**3GPP TSG-RAN WG2 Meeting #117 electronic *R2-22xxxxx***

**Online, February 21st – March 3rd, 2022**

**Agenda Item: 8.10.1**

**Source: Thales**

**Title: Summary of [AT117-e][109][NTN] Stage 2 CR (Thales)**

**Document for: Discussion and Decision**

# Introduction

This document aims to summarize the following discussion.

**[AT117-e][109][NTN] Stage 2 CR (Thales)**

Scope: Update the Stage 2 CR

Intended outcome: Agreed Stage 2 CR

Initial deadline (for companies' feedback): Monday 2022-02-28 1800 UTC

Initial deadline (for Stage 2 CR in R2-2203537): Tuesday 2022-03-01 1000 UTC

Status: To be started

This offline discussion first aims at consolidating the text as outcomes of RAN2#116-bis-e and RAN3#114-bis-e starting from the submitted R2-2202233 [1].

Then it will focuses on changes to capture stg2 related agreements of RAN2#117-e.

# 1st round discussion

## 2.1 Chapter 4.x Non-Terrestrial Networks overview

*The rapporteur as implemented the changes from RAN3 onto to the text as outcome of RAN2#116-bis-e:*

The Figure 4.x-1 below illustrates an example of a Non-Terrestrial Network (NTN) providing non-terrestrial NR access to the UE by means of an NTN payload and an NTN Gateway, depicting a service link between the NTN payload and a UE, and a feeder link between the NTN Gateway and the NTN payload.



**Figure 4.x-1: Overall illustration of an NTN**

NOTE: Figure 4.x-1 illustrates an NTN; RAN4 aspects are out of scope.

The NTN payload transparently forwards the radio protocol received from the UE (via the service link) to the NTN Gateway (via the feeder link) and vice-versa. The following connectivity is supported by the NTN payload:

- A gNB may serve multiple NTN payloads;

- An NTN payload may be served by multiple gNBs.

NOTE: In this release, the NTN-payload may change the carrier frequency, before re-transmitting it on the service link, and vice versa (respectively on the feeder link).

For NTN, the following applies in addition to Network Identities as described in clause 8.2:

- A Tracking Area corresponds to a fixed geographical area. Any respective mapping is configured in the RAN;

- A Mapped Cell ID as specified in subclause 16.x.5.

Non-Geosynchronous orbit (NGSO) includes Low Earth Orbit at altitude approximately between 300 km and 1500 km and Medium Earth Orbit at altitude approximately between 7000 km and 25000 km.

Three types of service links are supported.

* + Earth-fixed: provisioned by beam(s) continuously covering the same geographical areas all the time (e.g., the case of GSO satellites)
	+ Quasi-Earth-fixed: provisioned by beam(s) covering one geographic area for a limited period and a different geographic area during another period (e.g., the case of NGSO satellites generating steerable beams)
	+ Earth-moving: provisioned by beam(s) whose coverage area slides over the Earth surface (e.g., the case of NGSO satellites generating fixed or non-steerable beams).

With NGSO satellites, the gNB can provide either quasi-Earth-fixed cell coverage or Earth-moving cell coverage, while gNB operating with GSO satellite can provide Earth fixed cell coverage.

In this release, the UE supporting NTN is GNSS-capable.

In the case of NGSO, service link switch refers to a change of serving satellite.

**Question 2.1: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.2 Chapter 7.3 User Plane aspects

*The rapporteur introduced this new chapter following suggestions during the post RAN2#116-bis-e email discussion (without ENs):*

### 7.3.1 Overview

System Information (SI) consists of a MIB and a number of SIBs, which are divided into Minimum SI and Other SI:

- **Minimum SI** comprises basic information required for initial access and information for acquiring any other SI. Minimum SI consists of:

- *MIB* contains cell barred status information and essential physical layer information of the cell required to receive further system information, e.g. CORESET#0 configuration. *MIB* is periodically broadcast on BCH.

