NWM questionary for FS_5GSAT_Ph3_ARCH - Version 0.0.6

SA2

https://nwm-trial.etsi.org/#/documents/8852

1 Introduction

The present NWM document follows recommendations held in S2-2405527 ”Proposed process ahead of SA2”

To compare principles inherent to the different provided solutions, companies are kindly requested to answer to the following questions.

Reference to TR23.700-29 0.5.0 chapter providing descriptive part for a solution is welcome if principles are already described there.

2 questions for KI#1

With the assumption that we can categorize the solutions in:

Cat.1) Solutions which do not propose an intermediate IWF or proxy that can hide the mobility of eNB/gNB that is on board the satellite, and therefore migration of moving eNB/gNB (disconnecting and reconnecting a moving eNB/gNB leaving an area controlled by the CN) is needed

Cat. 2) Solutions which propose an intermediate IWF or proxy (called Intermediate GW for convenience) between the moving eNB/gNB and CN

Questions:

Feedback Form 1: KI1_Q1: Should Cat 1 solutions be supported? (Yes/No)

1 – Gatehouse Satcom A/S Yes
2 – VODAFONE Group Plc yes
3 – Qualcomm Technologies Int No
4 – Qualcomm Technologies Int Yes

5 – Qualcomm Technologies Int

Correct Qualcomm answer is ”Yes” (the 2 previous answers were ”on the job learning” first time NWM usage and can be ignored)

6 – MediaTek Inc.

Yes - we do not see a reason why Cat.1 should not be supported.

7 – vivo Mobile Communication Co.

Yes. This is a fundamental aspect of regenerative payload.

8 – Google Inc.

Yes

9 – China Mobile Com. Corporation

Yes, this is a basic aspect which we should studied.

10 – NOVAMINT

Yes - this category corresponds to the main aspect to be addressed in KI#1

11 – LG Electronics France

Yes

12 – Huawei Technologies R&D UK

Yes

13 – NEC Corporation.

yes

14 – Intel Deutschland GmbH

Yes

15 – Nokia Germany

YES, introducing IWF only shifts the problem from CN elements to IWF, it do not necessarily reduce signaling over the feeder link.

16 – THALES

Yes

17 – Dish Network Yes - and the final solution should minimize any complexity
18 – ZTE Corporation Yes
19 – Apple Distribution Intl Ltd Yes
20 – DOCOMO Communications Lab. Yes.
21 – Guangdong OPPO Mobile Telecom. Yes
22 – Samsung R&D Institute India Yes
23 – Ericsson LM Yes
24 – China Telecommunications yes
25 – Sateliot Yes
26 – CATT Yes
27 – Beijing Xiaomi Mobile Software Yes
28 – SES S.A. Yes, this is the baseline that has been discussed in the Rel-19 as baseline architecture. It is mandatory that Cat_1 solution works.
29 – Honor Yes.

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Feedback Form 2: KI1_Q2: Should Cat 2 solutions be supported? (Yes/No)

1 – Gatehouse Satcom A/S

Yes

2 – VODAFONE Group Plc

Neutral - I expect (but I may be wrong) that there would be RAN 3 work to do, e.g. if the IWF/proxy has a restart.

3 – Qualcomm Technologies Int

Yes

4 – MediaTek Inc.

We think Cat.1 is the minimum to be supported. In addition Cat.2 could be supported.

5 – vivo Mobile Communication Co.

Cat.2 can be an option for deployment considering no impacts added to CN and UE

6 – Google Inc.

Cat 2 can be supported based on operator's deployment without specification impacts.

7 – China Mobile Com. Corporation

Cat2 can be supported, but the specific impact should be further clarified, i.e. whether there is specification impact or not. Since if the IWF only touch the lower layer protocols and do not touch the signaling between eNB/gNB and AMF, which will be preferred. If not i.e. there is specification impact, we should further check with SA3 about the eNB/gNB changes while the AMF do not know the changes, whether there is any security problem.

8 – NOVAMINT

Cat.1 is the minimum to be supported. Optionally, Cat.2 could be supported but specific impact on the existing specifications should be further clarified

9 – LG Electronics France

No

10 – Huawei Technologies R&D UK

Yes

11 – NEC Corporation.

Cat 1 must be supported but Cat 2 can be optional.

12 – NEC Corporation.

Cat 1 must be supported but Cat 2 can be optional.

13 – Intel Deutschland GmbH

Yes. We expect that there will be no additional normative work to support deployments with IWF (Cat 2) other than a description in an informative annex in 23.501. The IWF is perceived as gNB/eNB by the CN and perceived as CN by the gNB/eNB, similar to the HeNB GW function (refer to 36.300 clause 4.6). We plan to provide a contribution for Jeju describing what the informative annex could look like.

14 – Nokia Germany

Can be considered as another deployment option, but none of the proposed solution on IWF/proxy explains how it can avoid standards impact. RAN3 study is required to figure out the possibility IWF/proxy for moving satellite scenario and its impact on core if any. Current HeNB GW do not deal with moving HeNB. RAN3 needs to confirm, if the current S1/NG interface can be kept intact.

15 – THALES

We believe that a new RAN Mobility Management Function (e.g: RMMF) (better name than existing IW) can be valuable to handle the mobility of e/gNBs wrt MMEs/AMFs. It can be added in the contour of the specifications of the core network. It may be deployed on board, at gateway or co-located with core network. However, this RMMF should not impact the N2 protocol. The RMMF shall support the S&F and UE-Sat-UE communication in all variants.

16 – Intel Deutschland GmbH

Replying to Nokia: the discussion in Changsha was that the IWF would support the interface mobility procedures defined for Cat 1 on the side facing the gNB/eNB.

There is no intent to ”keep S1/NG interface intact” on the IWF side facing the gNB/eNB.

The S1/NG interface is kept intact only on the side facing the CN.

Therefore there is no need for a ”RAN3 study” (beyond what they will study for Cat 1).

The analogy with HeNB GW is only in terms of how it is perceived by the RAN and the CN. The IWF functionality is obviously different from that of the HeNB GW.

17 – Dish Network

Neutral, and doubtable for the fully implementation specific IWF, need to evaluate if there is any issue

18 – ZTE Corporation

It is unclear about the functionality of IWF. It is better to show the protocol stack in details. SA2 should make decision whether to support this architecture.

19 – Apple Distribution Intl Ltd

Cat 2 can be optional.

20 – DOCOMO Communications Lab.

Yes, if time allows.

21 – Guangdong OPPO Mobile Telecom.

No

22 – Samsung R&D Institute India

No

23 – Ericsson LM

No. KI#1 can be solved by small updates to existing protocols and procedures (using cat-1 solutions) and a new IWF or Proxy does not seem justified. An IWF/Proxy will not be ”simple” and will not reduce the UE-specific signaling since it will need to be propagated to the AMF/MME to maintain the integrity of e2e procedures.

24 – China Telecommunications

Neutral. Cat2 is a deployment solution based on Cat1. Not sure, but there may be some other impacts beyond Cat1 which should be investigated by RAN3.

25 – Sateliot

It seems modifications identified as per Cat1 for NG/S1 interfaces are needed in any case, irrespective of whether these modifications are visible to the AMF/MME or hidden behind a proxy function.

If so, it seems reasonable to consider Cat1 as the must-have solution and treat Cat2 as an optional solution if justification exists that Cat2 is valuable/required for specific deployments/implementations.

26 – CATT

Neutral. it is claimed that Cat2 is a deployment solution which has no standard impact, but it is not clear whether OAM needs to configure this IWF, such as, an gNB/eNB ID for the IWF...

27 – Beijing Xiaomi Mobile Software

Yes Cat 2 can be an informative annex in 23.501

28 – VODAFONE Group Plc

In reply to Intel: your pointer to the HeNB GW section in 36.300 gives a strong hint that this IWF would have significant RAN impact.

29 – SES S.A.

Can be an option. Possibly, but with secondary priority, the focus should be on Cat_1 solution, which needs to work. An added value of an IWF could exist in specific architectures, but the baseline is to work without IWF.

For Cat 1 solutions, questions:

Feedback Form 3: KI1_C1_Q1: Should a procedure to handle the N2 and S1 connections in the Core Network when the gNB/eNB leaves an area served by an AMF/MME (e.g. when setting over the horizon) be supported? (yes/no/details)

1 – Gatehouse Satcom A/S

Yes - Satellite operators may require some level of IWF to interface to their respective ground-station/constellation/infrastru setups. The AMF/MME should have a procedure established to interface with the IWF and eNB/gNB in such cases (e.g. the IWF warns the AMF/MME that a satellite is about to leave the coverage area of a UE location and the MME/AMF goes through a handover procedure to another satellite)

2 – Gatehouse Satcom A/S

^UE location = GW location**

3 – VODAFONE Group Plc

yes

4 – Qualcomm Technologies Int

Decision is up to RAN3 as in S2-2405600

5 – MediaTek Inc.

Yes - but indeed RAN3 should decide.

6 – vivo Mobile Communication Co.

Yes, from CN's perspective, a procedure to notify AMF/MME is necessary considering how to manage the RAN context and how to select the correct RAN node(s) for sending paging requests. It is up to RAN3 to determine the final option about whether to reuse existing or new mechanisms/procedures.

7 – Google Inc.

Yes (it is up to RAN3

8 – NOVAMINT

yes and it is up to RAN3 to decide

9 – LG Electronics France

Yes, the message/procedure to be used is based on the reply LS from RAN.

10 – China Mobile Com. Corporation

Yes, should support.

11 – Huawei Technologies R&D UK

While not essential, as the same behaviour can be taken from a clean SCTP disconnect providing an indication up the stack that the N1/S1 connection has been disconnected, we can also see that a NGAP/S1AP Disconnect procedure may lead to neater handling. Nothing else is required for this scenario.

12 – NEC Corporation.

Yes. RAN3 will decide the possible procedure.

13 – Intel Deutschland GmbH

Yes

14 – Nokia Germany

YES, May be beneficial, but it is up to RAN3 to decide if it is required for RAN to gracefully disconnect.

15 – THALES

No strong view. Probably yes but maybe we can rely on legacy procedure and OAM

16 – Dish Network

Let's RAN3 decide it

17 – ZTE Corporation

Yes. RAN3 make decision. In our view the **N2 and S1 connection handling should cover the following aspects: node level NGAP connection, UE level NGAP connection, node level SCTP connection**

18 – Guangdong OPPO Mobile Telecom.

Yes. But this is in the remit of RAN3.

19 – Samsung R&D Institute India

Yes. We can align based on RAN3 decision.

20 – Ericsson LM Yes. There should be no need for further work in SA2 before RAN3 has discussed and concluded on the issue.
21 – China Telecommunications YES. At present we prefer disconnection procedures since it is simple and has no potential other problems. SA2 should align with RAN3 decision.
22 – CATT yes
23 – Beijing Xiaomi Mobile Software Yes, it's up to RAN3, we can align with RAN3 decision.
24 – SES S.A. Yes, absolutely, this is required and should be discussed in RAN#3.

Feedback Form 4: KI1_C1_Q2: Should gNB/eNB IP address change due to soft feeder link switch be supported using existing procedures? (yes/no/explanations)

1 – Gatehouse Satcom A/S No, we think that a minimal IWF could be used as an abstraction for the CN from this switch, so that the CN should address the eNB/gNB by the same identifier.
2 – VODAFONE Group Plc Neutral. A solution where the satellite uses different (logical) e/gNBs on the different feeder links is an alternative approach to changing the signalling and user plane IP address(es) of the e/gNB.
3 – Qualcomm Technologies Int Yes
4 – MediaTek Inc. Neutral
5 – vivo Mobile Communication Co. gNB/eNB IP address change is conditional and depends on deployment. - If by deployment the gNB/eNB IP address is changed due to the feeder link switch, it is valid to assume that existing procedures can be reused but requires the AMF/MME to have pre-knowledge of the changed IP address before sending new TNL associations to the RAN node, this is because that only AMF/MME can

establish new TNL associations, while RAN can only remove TNL associations as per TS38.413. Besides, this is only applicable when AMF/MME is not changed during feeder link switch, i.e. deployment should avoid a situation of changing AMF/MME during feeder link switch.

- If by deployment whenever feeder link switch happens, gNB/eNB changes its serving Global Node ID, the gNB/eNB IP address change issue can be supported by utilizing Xn/N2 handover procedure for (E)CM-CONNECTED UEs, and e.g. cell reselection procedure for (E)CM-IDLE UEs. This applies to both AMF change and AMF not change scenarios, but requires soft feeder link switch deployment.

6 – NOVAMINT

Neutral

7 – Huawei Technologies R&D UK

Yes. This is what we've already informed RAN3 by LS.

8 – NEC Corporation.

yes.

9 – Intel Deutschland GmbH

Not sure what is the intent behind this question. In the LS to RAN3 (S2-2405600) SA2 stated the following: "If the eNB/gNB IP address changes due to soft feeder link switch, SA2 assumes that this case can be supported using the existing procedures."

10 – Nokia Germany

YES, existing procedure should be sufficient for feeder link switchover. RAN3 needs to be involved if any changes are required.

11 – THALES

The Transport Network Layer procedure supporting feeder link switchover does not require network interface changes on e/gNBs like local endpoint IP address changes

12 – ZTE Corporation

Yes.

13 – Guangdong OPPO Mobile Telecom.

Yes, but the existing TNL procedures can be used to support the IP address change.

14 – Samsung R&D Institute India

Yes we have already stated this to RAN3. Thus I assume we already have agreement on this in SA2.

15 – Ericsson LM

Yes. Existing procedures are sufficient to handle feeder link switch.

16 – China Telecommunications

Yes. Existing procedures can handle soft feeder link switch.

If AMF/MME dose not change, then we prefer existing PDU Session Resource Modify Indication procedure, since it dose not need logical NG-RAN change. If NG-RAN can support TEID remaining unchanged when the IP address changes, then a new per node procedure is possoible. Above procedures are up to RAN3 decision.

17 – CATT

yes

18 – Beijing Xiaomi Mobile Software

Yes

19 – SES S.A.

This should remain an option possible.

Feedback Form 5: KI1_C1_Q3: Should it be assumed that the AMF/MME can treat the Mapped Cell IDs as per Rel-17? (yes/no)

1 – Gatehouse Satcom A/S

Yes

2 – Qualcomm Technologies Int

Yes as in S2-2405600

3 – MediaTek Inc.

Yes

4 – vivo Mobile Communication Co.

From RAN's perspective, yes. When a different RAN serves the same geographical area, the RAN can construct the mapped cell ID based on e.g. preconfigured mapping between Mapped Cell ID(s) and geographical area(s).

From AMF/MME's perspective, no. For a specific geographical area, AMF/MME may find plenty of corresponding Mapped Cell ID(s) (where only gNB ID may be changed in the format). When determining where to send the paging requests, AMF/MME needs enhancements to find out the correct RAN that is serving the geographical area at that moment, e.g. a RAN timetable as shown in Solution#2,#4

5 – Google Inc.

Yes

6 – NOVAMINT

Yes

7 – LG Electronics France

Yes

8 – China Mobile Com. Corporation

We think from AMF/MME perspective, the 5GC should know which one or few(limited number) gNB/eNB should be used to trigger the paging, instead of the plenty of satellites(carrying gNB/eNB). From this perspective, mapped cell id is not enough.

9 – Huawei Technologies R&D UK

Yes. This is what we've already informed RAN3 by LS.

10 – NEC Corporation.

yes

11 – Intel Deutschland GmbH

Yes. This too was indicated in S2-2405600 as: "SA2 assumes that AMF/MME can treat the Mapped Cell ID as per rel-17."

