

A comprehensive view on the 3GPP work on Non-Terrestrial Network:

3GPP-Release 17/18 and beyond

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Abstract— This contribution to the workshop on aligning European Non-Terrestrial Network (NTN) Convergence and Integration, is a comprehensive view on the 3GPP work related to NTN in 3GPP Release-17 and subsequent releases. It also provides an overview on the European Space Agency (ESA) funded NTN projects HELENA (Highly skilled satellite community members to drive 3GPP Non-Terrestrial Network standardization) and EAGER (technologies and techniques for satellite beyond 5G networks) which aim at a continued support of the standardization effort on NTN within the 3GPP.

Keywords—NTN; 3GPP; NR; Satellite; HELENA, EAGER

I. INTRODUCTION

With the recent completion of 3rd Generation Partnership Project (3GPP) Release-17 specifications related to Non-Terrestrial Network (NTN), a global standard for satellite systems is newly defined. It opens the door for the seamless integration of satellite network component in fifth generation (5G) systems and beyond. The emergence of this hybrid terrestrial-satellite systems is the result of a joint effort between stakeholders of both mobile and satellite industries and is paving the way to new business opportunities.

In this contribution, we provide a comprehensive view on the 3GPP work related to NTN and an overview on the ESA funded NTN projects HELENA and EAGER which aim at a continued support of the standardization effort on NTN within the 3GPP. The paper is structured as follows: The 3GPP activities on satellite access in the different Technical Specification Groups (TSG), including 3GPP works in study phase (Release 15 and Release 16) and normative phase (Release-17 onward) are summarized in section II. HELENA overview and EAGER overview are given in sections III and IV respectively.

II. 3GPP WORK ON NTN IN RELEASE-17 ONWARD

Prior to 3GPP Release-17, 3GPP networks are natively designed only for Terrestrial based cellular networks. On the other hand, Satellite Networks are based on proprietary technologies. Thereby, only limited interworking between Satcom based Networks and 3GPP cellular networks components is possible. 3GPP work on NTN and the integration of satellite technology in 3GPP specifications starting from 3GPP Release-17 open a new frontier in 3GPP cellular systems and usher in new paradigms for connected society by adding a satellite component to the 5G system and thereby delivering the promise of an ubiquitous end-to-end ecosystem that can support a myriad of new use cases.

In March 2017, for the first time in 3GPP, satellite industries and stakeholders have got a unique opportunity to be involved in the standardization process of a new standard integrating Terrestrial and non-Terrestrial networks. Since then, Satellite based access is included on 3GPP roadmap: as part of study items in Release-15 and Release-16 and normative work items starting from Release-17.

The first set of 3GPP technical specifications incorporating the necessary features and adaptations for 5G to support Non-Terrestrial Networks have been completed in September 2022 as part of the Release-17¹. This first 3GPP defined NTN standard covers 3GPP defined satellite access networks respectively based on the 5G New Radio (NR) protocols and on the Narrowband Internet of things (NB-IoT) and enhanced Machine Type Communication (eMTC) radio protocols both operating in FR1² bands. In Release-17, the NR based satellite access aims at serving handheld devices with enhanced

¹ The core part 3GPP Release-17 was completed in September 2022 by freezing radio protocol specs (ASN.1), and the performance part of 3GPP Release-17 was completed in March 2023.

² What we usually call sub 6 GHz; referred to as Frequency Range 1 or FR 1: corresponding frequency range is from 410 MHz to 7125 MHz.

Mobile Broadband services, while the NB-IoT and eMTC based satellite access aims at providing Machine Type Communications to Internet of Things devices for applications in the area of agriculture, transport, logistics and security. To support new scenarios covering deployments in frequency bands above 10 GHz and to introduce several enhancements for NR NTN and IoT NTN a normative work is being carried out in 3GPP as part of Release 18.

NTN Release 18, which started in May 2022, includes work items on further enhancements for NR and NB-IoT/ eMTC over NTN, respectively. As per the original RAN Rel-18 timeline, March 2024 is the target date for freezing radio protocol specs (ASN.1).