- *SIB1* defines the scheduling of other system information blocks and contains information required for initial access. SIB1 is also referred to as Remaining Minimum SI (RMSI) and is periodically broadcast on DL-SCH or sent in a dedicated manner on DL-SCH to UEs in RRC\_CONNECTED.

- **Other SI** encompasses all SIBs not broadcast in the Minimum SI. Those SIBs can either be periodically broadcast on DL-SCH, broadcast on-demand on DL-SCH (i.e. upon request from UEs in RRC\_IDLE, RRC\_INACTIVE, or RRC\_CONNECTED), or sent in a dedicated manner on DL-SCH to UEs in RRC\_CONNECTED (i.e., upon request, if configured by the network, from UEs in RRC\_CONNECTED or when the UE has an active BWP with no common search space configured). Other SI consists of:

- *SIB2* contains cell re-selection information, mainly related to the serving cell;

- *SIB3* contains information about the serving frequency and intra-frequency neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);

- *SIB4* contains information about other NR frequencies and inter-frequency neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters), which can also be used for NR idle/inactive measurements;

- *SIB5* contains information about E-UTRA frequencies and E-UTRA neighbouring cells relevant for cell re-selection (including cell re-selection parameters common for a frequency as well as cell specific re-selection parameters);

- *SIB6* contains an ETWS primary notification;

- *SIB7* contains an ETWS secondary notification;

- *SIB8* contains a CMAS warning notification;

- *SIB9* contains information related to GPS time and Coordinated Universal Time (UTC);

- *SIB10* contains the Human-Readable Network Names (HRNN) of the NPNs listed in SIB1;

- *SIB11* contains information related to idle/inactive measurements;

- *SIBpos* contains positioning assistance data as defined in TS 37.355 [43] and TS 38.331 [12].

For sidelink, Other SI also includes:

- *SIB12* contains information related to NR sidelink communication;

- *SIB13* contains information related to *SystemInformationBlockType21* for V2X sidelink communication as specified in TS 36.331 clause 5.2.2.28 [29];

- *SIB14* contains information related to *SystemInformationBlockType26* for V2X sidelink communication as specified in TS 36.331 clause 5.2.2.33 [29].

Figure 7.3-1 below summarises System Information provisioning.



Figure 7.3-1: System Information Provisioning

For a cell/frequency that is considered for camping by the UE, the UE is not required to acquire the contents of the minimum SI of that cell/frequency from another cell/frequency layer. This does not preclude the case that the UE applies stored SI from previously visited cell(s).

If the UE cannot determine the full contents of the minimum SI of a cell by receiving from that cell, the UE shall consider that cell as barred.

In case of BA, the UE only acquires SI on the active BWP.

For non-terrestrial network, other SI also includes:

- *SIBx* contains NTN-specific parameters;

**Question 2.2: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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## 2.3 Chapter 16.3.2 AMF and NW Slice Selection

*The rapporteur introduced this new chapter as per stg2 BL CR from RAN3:*

#### 16.3.2.1 CN-RAN interaction and internal RAN aspects

NG-RAN selects AMF based on a Temp ID or NSSAI provided by the UE over RRC as specified in TS 38.410 [16]. The mechanisms used in the RRC protocol are described in the next clause.

Table 16.3.2.1-1 AMF selection based on Temp ID and NSSAI

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| Temp ID | NSSAI | AMF Selection by NG-RAN |
| not available or invalid | not available | One of the default AMFs is selected (NOTE) |
| not available or invalid | present | Selects AMF which supports UE requested slices |
| valid | not available, or present | Selects AMF per CN identity information in Temp ID |
| NOTE: The set of default AMFs is configured in the NG-RAN nodes via OAM. |

**Question 2.3: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.4 Chapter 16.x.2 User Plane aspects

*The rapporteur recall here under the text as outcomes of the post RAN2#116-bis-e email discussion without ENs:*

The UEs may be configured to report information about the UE specific Timing Advance pre-compensation during Random Access procedure in Idle/Inactive states.

The UEs may also be configured to report information about the UE specific Timing Advance pre-compensation in connected mode using event-triggered reporting.

