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Abstract

The document reports the standardization activities undergone by the 5G-ALLSTAR project partners over the second year of the project.

Keywords

Multi-Connectivity, Standardization, 3GPP, ITU, V2X

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Executive Summary

5G-ALLSTAR WP6 includes standardization activities for inclusion of technologies developed by the project in the 5G system definition, mainly at 3GPP level.

The deliverable D6.5 “Standardization Action Plan” defines these activities and the associated actions to be undergone by the 5G-ALLSTAR consortium partners all along the 3 years of the project life.

This document is the second of a series of 3 reports that will be delivered and covers standardization activities led by the 5G-ALLSTAR project team from M13 (July 2019) to M24 (June 2020).

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List of Abbreviations

3GPP	3rd Generation Partnership Project
5G	Fifth Generation of cellular network technology
CRAT	Consortium for the Research in Automation and Telecommunication
DL	Downlink
eMBB	Enhanced Mobile BroadBand
ETRI	Electronics and Telecommunications Research Institute (South Korea)
ETSI	European Telecommunication Standards Institute
GEO	Geostationary Earth Orbit
IEEE	Institute of Electrical and Electronics Engineers
IMT	International Mobile Telecommunications
ITU	International Telecommunication Union
ITU-R	ITU Radio communication Sector
LEO	Low Earth Orbit
LLS	Low Latency Services
Mxy	Month xy
NR	New Radio
NTN	Non-Terrestrial Network
PRACH	Physical Random Access CHannel
RAN	Radio Access Network
RRM	Radio Resource Management
SA	System Architecture
SG	Specification Group
SI	Study Item (SI)
TAS	Thales Alenia Space
TDOC	Temporary DOCument
UE	User Equipment
V2X	Vehicle-to-everything
WI	Work Item (3GPP)
WP	Work Package

1 Introduction

5G-ALLSTAR WP6 includes standardization activities for inclusion of technologies developed by the project in the 5G system definition, mainly at 3GPP.

One of the project's objectives is indeed to contribute to the definition of 5G system as part of Release-16 and beyond with the inclusion of 5G satellite access, mobile wireless backhaul and multiple access/connectivity.

The plan, as defined in D6.5 (Standardization Action Plan) is to leverage ongoing standardisation on eMBB and 5G satellite access. Additional standardization activities in bodies such as ETSI, IEEE and ITU, may possibly be carried in complement to 3GPP activities. Contributions will be provided to selected groups in order to support product adoption and interoperability developed in the context of the project.

Opportunities related to the project scope will be identified and the standardization strategy may be reconsidered correspondingly.

The Standardization Action Plan defines these activities and the associated actions to be undergone by the consortium all along the 3 years of project lifetime.

Every 12 months, a standardization activity report is issued.

This document is the second of the 3 reports that will be delivered and covers standardization activities led by the 5G-ALLSTAR project team from M13 (July 2019) to M24 (June 2020).

2 Standardization action plan reminder

The Standardization Action Plan (deliverable D6.5) proposes an action plan for standardization activities on the 5G-ALLSTAR project to support the inclusion of technologies developed by the project, in 5G systems definition. These activities will be mainly undergone at 3GPP.

The document:

- Presents the rationale for a new standardization approach for Satcom based on the analysis of the current standardization context in Satcom market and the on-going standardization context for 5G;
- Proposes an approach to integrate satellite in the 5G related standards including the identification/justification of the potential standardization requirements arising from 5G-ALLSTAR;
- Gives a standardization action plan including the timeline, the Standardization Organizations and groups where 5G-ALLSTAR plans to contribute and the 5G-ALLSTAR members involved;

This plan may need to be revised during the course of the project to take into account the progress on the project, especially at architecture and research pillars (e.g. RRM) levels, as well as the evolving 5G standardization context.

The table below gives the list of all the standardization actions intended to be taken over the 5G-ALLSTAR project duration.

