3GPP TSG-RAN WG2 Meeting #124 R2-230xxxx

Chicago, US, November 13-17, 2023

Agenda Item: 7.7.4.2

Source: CMCC/Apple

Title: Report of [Post123bis][312][NR-NTN Enh] Unchanged PCI (CMCC/Apple)

Document for: Discussion and Decision

# 1 Introduction

In RAN2 #123bis meeting, there were some fruitful discussions about unchanged PCI. However, there are still some open issues needed further discussion.

This document captures the outcome of the following discussion in order to address all the open issues.

* [Post123bis][312][NR-NTN Enh] Unchanged PCI (CMCC/Apple)

 Scope: Continue the discussion on unchanged PCI specific aspects

 Intended outcome: email discussion summary

Deadline: Long

Please provide your comments before October 26th 0100 UTC.

# 2 Discussion

## 2.1 Configuration (Part A)

### **Issue 1: Target satellite information**

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| RAN2#123bis agreement:* *Only 1 target satellite information (i.e. NTN-config) of serving cell is provided in SIB19. FFS on exact signalling*
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Regarding the target satellite information, RAN2 agreed that only 1 target satellite information (i.e. NTN-config) of serving cell is provided in SIB19 with the FFS on exact signaling.

About the exact signaling in detail, there are several options proposed during offline discussion:

* Option 1: Introduce one new target satellite configuration (e.g. *ntn-TargetSatConfig*), and provide the *NTN-config* of the target satellite in it.

Following is one ASN.1 example.



* Option 2: Introduce one new target satellite configuration (e.g. *ntn-TargetSatConfig*), but for the provision of the target satellite’s *NTN-config*, it is not explicitliy provided in it, but rely on a pointer (e.g.targetSatInfo) to *NeighCellConfigList* (e.g.targetSatInfo) to aquire the NTN-config of the target satellite.



* Option 3: Just extend the additional information for hard/soft switch in the existing *NTN-NeighCellConfig* as follows:



* Option 4: Others?

#### **Question A1: Please provide your preferred options on the specific signaling format about the target satellite information in SIB19**

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| --- | --- | --- |
| **Company** | **Preferred Option** | **Comments** |
| Ericsson | Option 1 variation | As proposed in the running RRC CR, Option 1 is more compact and specifically addresses this new feature. SSB information can be added later when agreed.SatSwitchWithReSync-r18 ::= SEQUENCE { ntn-Config-r17 NTN-Config-r17 OPTIONAL, -- Need R t-serviceStart-r18 INTEGER (0..549755813887} OPTIONAL -- Need R} |
| Samsung | Both Option 1 and 2 | Both option 1 and 2 should be allowed. If the target satellite info is not in *NeighCellConfigList*, option 1 or the current CR is fine, if the targe satellite is one satellite that provides neighbor cells in *NeighCellConfigList*, by option 2 duplication can be avoided. |
| CATT | Option1 | For option 2, if the target satellite info is provided in the NTN neighbour cell list, the IDLE/INACTIVE may need to perform measurement on the target satellite that has not arrived. For option 3, we don’t see the necessity of introducing an new *NTN-NeighbourCellConfig* for Rel-18. |
| vivo | Option 1 | The assistance information is the content for the further target satellites, which is independent of the neighbor cell. In this sense, we don't think it's appropriate to use an element of the neighbor cell list to represent the target satellite information (i.e. Option 2 is not acceptable). For option 3, a list of target satellites is not needed since RAN2 agreed that only 1 target satellite information (i.e. NTN-config) of serving cell is provided.  |
| Qualcomm | See comments (option 1) | Now we wonder if it was right thing to broadcast this info in SIB19 as this is just happening once only at t-Service but SIB19 would have to be updated and broadcast frequently. It could have been in other SIB.Option 1 seems the simplest one but we think it should be clarified whether the UE needs to acquire new satellite SIB19 or not to trigger RACH. |
| Lenovo | Option 1 | Option 1 is simplest, and the new IE can be an implicit indication for PCI unchanged. |
| ZTE | Option 1 | It is a cleaner solution |
| Huawei, HiSilicon | Option 1 | Simplest solution. |
| Nokia | Option 2 | The option should be flexible – if NTN-Config is already available in the neighbour cell information then no need to signal it once again (and the pointer is sufficient. The pointer could actually indicate the PCI of the target cell). Regardless of which Option is ultimately chosen, this will cause a severe impact to Rel-17 UEs that would read the SIB with lots of new IEs they are unable to comprehend.In general – the ASN.1 examples above are missing the other important components of this satellite switching without L3 mobility procedure, such as -Start, smtc config, SSB index, etc. So perhaps those should be decided first and then we can think how to signal them |
| LGE | Option 1 | Option 1 is simplest and scalable. T-start and target SAT’s SMTC can simply be added in a new target satellite configuration.  |
| Sequans | Option 1 | As a baseline. We also have some concerns with the overhead. |
| Fujitsu | Option 1 | It seems the simplest, but it should be discussed which information is provided or not. |
| Xiaomi | Option 1 |  |
| Apple | Option 1 | Option 1 is simple and easy to understand.  |
| CMCC | Option 1 | Option 1 is simple. |

