite delays and delivers for a connection the aggregated bandwidth of all the links, allowing to transport 5G traffic over a hybrid backhaul. The experimentation is detailed in “5G hybrid backhauling for better QoE” presented 25th Ka and Broadband Communications Conference 2019.

Video demonstration for delivery of 5G connectivity services to airline passengers
The demonstration showcases 5G technology aboard aircraft, leveraging virtualized services for content distribution. An integrated approach for the delivery of 5G connectivity services based on a Medium Earth Orbit (MEO) satcom solution will be introduced. The innovation targets the next-generation inflight entertainment services to passengers and connectivity solutions for airplanes with a combined satellite and terrestrial 5G network. The demonstration is undertaken in partnership with Zodiac Inflight Innovations’ virtualised A320 airplane cabin mock-up and connectivity infrastructure, Broadpeak’s content delivery platform, Gilat Satellite Networks’ Taurus VSAT unit and virtualised satellite hub, i2CAT’s terrestrial satellite resource coordinator (TALENT), Quortus’ mobile network core, and SES’s low-latency high-throughput O3b MEO satellite constellation.

Demonstration of local (MEC) content caching in 5G with hybrid backhaul network
Using a satellite emulator testbed, TNO demonstrates local access using an established satellite and terrestrial backhaul link with User Plane Function (UPF) located at a MEC node for content delivery. The UPF in the MEC node is used to handle requests for the local content with the ability to optimally select between satellite or terrestrial links depending on available capacity, network policy, link performance and the type of end-user profile. The innovation lies with the ability to set up connections for downloading content with the DASH Enabled Network Element (DANE) collocated with UPF, which can now handle both satellite and terrestrial links simultaneously.
Figure 18: Photo from SaT5G booth hosting EuCNC 2019 demos.

Figure 19: A demonstration, a video and some posters at the SaT5G booth hosting EuCNC 2019 demos.
Figure 20: Photo from SaT5G booth hosting EuCNC 2019 demos.

6.4 Industry Day Demos

The aim of the Industry Day was to showcase project results and demonstrations to various stakeholders. The Industry Day included a brief overview of the project and its achievements and several SaT5G demonstrations. Furthermore, a panel session was organized at the end where various stakeholders could present their views about the subject. The event was open and people from industry, operators, research and alike stakeholders were invited by the project members from various countries and organizations. Altogether, 38 people registered that shows high interest to satellite and terrestrial integration. In addition to distinguish guests, there were over 20 project members explaining the results and various demonstrations.

The program of the Industry day included presentations, demonstrations and a panel, and was as follows:

Place: University of Surrey, 5GIC building
09:30 – 10:00 Arrival and Registration
10:00 – 10:15 Welcome presentation; Rahim Tafazolli, UoS
10:15 – 10:45 Keynote Session: Satellite & 5G; Mike Short, Department of International Trade
10:45 – 11:15 Overview of SaT5G project; Mike Fitch (SaT5G)
11:15 – 11:30 Coffee
11:30 – 12:45
SaT5G use-cases and techno- economics; Asma Chiha (SaT5G)
Architecture design of satellite integration with 5G terrestrial networks; Boris Tiomela Jou (SaT5G)
Implementation of integration of Satellite with 5G terrestrial networks; Joe Cahill (SaT5G)
SaT5G in standards; Konstantinos Liolis (SaT5G)
12:30 – 12:45 Q&A on SaT5G presentations
12:45 – 13:00 Brief on “what to expect” from demos; Barry Evans (SaT5G)

13:00 – 14:45 Lunch break and demonstrations.

14:45 – 15:00 Coffee and reconvene

15:00 – 15:30 Role of satellite in a mobile network – MNO perspective; Andy Sutton, BT

15:30 – 16.00 Panel session: “Way forward for integrating satellite into 5G”

Panel chair: Simon Watts (SaT5G)

Panel members: Andy Sutton (BT), Ammar Khan (Inmarsat), Antonio Franchi (ESA) and Barry Evans (SaT5G).