Standardisation body/group	Action description	Deadline
3GPP RAN1	Contribute to the study of physical layer issues of NR V2X-based vehicle communication	Early 2019
ITU-R SG4 & SG5	Inform relevant ITU-R Working Parties on activities in 3GPP	Mid 2019
3GPP RAN3	Study procedures for hand-over/multi connectivity between 2 satellite accesses or between satellite and cellular access and identify/describe solutions	Mid 2019
3GPP RAN2 & 3	Study enablers for coordinated radio resource management between satellite/cellular access	Mid 2019
3GPP RAN1	Contribute to the study of issues associated to NR physical layer support non-terrestrial network	End 2019
3GPP RAN1	Contribute to the specification of NR V2X physical layer design regarding vehicle communication	End 2019
3GPP RAN2	Study access layer protocol impacts associated to hand-over/multi connectivity between 2 satellite accesses or between satellite and cellular access and identify/describe solutions	End 2019
3GPP RAN3	Specify procedures for hand-over/multi connectivity between 2 satellite accesses or between satellite and cellular access	Mid 2020
3GPP RAN2	Specify NR access layer protocol modifications enabling support of hand-over/multi connectivity between 2 satellite accesses or between satellite and cellular access	Mid 2020
3GPP RAN1	Specify NR physical layer protocol modifications enabling support of non-terrestrial network	Mid 2020
3GPP RAN2 & 3	Specify enablers for coordinated radio resource management between satellite/cellular access	Mid 2020
ITU-R SG4 & SG5	Contribute to ITU-R Recommendation(s) on NTN integration in IMT-2020 networks	Mid 2020

Table 1: Standardization actions list

3 Standardization actions undergone over Year 2

3.1 Activity at 3GPP level

The 5G-ALLSTAR partners are actively participating in the different 3GPP working groups that are working on the integration of Non-Terrestrial Networks into future 5G Systems.

Contributions to 3GPP include the submission of Temporary Documents (TDOCs), focusing on different topics in the relevant 3GPP working groups.

In June 2019, a 3GPP RAN workshop focusing on Release-17 was held in Newport Beach, California USA. Fraunhofer shared its vision on 5G for Verticals, taking a stand for worldwide direct access via 5G satellite by supporting the NR NTN activities within 3GPP, (RP-191229).

In the RAN plenary meeting in September 2019, Fraunhofer actively supported NTN NB-IoT, RP-192238, and discussed OFDM operation over satellite in RP-192237, RP-192203, RP-192201. Furthermore two Change Requests (CRs) by Fraunhofer and Thales were approved RP-191835, RP-191825.

The Release-17 RAN work item on solutions for NR to support non-terrestrial networks initiated by Thales was approved in the December 2019 RAN plenary meeting in Sitges, Spain. This work item marks the start on the normative phase of the NTN standardization in working groups RAN1, RAN2, RAN3 and RAN4.

As of the original time plan the work in RAN1 should have started in February 2020, but this plan was affected by the Coronavirus pandemic and thus delayed to August 2020.

3.1.1 Focus on RAN1 activities

A study item (SI) for NR V2X standardization (V2X phase 3) was approved in the RAN#80 meeting, and started its first meeting at RAN1#94 meeting in August of 2018. It officially ended at RAN1#96 meeting in March of 2019, and the V2X group continued its standardization activities as work item (WI) since RAN1#96-Bis meeting of April 2019.

Based on the study outcome captured in TR 38.885, the WI is to specify radio solutions that are necessary for NR to support advanced V2X services (except the remote driving use case which was studied in TR 38.824) in addition to the services supported by LTE V2X.

Since one of the scopes of 5G-ALLSTAR project is the development of a mmWave-band NR vehicular communication system, we participated in the following NR V2X WI RAN1 meeting, and contributed our views on V2X sidelink design to the meeting.

RAN1#98 (August 2019): For the discussion/decision during this meeting, two contributions, R1-1908811 and R1-1908810, focusing on physical-layer procedures and sidelink synchronization for NR V2X, were submitted, and the detailed technical observations and proposals described in the contributions include as follows:

- R1-1908811, “Discussion on Physical Layer Procedures for NR Sidelink”
    - ***Observation 1*:** In our view, for the proposed retransmission mechanism, it is necessary for the UE that failed to receive the packet to detect the HARQ-ACK signals transmitted by the other UEs to find out which UE has successfully re-

ceived the packet, and then based on the pre-measured the RSRP of R-UE candidates, the UE can suggest its best R-UE to the group for making the decision on the R-UE for retransmission.