To accommodate the long propagation delays, HARQ procedure is adapted as follow:

* For downlink, HARQ feedback can be enabled or disabled per HARQ process.
* For dynamic grants on uplink, UEs may be configured with an [UL HARQ state] per HARQ process that controls the DRX behavior.

NOTE: It is up to network implementation to ensure proper configuration of HARQ feedback (i.e. enabled or disabled) for HARQ processes used by an SPS configuration and of HARQ mode for HARQ processes used by a CG configuration.

A LCH can be configured with a uplinkHARQ-DRX-LCP-Mode-r17, if configured it can only be mapped to a HARQ process with the same mode.

**Question 2.4: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.5 Chapter 16.x.4.1 Mobility in RRC\_IDLE and RRC\_INACTIVE

*The rapporteur recall here under the text as outcomes of the post RAN2#116-bis-e email discussion without ENs:*

The same principles as described in 9.2.1 apply to mobility in RRC\_IDLE for NTN and the same principles as described in 9.2.2 apply to mobility in RRC\_INACTIVE for NTN unless hereunder specified.

Tracking Area Codes in NTN are fixed to geographical location on Earth.

The network may broadcast up to 12 Tracking Area Codes (TAC) per PLMN in a NR NTN cell, including same or different PLMNs. A TAC change in the System Information is under network control, i.e. it may not be exactly synchronised with real-time illumination of beams on ground.

The UE can determine the network type (Terrestrial or non-terrestrial) implicitly no later than SIB1 reception.

UE may perform cell selection and reselection based on the NTN (satellite/HAPS) ephemeris provisioned. The NTN ephemeris is divided into serving cell’s satellite ephemeris and neighbouring cell’s satellite ephemeris.

At least in the quasi-earth fixed cell scenario,

* the timing and location information associated to a cell are provided via system information
* Timing information refers to the time when the serving cell is going to stop serving a geographical area
* Location information refers to the reference location of serving or neighboring cells

Location information may be used to assist cell reselection in NTN with for example a condition based on the distance between UE and the reference location of the serving cell and/or neighbor cells.

**Question 2.5: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.6 Chapter 16.x.4.2 Mobility in RRC\_CONNECTED (Hand-over only)

*The rapporteur recall here under the text as outcomes of the post RAN2#116-bis-e email discussion without ENs:*

##### 16.x.4.2.1 Handover

The same principle as described in 9.2.3.2 applies unless hereunder specified:

During mobility between NTN and Terrestrial Network, a UE is not required to connect to both NTN and Terrestrial Network at the same time.

DAPS handover is not supported for NTN in this release of the specification.

##### 16.x.4.2.2 Conditional Handover

The same principle as described in 9.2.3.4 applies to intra-NTN Conditional Handover (CHO) as well as to NTN-Terrestrial Network CHO unless hereunder specified.

NOTE: NTN-Terrestrial Network CHO refers to mobility in both directions, i.e. from NTN to Terrestrial Network (hand-in) and from Terrestrial Network to NTN (hand-out).

NTN supports the following additional trigger conditions upon which UE may execute CHO to a candidate cell, as defined in TS 38.331 [12]:

- Measurement event A4 for CHO execution triggering.

- A time-based trigger condition.

- A location-based trigger condition.

A time-based or a location-based trigger condition is always configured together with the measurement-based trigger conditions (CHO events A3, A4 or A5).

**Question 2.6: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.7 Chapter 16.x.4.2 Mobility in RRC\_CONNECTED (Measurements only)

*The rapporteur recall here under the text as outcomes of the post RAN2#116-bis-e email discussion without ENs:*

#### 16.x.4.3 Measurements

The same principle as described in 9.2.4 applies to measurements in NTN unless hereunder specified.

The network can configure

* multiple SMTCs in parallel (including offset, periodicity) per carrier and for a given set of cells depending on UE capabilities using propagation delay difference, feeder link delay as well as serving/neighbour satellite cell ephemeris
* measurement gaps using the same propagation delay difference as computed for SMTC

The adjustment of SMTCs through shifts is possible under network control for connected mode and under UE control based on UE location information and ephemeris for idle/inactive modes.