12 – Nokia Germany

YES, but it doesn't mean AMF/MME needs to translate Mapped cell IDs when it wants to page the UE using cell ID(s) of a new RAN node. mapped cell IDs are specific to a RAN node, if the RAN node changes, the mapped cell IDs can not be used for paging. Rather AMF/MME can use tracking area instead and leave it up to new RAN to decide the mapped cell based on the tracking area. AMF/MME needs to treat this as Rel-17 behavior.

13 – THALES

Yes, the Mapped Cell IDs are built at the RAN et is reported to OAM and CN

14 – ZTE Corporation

Yes. Prefer not to impact the AMF.

15 – Guangdong OPPO Mobile Telecom.

Yes

16 – Samsung R&D Institute India Yes
17 – Ericsson LM Yes
18 – China Telecommunications Yes. Same view as Nokia.
19 – CATT yes, but AMF behaviour on paging optimization needs to be specified
20 – Beijing Xiaomi Mobile Software Yes, but if RAN node changes, the mapped cell id defined as per R-17 cann't be used to paging directly, this needs to be resolved with minimum impact on CN
21 – SES S.A. Yes. (Reminder in Release 17 a mapped cell ID corresponds to a fixed geographical area irrespective of satellite orbit(s), so in fact this provides a static layer for the NTN NW to facilitate handovers etc which seems to be the objective of IWF)

For Cat 2 solutions, questions:

Feedback Form 6: KI1_C2_Q1: Shall the intermediate GW play the role of "earth fixed" eNB/gNB towards the CN and the role of AMF/MME/UPF towards eNB/gNB? (yes/no/details)

1 – Gatehouse Satcom A/S No, we think the intermediate GW could be a generic interface towards the CN in front of individual constellations, to enable switching of satellites/feeder-links, and GWs while the MME/AMF handles mobility as usual by interfacing directly with the eNB/gNB.
2 – Qualcomm Technologies Int Yes
3 – MediaTek Inc. If it is indeed per KI#1 only the BS that is onboard then this principle would indeed be the right approach - which concentrates the complexity into that very GW, making the rest basically agnostic to such GW.

4 – vivo Mobile Communication Co.

Yes, this is the reason why we have the Intermediate GW onboard in SA2. This can be an option to hide all impacts of regenerative payload from CN's perspective.

5 – LG Electronics France

Yes, because the main objective of the Cat2 solution is to minimize the impact on the core network.

6 – Gatehouse Satcom A/S

Revised comment: Yes, this enables the abstraction of the payload being regenerative.

7 – China Mobile Com. Corporation

This answer is not clear since the impact of the IWF for the specification in SA2 is not clear.

8 – Huawei Technologies R&D UK

Yes

9 – Intel Deutschland GmbH

Yes. The IWF is similar to the HeNB GW (36.300 clause 4.6) in that it is perceived as gNB/eNB by the CN, and as CN by the gNB/eNB, although their purpose is very different (the HeNB GW is basically a concentrator aiming to solve the scalability issue caused by a large number of HeNBs, whereas the IWF is intended to hide the gNB/eNB mobility to the CN). The use of IWF should allow the introduction of regenerative payload with unmodified Rel-17/Rel-18 CN deployments.

10 – Nokia Germany

YES, but it needs further RAN3 analysis to ascertain if there is no impact to existing NG/S1 interface towards core. HeNB GW probably do not get involved in U-plane handling.

11 – THALES

yes for playing the role of earth-fixed gNB, AMF/UPF could be designed by the network operator to always be the same for a given country/service thanks to ISL and in-constellation routing

12 – NOVAMINT

yes

13 – ZTE Corporation

It is unclear whether the **intermediate GW terminates the S1/N2 interface. Better to show the protocol stack.**

14 – DOCOMO Communications Lab. Yes.
15 – Guangdong OPPO Mobile Telecom. Yes
16 – Ericsson LM See reply to KI1_Q2 (feedback form 1)
17 – China Telecommunications Yes. But but there may be some other issues to be investigated by RAN3.
18 – CATT not sure, RAN3 is also discussing such IWF architecture, should we wait for RAN conclusion?
19 – Beijing Xiaomi Mobile Software Yes. At least from CN perspective.
20 – SES S.A. Yes, this seems to be a reasonable solution in case IWF is selected as the way forward. IWF shall terminate the NG interface from AMF/UPF towards the 5G-AN(s) then map and forward the signaling according to the NTN orbital dynamics & RAN configuration.

Feedback Form 7: KI1_C2_Q2: Shall Intermediate GW use existing N2/N3/S1 interfaces to connect to CN? (yes/no/details)

1 – Gatehouse Satcom A/S No, per aobve
2 – VODAFONE Group Plc At least for R19, yes.
3 – Qualcomm Technologies Int Yes
4 – MediaTek Inc. If introduced, yes, this should comply with existing interfaces.

5 – vivo Mobile Communication Co.

Yes, same reason as C2_Q1.

6 – LG Electronics France

Yes, In order to minimize the impact to the CN, the Intermediate GW shall use existing N2/N3/S1 interfaces as much as possible.

7 – Gatehouse Satcom A/S

Revised comment: Yes, this enables the abstraction of the payload being regenerative.

8 – China Mobile Com. Corporation

Still, the impact is not clear. We support to reuse the existing signaling, while in this case, what kind of impact should be further clarified, or not impact.

9 – Huawei Technologies R&D UK

Yes

10 – Intel Deutschland GmbH

Yes. With the use of IWF we expect no impact on the CN.

11 – Nokia Germany

Yes, only if RAN3 determines no interface impact in introducing proxy/IWF. As the impact is also towards S1-U/N3 further analysis is needed.

12 – THALES

Yes. Difficult in Rel-19 to introduce a new “Nx” interface for this specific use case.

13 – Dish Network

Hopefully

14 – NOVAMINT

yes no new interface

15 – ZTE Corporation

It is unclear whether the **intermediate GW terminates the S1/N2 interface. Better to show the protocol stack.**

16 – DOCOMO Communications Lab.

Yes.

17 – Guangdong OPPO Mobile Telecom.

yes. But the security aspects may need to be studied in SA3.

18 – Ericsson LM

See reply to KI1_Q2 (feedback form 1)

19 – China Telecommunications

Yes. Hopefully. But RAN3 investigation is needed.

20 – CATT

not sure

21 – Beijing Xiaomi Mobile Software

Yes, reusing the existing procedure as much as possible.

22 – SES S.A.

Yes. This is going to be in fact the major advantage for SNOs of IWF solution. Reusing N2/N3 interfaces without impact for NTN will allow to reuse 5G CN between TN & NTN NW and achieve better economies of scale.

Feedback Form 8: KI1_C2_Q3: Shall intermediate GW be responsible for propagating the additional ULI information to AMF/MME with the mapped cell-id and TAC information as is the case in existing NTN architecture defined in TS 23.501 [2] and TS 23.401 [5]. (yes/no)

1 – Gatehouse Satcom A/S

No

2 – Qualcomm Technologies Int

Yes

3 – MediaTek Inc.

If introduced, yes.

4 – vivo Mobile Communication Co.

If take C2_Q1 as an assumption, forwarding ULI and/or TAC (from onboard RAN) is not enough, the Intermediate GW should change the Global RAN Node ID in both ULI and TAC information to make the CN understand it is a “fixed” eNB/gNB.

5 – Gatehouse Satcom A/S

Revised comment: Yes

6 – Huawei Technologies R&D UK

Yes, but this is not new behaviour.

7 – Intel Deutschland GmbH

Yes, as in Rel-18.

8 – Nokia Germany

No, additional ULI would mean interface impact. It may be different mapped cell ID due to translations maintained by IWF but the ULI information need to remain same as per rel-18 towards core network.

9 – ZTE Corporation

It is unclear whether the **intermediate GW terminates the S1/N2 interface. Better to show the protocol stack.**

10 – DOCOMO Communications Lab.

Yes.

11 – Guangdong OPPO Mobile Telecom.

Yes

12 – Ericsson LM

It is not clear what is meant with additional ULI information. In general, an intermediate GW need to propagate all UE-specific signaling in order to maintain the integrity of the e2e procedures.

13 – China Telecommunications

Not clear what additional ULI means. If it means existing R18 ULI information for NTN, e.g. TAC list in ULI, intermediate GW should suppotr it.

14 – CATT

hope it is no, otherwise the IWF would be a new 3GPP network function instead of a deployment option.

15 – Beijing Xiaomi Mobile Software

Yes, same view as Huawei (it's not a new behavior)

16 – SES S.A.

No. In case of IWF there should be no need for Mapped Cell-IDs.

Feedback Form 9: KI1_C2_Q4: Shall existing intra or inter-intermediate GW mobility S1/N2 handover procedures be used to support handover between satellites with common or different earth station locations? (yes/no/details)

1 – Qualcomm Technologies Int

CN S1/N2 handover procedures must not be impacted. RAN handover procedures can change.

2 – MediaTek Inc.

Same view as Qualcomm

3 – vivo Mobile Communication Co.

Same view as Qualcomm

4 – China Mobile Com. Corporation

Same as previous answer, the impact should be firstly clarified.

5 – Huawei Technologies R&D UK

Not sure this is question is a generic question or something directly related to Cat 2. We are replying as question on regenerative payload in general and not specific to Cat 2.

Feeder link switch from a "setting" NTN gateway which accesses "setting" CN NFs to a "raising" NTN gateway that can only access "raising" CN NFs (i.e. no connectivity to "setting" CN NFs), in this case the UEs will have be released to CM_IDLE before the change of NTN gateway. If there is connectivity then the existing load balancing / handover procedures can be used as required (e.g. if the path cost to the old CN NFs is prohibitive, as determined by the deployment/operator).

Therefore, existing procedures can be used.

6 – Intel Deutschland GmbH

Yes. If the IWF needs to change (for whatever reason) the existing N2/S1 handover procedure can be used.

7 – Nokia Germany

There is no existing intra or inter intermediate GW mobility procedure. If the question is meant to ask if there is any HO procedure change required when introducing GW change, then answer is **NO.**

8 – Dish Network

Sorry but hard to understand the question

9 – NOVAMINT

question unclear

10 – ZTE Corporation

It is unclear whether the **intermediate GW terminates the S1/N2 interface. Better to show the protocol stack.**

11 – Guangdong OPPO Mobile Telecom.

Yes

12 – Ericsson LM

It is not clear what is meant with existing GW mobility handover procedures. See also reply to KI1_Q2 (feedback form 1).

13 – China Telecommunications

Question is not clear. If it is for GW change, then existing S1/N2 handover procedures can be used.

14 – CATT

not sure

15 – Beijing Xiaomi Mobile Software

Yes, the existing S1/N2 handover procedure can be used when GW changes.

16 – SES S.A.

Inter- IWF mobility should use existing N2 handover procedure. Intra IWF mobility shall be supported by new handover procedure, or as an Xn handover procedure when there is an Xn connection between the NTN gNBs of one IWF.

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Feedback Form 10: KI1_C2_Q5: Shall SA2 document Intermediate GW in informative Annex in TS 23.501 [2] and TS 23.401 [5] during the normative phase of the work? (yes/no)

1 – Gatehouse Satcom A/S

Yes (interface towards and procedures expected from it)

2 – Qualcomm Technologies Int

Yes – at a high level to allow different detailed implementations

3 – vivo Mobile Communication Co.

If the resulting Intermediate GW architecture adds no additional complexity to UE and CN compared to Cat.1 and/or existing NTN architecture defined in TS 23.501 [2] and TS 23.401 [5], it can be documented in Annex as a deployment option for operators.

4 – LG Electronics France

No

5 – China Mobile Com. Corporation

Same as previous answer the IGW impact or functionality should be firstly clarified. Then decide whether to document it.

6 – Huawei Technologies R&D UK

Yes. It can be documented as a deployment option.

7 – Intel Deutschland GmbH

Yes. For Jeju we plan to propose text for the informative annex (similar to the HeNB GW description in 36.300 clause 4.6).

8 – Nokia Germany

NO, As explained in Form 6 & 7, there can be some standards impact. Unless RAN3 verifies the IWF/proxy related impact, this cannot be considered as a deployment option.

9 – Dish Network

Depending on the discussion conclusion !

10 – NOVAMINT

eventually depending on the conclusion but it will mean it is clear there will be no normative work on this approach and it will need to outline that further impact needs to be verified by RAN3 if/when they have the will and the mandate through dedicated WID objective

11 – ZTE Corporation

It is unclear whether the **intermediate GW terminates the S1/N2 interface. Better to show the protocol stack.**

12 – DOCOMO Communications Lab.

Yes.

13 – Guangdong OPPO Mobile Telecom.

No, there is not a thorough analysis in the documented solutions, and ENs have not been addressed either. So, we do not think we can reach a conclusion to document Intermediate GW in informative Annex.

14 – Samsung R&D Institute India

No. If this has no impact on SA2 specs, then I fail to see the need for documenting this in SA2 specs.

15 – Ericsson LM

No. See also reply to KI1_Q2 (feedback form 1).

16 – China Telecommunications

Yes, if RAN3 can conclude it. In the normative phase, SA2 can wait RAN3 conclusion.

17 – CATT

wait for RAN3 conclusion

18 – Beijing Xiaomi Mobile Software

Yes

19 – VODAFONE Group Plc

Somewhat similar to the HeNB GW, I would expect limited/no impact to SA2 documents AND rather LARGE impact to RAN 36.300/38.300.

20 – SES S.A.

Inter- IWF mobility should use existing N2 handover procedure. Intra IWF mobility shall be supported by new handover procedure, or as an Xn handover procedure when there is an Xn connection between the NTN gNBs of one IWF.

21 – SES S.A.

(correction) If the Intermediate GW is retained as an option, then SA#2 should work on the architecture details and document this according to working group practice, which likely would require updating these documents.

3 Questions for KI2

In the first round of discussion (with timeframe discussed in S2-2405527), it is necessary to have a set of question to finalize global assumptions and principals:

Questions:

Feedback Form 11: KI2_Q1: please indicate if the multi-satellites scenario needs to be supported (as listed in the hypothesis of the study...) (yes/no/ motivation the ”no” to justify it)

1 – Gatehouse Satcom A/S

Yes

2 – VODAFONE Group Plc

Yes. But note that (in my understanding) having more satellites does not on its own reduce latency, instead it is having more than one earth station that reduces latency. Hence the solutions ought to describe how multiple earth stations are handled.

3 – Qualcomm Technologies Int

Yes

4 – MediaTek Inc.

Yes

5 – vivo Mobile Communication Co.

A multi-satellite scenario is needed considering the shorter period to complete the attach procedure and data transmission, but should be able to fall back to a single satellite deployment situation, otherwise, a solution to a single satellite scenario is needed.

6 – LG Electronics France

No, Multi satellite can reduce the delay for signalling procedures and MO/MT data transfer delay. But there is no requirement for single and/or multi satellite need to be supported or not and the S&F operation is targeted to the delay tolerant service. Therefore, it is not necessary to use multi satellite scenario.

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7 – NOVAMINT

Yes - the support of multi satellite is a fundamental principle of NGSO constellation - single satellite is a substract of multi satellite i.e. any solution working with multiple satellite will work with only one satellite while a solution made only for single satellite may not work with multiple satellites

8 – China Mobile Com. Corporation

Yes

9 – Nokia Germany

YES, single satellite-based S&F will significantly increase the delay in network access and service availing time delays.

10 – Huawei Technologies R&D UK

Support of multiple satellites is required. We cannot document 2 options (single satellite option and multi-satellite option) in the TS.

11 – NEC Corporation.

Yes. the system should support both single and multi-satellite deployment.

12 – Intel Deutschland GmbH

Yes.