- ***Proposal 1*:** We propose considering a retransmission protocol with R-UE selection in order to further improve the performance of retransmissions.
- ***Proposal 2*:** We propose discussing further enhancement on HARQ-ACK feedback option 2 and other necessary resource allocation/management and signaling mechanisms for the proposed retransmission with R-UE selection.
- ***Proposal 3*:** Location information (e.g. TX-RX geographical distance) can be used for R-UE selection.
- ***Proposal 4*:** For the sidelink open loop power control, RX UE derives the L3 filtered RSRP.

- R1-1908810, "Discussion on NR V2X sidelink synchronization"
  - Agreement on system and link level simulation assumptions (satellite parameters, UE characteristics, beam layout definition and parameters for single satellite simulations, assumptions for calibration and performance evaluation, impairments due to satellite payload and satellite movement, LLS parameters for DL synchronization, PRACH and data transmission performance evaluation)
  - ***Proposal 1*:** NR V2X supports multiple S-SSB transmissions in a period.
  - ***Proposal 2*:** In NR V2X, the number of S-SSB(s) transmitted within P1 is (pre-) configurable.
  - ***Proposal 3*:** NR V2X should investigate a multiplexing scheme between DL-SSB and SL-SSB, with the following options:
    - TDM
    - FDM
    - FDM with time-domain offset

After this meeting, 5G-ALLSTAR decided to shift our effort from 3GPP NR V2X standardization to 3GPP SA NTN standardization, which this project is closely related to and has significant impact on, and the description of the standardization activities and contribution is provided in Section 3.1.4.

RAN1#98 (26 – 30 August, 2019), Prague (CZ):

- Good progress in RAN1 for NTN.
- Fraunhofer and Thales continued to refine the NTN channel model by submitting a number of Change Requests (CRs) to the RAN1 meeting, R1-1909821, R1-1908995 and R1-1908994. Other topics like regulatory aspects and link-level simulation assumptions for calibration were introduced by Fraunhofer in R1-1909000 and R1-1908999. R1-1908996 discussed the downlink performance of NTN.
- Discussion on signalling enhancements: May include uplink transmission time indication enhancement, downlink/uplink frequency compensation, timing advance adjustment, PRACH, dynamic HARQ disabling and HARQ process number extension at least.
- Simulation assumptions: Almost complete.

RAN1#99 (18 – 22 November, 2019), Reno (NV, US): RAN1 discussion in NTN SI has been completed successfully

- Performance evaluation (R1-1913455, R1-1913426): Calibration, link budget analysis, multi-satellite simulation, UE throughput.
- Physical layer control procedures (R1-1913402): Uplink power control, link adaptation, timing relationship, beam management (including service link switch and polarization mode), and feeder link switch impact on physical layer.
- Initial access (R1-1913427): DL timing and frequency tracking, uplink timing advance, uplink frequency compensation, PRACH.
- HARQ (R1-1913260): HARQ feedback disabling/enabling, HARQ number extension, slot-aggregation, blind repetitions, HARQ enhancements for soft buffer management and stop-and-wait time reduction.
- RAN1 Recommendation (R1-1913436)
- Focus: Timing relationship enhancements, UL time and frequency synchronization, PRACH.
- Discussion: Beam management, polarization mode, feeder link switch, HARQ process number, HARQ feedback disabling/enabling.

RAN1#101-e (e-Meeting, May 25th – June 5th – 6th March 2020): Maintenance of NR Release-16:

- Discussion of need for correction for inconsistent shadow fading parameters in NTN rural scenario
- Correction for inconsistent shadow fading parameters in NTN rural scenario

The study item phase has identified issues and made recommendations on necessary features and adaptations enabling the operation of the New Radio (NR) protocol in non-terrestrial networks (NTN). Enhancing features to address the identified issues due to long propagation delays, large Doppler effects, and moving cells in NTN, are captured in TR 38.821 (Release-16).

At the **RAN#86 meeting in Sitges, Spain (09/12/2019 to 12/12/2019)**, upon successful completion of the "Study Item on NR support non-terrestrial network" [TR 38.821], the corresponding work item was approved [RP-193234], with the aim to specify the enhancements identified for NR NTN and core part completion by June 2021 (RAN#92), and the RAN4 performance part by December 2021 (RAN#94)

3GPP RAN will start normative work on 5G NR enhancements to support non-terrestrial access (NTN) In Release-17 (March 2020 – Sept 2021) which is delayed to August 2020 due to COVID-19, Initial studies are being performed for Internet of Things (IoT) as well, paving the way to introduce both NB-IoT and eMTC support for satellites.

