**3GPP TSG-SA5 Meeting #154 *S5-242112***

Changsha, China, 15 - 19 April 2024

**Source: Ericsson LM, China Telecom**

**Title: Rel-19 pCR TR 28.874 New NTN study issue and use cases**

**Document for: Approval**

**Agenda Item: 6.9.15**

# 1 Decision/action requested

***Approve the pCR for inclusion in NTN Phase 2 study draft TR 28.874***

# 2 References

[1] 3GPP TR 28.874-000 Study on management aspects of NTN – Phase 2

[2] SP-231423 New SID Study on Management Aspects of NTN Phase 2

[3] 3GPP TR 23.700-29: " Study on integration of satellite components in the 5G architecture Phase 3".

[4] 3GPP TS 28.808: " Study on management and orchestration aspects of integrated satellite components in a 5G network ".

# 3 Rationale

In Rel-19, SA2 has started a study TR 23.700-29 [3] on supporting of regenerative-based satellite access and identified that in scenarios where the RAN node is on-board satellite, and the 5GC is on the ground, it will cause disconnection between the RAN node and the 5GC due to the satellite moving out of a certain area.

--- Start of quote from TR 23.700-29---

*5.1 Key Issue #1: Support of Regenerative-based satellite access*

*5.1.1 Description*

*The deployment of an eNB or an gNB on a satellite for regenerative based satellite access for LEO/MEO deployment is to be studied. The aspects to be studied include:*

*- Identify and study whether there is any impact on 5GS and EPS to support an gNB/eNB embedded on a satellite:*

*- any impact of RAN nodes changing for any given 5GC/EPC and for a given area in the case of RAN nodes moving.*

---End quote---

**Observation 1: RAN nodes on-board NGSO satellites will change for any given 5GC/EPC and for a given area.**

After three meetings, SA2 has come up with some full solutions on this issue, including solution#1-4, solution#9-10, and solution#34.

--- Start of quote from TR 23.700-29 Solution#1---

*The gNB/eNB knows, based on its ephemeris and configuration, that it is about to stop serving a certain 5GC/EPC area and it is about to lose the connectivity to the 5GC/EPC via a ground connection.*

---End quote---

--- Start of quote from TR 23.700-29 Solution#2---

*MME/AMF supports to be configured with ephemeris information of all on-board (ng-)eNB by O&M;*

---End quote---

--- Start of quote from TR 23.700-29 Solution#3---

*gNB, NTN GW,and AMF needs to implement the suspend and resume \NG connection.*

*eNB, NTN GW and MME needs to implement the suspend and resume S1 connection.*

---End quote---

--- Start of quote from TR 23.700-29 Solution#4---

*Pre-condition: AMF and RAN both are pre-configured with the mapping relationship among Global RAN Node ID, supporting TAI list, and valid period.*

---End quote---

--- Start of quote from TR 23.700-29 Solution#9---

*RAN agent:*

*- New NF, which is located near the satellite ground station. The functionalities can be referred to clause 6.9.1.*

*Proxy RAN node:*

*- New NF, which is co-located with RAN agent. The functionalities can be referred to clause 6.9.1.*

*Link Layer Proxy:*

*- New NF, located on the ground with 1:1 mapping relationship with MME/AMF set, decoupled from the NTN gateway locations. Functionality of the LLP is described in the solution.*

---End quote---

--- Start of quote from TR 23.700-29 Solution#10---

*The OAM aspects of the IWF are expected to be defined by SA5 WG.*

---End quote---

--- Start of quote from TR 23.700-29 Solution#34---

*The Satellite/gNB is configured with the address of AMF Agent based on the ephemeris information of the Satellite/gNB, and this information may be updated by the satellite operator.*

---End quote---

**Observation 2: To address the issue described in observation 1, the solutions proposed by SA2 have impacts on O&M.**

The previous SA5 study FS\_5GSAT\_MO [4] did not cover the use case described in observation 2, and there are no relevant requirements and potential solutions in the existing standards for 3GPP management system to support the use case of RAN node on-board satellite leaving an area served by a CN.