The standardization effort on NTN will be continued over 3GPP Release-19 and subsequent releases. New features will be proposed to improve performances including throughput, radio link availability and/or to provide new capabilities and features/topology leveraging regenerative satellites.

Beyond 5G, it is expected that future 6G networks will natively support both terrestrial and satellite access networks highly integrated at both service and operational level by adopting a design optimized taking into account characteristics of both network components.

In line with these recent moves that have been seen towards the integration of satellite communication in 3GPP eco-system and the emergence of hybrid terrestrial-satellite systems, the two ESA funded NTN projects HELENA and EAGER aim to steer the 3GPP defined NTN standard towards the most relevant use cases, deployment scenarios and solutions for the European satellite communication eco system while meeting the requirements of user groups (e.g., mobile network operators and verticals) through selected technical contributions and networking activities. Once 3GPP 5G compatible satellite solutions/products are available, the satellite communication industry is expected to benefit from a global eco system and a multi-vendor supply chain.

III. HELENA

ESA HELENA, which stands for Highly skilled satellite community members to drive 3GPP Non-Terrestrial Network standardization, is an ESA funded study that will seek to capitalize on the investments made to date and secure the native integration of Satcom within the next generation of mobile networks. This project coordinated by Thales Alenia Space, encompasses the support to the NTN-related work items recently agreed for Release-18 as well as the preparation of NTN-related items for Release-19 and beyond. The proposed activity is to support standardization actions, help develop contributions and advocate positions favorable to the Satcom sector within the 3GPP standardization process such that they result in tangible industrial opportunities. Project detailed objectives are refined after each 3GPP plenaries on a quarterly basis. This project started mid-February 2023 and will end mid-February 2025, to cover the completion of Release-18 and the Release-19.

In addition, the project is managing a Satellite Standardisation Interest Group (SSIG) which is a platform where a broad range of satellite communication industry stakeholders can exchange information about satellite-related standards activities for the integration of satellite into the 5G ecosystem, with the aim of improving mutual understanding and collective effectiveness in pursuing the vision. Currently it gathers more than 50 participants (Airbus, Avanti, Cell&Sat, CeWitt, Cobham, CTTC, Dish, DLR, Echostar, ESA, GSOA, Eutelsat, ETRI, Fraunhofer Fokus, Fraunhofer IIS, Gatehouse, Gilat, iDirect, IIT-Hyderabad, IIT-T, Inmarsat, Intelsat, Iridium, IRT Saint Exupery, Hispasat, Hughes, Ligado, Lockheed Martin, Magister Solutions, Mangata Networks, Mitsubishi, NBN, NICT, Novamint, Omnispace, OneWeb, Sapienza Consulting, Satellite Application Catapult, Satify, Sateliot, SES, SnT Luxembourg, STMicroelectronics, Telesat, Telespazio, Terrestar, Thales Alenia Space, TNO, TTP, Univ Bologna, Univ Roma, Univ. Surrey, Univ Napoli, VTT, Yahsat/Thuraya) of which most are 3GPP members.

IV. EAGER

ESA EAGER (www.eagerproject.eu), which stands for Technologies and Techniques for SATCOM beyond 5G Networks project, is an ESA funded study coordinated by the University of Bologna, leverage the finalised Release-17 NTN standardization framework to research innovative technologies and techniques targeting highly efficient and deeply integrated satellite networks in 5G-Advanced, *i.e.*, Release-18-20 and in beyond 5G cellular systems in Release-21 onward, *i.e.*, 6G which is expected to be the next revolution in the mobile ecosystem. The objectives of EAGER project are: i) to evaluate and adopt discarded solutions or use cases, including, *e.g.*, Multiple-Input Multiple-Output (MIMO) techniques, advanced payload with digital beamforming and active antennas, etc.; ii) to identify and evaluate novel concepts (both in the waveform and in the network domain, as well as in the space and ground segment technologies); and iii) to develop the necessary software or analytical tools in order to properly assess the performance of the most promising techniques and technologies.