For RAN1, the detailed objectives of the normative work item are to specify enhancing features to Rel-15 & Rel-16's NR radio interface & NG-RAN as follows:

Enhancing features to address the identified issues due to long propagation delays, large Doppler effects, and moving cells in NTN, the following should be specified (see TR 38.821):

- Timing relationship enhancements
- Enhancements on UL time and frequency synchronization

- HARQ
  - Number of HARQ process
  - Enabling / disabling of HARQ feedback as described in the TR 38.821

In addition, the following topics should be specified if beneficial and needed

- Enhancement on the PRACH sequence and/or format and extension of the ra-ResponseWindow duration (in the case of UE with GNSS capability but without pre-compensation of timing and frequency offset capabilities)
- Feeder link switch
- Beam management and Bandwidth Parts (BWP) operation for NTN with frequency reuse (including signalling of polarization mode)

The following table shows the latest RAN#1 meetings in which Thales Alenia Space is taking a leading role on 5G satellite in 3GPP:

Meeting title	Start date	End date	Location
RAN1#101-e	2020-05-25	2020-06-05	e-Meeting
RAN1#100-bis-e	2020-04-20	2020-04-30	e-Meeting
RAN1#100-e	2020-02-24	2020-03-06	e-Meeting
RAN1#99	2019-11-18	2019-11-22	Reno, Nevada
RAN1#98-Bis	2019-10-14	2019-10-20	Chongqing
RAN1#98	2019-08-26	2019-08-30	Prague

Table 2: 3GPP RAN#1 meetings for NR NTN

The table below shows planned contributions to RAN#1 for 3GPP Release-17 normative work:

Lead editor	TDOC Title
TAS	Proposed work plan for the WI
TAS	NR NTN Reference scenarios
TAS	UL timing and frequency synchronisation
TAS	PAPR analysis with OFDM with non-linear HPA
TAS	Beam management and BWP operation for NTN with frequency reuse
TAS	Earth fixed/moving beam - reference scenarios justification
IIS	Timing relationship enhancements in NTN
IIS	Random access enhancements (PRACH and RA window)
HHI	NTN channel model K-factor analysis

Table 3: Planned contributions to 3GPP Release-17 RAN#1 normative work

3.1.2 Focus on RAN2 activities

RAN#2 107, 26 – 30 August 2019, Prague, Czech Republic:

- Some of the key agreements made during this meeting include prioritizing transparent GEO (scenario A) and LEO scenarios with moving beams (C2 and D2) for mobility analysis in SI phase, Cell level mobility to be considered in RAN2, de-prioritizing Dual connectivity between NTN-TN and power saving optimization in the initial release in the context of service continuity scenarios, RRC configurable HARQ feedback at UE or per HARQ process.
- The regulatory aspects discussed in a Fraunhofer RAN1 contribution were also submitted to RAN2 in R2-1910508.

RAN#2 108, 18 - 22 November 2019, Reno, USA:

NTN Study Item is considered complete from RAN2 point of view, pending conclusion of 'earth fixed vs earth moving cells' email discussion; the aim of the email discussion is to have views from companies on whether the impact analysis done for moving beams in SI phase would be applicable also to steerable beams or not. Thales is strongly pushing for steerable beams or fixed cells on earth to be also included in the WI phase. RAN2 agreed on recommendations to the WI.