13 – THALES

yes, the market for S&F in a 1-satellite constellation is very limited

14 – Dish Network

Yes, same reason with Thales

15 – ZTE Corporation

Yes

16 – OPPO

Yes, but the fall back to a single satellite deployment should also be supported. For example, users who have subscribed to a low-cost communications service to meet requirements of their delay-tolerant requirements might find that a single satellite deployment is more cost-effective.

17 – Samsung R&D Institute India

Yes - multiple satellite options should be supported. But it should implicitly support single satellite based mechanism otherwise single satellite based mechanism is required. i.e. a mechanism in which we can restrict subset of UEs to satellite-1 and another subset to satellite-2.

18 – Ericsson LM

The system should support both single and multi-satellite deployment.

19 – Sateliot

Yes, the solution should be valid for multi-satellite operation.

Deployment with single-satellite would be just a particular case.

Allowing a UE to be served by different satellites within the constellation is key to reducing the revisit time for the UE. Note that the revisit time with a single satellite in typical LEO orbits may be around 12h or longer (see R2-2107453). Therefore, restricting the solution to single-satellite would mean that a UE wil only be able to send/receive data e.g. twice a day on average.

In relation to the comment from Vodafone, yes, it is our understanding that the solution should be able to work with several ground stations/NTN gateways. However, we would like to note that is is a separate aspect and has no impact on the revisit time (which is mainly given by the multi-satellite) but it definitively has an impact on the transfer latency (i.e. the time elapsed since e.g. data is gathered from a UE and data can be downloaded in a ground station) and storage capacity on board.

20 – China Telecommunications

Multiple and single satellite shoud be supported by same same solution. Multiple earth stations should also be supported as mentioned by Vodafone and Sateliot.

21 – CATT

yes

22 – Beijing Xiaomi Mobile Software

Yes, but multi-satellite option should support single satellite based scenario. Otherwise, single satellite based solution is also required.

23 – SES S.A.

Yes, multi-satellite system support is required, although also single satellite system support is needed as well.

24 – Tencent

Yes, multi-satellite should be supported and the solution should also support single-satellite as a sub-case.

Feedback Form 12: KI2_Q2: please indicate if Roaming needs to be supported and explain which roaming definition in S&F Satellite operation is considered.

1 – VODAFONE Group Plc

yes, roaming needs to be supported. NB-IoT and LTE-M are ”IoT” and IoT is normally delivered with non-geographic IMSI ranges and permanently-roaming devices. For urgent/emergency messaging, it will be a major disadvantage to have to already have taken out a subscription with a satellite-only operator.

2 – Qualcomm Technologies Int

Yes, where roaming means that a UE can access a ground based VPLMN with no VPLMN pre-configuration but where satellite pre-configuration is not precluded.

3 – MediaTek Inc.

Yes where the network on the ground could indeed be a visited network.

4 – vivo Mobile Communication Co.

Roaming is ok to support if there is clear market profit but can only be taken as an objective in normative if any spec impact is detected. In the TR phase, no solution has taken roaming into account.

5 – Google Inc.

yes, roaming needs to be supported to make S&F satellite operation useful.

6 – NOVAMINT

Roaming: The ability for a user to function in a serving network different from the home network. The serving network could be a shared network operated by two or more network operator. (TR 21.905, TR 22.951)

Yes - Roaming is a fundamental principle which needs to be supported by the solutions for store and forward as it will be used as coverage extension to MNOs.

Regarding the eventual preconfiguration of the satellite to support this for some solutions, it needs to take into account the ”real life” deployments i.e scalability taking into account the following aspects:

- it is not unimaginable for a satellite operator to have roaming agreements with quite a lot of MNOs (> 10 and even >100 in the future)

- new roaming agreements can be concluded on a regular bases

=> so likely not operational for a sat operator to have to configure the HSS in all the satellites from the constellation all the time

7 – China Mobile Com. Corporation

Neutral. R19 time is limited, and currently the solutions in this TR not all can cover roaming. What’s more, this requirement is not provided at the beginning. If raoming supported, then the whole aspcts should be standardized, i.e. charging, UPF generate the online/offline usage information. If not, for this rel-19, no roaming still ok.

8 – Gatehouse Satcom A/S

Yes, agree that roaming needs to be supported for S&F.

9 – Nokia Germany

YES, Roaming: the UE is being served by different PLMN than its H-PLMN. It is most likely to see UE being served by different PLMN than its H-PLMN in satellite scenario. since S&F is envisioned for remote areas, it is utmost important for satellite operators.

10 – Huawei Technologies R&D UK

Allowing other networks subscribers to access via a satellite PLMN could be important, however this can be achieved without using the existing roaming interfaces, and many solutions don't require them to operate. We need to be clear on what Roaming means – all existing procedures or ability of subscribers of another network to use the S&F via another PLMN?

11 – NEC Corporation.

Yes, roaming needs to be supported.

12 – Intel Deutschland GmbH

Yes. The satellite network needs to be able to serve users from any PLMN. By referring to roaming support we also assume that there will be no preconfigured user-specific information on the satellite.

13 – THALES

Yes, where the network on the ground could indeed be a visited network.

14 – Dish Network

Yes, good to support but not our highest priority

15 – ZTE Corporation

It is unclear what kind of roaming, e.g. between the NTN operator and TN operator, or between the TN operators, or betwen the NTN operators.

16 – OPPO

yes, but we should also consider the case where the satellite operator is the same as the home operator, that means the satellite can holds the subscription data and credentials for the UE.

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17 – Samsung R&D Institute India

Yes Roaming has to be supported. Support of Roaming using SA2 defined roaming procedures in which MME onboard the satellite should be able to reach to any HSS(across globe) based on roaming agreements.

If operators want to use IMSI switch mechanism as warranted for few solutions, this can be additional deployment mechanism. But in our view this cannot be mainstream solution.

18 – Sateliot

Yes, roaming has to be supported.

Roaming is already a consolidated capability in 3GPP networks. In our opinion, a solution for S&F should not restrict or condition the use of existing roaming capabilities.

Indeed, we consider that roaming is a fundamental capability for satellite operators to be able to provide coverage extension solutions (i.e. serving as a Visited PLMN) to a terrestrial MNO (serving as a Home PLMN) without requiring any pre-configured information about the potential roaming subscribers in the Visited PLMN (i.e. access in the Visited PLMN can be just performed using the SIM issued by the Home PLMN and relying on conventional roaming interconnection between the two networks).

19 – China Telecommunications

Yes, roaming is needed. But in Release19 it should refers to and be limited to traditional roaming. For S&F satellite operation, a ’roaming ’ UE located in a VPLMN can also be served by onboard MME which belongs to HPLMN, if this can be deployed. This deployment looks like RAN sharing.

20 – CATT

yes, roaming means any UE can access the VPLMN based on the subscription in its HPLMN

21 – Beijing Xiaomi Mobile Software

Neutral, considering R19 time units□we’d better focus on non roaming case first, unless there is strong market requirement for roaming case.

22 – SES S.A.

Yes. Roaming is mandatory to be supported from our point of view. Inter-satellite coverages roaming is required for mobility and roaming between different operators optionally.

23 – Tencent

Yes, roaming should be supported

Feedback Form 13: KI2_Q3: please indicate if MO/MT SMS service, CIoT CP, CIoT UP data exchange and additional types of data exchanges (please list it) need to be supported. (please answer yes/no for each type)

1 – Gatehouse Satcom A/S

MO/MT SMS: yes

CIoT CP data: yes

CIoT UP data: not necessarily

2 – VODAFONE Group Plc

MO/MT SMS: yes

CIoT CP data: yes

CIoT UP optimisation: no (as any UE RRC context is likely to be in a different satellite)

normal UP data: probably not

3 – Qualcomm Technologies Int

MO/MT SMS: Yes (essential)

CIoT CP: Yes (essential)

CIoT UP: Yes (preferred)

Regular UP and IMS: Yes (nice to have)

4 – MediaTek Inc.

MO/MT SMS: Yes, must-have

CIoT CP: Yes, must-have

CIoT UP: Yes, if possible

Normal UP: Nice-to-have

5 – vivo Mobile Communication Co.

MO/MT SMS: Yes in this release

CIoT CP: Yes in this release

CIoT UP: Yes (preferred) in this release, if not, the chosen architecture should be able to be enhanced to support CIoT UP in the next release without adding additional CN NF(s) onboard

Normal UP: Nice-to-have

6 – Google Inc.

MO/MT SMS: yes

CIoT CP data: yes

others: next release

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7 – LG Electronics France

MO/MT SMS: yes

MO/MT CIoT CP data: yes

MO/MT CIoT UP data: yes

8 – NOVAMINT

MO/MT SMS: Yes (essential)

CIoT CP: Yes (essential)

CIoT UP: if possible/nice to have (better if solutions do not prevent support of UP)

Normal UP: Nice-to-have

9 – China Mobile Com. Corporation

MO/MT SMS: Yes, must-have

CIoT CP: Yes, must-have

CIoT UP: Yes, must-have

Normal UP: If there is approach to have it, nice-to-have

10 – Nokia Germany

MO/MT SMS: **YES**

Control Plane CIoT: **YES**

CIoT UP (N3 data transfer): **NO**, though, it may be studied in RAN for further possibility, as store and forward operation needs to be done in RAN. On-board UPF is not preferable for us to avoid high computational need (packet filtering, charging, etc..).

Normal UP data: **NO**, delay tolerant services using normal UP data in S&F mode is not required.

11 – Huawei Technologies R&D UK

Which transports (e.g. UP or CP) can be used is only part of the solution, coupled with that is which data types can be used (e.g. TCP, UDP, nonIP etc) (e.g. CP data transfer can support TCP/IP). We should avoid mixing up the 2 aspects.

Control Plane CIoT EPS Optimisations (e,g, user data over control plane): Yes

User Plane CIoT EPS Optimisations: If user plane data transfer is supported then they can additionally be supported (i.e. User Plane CIoT EPS Optimisations requires the support of user plane data transfer, but user plane data transfer does not require the support of User Plane CIoT EPS Optimisations).

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12 – NEC Corporation.

MO/MT SMS : Yes

CP CIOT: Yes

UP CIOT : Yes

13 – Intel Deutschland GmbH

MO/MT SMS: Yes

CP CIoT: Yes

No need for other data services. Keep in mind that this network operates in Store-and-Forward manner, meaning that no TCP-based traffic (or any other traffic relying on e2e feedback for that matter) can be handled.

14 – THALES

MO/MT SMS: Yes (essential)

CIoT CP: Yes (essential)

CIoT UP: Yes (preferred)

Regular UP and IMS: Yes (nice to have)

15 – Dish Network

MO/MT SMS: Yes (essential)

CIoT CP: Yes (essential)

CIoT UP: Yes (nice to have)

16 – ZTE Corporation

It is better to support all. However due to time restriction R19 can focus on CIoT CP first.

17 – OPPO

MO/MT SMS: Yes

CIoT CP: Yes

CIoT UP: No

18 – Samsung R&D Institute India

MO/MT SMS: Yes (essential)

CIoT CP: Yes (essential)

CIoT UP: Yes (nice to have)

Regular UP: Yes (nice to have)

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19 – Ericsson LM MO/MT SMS: Yes CIoT CP: Yes CIoT UP: Yes
20 – Sateliot MO/MT SMS: Yes, must-have CIoT CP: Yes, must-have CIoT UP: Nice-to-have Normal UP: Nice-to-have
21 – China Telecommunications MO/MT SMS: Yes CIoT CP: Yes CIoT UP: No. Otherwise it means more impact on RAN, or more NFs (e.g. UPF) onboard satellite.
22 – CATT MO/MT SMS: yes CIoT CP data: yes CIoT UP data: optional
23 – Beijing Xiaomi Mobile Software MO/MT SMS: Yes CIoT CP: Yes CIoT UP: Yes
24 – SES S.A. Yes for MO/MT SMS services and CIoT CP. Possibly (nice to have) for CIoT UP. Regular UP and IMS: Yes.
25 – Tencent MO/MT SMS: Yes CIoT CP: Yes CIoT UP: Yes

Feedback Form 14: KI2_Q4: please indicate principals to use to support UE location verification (high level principals).

1 – Gatehouse Satcom A/S

Spoof satellite position a bit and observe whether timing and frequency error in UL pre-compensation corresponds to the given UE location. Spoof-corrections could be given to verified UEs if needed (spoofing impacts RAN performance depending on level necessary)

2 – VODAFONE Group Plc

Use GNSS position in a encrypted/integrity protected NAS message. The S&F satellites are non-GEO. Hence the UE needs a reasonably accurate position from GNSS in order to calculate the correct timing advance and doppler shift correction in order for the eNB to decode the UE's transmission. Each NAS message forwarded by the eNB on the satellite to the MME should include a new SA1-AP IE that carries the time at which the UE sent the NAS message.

3 – Qualcomm Technologies Int

UE sends its GNSS location to a satellite using RRC or NAS as in Release 18. Satellite then determines whether coverage is permitted and to which ground based PLMN(s). Ground based PLMN can make an additional coverage determination as in Release 18.

4 – MediaTek Inc.

No change to UE behavior vs Pre-R19.

5 – vivo Mobile Communication Co.

no additional impact on UE compared to R18 defined UE location verification mechanism.

6 – China Mobile Com. Corporation

no additional impact on UE

7 – Nokia Germany

Reuse of Rel17/18 mechanism to use GNSS and coarse location-based UE location verification is sufficient.

8 – Huawei Technologies R&D UK

UE Location Verification is important and must be supported to ensure compliance. There are existing (pre-Rel-19) mechanisms that can be leveraged.

9 – NEC Corporation.

Use existing Rel-17/18 procedure.

10 – Intel Deutschland GmbH UE location verification defined in Rel-17 can be used.
11 – THALES As mentioned above, UE sends its GNSS location to a satellite using RRC or NAS as in Release 18. Satellite then determines whether coverage is permitted and to which ground based PLMN(s). Ground based PLMN can make an additional coverage determination as in Release 18.
12 – NOVAMINT Re-use of existing Rel-17/18 procedures.
13 – ZTE Corporation Re-use existing mechanisms.
14 – OPPO No additional impact on UE
15 – Samsung R&D Institute India Existing mechanisms can be used.
16 – Ericsson LM Re-use of pre-rel-19 solutions is preferable.
17 – Sateliot Re-use existing mechanisms. No additional impact on UE.
18 – China Telecommunications Re-use of pre-rel-19 solutions for UE location verification for NTN access.
19 – CATT Re-use existing Rel-17/18 procedure
20 – Beijing Xiaomi Mobile Software Reuse of existing Rel-17/18 mechanisms is preferable. No additional impact on UE.
21 – SES S.A. Principle as defined in Release-18 is sufficient basis. GNSS can be used in many cases. Requirements outside that scope do not require standard compliance. No additional impact on UE.

22 – Tencent

Reuse pre-Rel-18 mechanisms is preferred

Feedback Form 15: KI2_Q5: which security principles, requirements and hypothesis are needed (in coordination with SA3)? (Briefly describe the principles).

1 – VODAFONE Group Plc

Mixture of SA3 and CT 4, but the delayed NAS signalling sent through the S&F system must not cause harm if the UE has (after starting to Attach/TAU with the S&F satellite) subsequently attached to another network.

SA3-LI: the different lists of LI targets for the different countries the satellites fly over shall NOT be stored in the satellite.

SA3-LI: the earth stations may need to route signalling and user plane traffic to the country where the UE was located. (This could be done based on timestamps provided by the satellite and knowledge of the satellite orbit and/or earth stationary cell ID.)

2 – VODAFONE Group Plc

SA3 - For multi-satellite systems, the ”ground MME” is likely to send the same authentication vectors to multiple/all satellites in the constellation. SA3 need to comment on the acceptability of this.