The shown demonstrations are listed in the table below. Brief descriptions of the demonstrations follow the table. An introduction to the demonstrations was recorded in a day before. The video can be downloaded from the SaT5G project’s web page early 2020.

<table>
<thead>
<tr>
<th>Title</th>
<th>5G Use Case</th>
<th>live satellite/emulation</th>
<th>Test bed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Integration of virtualised satellite equipment to 5G network</td>
<td>Backhaul</td>
<td>Live satellite/5G</td>
<td>5GIC</td>
</tr>
<tr>
<td>C/U plane split and NR over satellite</td>
<td>Backhaul</td>
<td>Live 4G mobile &amp; emulated satellite</td>
<td>Oulu/5GIC</td>
</tr>
<tr>
<td>Multicast over satellite and caching for video</td>
<td>Multiplay</td>
<td>Live satellite/5G</td>
<td>5GIC</td>
</tr>
<tr>
<td>Integration of virtualised satellite equipment to 5G network and MEO satellite</td>
<td>Backhaul Mobility</td>
<td>Video live satellite</td>
<td>ZII</td>
</tr>
<tr>
<td>Multi linking S+T for multi users of video-application level</td>
<td>Content to edge</td>
<td>Live satellite/5G</td>
<td>5GIC</td>
</tr>
<tr>
<td>Multi linking S+T for 5G users of all traffic at transport level</td>
<td>Content to edge</td>
<td>Live satellite/5G</td>
<td>5GIC</td>
</tr>
<tr>
<td>Multi linking S or T for all traffic types</td>
<td>Content to edge</td>
<td>Emulated satellite</td>
<td>TNO</td>
</tr>
</tbody>
</table>

In what follows are short descriptions of the demonstrations as they are in the press release of the event.

5G backhaul to a fixed terminal

This demonstration illustrated the architecture implemented for an NTN relay 5G integrated satellite terminal that is directly connected via a Satellite RAN at the Hylas 4 satellite gateway hub in Goonhilly to the 5G Core network in the Surrey 5G testbed and out to the 5G UE’s. It showed how the terminal and gateway network functions have been virtualised on the OpenStack platform and orchestrated ETSI MANO compliant OSM. 5GIC testbed also used SDN switched sliced network to integrate the satellite backhaul with terrestrial 5G mobile network slices.
Edge delivery of multimedia content

This demonstration showed over-the-air satellite multicast technology for the delivery of live video channels using a MEC platform for Content Delivery Network (CDN) integration with efficient edge content delivery. The demonstration highlighted the benefits, in terms of bandwidth efficiency, delivery cost and end-user Quality of Experience (QoE), of using a satellite-enabled link for provisioning live content in a 5G system.

5G to the premises:

These demonstrations included the complementary use of satellite with terrestrial networks for delivery to home/office small cell in underserved areas.

**Over-the-air MEC-based layered video streaming over a 5G multilink satellite and terrestrial network**

The demonstration displayed a network, which integrated 5G over parallel satellite and terrestrial delivery paths to provide enhanced Quality of Experience (QoE) for users consuming 4K video content. The innovative demonstration highlighted how a Video-segment Scheduling Network Function (VSNF) which is deployed at MEC can incorporate bit-rate adaptation, link selection and enhance video streams for future satellite and terrestrial integrated networks.

**Backhauling to extend services for rural markets and large-gathering events**

This demonstration showed how a standard 5G User Equipment (UE) leverages a hybrid backhaul and validates the performance required by 5G services. The solution provides tangible measurements of very high Quality of Experience (QoE) achieved by combining satellite-terrestrial links bandwidths for fast upload and download traffic and the terrestrial link low latency for interactive traffic. The demonstrated 5G-hybrid backhaul relies on state-of-the-art MPTCP, MPQUIC multipath protocols, and shows satellite as a viable backhaul link for 5G service.

New Radio air interface over the satellite

Demonstrated changes needed in the uplink random access process such that 5G NR can be used over long propagation distances exceeding the terrestrial cell size. An NTN terminal is connected to an NTN base station through an emulated satellite channel, and timing advance calculation and transmission, as well as uplink random access signal guard interval, are changed. The system was connected to a 5G testbed to show that end-to-end data can be transmitted through the system, to provide backhaul connection to a base station.