**Question 2.7: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.8 Chapter 16.x.5 Switch over

*The rapporteur introduced this new chapter as per stg2 BL CR from RAN3:*

#### 16.x.5.1 Definitions

A feeder link switch over is the procedure where the feeder link is changed from a source NTN Gateway to a target NTN Gateway for a specific NTN payload. The feeder link switch over is a Transport Network Layer procedure.

Both hard and soft feeder link switch over are applicable to NTN.

#### 16.x.5.2 Assumptions

A feeder link switch over may result in transferring the established connection for the affected UEs between two gNBs.

For soft feeder link switch over, an NTN payload is able to connect to more than one NTN Gateway during a given period i.e. a temporary overlap can be ensured during the transition between the feeder links.

For hard feeder link switch over, an NTN payload only connect to one NTN Gateway at any given time i.e. a radio link interruption may occur during the transition between the feeder links.

#### 16.x.5.3 Procedures

The NTN Control function determines the point in time when the feeder link switch over between two gNBs is performed. The transfer of the affected UE(s)’ context between the two gNBs at feeder link switch over is performed by means of either NG based or Xn based handover, and it depends on the gNBs’ implementation and configuration information provided to the gNBs by the NTN Control function.

**Question 2.8: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.9 Chapter 16.x.6 Signalling

*The rapporteur introduced this new chapter as per stg2 BL CR from RAN3:*

The Cell Identity, as defined in TS 38.413 [26] and TS 38.423 [x], used in following cases corresponds to a Mapped Cell ID, irrespective of the orbit of the NTN payload or the types of service links supported.

- The Cell Identity indicated by the gNB to the Core Network as part of the User Location Information;

- The Cell Identity used for Paging Optimization in NG interface;

- The Cell Identity used for Area of Interest;

- The Cell Identity used for PWS.

The Cell Identity included within the target identification of the handover messages allows identifying the correct target cell.The Cell Identities used in the RAN Paging Area during Xn RAN paging allow the identification of the correct target cells for RAN paging.

NOTE: The Cell Identity used for RAN Paging is assumed to typically represent a Uu Cell ID.

The mapping between Cell Identities and geographical areas is configured in the RAN and Core Network.

The gNB is responsible for constructing the Mapped Cell ID based on the UE location info received from the UE. The mapping may be pre-configured (e.g., up to operator’s policy) or up to implementation.

NOTE: As described in TS 23.501 [3], the User Location Information may enable the AMF to determine whether the UE is allowed to operate at its present location. Pre-configuration of special mapped cell identifiers may be used to indicate areas outside the serving PLMN’s country.

The gNB reports the broadcasted TAC(s) of the selected PLMN to the AMF as part of ULI. In case the gNB knows the UE’s location information, the gNB may determine the TAI the UE is currently located in and provide that TAI to the AMF as part of ULI.

**Question 2.9: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.10 Chapter 16.x.7 AMF (Re-)Selection by gNB

*The rapporteur introduced this new chapter as per stg2 BL CR from RAN3:*

The gNB implements the NAS Node Selection Function specified in TS 38.410 [16].

For a RRC\_CONNECTED UE, when the gNB is configured to ensure that the UE is using an AMF that serves the country in which the UE is located.

If the gNB detects that the UE is in a different country to that served by the serving AMF, then it should perform an NG handover to change to an appropriate AMF, or initiate an UE Context Release Request procedure towards the serving AMF (in which case the AMF may decide to de-register the UE).

**Question 2.10: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.11 Chapter 16.x.8 O&M requirements

*The rapporteur introduced this new chapter as per stg2 BL CR from RAN3:*

The following NTN related parameters shall be provided by O&M to the gNB providing non-terrestrial NR access:

- Ephemeris information describing the orbital trajectory information or coordinates for the NTN vehicles. This information is provided on a regular basis or upon demand to the gNB;

- Two different sets of ephemeris format shall be supported

 - Set 1: Satellite position and velocity state vectors:

 - Position;

 - Velocity;

 - Set 2: At least the following parameters in orbital parameter ephemeris format, as specified in NIMA TR 8350.2 [y]:

 - Semi-major axis;

 - Eccentricity;

 - Argument of periapsis;

 - Longitude of ascending node;

 - Inclination;

 - Mean anomaly at epoch time to.