**Summary:**

The options related to the exact signaling of the target satellite information can be summarized as follows:

* Option 1: Introduce one new target satellite configuration (e.g. *ntn-TargetSatConfig*), and provide the *NTN-config* of the target satellite in it.

**Ericsson/Samsung/CATT/vivo/QC/Lenovo/ZTE/Huawei,HiSilicon/LGE/Sequans/Fujitsu/Xiaomi/Apple/CMCC (14/15)**

* Option 2: Introduce one new target satellite configuration (e.g. *ntn-TargetSatConfig*), but for the provision of the target satellite’s *NTN-config*, it is not explicitliy provided in it, but rely on a pointer (e.g.targetSatInfo) to *NeighCellConfigList* (e.g.targetSatInfo) to aquire the NTN-config of the target satellite.

 **Samsung/Nokia (2/15)**

**Obviously, for the exact signaling of the target satellite information, for majority (14/15), option 1, i.e., to introduce one new target satellite configuration (e.g. ntn-TargetSatConfig), and provide the NTN-config of the target satellite in it can be accepted. Therefore, the rapporteur recommend the majority’s view as agreed conclusion:**

**Proposal 1: it is proposed to introduce one new target satellite configuration, e.g. *ntn-TargetSatConfig*, and provide the *NTN-config* of the target satellite in it for the the specific signaling format about the target satellite information in SIB19. (14/15)**

### **Issue 2 Target satellite SMTC aspects**

For the additional information distributed in the system information, SMTC configuration of target satellite is needed based on some companies comments, as in the F2F offline discussion [2], the following issues are raised and need further discussion:

* + Is the SMTC configuration of the target satellites the same or different from the source? *Notes: the answer can be respectively provided for the hard switch and soft switch.*
	+ Is the SMTC adjustment handled by network or by UE?
	+ How to provide the SMTC configuration of the target satellite if it’s different?

#### **Question A2-1 : Do you think the SMTC configuration of target satellite can be different from that in source?**

* + *Notes: the answer can be respectively provided for the hard switch and soft switch.*