The work in FS\_5GSAT\_MO only investigated the new architecture scenarios for 5G networks with an NGSO regenerative satellite RAT, and provide one general requirement.

--- Start of quote from TR 28.808---

*[REQ-FS\_5GSAT\_MO-2.1-01] In a 5G network integrating an NGSO regenerative satellite RAT, the 5G network shall have the capability of managing moving gNBs or gNB-DUs.*

---End quote---

The previous SA5 work OAM\_NTN cannot cover this use case either, because the work carried out under the architecture of a 5G network integrating transparent satellite components.

**Observation 3: The existing SA5’s work cannot cover this use case.**

Based on the above observations, we found that in the case where RAN node is on-board satellite, and the 5GC is on the ground, it will cause disconnection between the RAN node and the 5GC due to the satellite moving out of a certain area. This is a new use case with O&M enhancement requirements.

Also, another issue of managing connections between the satellite RAN node and 5GC is the topology between space segment RAN node (MnS producer) and the ground based Management System (MnS consumer): With long distances in between, disturbances (e.g. bad weather conditions), and partial reachability issues (when satellites fly over oceans with no gateway coverage), the latency, availability and reliability of the interface between them (feeder link + Inter-satellite link) are impacted.

From the perspective of the operator, it is necessary to study how to efficiently manage the connection between RAN nodes on-board satellite and 5GC. This will assist SA2 to provide evaluation of different solutions and draw conclusions.

**Proposal: NRM enhancements need to be investigated to manage the connection between RAN nodes on-board satellite and 5GC.**

**Observation 4: Observation 3 also applies to NTN system with transparent satellite payload.**
Based on observation 3, we also found that the disconnection due to satellite moving out of a certain area also applies to NTN architecture with transparent satellite payload, i.e. in the case where sector equipment is on-board satellite, and the RAN node is on the ground, it will cause re-association between the RAN node and the sector equipment due to the satellites moving in and moving out of a certain area. This is a new use case with O&M enhancement requirements.

Also, another issue of managing connections between the satellite sector equipment and RAN node is the topology between space segment sector equipment (MnS producer) and the ground based Management System (MnS consumer): With long distances in between, disturbances (e.g. bad weather conditions), and partial reachability issues (when satellites fly over oceans with no gateway coverage), the latency, availability and reliability of the interface between them (feeder link + Inter-satellite link) are impacted.

From the perspective of the operator, it is necessary to study how to efficiently manage the connection between sector equipment on-board satellite and RAN node.

Proposal: NRM enhancements need to be investigated to manage the connection between sector equipment on-board satellite and RAN node.

With the observations and proposal above, this contribution is proposed to provide the new use case for management enhancement to support RAN node on-board satellite leaving an area served by a CN.

# 4 Detailed proposal

## 5.X Management of connections and associations between satellite and ground systems (gNB/eNB/CN/management system)

### 5.X.1 Use case #1: Connections between RAN node on-board satellite and CN (regenerative mode)

#### 5.X.1.1 Description

When non-geo synchronized objects like LEO and MEO satellites are used for the NTN system, the satellites will not always be at the same position relative the earth’s surface, and the coverage area on the earth surface for one satellite varies over time.

One consequence of non-geosynchronous satellites is that the associations between the entities on ground segment and entities in space segment are changing frequently, typically with a period of one to several minutes.



Figure 5.X.1.1-1 Non-geosynchronous satellites in NTN with regenerative gNB processed satellite payload

Fig. 5.X.1.1-1 illustrates this association change in an NTN system with regenerative gNB satellite payload. In this case, the ground segment Core Network (CN) will serve the same spotbeams all the time, while the space segment gNB on different satellites (satellite 1, 2 and 3) will serve the spotbeam in different time period as the satellites are approaching and leaving the coverage of the spotbeam over time. From management point of view, it will e.g. impact the association between GNBCUCPFunction and AMFFunction.