- The explicit epoch time associated to ephemeris data;

- The location of the NTN-Gateways;

NOTE: The ephemeris of the satellites and the location of the NTN-Gateways, are used at least for the Uplink timing and frequency synchronization. It may also be used for the random access and the mobility management purposes.

- Additional information to enable gNB operation for feeder/service link switch overs.

NOTE: The NTN related parameters provided by O&M to the gNB may depend on the type of supported service links e.g. earth fixed beams, quasi earth fixed beams, earth moving beams, etc.

**Question 2.11: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.12 Chapter 16.x.8 UE location aspects

*The rapporteur recall here under the text as outcomes of the post RAN2#116-bis-e email discussion without ENs:*

After AS security is established, gNB can obtain a GNSS-based location information from the UE using existing signalling method,

Periodic location reporting can be configured by gNB to obtain UE location update of mobile UEs in RRC\_CONNECTED

**Question 2.12: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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## 2.13 Annex B.x Example implementation of Non-Terrestrial Networks (informative)

*The rapporteur introduced this new chapter as per stg2 BL CR from RAN3:*

The following figure illustrates an example implementation of an Non-Terrestrial Network for transparent NTN payload:



Figure B-1: NTN based NG-RAN

The gNB depicted in Figure B-1 may be subdivided into non-NTN infrastructure gNB functions and the NTN Service Link provisioning System. The NTN infrastructure may be thought of being subdivided into the NTN Service Link provisioning System and the NTN Control function. The NTN Service Link provisioning System may consist of one or more NTN payloads and NTN Gateways.

The NTN payload is embarked on a spaceborne (or airborne) vehicle, providing a structure, power, commanding, telemetry, attitude control for the satellite (resp. HAPS) and possibly an appropriate thermal environment, radiation shielding.

The NTN Service Link provisioning System maps the NR-Uu radio protocol over radio resources of the NTN infrastructure (e.g. beams, channels, Tx power).

The NTN control function controls the spaceborne (or airborne) vehicles as well as the radio resources of the NTN infrastructure (NTN payload(s) & NTN Gateway(s)). It provides control data, e.g. Ephemeris, to the non-NTN infrastructure gNB functions of the gNB.

Provision of NTN control data to the gNB is out of 3GPP scope.

NOTE: The transport of NR-Uu protocol between the NTN Service Link provisioning system and the non-NTN infrastructure gNB functions is out of 3GPP scope.

At least the following NTN related parameters are expected to be provided by O&M to the gNB for its operation

a) Earth fixed beams: for each beam provided by a given NTN-payload:

- The Cell identifier (NG and Uu) mapped to the beam;

- The Cell’s reference location (e.g. cell’s center and range).

b) Quasi Earth fixed beams: for each beam provided by a given NTN-payload:

- The Cell identifier (NG and Uu) and time window mapped to a beam;

- The Cell’s/beam’s reference location (e.g. cell’s center and range);

- The time window of the successive switch overs (feeder link, service link);

- The identifier and time window of all serving satellites and NTN-Gateways;

c) Earth moving beams: for each beam provided by a given NTN-payload:

- The Uu Cell identifier mapped to a beam and mapping information to fixed geographical areas reported on NG, including information about the beams direction and motion of the beam’s foot print on Earth;

- Its elevation wrt NTN-payload;

- Schedule of successive serving NTN-Gateways/gNBs;

- Schedule of successive switch overs (feeder link, service link).

**Question 2.13: Do companies agree with the proposed text or have further suggestions ?**

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| **Company** | **Agree/Disagree** | **Comments/Suggestions** |
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**[Rapporteur summary]:**

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# 3. Summary and Proposals

This section summarizes the discussion and reports the following proposals:

Based on the feedbacks, the proposed modifications are implemented in the draft CR

# 4. References

1. R2-2202233 Draft NTN Stg2 Running CR Thales

# Contact information

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