3 – Qualcomm Technologies Int

Security should align with Release 18 with no change if possible. Deviations from Release 18 need SA3 approval. We have proposed IOPS for UE-satellite security which has no impact on security procedures except in a USIM.

4 – vivo Mobile Communication Co.

Different architectures and attach procedures may reveal different security issues, e.g. MME split architecture may enable an FBS to track a UE by assigning T-GUTI. Therefore, it is proposed to agree a principle that SA2 will make a decision on the chosen architecture and send LS to SA3 to let SA3 consider the security risks. This can help to avoid the “chicken-egg” situation.

5 – China Mobile Com. Corporation

It is suggest we can send a LS to SA3, to check some architecture solutions, e.g. whether the MME-proxy has problem, whether the whole MME on board has problem, or whether the HSS/UDM on board has problem.

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6 – Nokia Germany

In multi-satellite S&F, the NAS/RRC keys are centrally stored in MME/AMF on ground (Soln 11). So, there is no key sharing with multiple satellite. This enables to reuse existing security/authentication mechanism for both EPS/5GS. SA3 may need to study the denial of service to a UE till it gets successfully attached/registered. Similar condition in terrestrial access exist but in S&F the expected time to get attached/registered/authenticated is longer. How to build trustworthiness of satellite during initial access needs to be studied by SA3.

7 – Huawei Technologies R&D UK

Security is important; however, it is not totally clear what SA2 can do for this at this point apart from select solutions which will not result in changes to the security mechanisms.

8 – NEC Corporation.

This question is not clear to me. What are the security options SA2 is considering? IMO we should leave it to SA3 to decide.

9 – Intel Deutschland GmbH

Security should be left to SA3.

10 – THALES

Agree that security should align with Release 18 with no change if possible. Deviations from Release 18 need SA3 approval. We also have proposed IOPS for UE-satellite security @SA3 which has no impact on security procedures except in a USIM, plus “inverse AKA” with AV generated by USIM, that also maintains security level and enable to send small data payload together with ATTACH messages request and response, to be able to exchange data between terminal and satellite at the first and single fly-over.

If SA3 accepts inverse AKA scheme, this could be a simple way to have a simple solution for one shot small messaging, in addition to the full set of S&F SA2 principals.

To avoid the “chicken-egg” situation, SA2 needs to freeze the architecture and inform SA3 about it.

11 – NOVAMINT

leave this decision to SA3 once SA2 has frozen the possible architecture(s)

12 – ZTE Corporation

SA3 will discuss the security aspects in details

13 – OPPO

Suggest sending LS to SA3, for example, checking how to provide security credentials (i.e. long-term keys) between UE and the network.

14 – Samsung R&D Institute India

In last meeting there was proposed LS to SA3 to get their confirmation. But there was a view that SA2 should agree the solution(conclude) and if any security impacts arise, SA3 is expected to solve. Thus we should put our efforts to conclude the KI#2 and assume SA3 will solve the problems which can arise due to agreed solution for S&F.

15 – Ericsson LM

Security is in SA3 scope. SA2 solutions that are not aligned with rel-18 security principles need SA3 feasibility analysis.

16 – Sateliot

Security should be validated in SA3. However, to avoid a "chicken-egg" situation, SA2 may need to converge on the possible architecture(s) before involving SA3.

17 – China Telecommunications

Same view as China Mobile. Since most solutions have possible security issues, we should quickly send a LS to SA3, to validate different architecture hypothesis.

18 – CATT

LS to SA3 is necessary.

19 – Beijing Xiaomi Mobile Software

Security issue should be left to SA3.

20 – TNO

KPN

SA3 - Subscription data and keys should NOT be stored on the satellite, because they need an extraordinary level of security and should not be sent over the feeder link. Furthermore, if the owner of the satellite and the operator are not the same company, then operators will definitely not want to store any subscription data and keys in another owner's network.

21 – VODAFONE Group Plc

In reply to Nokia: In order to discuss with SA3, I think that you need to show the realistic terrestrial deployment of your multiple earth stations in solution 11 (e.g. not Rennes and Orleans, but Rennes and New-Orleans).

22 – SES S.A.

Security principles can be based on previous Release-18 principles for the purpose of these networks. Additional optional security can be implemented on top and can be discussed in SA#3.

23 – Tencent

Agree security issues should be discussed and decided by SA3

Feedback Form 16: KI2_Q6: Do specific principles to optimize UE power consumption needs to be considered? (Briefly describe the principles).

1 – VODAFONE Group Plc

R17 (non-standardised) mechanisms and R18 discontinuous coverage mechanisms might be sufficient?

2 – Qualcomm Technologies Int

All solutions are susceptible to high UE power consumption and can probably use similar means to reduce this. Therefore, there seems no need for power consumption to be a principle or criterion for solution agreement. Instead, this aspect can be included as part of a WI for later agreed solutions.

3 – MediaTek Inc.

Not really. Having said that, minimizing UE power consumption is of course important. But ultimately what is important here is to provide service to the UE where service would otherwise not be provided - and this naturally will come with added UE power consumption (it is expected). We do not expect this be a decisive criteria, unless a solution is blatantly terrible for the UE. Also, clear (pref. quantified) evidence should be shown of what ”savings” a particular solution would claim.

4 – vivo Mobile Communication Co.

There is no solution discussed for power consumption. Can be considered in the next release.

5 – Google Inc.

UE power consumption needs to be one of the solution evaluation factor. The mechanism is for UEs use services applicable for S&F operation. R18 discontinuous coverage mechanisms can be enhanced for UEs that do not need services for S&F.

6 – LG Electronics France

The UE operate in Store and Forward Mode can stay ECM Idle (RRC suspend) during it is not covered by the serving satellite(s) (single and/or multi), also the UE may only attempt to access the satellite which have S&F capability.

7 – China Mobile Com. Corporation

Seems no need.

8 – Gatehouse Satcom A/S

No specific power consumption needs to be considered, besides the general understanding that power needs to be minimized.

9 – Nokia Germany

NO, the existing Rel-18 discontinuous coverage timer is sufficient.

UE power consumption should not be considered as a criterion for solution evaluation/conclusion.

10 – Huawei Technologies R&D UK

Reducing UE power consumption is important, i.e. to avoid it spending unnecessary energy on satellites that cannot/will not have DL traffic for it or the UE does not want to use.

For optimisation of power consumption we recommend that the UE, based on delay sensitivity of the data and status, requests the network to only monitor a subset of the satellites (e.g. only 1, all, etc). If the CN accepts such request, the CN will ensure that MT data destined for the UE is loaded on one of the satellites the UE is monitoring.

In addition, the CN can provide information about which "raising" satellites out of the list of satellites the UE monitors, can/will have (and therefore which "raising" satellites cannot/will not have) information for the UE, allowing the UE to save power as the UE won't spend unnecessary energy on those satellites and additionally it can save network resources as the UEs won't speculatively connect to those satellites which cannot have information for the UE.

11 – NEC Corporation.

UE power consumption is important during the registration procedure as registration procedure will take longer timer probably not deterministic. so saving energy when the UE is registering becomes more important. **eDRX procedure can only work when UE is successfully registered.**

12 – Intel Deutschland GmbH

Power consumption and related optimizations have not been studied. Any optimizations should be left for a future release.

13 – THALES

Not in this release

14 – Dish Network

Rel-18 discontinuous coverage timer is sufficient.

15 – NOVAMINT

no - however, we should not have solutions having unnecessary UE power consumption

16 – ZTE Corporation

depends on purticular proposal. Currently we believe existing mechniasm is sufficient.

17 – OPPO

No, the existing mechanism is sufficient. However, how long time and how much NAS signaling interaction does it take to complete the attach procedure can be considered as one of the evaluation criteria.

18 – Samsung R&D Institute India

Yes if there is less impact to system.

19 – Ericsson LM

No specific power consumption topic has been studied. Existing mechanisms seems sufficient.

20 – Sateliot

While not negatively impacting on UE power consumption is paramount, existing mechanisms seem sufficient.

In our understanding, no specific power consumption issues have been raised so far due to the support of a S&F service.

21 – China Telecommunications

Same view as Qualcomm. If time permits, this aspect can be considered in WI.

22 – CATT

this should be a general principle to be considered in normative phase.

23 – Beijing Xiaomi Mobile Software

Prefer to reuse existing mechanisms

24 – SES S.A.

No additional requirements specifically for these types of UEs.

25 – Tencent

Yes if standards impact is not much

Feedback Form 17: KI2_Q7: Which shall be maximum time for a UE to attach and access services? (immediate on serving satellite? consecutive -and different- satellites? next same satellite serving occurrence? other (please explain)?)

1 – VODAFONE Group Plc

As long as it takes... but it should decrease as more satellites and earth stations are deployed. Operation with Rel 17 UEs is highly desirable.

2 – Qualcomm Technologies Int

Immediate satellite access is obviously preferred. Satellite access which first requires a ground PLMN to be notified and respond (e.g. which might take an hour or several hours) risks several types of failure – e.g. UE is not accessible later, UE finds alternative coverage, user loses patience and restarts initial access.

3 – MediaTek Inc.

This is intending to allow data push/pull in areas where no data push/pull would otherwise be possible, bearing in mind in CIoT scenario, data aren't delay sensitive as such. Having said that it is important to ensure predictable system behavior (from both NW and UE points of view), and thus avoid procedures hanging in mid-air for "too long". CT1 could provide some guidance on this or simply decide on how long timers could run - there is some trade-off to be had. It is also important to enable operation with Rel-17 and Rel-18 UEs (new UEs could be more patient)

4 – vivo Mobile Communication Co.

It is expected that more evidence on satellite constellation, and earth station deployment is needed before calculating the time. Here is an example, if take the polar satellite orbit into account□

- The "next same satellite serving occurrence" may take a minimum 12×3=36 hours to complete the attach procedure (e.g. solution#16), where 12 hours is an average period to enable a polar orbit satellite to come back to serve the same geographical area, 3 is the rounds of "feeder-service link availability" pattern; and may take a minimum of 12 hours to make the MO data arrive at the data center.

- The "consecutive and different-satellite" may take a shorter period, e.g. 36÷4=9 hours to complete the attach procedure, where 4 stands for the number of satellites in the same orbit. The period depends on the number of satellites in the same orbit and also the deployment of earth stations; and may take a minimum of 12 hours to make the MO data arrive at the data center if the MO data is only carried by only 1 satellite;

- The "immediate on-serving satellite" takes the shortest period to complete the attach procedure, but requires placing the whole CN on every satellite (high CAPEX); and may take a minimum of 12 hours to make the MO data arrive at the data center if the MO data is carried by only 1 satellite.

5 – LG Electronics France

This depends on the architecture option and ephemeris and constellation of satellite that can cover the UE.

6 – Gatehouse Satcom A/S

Our comments match comments provided above (QC, MTK, LG).

7 – Nokia Germany

Since S&F is meant to serve delay-tolerant services, the time UE takes to attach and avail of services should not matter. The maximum time will depend on the number of satellites, number ground stations, and UE's location to determine whether consecutive satellites or different satellites are needed to serve the UE. "Immediate on serving satellite" will require all core network elements, including edge compute and application servers in satellite, which will be an over engineered solution for delay-tolerant services and is not scalable.

8 – Huawei Technologies R&D UK

The delay question for attach, while interesting to observe, will always be present for all solutions which either don't have a complete enough CN onboard, or have to fetch additional information from the ground. This delay calculation will also be relevant for many procedures, and not just Attach, that require a response (depending upon NFs onboard).

This delay calculation is highly dependent on the satellite deployments.

9 – NEC Corporation.

There is no deterministic way to know when the attach procedure will finish in case of S&F architecture. how can make an assumption here? Probably this question needs to be clarified further. it is not clear to NEC what exactly we want to know.

10 – NEC Corporation.

There is no deterministic way to know when the attach procedure will finish in case of S&F architecture. how can make an assumption here? Probably this question needs to be clarified further. it is not clear to NEC what exactly we want to know.

11 – Intel Deutschland GmbH

We understand ”attach” and ”access to service” to be two different things. The ”attach” can take as long as needed and depends on the number of deployed satellites. Once the UE is ”attached”, the ”access to service” should be immediate (i.e. as soon as the UE re-establishes contact with the satellite).

12 – THALES

System should provide a way to send/receive immediately small data pieces to/from the serving satellite, for example with secured ATTACH payload (see KI2_Q5 – inverse AKA scheme). As it is not possible to exchange big pieces of data on single fly-over, constrains need to be relaxed for big data amount where nice to have solution is handing the data transfer over consecutive and different satellites

13 – NOVAMINT

Agree with Intel - the attach depends on the number of satellites and ground stations deployed and should not be a factor as anyway it will ramp up and then the ”access to service” once attached should be immediate

14 – ZTE Corporation

In our view ”Attach” means the UE is authorized and accepted by the network, and Access to service means that the UE sends uplink traffic or receive downlink traffic. Attach may take time because the authorization procedure needs both service link and feeder link. The access to service can be very quick because the satellite on board can store the traffic.

15 – OPPO

Prefer Immediate on serving satellite. The maximum time for a UE to attach and access services depends on specific architecture deployment and service requirements.

16 – Samsung R&D Institute India

With least number of CN elements onboard(i.e. less CAPEX) and have maximum possible processing capability(without the need to goto ground network) in terms of protocol - is the idealistic solution to choose. We should choose the solution which is close to this ideal behavior to reduce the time to attach and access services.

17 – Ericsson LM

The smaller the better but it should be weighed against overall system complexity.

18 – Sateliot

As commented by many above, delays will depend mostly on the specific deployment (number of satellites and orbits, number of ground stations and its locations).

What is important in our view, is that the solution provided by the standard is flexible enough to accommodate different potential delays and does not prevent improving the delay as the deployment scales up (adding more satellites, adding more ground stations).

With respect to the initial attach procedure, in our opinion it is not critical if this cannot be performed during a single satellite pass and it needs at least two satellite passes. Note that if the S&F solution supports multi-satellite, these two passes to perform the attach may correspond to different satellites, thus reducing the delay of the procedure.

Then, once the UE is registered into the network, the UE should be able to send/transmit data any time a new satellite is flying over (no need to be the same serving satellite all the time).

19 – China Telecommunications

Same view as Sateliot.

20 – CATT

depends on service layer requirements

21 – Beijing Xiaomi Mobile Software

Share the same view as Intel and ZTE

22 – TNO

KPN

At the moment, none of the solutions presented address the scenario where NO end-to-end link is present and thus an attach procedure cannot be completed. In order to have a comprehensive study, we need to propose solutions for when an end-to-end link is not available, because there is no way to guarantee that that an end-to-end link will be available at any time for every location on the Earth.

23 – SES S.A. Quasi immediate network access is mandatory for on serving satellite shall be supported as a minimum. This should be comparable to terrestrial network access times (a few seconds).
24 – Tencent The delay-tolerant services which use S&F feature normally don't have demanding requirements on delay, thus not sure if immediate network access is a must. Also the delay performance is highly dependent on deployment instead of protocol design itself.