For RAN2, the detailed objectives of the normative work item are to specify enhancing fea-tures to Rel-15 & Rel-16's NR radio interface & NG-RAN as follows:

The following user plane procedures enhancements should be specified (see TR 38.821)

- MAC
  - Random access:
    - Definition of an offset for the start of the ra-ResponseWindow for NTN.
    - Introduction of an offset for the start of the ra-ContentionResolutionTimer to resolve Random access contention
    - Solutions for resolving preamble ambiguity and extension of RAR window.
    - Adaptation for Msg-3 scheduling: only for the case with pre-compensation of timing and frequency offset at UE side)
  - Enhancement on UL scheduling to reduce scheduling latency.
  - DRX:
    - If HARQ feedback is enabled, introduction of offset for drx-HARQ-RTT-TimerDL and drx-HARQ-RTT-TimerUL.
    - If HARQ is turned off per HARQ process, adaptions in HARQ procedure
  - Scheduling Request: Extension of the value range of sr-ProhibitTimer
- RLC
  - Status reporting: Extension of the value range of t-Reassembly
  - Sequence Numbers: extension of the SN space only for GEO scenarios
- PDCP
  - SDU discard: Extension of the value range of discardTimer.
  - Sequence Numbers: extension of the SN space for GEO scenarios.

The following control plane procedures enhancements should be specified (see TR 38.821)

- Idle mode:
  - Definition of additional assistance information for cell selection/reselection (e.g. using UE location information, satellite Ephemeris information)
  - Definition of NTN (satellite/HAPS) cell specific information in SIB
- Connected mode
  - Enhancement necessary to take into account location information (UE & Satellite/HAPS) and/or ephemeris in determining when to perform hand-over, in order to have a high degree of hand-over control for hand-over robustness and coverage management.
  - Enhancement to existing measurement configurations to address absolute propagation delay difference between satellites (e.g. SMTC measurement gap adaptation to the SSB/CSI-RS measurement window) [RAN2/4].
- Service continuity for mobility from TN to NTN and from NTN to TN systems (to be addressed when connected mode mobility has sufficiently progressed)
- Identify potential issues associated to the use of the existing Location Services (LCS) application protocols to locate UE in the context of NTN and specify adaptations if any [RAN2/3]

Furthermore the following can be considered with 2nd priority: verify the applicability of existing Rel-16 ANR techniques to solve PCI confusion in order to support co-channel operation between HAPS & terrestrial networks and develop enhancements if needed [RAN2/3].

The following table shows the latest RAN#2 meetings in which Thales Alenia Space is taking a leading role on 5G satellite in 3GPP:

Meeting title	Start date	End date	Location
RAN2#110-e	2020-06-01	2020-06-12	e-Meeting
RAN2#109-bis-e	2020-04-20	2020-04-30	e-Meeting
RAN2#109-e	2020-02-24	2020-03-06	e-Meeting
RAN2#108	2019-11-18	2019-11-22	Reno, Nevada
RAN2#107	2019-08-26	2019-08-30	Prague

Table 4: 3GPP RAN#2 meetings for NR NTN

The table below shows planned contributions to RAN#2 for 3GPP Release-17 normative work:

Lead editor	TDOC Title
TAS	Proposed work plan
TAS	Reference scenarios
TAS	SIB NTN – Ephemeris and Random access principles
TAS	Earth fixed/moving Beam - Reference scenarios Justification (HO signalling)

TAS	Feeder link switch over and satellite handover in NTN
TAS	Idle mode mobility
IIS	Principles of UE location in NTN using the Location Services (LCS) application protocols to locate UE in the context of NTN and identification of possible enhancements if any. Up to Rel-15, based on a finalized specification. Analysis of Rel-16 positioning specifications over NTN systems (TS 38.305 & TS36.305).

Table 5: Planned contributions to 3GPP Release-17 RAN#2 normative work

3.1.3 Focus on RAN3 activities

For RAN3, the detailed objectives of the normative work item are to specify enhancing fea-tures to Rel-15 & Rel-16's NR radio interface & NG-RAN as follows:

The following NG-RAN architecture enhancements should be specified (see TR 38.821)

- to support feeder link switch over in Transparent payload architecture based LEO scenarios
- network identities handling
- registration update and paging handling
- cell relation handling and related features e.g. neighbours, ANR, RAN paging

The following table shows the latest RAN#3 meetings in which Thales Alenia Space is taking a leading role on 5G satellite in 3GPP:

Meeting title	Start date	End date	Location
RAN3#108-e	2020-06-01	2020-06-12	e-Meeting
RAN3#107-bis-e	2020-04-20	2020-04-30	e-Meeting
RAN3#107-e	2020-02-24	2020-03-06	e-Meeting
RAN3#106	2019-11-18	2019-11-22	Reno, Nevada
RAN3#105-bis	2019-10-14	2019-10-18	Chongqing
RAN3#105	2019-08-26	2019-08-30	Ljubljana