5G to moving platform backhaul

The 5G moving platform backhaul demonstrated for the first-time application of 5G technology for aircraft connectivity and content distribution services. The 5G testbed led by Zodiac Inflight innovations was successfully used for virtualised network services. A video recording provided a live demonstration of the SaT5G R&D activities undertaken by Zodiac Inflight innovations in cooperation with SES, Gilat, Quortus, Broadpeak, and i2CAT. Specifically, Gilat’s VSAT terminal and virtualised SkyEdge II-c hub were demonstrated over an emulated GEO satellite system. Deployment of Quortus’ virtualised mobile core on-board was also demonstrated to deliver both internet access, and local breakout content based on Broadpeak’s content delivery service, with all services, managed and configured by the i2CAT’s Terrestrial and Satellite coordination framework - TALENT. The testbed also included a first-of-its-kind over-the-air non-GEO satellite system setup, relying on SES’s high-throughput O3b MEO HTS satellite constellation and end-to-end managed services, Gilat’s GLT-1000 modem, and MEO Booster technology.
5G Edge Caching

This demonstration showed the improvements in streaming content quality, which are enabled by local content caching. Increased delays introduced by satellite links result in lowering of bitrate and resolution (adaptation) for HTTP based streaming. Local caching of content improves this situation. It is based on local access to DANE client running on MEC (Multi-Access and Edge Computing) node. The MEC node located next to eNB was connected to the core network using established satellite and terrestrial backhaul links. User Plane Function (UPF) at a MEC node was used to handle requests for the local content and to set up connections via core network to the content server thus optimally could request video segments over the satellite link. The innovation here is the ability to set up connections for downloading content with the DASH Enabled Network Element (DANE) collocated with the UPF.

Hereinafter are some pictures taken at the SaT5G Industry Day event.

Figure 21: Professor Barry Evans, UoS, (SaT5G) opening the SaT5G Industry Day event and the host’s 5GIC facilities.
Figure 22: Mike Short, Dep. of International Trade (UK) gave an inspiring talk at SaT5G Industry Day.

Figure 23: The technical manager of the project Mike Fitch introduced the project and its achievements at SaT5G Industry Day.
Figure 24: The project members gave more precise view into results at SaT5G Industry Day: a) Asma Chiha ep Harpi, b) Boris Tiomela Jou, c) Joe Cahill, and d) Konstantinos Liolis.
Figure 25: The visitors followed the demonstrations at SaT5G Industry Day: a) demos 1-3 were in the same room, b) demo 4, c) demo 5, d) demo 6, e) demo 7, and g) demo 6.
Figure 26: Panel discussion was lively at SaT5G Industry Day.

Figure 27: SaT5G group photo after the SaT5G Industry Day event.
Figure 28: Promotion of SaT5G Industry Day through LinkedIn.
7 Cooperation with other 5G Parties

This section explains how co-operation with other 5G projects went and what were the forms of it.

7.1 Participation in the 5G-PPP Working Groups

Co-operation within 5G-PPP was in the form of contributions to various white papers, as well as via attending the regular meetings and contributing to the various discussions aiming to promote the satellite integration into 5G.

The SaT5G consortium identified at early stage of the project a list of 5G-PPP WGs that have been the most relevant to the project (see Table 7). Representatives of SaT5G have been regularly participating at the meetings of these 5G PPP WGs and contributed to the sharing of communication and dissemination information across the whole 5G PPP community and the external target audience.