Feedback Form 18: KI2_Q8: do legacy UEs (Rel-17 & Rel-18 UEs) need to be supported? (yes/no/justification)

1 – VODAFONE Group Plc ideally, yes. It increase the number of supportable UEs.
2 – Qualcomm Technologies Int No – while limited support seems possible with some solutions, error cases would probably arise when a legacy UE moves to another satellite and the user experience would be bad.
3 – MediaTek Inc. Ideally yes.
4 – vivo Mobile Communication Co. No. legacy UE support is only a plus which cannot be a principle, besides, based on current solutions, error cases may happen if legacy UE is supported
5 – LG Electronics France No, the UE requires new capability or the UE need to suspend the ongoing signalling procedure or wait for the data exchange. So, legacy UEs cannot be supported.
6 – China Mobile Com. Corporation Netrual
7 – Gatehouse Satcom A/S No, even though legacy UEs might be able to be supported in certain conditions, they likely will have an overall, negative influence on other UEs experiences and general network resource utilization (error cases).
8 – Nokia Germany No

9 – Huawei Technologies R&D UK

We believe it is not possible to have zero impact to a UE (up to and including the application) for S&F operation, as at least we expect applications to adjust their behaviour / operate in a S&F way. The main aspect we can consider is the impacts to the 3GPP procedures and it is important to ensure that the 3GPP procedures (i.e. the part we can control in SA2) does not have to change or should be changed as little as possible, otherwise it will not be possible to complete the work.

10 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

11 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

12 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

13 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

14 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

15 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

16 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

17 – NEC Corporation.

No. it will have impact on the user experience. user is not going know that it is camping on a S&F supported cell and can't make voice call or not reachable for MT voice services. to certain extent SMS could be possible but successful SMS transmission case will be very rare.

18 – NEC Corporation.

sorry repeated post. the system seemed hanged and clicked on "Post" to many times.

19 – Intel Deutschland GmbH

Yes, definitely. We are aware of public announcements from three different satellite network operators saying that they have successfully demonstrated texting from unmodified smartphones in direct-to-satellite communication. It would be totally counter-productive for 3GPP to develop a solution that does not provide at least some limited support (e.g. MO/MT SMS) to unmodified smartphones.

20 – THALES

As for regenerative payload, legacy UE shall be able to access to regenerative architecture-based access network. But for S&F, it will be needed to add new system messages to support the service (S&F availability, estimated time to deliver data,…)

21 – Dish Network

Ideally Yes

22 – NOVAMINT

the point is more it is a bonus if the solutions do not prevent to support legacy UEs

23 – ZTE Corporation

It is not possible that the solution has no UE impact.

24 – OPPO

Yes, if possible.

25 – Samsung R&D Institute India

No solution in the TR supports this. We think its not possible to support S&F for legacy behaviors.

The UEs do not support S&F mechanism should be barred/not trigger signaling on the cells which support only S&F mechanism.

26 – Ericsson LM

No, it does not seem realistic in practice, considering the complexity and differences compared to regular "e2e" access.

27 – Sateliot

Yes.

Our view is that the current standard does not prevent deploying a minimum S&F service with R17/R18 UEs by relying on the application layer to handle the S&F nature of the network. For instance, a R17/R18 UE can try to register into a R17/R18 satellite network and, if the initial attach in a first satellite pass gets rejected but the application is aware that the rejection is due to the S&F operation of that network, the application can simply re-attempt the initial attach in a next pass.

In the same way, once the UE is registered, the application can limit the amount of data to be transmitted in each satellite pass to account for S&F constraints.

From this perspective, we think Rel-19 should bring new capabilities into the standard that will allow for an enhanced S&F operation (signaling that the network operates in S&F, rejection cause due to S&F, timers for the UE to know when to re-attempt, etc.) so that R19 devices could benefit from these enhancements while not preventing R18/R17 UE devices still be handled.

28 – China Telecommunications

NO. It is not possible to support legacy UEs from the solutions in the TR

29 – CATT

Not necessary

30 – Beijing Xiaomi Mobile Software

No. But, of course solutions supporting legacy UE without any UE impact is preferable.

31 – Gatehouse Satcom A/S

Revised comment: Neutral, if legacy UEs can be supported in certain conditions (as an extra win/bonus) without a negative influence on other UEs experiences (error cases).

32 – NOVAMINT

to complete previous comment - yes

33 – SES S.A.

Ideally yes, support of legacy terminals is preferred whenever possible.

34 – Tencent

Neutral, legacy UE can be supported when doable but should not use legacy UE support as a criteria to select solution for TR conclusion.

Feedback Form 19: KI2_Q9: In addition to onboard RAN, shall the objective be to minimize the CN functionalities on the satellite payload? (yes/no/justification).

1 – VODAFONE Group Plc

HSS and PDN GW should not be on the satellite as roaming support is essential.

Other CN functions are OK as they are trivial in complexity compared to the eNB.

2 – Qualcomm Technologies Int

No - CN functionalities on the satellite payload are irrelevant. What mainly matters are the UE and ground PLMN impacts.

3 – Qualcomm Technologies Int

No - CN functionalities on the satellite payload are irrelevant. What mainly matters are the UE and ground PLMN impacts.

4 – MediaTek Inc.

Same view as expressed by Vodafone above.

5 – vivo Mobile Communication Co.

Yes, such an objective is already agreed in the SID and solutions are developed based on this assumption to e.g. make attach work, reduce the CAPEX

6 – LG Electronics France

Yes, Once a satellite is deployed, it is difficult to update and manage, so it is desirable to keep the CN functionalities on the ground as much as possible.

7 – China Mobile Com. Corporation

Not understand the purpose of this question. The UDM/HSS on board can definitely make the whole attach/registration/PDU session establishment procedure more simple. If there is some concern for this UDM/HSS data on board, a LS to SA3 maybe needed.

What's more, for current satellite, the payload i.e. compute, storage ,electricity, are not big issue, so it is possible to bring the whole 4GC/5GC onboard.

8 – Gatehouse Satcom A/S

Yes, matching to the current SID scope. It should be an advantage to keep Core functionalities as much as possible centralized, and not distributed (with an S&F constellation). 6G could optimize distribution - if necessary.

https://nwm-trial.etsi.org/#/documents/8852

9 – Nokia Germany

YES, it is a regen satellite at first with only RAN on-board. We should keep it that way by only introducing the bare minimum functionality to help with S&F operations.

10 – Huawei Technologies R&D UK

There has to be a balance. Splitting NFs between the ground and satellites adds lots of complexity and potentially massively impacts many many CN interfaces, therefore if the objective is read as minimising impacts as much as possible to the NFs and their interfaces, then all NFs shall be onboard. If we choose not to standardise the interfaces for split NFs then we are left (only?) with UE interface impacts to consider.

11 – TNO

KPN-

CN functionalities onboard the satellite should be kept to a minimum, and esp UDM/HSS should NOT be on the satellite.

12 – NEC Corporation.

We should avoid putting CN on the satellite.

13 – Intel Deutschland GmbH

Not really. What matters is the impact on the UE and the ground CN. In any case we do not see the need for any CN function on board other than some MME functionality.

14 – THALES

Embark only the necessary to perform S&F operations, like for regenerative, embark only the necessary to support UE-SAT-UE communications. CN NFs are very memory consuming (contexts are remanent), so shall be minimized on board

15 – Dish Network

Yes, onboarding CN functionalities should be minimum and as much as possible on the ground

16 – OPPO

No, what matters is the impacts on the existing procedures and mechanisms.

17 – ZTE Corporation

We supports to keep some CN functionalities onboarding. Also agree that it is better to keep the UDM and PDN GW on the ground as much as possible.

18 – Samsung R&D Institute India

Atleast MME onboard should be supported.

19 – Ericsson LM

No, CN NFs onboard is OK. This needs to be weighed against overall system complexity. Having existing CN NFs onboard should be simpler compared to the complexity introduced with e.g. new NFs or splitting existing NFs.

20 – Sateliot

Same view as expressed by Vodafone and MTK.

21 – China Telecommunications

Some NF should be onboard, to minimize the possible impact on RAN. Prefer to keep the HSS and PDN GW on the ground.

22 – CATT

yes, but it also depends on the satellite payload capability

23 – Beijing Xiaomi Mobile Software

Yes, such an objective is already agreed in the SID.

24 – NOVAMINT

Some NF functions should be on board like partial MME to be efficient and to address the service however we consider that HSS and PDN GW should not be on board as it will prevent roaming which is key

25 – SES S.A.

Yes, we should minimise the functionality onboard the satellite required and keep that to only the required minimum, however it needs to be considered in a system and application context. We need to create a basis for the satellite systems to be optimised on only the needed functions but keep the option to include the necessart functions onboard, some of which may be CN NFs. There should be no need for new NFs to be introduced.

26 – Tencent

Support to put some CN functions on board and some on ground as long as satellite payload capability can accommodate.

Feedback Form 20: KI2_Q10: Do new NFs need to be introduced to support S&F? (yes/no/justification).

1 – VODAFONE Group Plc

Split of MME with some parts on the satellite and some parts on earth is probably needed. Otherwise probably nothing new is essential.

2 – Qualcomm Technologies Int

No new RAN or CN NFs should be added for a ground PLMN. New NFs in a satellite or NTN gateway can be added if there are no 3GPP impacts.

3 – MediaTek Inc.

Similar view as above.

4 – vivo Mobile Communication Co.

No, existing NFs are enough to handle the S&F

5 – LG Electronics France

No, Existing NFs can be enhanced.

6 – China Mobile Com. Corporation

No

7 – Gatehouse Satcom A/S

No

8 – Huawei Technologies R&D UK

3GPP should not define proprietary NFs. A new 3GPP NF to support information about satellites and their movements can be considered, however this is not just for KI2.

9 – NEC Corporation.

No

10 – Nokia Germany

Yes, A split of MME/AMF is needed to make a light-weight CN functionality to handle S&F, which is an extension of existing network element. It is a reuse of existing MME/AMF functionality without the security key/UE's CM state handling. The split MME/AMF requires coordination with MME/AMF in ground for security key/UE/s state (MME/AMF on the ground will be doing all the heavy lifting). In the ground network UE reachability estimator (URE) NF is a good way to keep track of satellite movement and choose the appropriate satellite for DL data/signaling. But again, this can be implemented within AMF/MME without standard impact.

11 – THALES

No strong view.

12 – Intel Deutschland GmbH

No new NF. As stated earlier, we only see the need for some MME functionality on board.

13 – Dish Network Not necessary
14 – OPPO Yes, if multiple satellites deployment is supported, new NF(or existing NF) on the ground need to be introduce (enhanced) to synchronized the UE context, RM/CM states with those satellites that could provide coverage to the UE.
15 – ZTE Corporation No. prefer to update some existing NFs.
16 – Samsung R&D Institute India Split of MME with some parts on the satellite and some parts on earth is needed.
17 – Ericsson LM No
18 – China Telecommunications No. If some function is needed, it can be implemented in existing NF.
19 – Sateliot We think it's not necessary
20 – CATT no new defined NF
21 – Beijing Xiaomi Mobile Software Not necessary.
22 – NOVAMINT No - not necessary
23 – SES S.A. No. We believe existing NFs are sufficient and can be enhanced for the support of regenerative satellites with RAN functions.
24 – Tencent Neutral, as long as the functions to be supported is clear, fine with either new NF or enhancing existing NF.

Feedback Form 21: KI2_Q11: If NFs need to be introduced to support S&F, is it in 3GPP scope? (yes (which TS)/no/justification).

1 – VODAFONE Group Plc Probably the High level description (stage 2) of MME split should be described by SA2 in order for SA3 to perform the security analysis.
2 – Qualcomm Technologies Int No – if in a satellite or NTN gateway and 3GPP procedures are not impacted. Yes otherwise
3 – MediaTek Inc. See above.
4 – vivo Mobile Communication Co. same view as KI2_Q10
5 – LG Electronics France It depends on the architecture option to be used for S&F operation.
6 – China Mobile Com. Corporation No new NF introduced.
7 – Huawei Technologies R&D UK 3GPP shall not define proprietary NFs.
8 – Nokia Germany **Yes**, any new NF and its interface change, and behavior change needs to be standardized and is within the scope of 3gpp. otherwise, we will end up having interoperability/scalability issues.
9 – Intel Deutschland GmbH No new NF.
10 – OPPO It depends on whether the 3GPP procedures are impacted
11 – ZTE Corporation No new NF.

12 – ZTE Corporation No new NF.
13 – Ericsson LM No new NF
14 – China Telecommunications No new NF
15 – Sateliot It depends on whether the 3GPP procedures are impacted
16 – CATT no new defined NF
17 – Beijing Xiaomi Mobile Software No new NF.
18 – NOVAMINT no - in principle no new NF - the study has already shown that they are several solutions reusing existing NF so no need to focus on new NF
19 – SES S.A. No.
20 – Tencent same view as KI2_Q10

4 Questions for KI3

In the first round of discussion (with timeframe discussed in S2-2405527), it is necessary to have a set of question to finalize global assumptions and principals:

Questions:

Feedback Form 22: KI3_Q1: Shall the solution supports UEs served with different interconnected satellites as per the hypothesis of the study? (yes/no/ if ”no” give the justification of hypothesis downscoping)

1 – Qualcomm Technologies Int

No - because the complexity introduced to support UEs with different interconnected satellites is greater than the benefit it provides.

2 – vivo Mobile Communication Co.

Yes.

3 – Nokia Germany

Yes. The use of ISL is essential. Otherwise, we will end up supporting UE-Sat-UE only for the same satellite coverage, which will cause frequent call drops in moving satellite scenario.

4 – Huawei Technologies R&D UK

No.

Support of interconnected satellites, while attractive, also brings additional issues and problems that need to be resolved, dependency on ISL which is agreed to be out of scope of 3GPP. Note also that it cannot be expected that each satellite in a constellation is connected to every other satellite (i.e. LEO satellites normally only connect to other satellites in the same planar orbit). Furthermore, the latency introduced by the ISL is not predictable and could be worse than when the traffic is routed through the ground.

Finally, for scenarios such as mission critical, support in a single satellite is sufficient.

Therefore, we recommend that we should start with single satellite scenarios in this release.

5 – THALES

same comment as Nokia Germany

6 – DOCOMO Communications Lab.

Yes. Given most solutions assume ”LEO” satellites, these satellites are mobile and the coverage area changes. Hence, to support UE-Sat-UE communication for a longer duration of time, support of interconnected satellites over ISL is necessary.

7 – Guangdong OPPO Mobile Telecom.

We believe in this release, we should downscope this key issue to consider the scenario where both UEs are served by one satellite. The scenario of UEs served by different interconnected satellite requires IMS system to verify the satellite constellation to obtain the inter-link information between the satellites, which we might not have enough TUs to study in this release.

It is also specified in the clause 4 of TR 23.700 that the study of the scenario when two UEs are under the coverage of the same satellite will be prioritized.

8 – ZTE Corporation

Yes. However we are also fine to focus on single satellite in this release.

9 – Ericsson LM

The 2 UEs must be served by the same satellite, same HPLMN, and LI can be supported with AGW on the satellite. This is the only case for UP optimization to be considered. Once this condition is not applicable then the UP and AGW on the ground is to be used.

10 – China Telecommunications

Yes. Same view as Nokia.

11 – CATT

yes, but for realistic considerations on TU left, we are also fine to focus on single satellite in this release.

12 – China Mobile Com. Corporation

Yes, for LEO scenario limiting the solution to single satellite case will dramatically limit the usage of the outcome of the study.

13 – NOVAMINT

Yes same view as Nokia

14 – SES S.A.

Yes, it is required to support ISL and UE-Sat-UE use cases.

Feedback Form 23: KI3_Q2: Shall the solution supports for IMS services other than voice/video (e.g. mission critical comms)? (yes/no/list the services with justification).

1 – Qualcomm Technologies Int

No

2 – vivo Mobile Communication Co.

No. Other services are not discussed in TR

3 – Nokia Germany

NO. None of the proposed solution supports MC services.

4 – Samsung R&D Institute UK

No.

5 – Huawei Technologies R&D UK

Yes.

Mission critical communications that have less stringent latency requirements than voice/video could be supported under the same conditions as voice/video (e.g. single satellite, users subscribed to the IMS of the serving network, etc.)

NG-RTC could also be considered a target as long as the media in the SDP are not introducing more stringent latency and bandwidth requirements than voice/video.