Table 6: 3GPP RAN#3 meeting**s** for NR NTN

The table below shows planned contributions to RAN#3 for 3GPP Release-17 normative work:

Lead editor	Title
TAS	Proposed work plan
TAS	Reference scenarios
TAS	Feeder link switch: identification of what needs to be specified
FhG	Network identities handling: identification of what needs to be specified

Table 7 : Planned contributions to 3GPP Release-17 RAN#3 normative work

3.1.4 Focus on SA5 activities

In-line with 5G-ALLSTAR Standardization Action Plan, a contribution on Multi-Connectivity to 3GPP TR 28.808 “Study on management and orchestration aspects with integrated satellite components in a 5G network” Release-17 was submitted by the project Korean partner, ETRI and accepted at the SA Working Group 5 meeting session #129 (Zhuhai, 18-22thNovember 2019).

The objectives for TR 28.808 are identifying the key issues associated with business roles, service and network management and orchestration of a 5G network with integrated satellite components (whether as NG-RAN or non-3GPP access, or for transport), and to study the associated solutions. This study aims at minimising the impacts and the complexity of the satellite integration in the existing business model, management and orchestration of the current 5G network.

The studied items are the following:

- Reference management architecture for integrated satellite components
- Architecture scenarios for 5G networks with an integrated satellite component
- Various use cases for multi-connectivity

The following figure illustrates a reference architecture for management of a satellite NR-RAT.

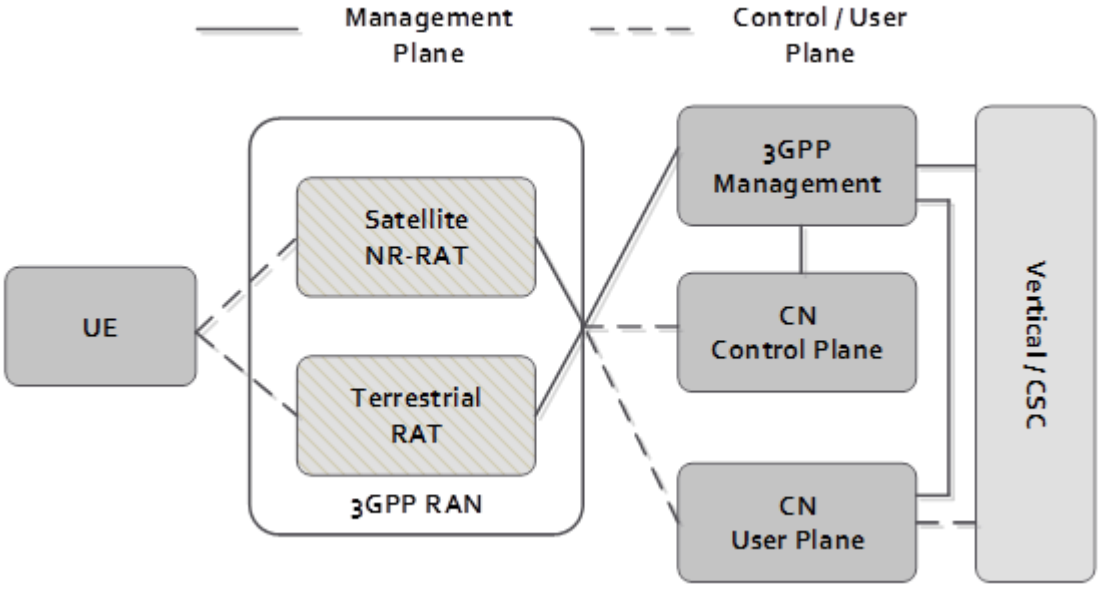

Figure 1: Reference architecture for management of a satellite NR-RAT

The new contribution introduced a use case for the multi-RAT load-balancing which is associated with both a Satellite RAN and a Terrestrial RAN to TR 28.808. As defined by SA1 in TS 22.261, the satellite integration in the 5G system is required. The purpose of this use case is to identify resource management aspects that are needed to support this specific use case.

3.2 Activity at ITU-R level

No activity at ITU level was performed over the 2nd year of the Project.