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| **Company** | **Yes/No** **（for hard switch）** | **Yes/No** **（for soft switch）** | **Comments** |
| Ericsson | No | Yes | For soft switch, there is no technical reason precluding SMTC to be the same as long as different cells use separated SSB indexes to avoid collisions. |
| Samsung | Yes | Yes | If PDD is changed, smtc can be different regardless of hard or soft switch, but the new smtc can be reconfigured by NW as legacy for UE in connected mode. |
| CATT | See comments | See comments | For hard satellite switchthe NW does not need to broadcast SSB via source satellite and target satellite with difference. Hence, the UE could estimate the time window of SSB provided by the target satellite based on the ephemeris and common TA info autonomously. For soft satellite switch, the NW may configure the target satellite broadcast SSB with an offset compare with source satellite to avoid interference. So the NW could send the SSB with a time offset comparing with the source satellite. Especially for the soft switching case, we think there is potential overlap between the SMTC configuration in this question and time offset option in QA4-1.  |
| Vivo | Yes, but | Yes, but | We are wondering about the motivation of this question. The SMTC configuration is totally up to NW, that is NW can reconfiguration the configuration at any time in any case. So the NW of course can have different configurations for source and target. But generally, the same configuration should be used considering the gNB configuration is not changed in the unchanged PCI case.In our understanding, the issue herein is how to efficiently measure the target satellite (i.e. DL sync with the target) using the configured SMTC configuration (with potential adjustment) or other SMTC configuration.  |
| Qualcomm | Yes  | Yes | Change of satellite means in both cases, the SMTC offset could be different. |
| Lenovo | Yes | Yes | We think there is no need to restrict or differeciate. |
| ZTE | No | Yes | There is no enhancements needed for hard switch. For soft switch case it is possible that the SMTC from source and target could be different or the same, but in any case UE can based on common TA and ephemeris info in SIB19 to calculate PDD and adjust the SMTC autonomously.  |
| Huawei, HiSilicon | Yes | Yes | SMTC configuration helps the UE to synchronize with the target satellite, and we don’t see any difference between hard and soft switching on this aspect. |
| Nokia | Most likely yes | Yes | In our view, the question is not whether the SMTC config “can” be different from source to target satellite, but if it “needs to” be different. In our view, for both cases, the answer is Yes.For soft-switching we need to use a separation (also in time), and both SMTC configurations need to be available at the same time. For hard switching time will also differ, but only one SMTC configuration is needed toward the serving cell at any given point in time. In Rel-17 we have the UE capability for measuring according to multiple SMTC. Thus, it should be possible to reuse a similar principle if source and target satellites are separated in time (i.e. via different SMTCs). |
| LGE | Yes | Yes | Satellite change means the change of feeder link which causes SMTC difference. |
| Sequans | No | Likely | The pattern (periodicity/duration) has no reason to change. For hard switch there is no reason to have a different timing offset.For soft switch it may be required to separate source and target SSBs. |
| Fujitsu | Yes | Yes | No need to restrict NW configuration both hard and soft switching. |
| Xiaomi | Yes | Yes |  |
| Apple | No | Maybe | If UE performs the SMTC timing adjustment by itself, then the SMTC configuration could be same between source and target satellites.  |
| CMCC | No | Yes | There is no need to change SMTC when the satellite switch for hard switch. |

**Summary:**

The views from the participants on whether the SMTC configuration of target satellite can be different from that in source seem to be quite diverse, and can be summarized as follows:

1. **For hard switch:**
	1. Yes (Samsung/vivo/QC/Lenovo/Huawei, HiSilicon/Nokia/LGE/Fujitsu/Xiaomi/CATT) (10/15)
	2. No (Ericsson/ZTE/Sequans/Apple/CMCC) (5/15)
2. **For soft switch:**
	1. Yes (Ericsson/Samsung/vivo/QC/Lenovo/ZTE/Huawei, HiSilicon/Nokia/LGE/Fujitsu/Xiaomi/CMCC/CATT) (13/15)
	2. Maybe (Sequans/Apple) (2/15)

And one company indicates that for hard switch, UE could estimate the time window of SSB provided by the target satellite based on the ephemeris and common TA info autonomously, no need of different SSBs. And for soft switch, NW could send the SSB with a time offset comparing with the source satellite. Considering the views from the participant, the rapporteur comments the following proposal:

**Proposal 2 : At least for soft switch, support SMTC configuration of target satellite can be different from that in source. (15/15) FFS for hard switch.(10/15)**

#### **Question A2-2 : Do you think the SMTC configuration adjustment should be handled by network or by UE?**

* Option 1: network control

If network handles the SMTC configuration adjustment, UE does not need to adjust the SMTC configuration of the target satellite based on the PDD.

* Option 2: UE control

If UE handles the SMTC configuration adjustment, UE needs to perform the adjustment based on the PDD between source SAT and target SAT, and the behavior is similar as that in IDLE/INACTIVE operation.

* Option 3: other?