6 – THALES

yes to extend the market, but do not see the use cases for the moment.

7 – DOCOMO Communications Lab.

No.

8 – Guangdong OPPO Mobile Telecom.

In this release, IMS voice and video only, and leave the MCPTT for the next release. As stated in NOTE 3 of KI#3, SA6 is assumed to determine what Mission Critical services can be supported. Possible impacts on the MCPTT services or other applicable MC services need to be studied by SA6.

9 – ZTE Corporation

No

10 – Ericsson LM

No, only IMS audio is the target.

11 – China Telecommunications

No.

12 – CATT

no

13 – NOVAMINT

Yes if possible

14 – China Mobile Com. Corporation

Basically all the IMS services using the same procedures as voice/video can be supported. But we are ok to just focus on voice/video services without asking for any further enhancements to the solutions.

15 – SES S.A.

No. Not needed with priority.

Feedback Form 24: KI3_Q3: What shall be hypothesis on subscription constraints (do the two parties need to belong to the same HPLMN?). (no/yes/justification).

1 – Qualcomm Technologies Int

Yes (the two parties need to belong to the same HPLMN). Because a single P-CSCF should make the decision on whether to trigger invocation of UPF and AGW on the satellite. This can only happen if the 2 UEs are from the same HPLMN and same P-CSCF is selected

2 – vivo Mobile Communication Co.

Yes. It is not very common for different PLMNs to share the same satellite or satellite constellation.

UE-satellite-UE needs UEs to share the same gNB/UPF/AGW, considering requirements on UPF, HR roaming is challenging; LBO could be ok if different IMS CNs are deployed, but may cause impacts if Home P-CSCF is selected.

3 – Nokia Germany

NO. The UE-Sat-UE can still be served by V-PLMN using LBO roaming. i.e. P-CSCF in V-PLMN and S-CSCF/UDM in H-PLMN.

4 – Huawei Technologies R&D UK

The following solutions may work in case the UEs belong to different PLMNs under the assumption that each UE will use the IMS provided by their respective HPLMN (home routing). Note that all the solutions require that the IMS of the two UEs (if different) are interconnected so that the P-CSCFs can exchange

information to determine and prepare the IMS communication. At present such connection is not widely deployed (both nationally and internationally):

- Solution 28
- Solution 29
- Solution 32
- Solution 40
- Solution 41

Solution 31 supports UEs belonging to different PLMNs but requires the deployment of local breakout so that both UEs regardless of the identity of their HPLMN will use the serving network IMS to establish the IMS communication. Note that at present local breakout, though fully specified in 3GPP is not deployed for roaming).

Solution 42 requires the two UEs to belong to the PLMN that provides satellite access but could be extended to align with Solution 31 and adopt local breakout roaming model.

5 – THALES

neutral

6 – DOCOMO Communications Lab.

No. We don't think the two parties need to belong to the same HPLMN.

7 – Guangdong OPPO Mobile Telecom.

Yes, the two parties need to belong to the same HPLMN unless it is allowed to deploy two PLMNs on the same satellite.

8 – ZTE Corporation

This depends on the previous question, i.e. whether to consider two satellites or single satellites. We prefer to consider two satellites so it is not necessary to restrict that the two parties belong to same HPLMN.

9 – Ericsson LM

Any UP optimization must be restricted to UEs served by the same HPLMN, in addition to other restrictions described in the answer to KI3 Q1. There will be no special support for roaming or when UEs belong to different HPLMN.

10 – China Telecommunications

No. Technically the two UEs can belong to different HPLMN. But at present different HPLMN IMS are not widely connected, as mentioned by Huawei. The HPLMN IMS can distinguish and control this situation.

11 – CATT

not same HPLMN, but same serving PLMN, so that we don't need to consider the interaction between two serving PLMNs for establishing UP connection.

12 – NOVAMINT

No - we believe if we are considering multi satellites as per question 1 (KI3_Q1) then we could consider as well UEs belonging to different HPLMN

13 – China Mobile Com. Corporation

No. We don't know why we have to restrict to single PLMN. It is not difficult for IMS session to interconnect between different PLMNs following the IMS interworking principles.

14 – SES S.A.

No, not necessarily, the UEs can belong to different HPLMN networks and we do not see the necessity of a restriction to a single PLMN.

Feedback Form 25: KI3_Q4: Please provide the list of criteria used to determine whether UE-Satellite-UE can be activated and how the P-CSCF obtains the required information to take the decision.

1 – Qualcomm Technologies Int

The 2 UEs need to be registered in the same sPLMN, be part of same HPLMN and connected in the same satellite. Some other IMS specific criteria e.g. select the same codec may be considered if AGW is not mounted on the satellite.

2 – vivo Mobile Communication Co.

UE-satellite-UE communication link can be activated based on the following criteria:

via deployment:

- The satellite has gNB/UPF/AGW onboard

- UEs are served by the same SMF

- Same IMS CN or P-CSCF is preferred

via procedure

- UEs are served by the same satellite or different satellites that can connect via ISL. If same IMS CN is deployed, P-CSCF needs to be aware of the UE's access satellite (constellation) ID, which can be provided by PCF(s) or UEs; if different IMS CN are deployed, MO P-CSCF and MT P-CSCF will separately obtain UE's satellite (constellation) ID and forward to the other side, MO P-CSCF and MT-PCSCF need to make the "activation" decision separately when they find the UEs' serving satellite is the same or can linked via ISL.

3 – Nokia Germany

Access network information, current satellite coverage information and the satellite's capability of handling U-plane offload traffic. i.e. P-CSCF obtains P-ANI, user location (access network information) fetched from PCF, N6 breakout point information received from UPF->SMF->PCF to determine possibility of UE-Sat-UE communication.

4 – Huawei Technologies R&D UK

The selected solution should require that the IMS evaluates and verifies that the following conditions are met:

1. The calling and the called party are both using satellite access. The P-CSCF can inspect the P-ANI header that the UE can provide during call setup. Note however that the use of the P-ANI header is optional. As the P-ANI only indicates the use of a specific RAT type, there is limited value in providing the P-ANI header of the other party to the P-CSCF.

2. The IP address of the both parties belong to the same realm.

The P-CSCF will be notified of the IP address of the other party during call setup. This IP address is allocated by the UPF (or by the IMS-AGW if present) and if the two addresses belong to the same realm, by combining this information with the P-ANI header the P-CSCF can determine that both parties are using satellite access and the same constellation.

3. If an IMS-AGW is used the P-CSCF of both parties can anchor the media plane to the IMS-AGW onboard the satellite.

NOTE: In case of roaming, this may require standardisation efforts.

4. The subscription of the two users allow to set up an IMS communication service via satellite.

It is Huawei view that the UE-Satellite-UE communications should be established only when:

a) the two UEs are in geographic proximity and more specifically, served by the same satellite at any given time

NOTE: When the users are distant from each other, it may be more beneficial from a latency point of view to anchor the user plane on the ground. Besides this will avoid having to prepare for costly user plane nodes relocations. It will also remove dependency from ISL.

b) under condition a), the satellite serving the two UEs should provide coverage for a minimum amount of time prior handing over to a different satellite.

c) Lawful interception can be supported

NOTE: lawful interception in the home network is a legal requirement in most jurisdictions even when the user is roaming.

d) Transcoding is not required

NOTE: this is the default for UE to UE communications.

5 – THALES

In line with Nokia

6 – DOCOMO Communications Lab.

Criteria:

- Both Originating and Terminating UEs belong to the same ”Satellite Constellation ID”.

How P-CSCF obtains:

- During the Register procedure, P-CSCF judges UE’s Satellite Constellation ID based on UE IP address that has been assigned to the UE from a dedicated IP address pool.

- P-CSCF in the originating network sends SIP INVITE (or SDP offer) containing the Satellite Constellation ID of the originating UE towards the P-CSCF in the terminating network.

- P-CSCF in the terminating network takes the decision on the possibility of UE-Satellite-UE communication.

- P-CSCF in the terminating network sends SIP 183 Session Progress (or SDP answer) containing the Satellite Constellation ID of the terminating UE towards the P-CSCF in the originating network.

- P-CSCF in the originating network takes the decision on the possibility of UE-Satellite-UE communication.

7 – Guangdong OPPO Mobile Telecom.

Whether both UEs are served by the same SMF and PCF.

Whether both UEs are served by the same satellite.

Whether both UEs are served by the same regenerative RAT type.

8 – Ericsson LM

P-CSCF can acquire the needed location access information via the NPLI that can be fetched from 5GC. The originating P-CSCF send the NPLI (PANI information) to the terminating P-CSCF. The terminating P-CSCF sends the terminating NPLI (PANI) to the originating P-CSCF. User plane optimization is only performed when both UEs are served by the same satellite as stated in the answer to KI3 Q1.

9 – China Telecommunications

- Whether both UEs are served by the same regenerative RAT type.

10 – China Telecommunications

1. Whether both UEs are served by the same regenerative RAT type. 2. Whether both UEs are close to each other, determined by satellite IDs of the UEs. 3. Whether there is onboarding UPF and AGW. 4. Whether the UEs are subscribed to permit UE-satellite-UE communication.

11 – CATT

1/ RAT type from 5GC, 2/ satellite ID from 5GC, 3, subscription, 4. LI requriements.

12 – NOVAMINT

Agree with Nokia

13 – SES S.A.

A solution should be possible for UE-Sat-UE connectivity activation.

Inline with Nokia's view as possible solution.

Feedback Form 26: KI3_Q5: Please explain how to deal with change of serving satellite (user plane nodes relocation).

1 – Qualcomm Technologies Int

It is preferable to handover the UE-Sat-UE UP connection, else move the UP connection back to the ground PLMN.

2 – vivo Mobile Communication Co.

Handover from source satellite to target satellite, and the UPF and AGW on satellite should also be changed to target satellite.

3 – Nokia Germany

Change of satellite, i.e. user plane node relocation is being described in soln 43, clause 6.43.3.4 & 6.43.3.5 for with/without AGW case.

4 – THALES

in line with Nokia Germany here: Change of satellite, i.e. user plane node relocation is being described in soln 43, clause 6.43.3.4 & 6.43.3.5 for with/without AGW case

5 – DOCOMO Communications Lab.

Handover procedure by simultaneous change of UL CL.

6 – Guangdong OPPO Mobile Telecom.

Taking into account the assumption that both UEs are within the coverage of a single satellite, if this condition does not meet due to factors such as one UE being outside the satellite's coverage area, the involved parties should, relying on ephemeris information, await the next available time window when the condition is met again.

7 – Ericsson LM

Please see the answer to KI3 Q1. The UP moves to the ground and no UP optimization is performed.

8 – China Telecommunications

As described in S2-2404027, we prefer to use the procedures for Edge Relocation described in clause 6.3 of TS 23.548, to support the UPF and AGW relocation caused by serving satellite change.

9 – CATT

2 cases:

1/ between satellites: Handover procedure by simultaneous change of UL CL, and possibly AGW;.

2/ satellite to ground: handover procedure with removal of UL CL

10 – NOVAMINT

In line with Nokia

11 – SES S.A.

From our understanding, this shall occur by using the NTN Conditional Handover procedure (with some enhancement for regenerative payload) Xn based or NG based (if Xn is not available). However, we foresee that sometime while Satellite is moving and illuminating new regions, these new regions could require more capacity in terms of traffic demand, so the regenerative Satellite would need to reconfigure the channel bandwidth in advance which would require a reboot of the gNB (can take several 10's of seconds).

Feedback Form 27: KI3_Q6: Is IMS AGW on board mandatory or is it possible to make assumptions on UE capabilities. (yes/no/justification)

1 – Qualcomm Technologies Int

Not mandatory

2 – vivo Mobile Communication Co.

Yes, currently only AGW can perform LI for IMS voice

3 – Nokia Germany

No; Not mandatory.

- If the operator does not require LI.
- Assuming 3gpp defines assumptions e.g. supported codecs in UE.

4 – Huawei Technologies R&D UK

NOTE: Huawei would like to clarify the second part of the question as it is not immediately obvious what the relation is between IMS AGW onboard and UE capabilities.

Regarding the presence of an IMS AGW onboard, Huawei's view is that solutions supporting this should be preferred as this is the default configuration of terrestrial IMS communications.

5 – THALES

Not strictly mandatory but strongly recommended to have it on board as it removes potential LI limitations and restrictions on UE codecs.

6 – DOCOMO Communications Lab.

No. We believe it is not necessary to have IMS AGW onboard. However, if this is possible in the context of Lawful Interception, needs to be confirmed by SA3.

7 – Guangdong OPPO Mobile Telecom.

No, it should not be mandatory. It is preferred to make assumptions on UE capabilities, i.e. the UEs supporting UE-Satellite-UE has pre-defined capabilities/media codec profile to support this service, to reduce extra negotiation by using satellite resources.

8 – Ericsson LM

If UP optimization is to be performed according to the condition in KI3 Q1 then AGW is mandatory and LI is mandatory.

9 – China Telecommunications

If LI is mandotary then we prefer IMS AGW on board. Better to ask for SA3 suggestion. Not sure it is possile to support IMS LI without AGW.

10 – CATT

Not mandatory

11 – NOVAMINT

Not mandatory but recommended

12 – SES S.A.

Not mandatory but possible and recommended option to have it onboard.

Feedback Form 28: KI3_Q7: Please explain how to deal with lawful interception / data retention.

1 – Qualcomm Technologies Int

Evaluation from SA3-LI is required. Not responsibility for SA2.

2 – vivo Mobile Communication Co.

LI can be achieved with AGW onboard as current spec and deployment. To reduce complexity, it is proposed to assume gNB/UPF/AGW onboard the same satellite.

3 – Nokia Germany

LI is in SA3 purview. SA2 can keep existing AGW and IMS-ALG(P-CSCF) interfaces to enable the reuse of the existing LI mechanisms as much as possible.

4 – Huawei Technologies R&D UK

Huawei view is that to deal with lawful interception and data retention the network elements used in the ground network (namely IMS-AGW, UPF) should be on board. This allows for reusing of existing specifications and that regulations (where they exist) are met ”out of the box”.

5 – THALES

in line with above comment: LI is in SA3 purview. SA2 can keep existing AGW and IMS-ALG(P-CSCF) interfaces to enable the reuse of the existing LI mechanisms as much as possible.

6 – DOCOMO Communications Lab.

P-CSCF via PCF and SMF requests ULCL on satellite to copy QoS flow of 5QI=1 (voice media) of a particular PDU session ID and send it to LMISF. (This is a new solution, not captured in TR).

7 – Guangdong OPPO Mobile Telecom.

This is in the remit of SA3-LI.

8 – Ericsson LM

LI is mandatory. It is also worth mentioning that LI from satellite to the ground has never been studied nor the impacts of an AGW change in the middle of a session on LI. Hence the feasibility of LI for this feature is largely unstudied

https://nwm-trial.etsi.org/#/documents/8852

9 – China Telecommunications

Existing LI mechanisms can be used. Evaluation from SA3-LI is required, especially for the AGW/UPF change case.

10 – CATT

LI is in SA3-LI scope. SA2 can choose whether to activate UE-sat-UE communciation based on LI consideration.

11 – NOVAMINT

this required evaluation from SA3-LI

12 – SES S.A.

Lawful interception principle should be studied within the right SA working group (probably SA#3). There is no specific ”new” requirement in principle for this UE-Sat-UE connection, but there should be a study reviewing the impact of this connection on existing NFs for that LI purpose.

Feedback Form 29: KI3_Q8: Please provide Additional parameters the IMS of the originating network needs to exchange with the IMS of the terminating network (if different).

1 – Nokia Germany

Satellite access information (e.g. P-ANI + satellite ID), local termination(N6) if PtP tunneling is being used.