<table>
<thead>
<tr>
<th>5G-PPP Working Groups</th>
<th>SaT5G coordinating partner</th>
<th>SaT5G participating members</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-Standardization</td>
<td>TAS</td>
<td>ADS, SES, TNO</td>
</tr>
<tr>
<td>5G Architecture</td>
<td>ADS</td>
<td>TAS, BT, SES, GLT, TNO</td>
</tr>
<tr>
<td>SDN / NFV</td>
<td>i2CAT</td>
<td>UoS, IDR, GLT</td>
</tr>
<tr>
<td>NetMgmt &amp; QoS</td>
<td>BT</td>
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<tr>
<td>Vision and Societal Challenges</td>
<td>AVA</td>
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<tr>
<td>Trials</td>
<td>AVA</td>
<td>SES, UoS, OUOULU, ZII, TNO</td>
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<tr>
<td>Steering Board</td>
<td>AVA</td>
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<tr>
<td>Technology Board</td>
<td>TAS / UoS</td>
<td></td>
</tr>
</tbody>
</table>

As a result of this co-operation with 5G-PPP WGs, SaT5G has been involved to the writing of the following white papers and brochures of 5G PPP working groups or related groups:

- 5G Infrastructure Association (5G-IA), "5G PAN-EUROPEAN TRIALS ROADMAP" Version 3.0, white paper.

7.2 Cooperation with other 5G Projects

SaT5G cooperated by other projects in various ways. There for demonstration or test bed level cooperation as well as jointly organized special sessions and workshops. Partially this was possible since some project partners are involved into many projects and it is beneficial to do test bed development that supports several projects.

Demonstration level cooperation

Joint demo with 5G-XCAST at EuCNC2019: See details provided in Section 6.3 of this document.

The output of the SaT5G hybrid backhaul system designed by Ekinops will be used by 5GENESIS for the Limassol testbed. The 5GENESIS real world testbed requirements, such as platform and orchestrator, are used to enhance the SaT5G multilink system.

Special session level cooperation
Details of joint workshops and special sessions were provided in earlier sections of this document. The lists below summarizes these co-operations:

- EuCNC 2018 Workshop co-organized together with other H2020 5G-PPP Phase 2 Projects: 5G-Xcast, 5G-Media, 5GCity, IoRL and FLAME (see Section 5.2).
- EuCNC 2018 Special Session co-organized together with ESA and ESA ARTES project SATis5 (see Section 5.1).
- EuCNC 2019 Special Session co-organized together with ESA, 5G-PPP Phase 3 projects 5GVINNI, 5GENESIS, and ESA ARTES projects SATis5 and EdgeSAT (see Section 5.3).
- EuCNC 2019 Business Modeling Workshop co-organized together with Global5G supported by 5G City, 5G-CORAL, 5G-EVE, 5GENESIS, 5G-MIEDGE, 5G-TRANSFORMER, CARMEN (see Section 5.4).
8 Conclusions

Thanks to all these dissemination activities conducted and reported in this deliverable, it can be stated that the H2020 SaT5G project has been a key enabler in promoting the SatCom role in the 5G ecosystem. The work carried out in SaT5G has had a considerable impact in the area of 5G and SaT5G has helped drive the dissemination effort on SatCom integration into 5G.

All the target KPIs set in the SaT5G DoW have been well achieved and in many cases even exceeded. As outlined in Table 1 and further elaborated in the rest of this document, the SaT5G project dissemination activities have resulted in the following dissemination results:

- 4 published/accepted + 4 submitted Journal Publications
- 1 published Book Chapter
- 21 published + 2 to be submitted Conference Publications
- >25 Public Presentations
- >10 Posters
- 3 successfully held Workshops
- 2 successfully held Special Sessions
- 15 successfully held Demos
- 5 published Press Releases
- 5 published Project Flyers
- 4 published + 1 planned White Papers
- 2 published Newsletters
- Commercial Propositions published in 3 conference papers + 2 journal papers accepted
- Collaboration with 7 5GPPP WGs
- SaT5G Project Website + SaT5G Entry in 5GPPP Website
- 1 SaT5G Industry Day successfully held
- 5 lectures given + 2 lectures planned to be given at Universities

Overall, the project partners are very satisfied with the dissemination activities and the impact created. Furthermore, the dissemination activities reported in this deliverable showed very good progress that SaT5G provided to the integration of satellite and terrestrial networks into 5G ecosystem.

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