Another issue is the topology between space segment Managed Element (MnS producer) and the ground based Management System (MnS consumer): With long distances in between, disturbances (e.g. bad weather conditions), and partial reachability issues (when satellites fly over oceans with no gateway coverage), the latency, availability and reliability of the interface between them (feeder link + Inter-satellite link) are impacted.

Summary:

For the deployment scenario of RAN nodes on-board satellites, this would result in the following scenario: a LEO or MEO satellite with an onboard RAN node leaves the coverage area of a CN and then returns to the coverage area of that CN after cycling around the Earth.

From the operator’s perspective, It’s necessary to investigate how to efficiently manage the connections between RAN nodes and CN to avoid errors in CN due to stale connections, e.g. AMF/MME sending paging requests or AMF configuration updates to an unavailable RAN node. For example, 3GPP management system configures AMF/MME and/or gNB/eNB to add necessary information to support their awareness of when connectivity between a RAN node and a CN NF is available or unavailable.

#### 5.X.1.2 Potential requirements

**REQ-NTN-REGCON-1：**3GPP MnS producer should have the capability to configure the connections between RAN nodes on-board satellite and 5GC on an unreliable management interface.

#### 5.X.1.3 Potential solutions

##### 5.X.1.3.i Potential solution #<i>: <Potential Solution i Title>

#### 5.X.1.4 Evaluation of potential solutions

### 5.X.2 Use case #2: Associations between SectorEquipmentFunction on-board satellite and the RAN nodes (gNB/eNB) on ground (transparent mode)

#### 5.X.2.1 Description

When non-geo synchronized objects like LEO and MEO satellites are used for the NTN system, the satellites will not always be at the same position relative the earth’s surface, and the coverage area on the earth surface for one satellite varies over time.

One consequence of non-geosynchronous satellites is that the associations between the entities on ground segment and entities in space segment are changing frequently, typically with a period of one to several minutes.



Figure 5.X.2.1-1 Non-geosynchronous satellites in NTN system with transparent satellite payload

Fig. 5.X.2.1-1 illustrates this association change in an NTN system with transparent satellite payload. In this case, the ground segment gNB will serve the same spotbeams all the time, while different satellites (satellite 1, 2 and 3) in the space segment will serve the same spotbeam in different time periods as the satellites are approaching and leaving the coverage to the spotbeam over time. From management point of view, it will e.g. impact the association between NRSectorCarrier in the gNB and SectorEquipmentFunction in the satellite.

Another issue is the topology between space segment Managed Element (MnS producer) and the ground based Management System (MnS consumer): With long distances in between, disturbances (e.g. bad weather conditions), and partial reachability issues (when satellites fly over oceans with no gateway coverage), the latency, availability and reliability of the interface between them (feeder link + Inter-satellite link) are impacted.

Summary:

For the deployment scenario of SectorEquipmentFunction on-board satellite and the RAN nodes (gNB/eNB) on ground, this would result in the following scenario: a LEO or MEO satellite with an onboard SectorEquipmentFunction leaves the coverage area of a RAN node (gNB/eNB) on ground and then returns to the coverage area of that RAN node (gNB/eNB) after cycling around the Earth.

From the operator’s perspective, It’s necessary to investigate how to efficiently manage the connections between SectorEquipmentFunction on-board satellite and the RAN nodes (gNB/eNB) on ground due to stale connections. For example, 3GPP management system configures association between NRSectorCarrier in the gNB and SectorEquipmentFunction in the satellite, adding necessary information to support their awareness of when connectivity between the satellite and the RAN nodes (gNB/eNB) on ground is available or unavailable.

#### 5.X.2.2 Potential requirements

**REQ-NTN-TRANSCON-1：**3GPP MnS producer should have the capability to configure the associations between SectorEquipmentFunction on-board satellite and NRSectorCarrier in the RAN nodes (gNB/eNB) on ground on an unreliable management interface.

#### 5.X.2.3 Potential solutions

##### 5.X.2.3.i Potential solution #<i>: <Potential Solution i Title>

#### 5.X.2.4 Evaluation of potential solutions