2 – Huawei Technologies R&D UK

The main parameter that the originating and terminating IMS needs to exchange is the IP address of the UEs engaged in a IMS communication setup. This will allow the IMS of the two parties to determine whether UE-Satellite-UE communication is possible and a) instruct the SMF to select the appropriate UPF to carry the media plane; b) allow the P-CSCF to select the appropriate IMS-AGW

3 – DOCOMO Communications Lab.

Satellite Constellation ID

4 – Guangdong OPPO Mobile Telecom.

Taking into account the assumption that both UEs are within the coverage of a single satellite, the IP addresses of the two participants need to be exchanged.

5 – Ericsson LM None beyond what is specified in the answer to KI3 Q4 given the conditions in the answer to KI3 Q1.
6 – China Telecommunications Satellite ID serving the UE
7 – CATT If IMS-AGW is not deployed on the satellite, the following information should be exchanged: 1/ satellite ID. 2/ codec information
8 – NOVAMINT At least serving satellite ID
9 – SES S.A. Satellite network identification ID at least.

Feedback Form 30: KI3_Q9: Are deployment constrains (e.g. single SMF? single PCF? single P-CSCF?) acceptable? (no/yes/justification with details on deployment constrains).

1 – Qualcomm Technologies Int Yes to all - single SMF, single PCF, single P-CSCF
2 – vivo Mobile Communication Co. Yes, single SMF and single CSCF are necessary to minimize the impacts on the procedures.
3 – Nokia Germany **NO,** Single SMF, PCF, or P-CSCF limits the deployment use cases. The calling and called party can be served by different SMF, different PCF, different P-CSCF even from different PLMN.
4 – THALES Neutral
5 – DOCOMO Communications Lab. No.

6 – Guangdong OPPO Mobile Telecom. Yes, single SMF, single PCF and single P-CSCF only deployment in this release.
7 – ZTE Corporation Preference is ”no”
8 – Ericsson LM None beyond the conditions provided in the answer to KI3 Q1
9 – China Telecommunications No. Same view as Nokia.
10 – CATT Preference is ”no”, but can live with single SMF, single PCF and single P-CSCF only deployment in this release.
11 – NOVAMINT Same view as CATT - preference is No but can live with restriction for this release
12 – SES S.A. Single SMF/PCF/P-CSCF can be considered acceptable to limit scope and work for this Release, but preferably more flexibility is desirable.

5 Additional questions for Round#2

Following questions are proposed to complete the questionary:

For KI#1:

Feedback Form 31: KI1_C2_Q6: Is having Intermediate GW in between RAN and CN transparent for CN side or not? (Yes/No). If you think NO, please precise impactes interfaces/procedures/Information Elements.

1 – Gatehouse Satcom A/S Yes - if procedures between the AMF/MME and NB need to be defined for a CAT1 solution, the intermediate GW should also act transparently with respect to those.

2 – SES S.A.

An IWF should remain not mandatory. If it is used it should be transparent for the CN.

3 – China Telecommunications

Hopfully yes.

4 – Qualcomm Technologies Int

Yes - Intermediate GW should be transparent

5 – China Mobile Com. Corporation

Support the I-GW as transparent.

6 – Nokia Germany

That's the expectation. Otherwise, the additional impacts are not warranted to support Cat1 changes.

7 – DOCOMO Communications Lab.

Yes.

8 – THALES

yes

9 – NOVAMINT

yes it should be transparent for CN as there are a number of remote and local core network architectures that are being deployed by many satellite operators on the ground segment.

10 – ZTE Corporation

Yes. However it is better to have a figure to show the protocol stack

11 – Huawei Technologies R&D UK

Yes. To RAN it appears as a CN, and to a CN it appears as RAN.

As this is the case no work is required in RAN on this deployment option documented in an informative annex.

12 – Intel Deutschland GmbH

Yes. The use of IWF should allow the introduction of regenerative payload on the satellite with unmodified Rel-17/Rel-18 CN.

13 – LG Electronics France

If an Intermediate GW is deployed, it should be transparent for CN.

14 – Beijing Xiaomi Mobile Software

Yes□from CN side, it acts as RAN, it should be transparent for CN

15 – vivo Mobile Communication Co.

Yes, no additional CN impacts compared to Cat.1 solutions, or no impacts on compared to current NTN architecture is the reason why this IWK is introduced

16 – Ericsson LM

As we answered to round 1, we do not see the need for documenting an architecture variant with intermediate GW. The solutions in the TR indicate that the IWF is transparent to the Core Network, so any vendor can implement this as a product choice. There is no need to document it in the specifications.

17 – Guangdong OPPO Mobile Telecom.

The same view as Ericsson. The Intermediate GW (if exist) in between RAN and CN should be transparent for CN side and RAN side. Therefore there is no need to document it as it is an implementation choice.

Feedback Form 32: KI1_Q7: Does the scenario of hard feeder link switch can be addressed by existing procedure without normative work? if not, what is the standard impact?

1 – China Telecommunications

Existing procedures only apply to soft feeder link switch. It can not handle the issue of data loss during hard feeder link switch. Resending data at the application layer is not the 3GPP style to solve the issue, e.g. the IMS vioce data could not be resent.

Soution 7 propose 5GC to support the ”per UE” precedure for data buffer during hard feeder link switch. To optimize this procedure with scalability issue, a ”per node” procedure is proposed in the update of solution(S2-2404025). It can be discussed in normative phase.

2 – Qualcomm Technologies Int

Yes

3 – Nokia Germany

Yes, NGAP related procedure change if any needs RAN3’s input.

4 – ZTE Corporation

Yes

5 – Huawei Technologies R&D UK

Feeder link switch from a “setting” NTN gateway which accesses “setting” CN NFs to a “raising” NTN gateway that can only access “raising” CN NFs (i.e. no connectivity to “setting” CN NFs), in this case the UEs will have be released to CM_IDLE before the change of NTN gateway. If there is connectivity then the existing load balancing / handover procedures can be used as required (e.g. if the path cost to the old CN NFs is prohibitive, as determined by the deployment/operator).

Therefore, existing procedures can be used.

6 – Beijing Xiaomi Mobile Software

Yes, existing procedure can be reused.

7 – vivo Mobile Communication Co.

When a hard feeder link disruption occurs, the user plane temporarily loses its connection. Whether notifications are issued per Node level or per UE level is determined based on outcomes from RAN3 discussions. SA2 can determine the requirements of whether UPF needs to be notified to buffer data or not.

8 – Ericsson LM

Yes, existing procedures can be used.

9 – Guangdong OPPO Mobile Telecom.

Yes, the scenario of hard feeder link switchover can be addressed by existing procedures, e.g. load-rebalancing, TAU or handover in the case of two eNB/gNBs.

10 – NEC Corporation.

Yes existing procedure can be used.

Feedback Form 33: KI1_Q8: Do new RAT types need to be introduced for regenerative payload satellite access? if yes, what is the motivation?

1 – VODAFONE Group Plc

Probably not needed. (It seems unlikely that an HPLMN would have separate subscription categories for ’transparent’ and ’regenerative’ as the customer service is basically the same.)

2 – CATT

probably not, since the 5GC may implicitly know regenerative based satellite access based on satellite access type and dynamic satellite backhaul category.

3 – China Telecommunications

New RAT type is prefered. Several motivations below could be considered:

1. For KI3 , IMS need to know the UE accessing regenetive RAT type, before UE-Satellite-UE communication can be activated. Since UE-Satellite-UE communication is not supported for transparent satellite accsess.

2. Although regenerative and transparent satellite accsess have same propagation delay, regenerative satellite accsess could introduce more delay if ISL is included.

The 5GC, e.g. PCF, needs to know this difference before it could make appropriate QoS/policy decision.

3. Operator may need to apply different subscription or Mobility Restrictions for regenerative and transparent satellite accsess.

4 – MediaTek Inc.

No

5 – Qualcomm Technologies Int

Preferably not needed

6 – China Mobile Com. Corporation

Seems No

7 – Nokia Germany

Not needed, core network can know the RAN access type. We do not see there will be any subscription or policy differentiation based on RAT type at the moment.

8 – DOCOMO Communications Lab.

No, not needed.

9 – THALES

not needed, UE should know as less as possible from the network topology

10 – NOVAMINT

No not a new RAT type. However, we probably need a proper network selection allowing to select a satellite access based on the fact it has a regenerative payload and it can support use case such as UE-Sat-UE communication.

11 – ZTE Corporation

No need a new RAT

12 – Huawei Technologies R&D UK The RAT type can be determined based on cells and existing SAT RAT Types. The thing to be absolutely clear on is why a new RAT Type is required, as if there is sufficient justification it could be added, however that does not seem to be there at present.
13 – Beijing Xiaomi Mobile Software Not needed. Seems the 5GC knows the eNB/gNB is on boarding or not.
14 – vivo Mobile Communication Co. Seems no need considering if the charging aspect is not needed from operator's perspective, and the QoS aspect if RAN cannot implement a very dynamic resource scheduling corresponding to the dynamic AN PDB. But whether it is needed by IMS depends on KI#3 evaluation and conclusions
15 – Guangdong OPPO Mobile Telecom. No, we do not see the need to introduce a new RAT type for regenerative payload satellite access.
16 – NEC Corporation. no

For KI#2:

Feedback Form 34: KI2_Q12: KI2_Q2 answers show that roaming support is mandatory. Does this imply that HSS and P-GW are mandatorily on the ground?

1 – TNO **KPN** Regardless of roaming scenario, the subscription data and the keys should NOT be stored on the satellite. These need an extraordinary level of security and cannot be sent over the feeder link.
2 – VODAFONE Group Plc Basically "yes" (although SMS might be the only service offered to the user and hence there is no PGW anywhere)
3 – China Telecommunications Yes. In practice Home Routed data is main scene for roaming. If there are multiple NTN Gateway, then the PGW should be also on ground, otherwise there is issue of route of DL SGi data. This is regardless of roaming.

4 – SES S.A.

Yes, home roaming scenario should be supported. We agree that this means that the PGW should be considered to be on the Ground.

5 – MediaTek Inc.

Same view as expressed above by Vodafone.

6 – Qualcomm Technologies Int

No as this depends on the solution. SA3 can verify whether HSS (or P-GW) not on the ground is a security risk. This aspect is outside SA2 scope.

7 – China Mobile Com. Corporation

Same view as expressed by Qualcomm.

8 – Nokia Germany

Yes, putting the credential holder and subscription data of all the roaming partners in a satellite will be complicated. It is even further complicated for multiple satellite to have same HSS instance in multiple places. The PGW on-board satellite will require the Data network to know which satellite (PGW) to point for DL data.

9 – THALES

Solution (like IOPS) exists to not have main (but derivated) subscription information onboard of the satellite.

10 – NOVAMINT

Yes

HSS and P-GW needs to be on the ground as onboarding them on the satellite is not scalable and will not allow to support roaming properly which is key for MNOs and Satellite operators

11 – ZTE Corporation

Yes. For store and forward feature, the HSSand P-GW are better to be on the ground

12 – Huawei Technologies R&D UK

HSS and P-GW have to be on the ground for the “home” network anyway.

If the question is asking whether these can be on a satellite in addition (rather than instead of) then yes they can be in both places and should be to enable a UE to attach etc.

13 – Intel Deutschland GmbH

Yes. We assume that there will be no preconfigured user-specific information on the satellite.

14 – Intel Deutschland GmbH

Yes. We assume that part of the MME will be on the satellite (MME-SAT) and another part on the ground (MME-GND). We also assume that the interface between MME-SAT and MME-GND will remain out of 3GPP scope. 3GPP should focus only on the interface impacts between MME-GND and the other network nodes on the ground (notably the HSS), in addition to the Uu impacts.

15 – OPPO

No, it up to SA3 to determine whether HSS onboard satellite is sufficiently secure.

16 – LG Electronics France

Yes, based on the current roaming architecture, the P-GW and the HSS are in the HPLMN. So, they should be in the ground.

17 – Beijing Xiaomi Mobile Software

Yes, for supporting roaming case, P-GW and HSS should be on the ground

18 – vivo Mobile Communication Co.

Yes. Besides, privacy issues raised by HSS onboard could be a problem, and how many user's subscription copies will be onboard is also a problem, how to sync them on different satellites is a new topic which is within SA2 scope

19 – Sateliot

Yes.

As established in 23.401 clause 4.2.2, if a satellite network serves as a VPLMN for roaming subscribers belonging to a terrestrial HPLMN network, the HSS and the P-GW of the HPLMN are both always going to be on the ground for home routed roaming.

20 – Ericsson LM

It depends on the solution. It should be up to SA3 to determine whether HSS on-board poses security risks.

21 – NEC Corporation.

it depends on the solution and feedback from SA3.

Feedback Form 35: KI2_Q13: KI2_Q3 answers show that MO/MT SMS and CIoT CP support are mandatory. Does this imply that full or part of MME need to be on board?

1 – VODAFONE Group Plc

At least part of the MME would be on the satellite.

With >1 earth station, at least some of the MME needs to be on the earth.

Some functions of the MME are likely to be duplicated and be on both the satellite(s) and on the earth.

2 – Gatehouse Satcom A/S

At least part of the MME onboard SAN

3 – SES S.A.

At least part of the MME onboard the satellite should be possible.

4 – CATT

to my understanding, the support of SMS and CIoT CP doesn't imply MME must be on board satellite. as the architecture of only eNB onboard satellite can also support the S&F of NAS PDU.

5 – Qualcomm Technologies Int

Probably yes. But an assumption seems to be that an on board MME is part of a ground CN which complicates the CN and justifies the question.

6 – China Mobile Com. Corporation

No, this does not imply the MME/ part of MME on board. Solution dependent. Other solutions like the whole 4G EPC/5GC onboard can also support this service.

7 – China Telecommunications

Prefer Yes. If MME is on ground, it implies more impact on RAN. Not sure that an eNodeB can work without connection to MME and RAN2/RAN3 can develop such soulution. Only RAN onboard has also security issue as mentioned ar round 1.

8 – Nokia Germany

Yes, some part of MME is needed to handle UE's initial access (attach, service request, etc.). It will be required to indicate the S&F mode and temporary identifier to the UE so that network can reach UE via another satellite to complete a procedure. Part of MME presence at the satellite could help to avoid making more changes at the UE side/behavior for the attachment and data forwarding procedures.

9 – THALES

same view as expressed by Nokia

10 – NOVAMINT

Yes - At least part of the MME should be on board the satellite as mentioned by Nokia

11 – ZTE Corporation

We prefer a full MME on board.

12 – Huawei Technologies R&D UK

The responses to the data types does not imply anything about what parts of the MME are onboard.

As far as 3GPP is concerned the MME is a single entity and not a split entity. Solutions that propose splitting it are not proposing to define the functional split, so there is nothing normative for 3GPP to do in these cases either.

The best direction is to normatively specify impacts to the UE interface and document that something propriety can be done in an informative annex.

13 – Intel Deutschland GmbH

We assume that part of the MME will be on the satellite (MME-SAT) and another part on the ground (MME-GND). We also assume that the interface between MME-SAT and MME-GND will remain out of 3GPP scope. 3GPP should focus only on the interface impacts between MME-GND and the other network nodes on the ground (notably the HSS), in addition to the Uu impacts.

14 – OPPO

We understand the support of SMS and CIoT CP doesn't imply MME must be on board satellite, it depends on the specific solutions.

It would be preferable to have MME onboard to avoid RAN complexity, but it doesn't preclude the possibility of having other CN functionalities (e.g. MME) on the satellite.

15 – LG Electronics France

No, it is not necessary to have full or part MME function to be on board.