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Nicolas Chuberre graduated from “Ecole Supérieure d'Ingénieur en Electronique et Electrotechnique” in Paris in 1988. Previously with Nokia and Alcatel Mobile phones to design signal processing algorithms, Medium Access Control protocols and test tools for 2G cellular handsets and systems assembly, he joined Thales Alenia Space to manage the development of satellite payload equipment and the design of advanced Satellite Communication Systems (GEO and Non GEO). He has successfully initiated and led several European collaborative research projects in FP6, FP7, H2020, Horizon Europe and ESA ARTES context. He has been chairing the SatCom Working Group of Network2020 technology platforms (<https://www.network2020.eu/>) during 9 years and as such was member of the partnership board of the 5G Infrastructure Association (<http://5g-ppp.eu/>). Nicolas has published several papers on innovative Satellite System concepts. Currently, he is defining and developing Satellite Solutions for 5G. In addition, he is the lead representative of Thales in 3GPP TSG RAN where he is the rapporteur of the standardization on satellite integration in 5G since 2017 (https://www.3gpp.org/news-events/partners-news/2254-ntn_rel17, <https://www.3gpp.org/news-events/3gpp-news/nr-ntn>). He also chairs since 2006 the Satellite Communication and Navigation working group at ETSI (www.etsi.org).

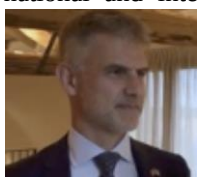


Mohamed El Jaafari is a radio access network specialist engineer with 23+ years of experience in cellular communications including 5G NR, eUTRAN, GERAN, and Cellular IoT. He received the Engineer degree in telecommunications from EMI in 1999. He is an expert in radio access network design, RF Planning, Radio Network Optimization, and Radio Access Network System dimensioning with large multi-vendor experience. He currently conducts extensive research work on 5G NR NTN and IoT NTN. He joined the R&D department of the Telecommunication Business Line of Thales Alenia Space in 2020. He is the lead representative of Thales in 3GPP RAN1 working group where he is a feature lead for the 3GPP work item on satellite integration in 5G. Currently, he is defining and developing solutions for 5G NR to support non-terrestrial networks. He is active in national and international research projects on wireless and satellite communication systems in several European Space Agency and European Commission funded projects. He is the Co-Chair for Track WOS – Wireless, Optical and Satellite Networks for EuCNC & 6G Summit 2023. He is Workshop Co-Chair of the 2023 IEEE International Conference on Wireless for Space and Extreme Environments (WiSEE). His research interests include wireless communication systems, Satellite Communications and their integration in 5G and future 6G Networks. He has recently led the drafting of a special edition on non-terrestrial network standard, <https://onlinelibrary.wiley.com/toc/15420981/2023/41/3>

Alessandro Guidotti (Member, IEEE) received the master degree (magna cum laude) in telecommunications engineering and the Ph.D. degree in electronics, computer science, and telecommunications from the University of Bologna, Italy, in 2008 and 2012, respectively. From 2009 to 2011, he was a representative for the Italian Administration within CEPT SE43. In 2011 and 2012, he was a Visiting Researcher at SUPELEC, Paris, France. From 2014 to 2021, he was a Research Associate with the Department of Electrical, Electronic, and Information Engineering “Guglielmo Marconi,” University of Bologna. From 2021, he is a Researcher with the National Inter-University Consortium for Telecommunications (CNIT), at the University of Bologna unit. He is active in national and international research projects on wireless and satellite communication systems in several European Space Agency and European Commission funded projects. He is a Review Editor of the Aerial and Space Networks journal for Frontiers in Space Technologies. He has been serving as TPC and Publication Co-Chair at the ASMS/SPSC Conference since 2018 and he is Workshop Co-Chair of the 2023 IEEE International Conference on Wireless for Space and Extreme Environments (WiSEE). His research interests include wireless communication systems, Satellite Communications and their integration in 5G/6G, interference management, and Machine Learning.



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