CP CIoT can be supported by only eNB on board satellite, and CP CIoT also can be used for MO/MT SMS transfer as in current specification. In this case, MME on the ground can

- store Delivery Report of MO SMS received from SMS-GMSC until the feeder link is available.

- provide the Delivery Report to the SMS-GMSC including the "requested retransmission time" as specified in TS 23.040 and TS 29.338. The "requested retransmission time" can be the expected time that the feeder link to the satellite is available based on the feeder link availability information.

16 – Beijing Xiaomi Mobile Software

NO.

The support of SMS and CIoT CP doesn't imply MME must be on boarding. Solution related only eNB onboard satellite can also be workable as described in the TR.

https://nwm-trial.etsi.org/#/documents/8852

17 – vivo Mobile Communication Co. If considering minimum CN NFs onboard, deploying an onboard eNB as a solution without any CN NFs is also viable, however the feasibility analysis depends on RAN2.
18 – Sateliot No. Support of MO/MT SMS and CP CIoT does not imply necessarily that MME or part of the MME should be on board. However, having part of the MME on board is a plausible approach to support these services under S&F operation mode, as proposed by multiple solutions.
19 – Ericsson LM The question is no clear and seems to make assumptions about the rest of the CN being on ground. Solutions with CN on-board are also possible. It should also be noted that the MME is a single functional entity in the 3GPP architecture, with no internal standardized interfaces. This should not change.
20 – NEC Corporation. no. Support of these features doesn't imply full or part of MME should be on board.

Feedback Form 36: KI2_Q14: Please precise if full MME or part of MME need to be on board on the satellite, with justification for your choice and impacted specification(s) if any.

1 – VODAFONE Group Plc With > 1 earth station, I think that at least the S6a (HSS interface) part of the MME needs to be on earth. Similarly for the MME's interfaces *towards* the SMSC (inc. SGs) and PDN GW.
2 – Qualcomm Technologies Int The question is again mainly relevant to a CN split between the ground and satellites. In addition, unless a satellite supports just one ground PLMN, it would need to support multiple instances of each onboard NF (e.g. MME) and maybe one shared eNB (or gNB).
3 – China Mobile Com. Corporation Generally for KI#2, MME/part of MME onboard is not so straight forward. Other solutions can also support the services.
4 – Nokia Germany The advantage of keeping part of MME than full MME:

- The security keys are centrally placed than copied across multiple satellite. This will avoid additional complications of context synchronization and NAS sequence number sync among all candidate satellites. All satellite will keep the same UE contexts which may or may not be used. Encryption/decryption are CPU consuming processes, avoiding them at satellite will be beneficial. Decrypting payload at satellite is not useful, as the next set of services or procedure can only continue after ground connectivity is recovered.
- Keeping full MME (and part MME on-board satellite) on the ground also avoids inter-PLMN procedures such as authentication/security involving H-PLMN's HSS. The H-PLMN will not require to handle anything differently for roaming UEs in terrestrial vs non-terrestrial (no impact to S6a).
- LI consideration: The full MME will require an IRI-POI to be implemented for tracing in satellite. It can be avoided if message handling is kept at ground by keeping the existing LI interception point in MME on ground. The part of MME can send the encrypted packets along with timestamp information and last served location to ground MME to evaluate LI need for time and location-based tracing after decryption.
- Split MME proposal will be simple to reuse for 5G as well. In 5G, the AMF also gets authenticated (serving network name based authentication) and it will be complicated to authenticate all involved satellite's AMF for every single UE. In split AMF deployment only ground network AMF needs to be authenticated.

Impact: As the split MME on board satellite is reusing existing MME functionality, the network element related changes are minimal. The existing MME-MME interface can be extended to carry NAS/NGAP payload between satellite to ground MME. The split MME serving on the satellite, will serve the PLMN based on country the satellite is providing coverage.

5 – ZTE Corporation

We prefer full MME to be on board, in order to simplify the procedure. There is no need to split part of MME on the ground.

6 – Huawei Technologies R&D UK

As far as 3GPP is concerned the MME and other entities are a single entity and not a split entity. Solutions that propose splitting it are not proposing to define the functional split or the interface between them, so they remain a single entity, therefore there is normative for 3GPP to do in these cases either.

The best direction is to normatively specify impacts to the UE interface and document that something propriety can be done in an informative annex.

7 – Huawei Technologies R&D UK

Typo correction: ...therefore there is **nothing** normative for 3GPP to do in these cases either.

8 – Intel Deutschland GmbH

We assume that part of the MME will be on the satellite (MME-SAT) and another part on the ground (MME-GND). We also assume that the interface between MME-SAT and MME-GND will remain out of 3GPP scope. 3GPP should focus only on the interface impacts between MME-GND and the other network nodes on the ground (notably the HSS), in addition to the Uu impacts.

9 – China Telecommunications

We prefer full MME to be on board. Although the approach of full MME approach seems more complex than part of MME, but it has the advantage of standardization of the impacted interfaces, e.g. S6a, S11. Part of MME hides the complexity by no standardization of the procedures between MME-GND and MME-SAT, which implies one vender for all the MME parts on board and on ground.

10 – OPPO

We would support the approach of full MME on board. In addition, we believe that the ground entity is also needed to maintain UE context and RM/CM states to avoid duplicate registration to multiple satellites. This entity on ground can also be used to synchronize subscription data with candidate satellites when the HSS is onboard the satellite.

11 – Beijing Xiaomi Mobile Software

To simplify procedure and reuse existing procedure as much as possible, we prefer full MME on board.

12 – vivo Mobile Communication Co.

If the eNB onboard solution is completely ruled out in SA2, we prefer part of MME onboard considering privacy preservation.

13 – Sateliot

Only part of the MME needs to be on board, including at least the functions needed to handle the S1 interface with the onboard eNB and the functions to handle the NAS protocol signalling from/to UEs.

Other functions of the MME can be ground, including the functions to handle the interfaces towards other CN functions (S6a towards HSS, SGd towards SMS-GMSC/IWMSC / SMS Router, T6a towards SCEF, T6ai towards IWF-SCEF, S11 towards SGW).

Considering such architectural approach:

- Standardization efforts could be focused on the impact that the support of S&F Satellite operation have on the existing interfaces (NAS protocols, S1, S8/SGi, T6a/T7/T8, S6a and SGd).
- The split/interface between the part of the MME on board and the part on ground can be left to implementation, given that multiple and diverging solutions may exist depending on particular constellation and network configurations. However, we would also support the standardisation of such interface if there is consensus to do so.

14 – Ericsson LM

The MME is a single functional entity in the 3GPP architecture, with no internal standardized interfaces. In case a solution with part of the MME on-board moves forward, the functional split between MME functionality in space and on ground and the interface in-between should not be standardized.

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15 – NOVAMINT

Only part of the MME needs to be on board and as the split MME on board satellite is reusing existing MME functionality, the network element related changes are minimal.

We also agree with Sateliot's statement considering such architectural approach:

- to focus standardization efforts on the impact that the support of S&F Satellite operation have on the existing interfaces (NAS protocols, S1, S8/SGi, T6a/T7/T8, S6a and SGd).
- The split/interface between the part of the MME on board and the part on ground can be left to implementation
- However, we would as well support the standardisation of such interface if there is consensus for that

For KI#3:

Regarding answers to KI3_Q4, it is possible to imagine that two options can be considered for R19:

Opt1: step by step approach with "simpler" solution in R19 as described below, with possible complements in later releases:

- 2UEs subscriptions from same HPLMN and served by same serving PLMN.
- Same SMF, P-CSCF.
- 2UEs under coverage of same satellite.
- Everything necessary on board for LI as required by SA3-LI (after liaison).

Opt2: full feature in R19

- 2UEs subscriptions from different HPLMNs.
- no restrictions on SMF, P-CSCF.
- 2UEs under coverage of different satellites connected via ISL.
- Everything necessary on board for LI as required by SA3-LI (after liaison).

Feedback Form 37: KI3_Q10: Please indicate your preferred option between Opt1 and Opt2 as described above. Since existing solutions in the TR can support Opt2, in case you prefer Opt1, please give precise and argumented reasons for your choice.

1 – VODAFONE Group Plc

No real preference, but, for option 1 we should clarify that we expect that the 2 UEs are within [100] km of each other and that the call is interrupted every [7] minutes (when one UE is moved to the next satellite before the other UE moves)

2 – Gatehouse Satcom A/S

IF required to save time: downscope to Opt1.

perhaps with ”2UEs under coverage of different satellites connected via ISL.” included in scope.

3 – SES S.A.

If time constraint for Release-19 requires it, Opt_1 can be considered as first step, but only as intermediate step to subsequently work on Opt_2. The full feature capability of Opt_2 is required.

4 – CATT

it is preferred to have a restricted scope, so that we can conclude this KI in this release. however, we think the restriction should be ”single SMF, single PCF and single P-CSCF only deployment”.

we don’t think it is feasible to only consider the UEs served by same satellite, since the call would be interrupted if the serving satellite changes as pointed out by VDF, which would downgrade users’ experiences.

In fact, if UEs are served by same SMF, whether they are served same or different satellites will not be a problem, as this single SMF can know whether and how to establish the tunnel between two satellites.

5 – Qualcomm Technologies Int

We prefer option 1, but don’t think that it satisfies the LI requirements in the LS especially this:

SA3-LI also confirms that a CSP ***can be required to perform intercept in the country where the warrant’s jurisdiction applies****. Additionally, the CSP is required to have the ability to capture and deliver the intercept product without exposing (both confidentiality and undetectability) the LI product to any unauthorized party.* ***SA3-LI is unsure if the latter requirement can always be met if former requirement is not.***

This possibly requires that the UE-UE communication can only happen in the same country as the two HPLMNs.

6 – China Telecommunications

We prefer option 2. It seems Option2 dose not need much more normative work comparing to option 1.

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7 – Nokia Germany

We prefer Opt 2. The Opt 1 will is not feasible to improve to support Opt 2 in future. All the solutions present for Opt 2 have same amount of impact as Opt 1. There is no time saving in normative phase in choosing Opt1. The impact from LI pov is also same. The AGW (CC-POI) on-board satellite will be intercept point and P-CSCF on ground managing AGW will act as CC-TF and CC-IRI intercept point to track user's call. Keeping the same Iq interface, allows to reuse existing LI architecture for both call tracking and user plane trace triggers. LI warrant in respective country can be served by respective V-PLMN in the existing way, without any additional impact.

8 – DOCOMO Communications Lab.

We prefer Opt 2.

9 – THALES

Regenerative payload makes sense primarily to support ISL between satellites. This allows to provide services in areas where no gateway can be deployed (e.g. oceans, remote regions). Typically such a regenerative payload based constellation will be designed with ISL connecting neighboring satellites in the same plane and possibly neighboring satellites across adjacent planes.

ISL shall be considered as transport link with no impact on the 3GPP network signaling, protocols or data.

ISL connecting neighboring satellites in the same plane feature a constant delay.

ISL connecting neighboring satellites across adjacent plane feature a variable delay.

We recommend to consider for UE-SAT-UE communications: both single satellite and 2 neighboring satellites in the same plane. The difference between both scenarios in the number of UPFs involved (1 versus 2). A SATCOM service as proposed in Solution#30 shall be able to indicate if UE-Sat-UE communication via ISL can provide good user experience.

10 – NOVAMINT

We would prefer Option 2 - agree with the rationale provided by Thales

11 – ZTE Corporation

OK with option 1 in this release, considering the time restriction.

12 – Huawei Technologies R&D UK

Huawei would like to propose an alternative option that combines elements of option 1 and elements of option 2 and that hinges on whether SA3-LI will require that the IMS-AGW along with the functions to perform lawful interception **need** to be onboard the satellite or not.

Network nodes and functions onboard the satellite to enable lawful interception

Based on the LS received from SA3-LI Huawei would like to make the assumption that the architecture used in the terrestrial network is adopted, meaning that the IMS-AGW and any necessary functions are onboard the satellite.

Proposal 1: If lawful interception of the UE-Satellite-UE IMS communication is required, then the IMS-AGW along with the functions to perform lawful interception are onboard the satellite.

Subscription of UEs engaging in a UE-Satellite-UE IMS communication

Only the P-CSCF of the PLMN offering satellite coverage can allocate the IMS-AGW on board the satellite. This implies that both UEs need to be served by the IMS of the PLMN offering satellite coverage. As a consequence we have two cases:

a) either the two UEs have a subscription with the PLMN offering satellite coverage (both UEs in HPLMN) or

b) LBO roaming architecture is used as per TS 23.228 annex M.1 or annex M.3 (one or both UEs in VPLMN).

Note that Huawei believes that no further standardisation work is required in 3GPP to enable PLMNs offering satellite access to strike roaming agreements based on local breakout though acknowledging that this type of roaming is not commonly used.

Proposal 2: two UE subscriptions may belong to any PLMN as long as a local breakout roaming architecture is used; otherwise the two UEs shall belong to the PLMN offering satellite access (and IMS-AGW onboard the satellite).

Use of ISL

Huawei think that restricting the use of UE-Satellite-UE communications to a single satellite is the most pragmatic choice in this release and does not preclude extending the scope of the solution to multiple satellites in future releases.

Proposal 3: the two UEs engaging in a UE-Satellite-UE IMS communication are in a region served by the same satellite.

Single/multiple P-CSCFs, single/multiple SMFs.

If proposals 1 to 3 are agreed, then it would be safe to assume that the same P-CSCF and SMF is used and specifically that this is the P-CSCF and SMF at the end of the feeder link of the serving satellite.

In summary the preferred Huawei option looks as follows:

Proposal 4: the same P-CSCF and the same SMF is used by both UEs.

Option H

· 2 UEs subscriptions from different PLMNs. (if LBO roaming used)

· same SMF, same P-CSCF for both UEs

· 2 UEs under coverage of same satellite.

· IMS AGW and all functions needed to perform Lawful interception onboard the satellite. (if LI is required)

13 – China Mobile Com. Corporation

We prefer option2.

14 – IPLOOK

We prefer Opt2. But considering the TU restriction, we are fine with Opt1.

15 – vivo Mobile Communication Co.

We prefer opt.1 but without restrictions on ”UEs under same satellite coverage”, ISL can be used to extend the service area.

16 – Ericsson LM

Option 1 cannot be considered because of LI reasons depicted clearly in the LS from SA3-LI (S3i240295). Option 1 does not fulfil 2 key requirements:

- Detectability

- Mid-Session support of LI.

Hence the proposal below is variant for option 1:

The 2 UEs must be served by the same satellite, same HPLMN, and LI can be supported with AGW on the satellite, as well as on the ground.

P-CSCF can acquire the needed location access information via the NPLI that can be fetched from 5GC. The originating P-CSCF sends the NPLI (PANI information) to the terminating P-CSCF. The terminating P-CSCF sends the terminating NPLI (PANI) to the originating P-CSCF.

User plane optimization is only performed when both UEs are served by the same satellite.

If one UE goes to another satellite than the initial one, the P-CSCF handling the UE would reuse an AGW on the ground.

If the second UE goes to yet another satellite than the initial satellite, then both UEs will be served by AGWs on the ground. The UPF can be moved to the ground as well. No more UP optimization will be done even if they are served later by the same satellite.

There will be no special support for roaming or when UEs belong to different HPLMN.

It is also worth mentioning that LI from satellite to the ground has never been studied nor the impacts of an AGW change in the middle of a session on LI. Hence the feasibility of LI for this is largely unstudied.

17 – Guangdong OPPO Mobile Telecom.

OPPO prefers option 1, the stepped approach where Opt 1 assumption is used in Rel-19, and possibly complement in later releases.

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18 – NEC Corporation.

Fine with option 1 considering the TU budget. later release should also support option 2.