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| --- | --- | --- |
| **Company** | **Option** | **Comments** |
| Ericsson | Option 2 | A similar behavior as in RRC\_IDLE/INACTIVE should be followed. UE should adapt SMTC to its location with the use of ephemeris and common TA parameters. Otherwise, dedicated signaling for SMTC configuration is needed which increases signaling overhead and makes the unchanged PCI procedure not transparent which was the initial objective. |
| Samsung | Option 3 (no need to broadcast smtc) | For neighbor cell measurement, SMTC is given because UE is not synchronized with the neighbor cell and it has to measure SSBs within the indicated smtc window. While for the serving cell, UE has to synchronize with the serving cell by searching SSBs. Therefore, similar to performing HO where *ssb-PositionsInBurst* and ssb-periodicityServingCell are given in ServingCellConfigCommon, *ssb-PositionsInBurst* for the target satellite should be provided in SIB19 so that UE can search the SSB based on the SSB pattern, assuming ssb-periodicityServingCell shall not change for the same serving cell. The offset caused by PDD can be calculated by UE based one target satellite ephemeris and handled by UE based on serving cell existing smtc. So no need to broadcast additional smtc. |
| CATT | See comments | For the hard satellite switch, the measurement timing window of the SSB via the target satellite can be adjusted by UE autonomously by the ephemeris and common TA parameter.For the soft satellite switch, the UE measurement timing window of the SSB via the target satellite is adjusted by UE based on the time offset configured by NW (as mentioned in QA2-1). |
| Vivo | Option 2 | For Opt1, it seems infeasible. Assistance information (e.g., PDD between source satellite and target satellite) is needed from UE. However, UE cannot report PDD between source satellite and target satellite to the NW before the target satellite appears, which means the NW can not provide SMTC configuration in advance (i.e., before the target satellite appears). If the network-based solution is applied, the latency of accessing the target satellite will increase, because the UE reports the PDD between source satellite and target satellite after the target satellite appears and then the NW provides SMTC configuration, then UE can synchronize with the target satellite. Opt2 is more reasonable. |
| Qualcomm | Option 2, see comments | It seems UE would have to adjust the SMTC offset for the target. We need to discuss whether the UE provides the updated SMTC to network or trigger PDD report, otherwise UE and network may be out of sync once UE resumes UL/DL. |
| Lenovo | Option 2 | Prefer to have similar behavior to RRC\_IDLE. |
| ZTE | Option 2 | Since UE will have to reacquire SIB19, it is possible for UE to adjust SMTC autonomously based on the derived propagation delay.  |
| Huawei, HiSilicon | Option 2 | On Samsung’s comment, we think SMTC configuration is not entirely the same with *ssb-PositionsInBurst* and *ssb-periodicityServingCell*, there is no SSB index bitmap in SMTC and there is an offset in the SMTC configuration. Regardless of that, the configuration is separate with the current serving cell, because the configuration could be different between the two satellites.On the signaling of this separate SMTC configuration, we think dedicated signaling is not desired because the motivation of unchanged PCI is to save the HO command. It should be provided by system information. Therefore, UE adjustment is needed because the PDD for different Ues is different. |
| Nokia | Option 1+2 | UE shall adjust it, based on the configuration received from the NW and/or the PDD calculations. In soft-switching case, though, this might not be possible. This may also impact the scheduling restrictions for the NW. If the UE does not support the NTN capability “parallelMeasurementWithoutRestriction-r17” a scheduling interruption is required when the UE is measuring the neighbor satellite. NW must be aware of the restricted slots. |
| LGE | Option 2 | For hard satellite switching, Option 1 is not forward compatible when the non-negligible gap is considered. Furthermore, for soft satellite switching, Option 1 is impossible that the network reconfigure SMTC configuration to switch SMTC of source satellite to SMTC of target satellite in every SSB timing of target satellite. |
| Sequans | Option 2 | Similar view as Ericsson.  |
| Fujitsu | Option 2 | It is a similar UE behaviour in IDLE then option 2 is feasible and simple solution.  |
| Xiaomi | Option 2 |  |
| Apple | Option 2 | L3 signaling is not involved in this procedure, so it’s impossible for network to control the SMTC timing adjustment.  |
| CMCC | Option 2 | Similar to UE behavior in Idle/Inactive mode. |

**Summary:**

The views from the participants on whether the SMTC configuration adjustment should be handled by network or by UE can be summarized as follows:

Support option 2: Ericsson/vivo/QC/Lenovo/ZTE/Huawei, HiSilicon/LGE/Sequans/Fujitsu/Xiaomi/

Apple/CMCC (12/15)

Support option 1+2: Nokia (1/15)

Support option 3: Samsung(no need to broadcast smtc) (1/15)

One company indicates that UE could adjust the measurement timing window of the SSB of target satellite based on ephemeris and common TA parameter and via time offset configured by NW for soft switch.

**Therefore, the rapporteur recommend the majority’s view as agreed conclusion:**

**Proposal 3: SMTC configuration adjustment should be handled by UE. (12/15)**

#### **Question A2-3 : If SMTC configuration is different from source and target satellite, do you think the SMTC configuration of target satellite should be provided in SIB19 or in RRC dedicated signaling in advance?**

* Option 1: provided in SIB19
* Option 2: provided in RRCReconfiguration before SAT switching
* Option 3: others?

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| --- | --- | --- |
| **Company** | **Option**  | **Comments** |
| Ericsson | Option 1 | Same reasoning as in A2-2. |
| Samsung | Option 3 (no need to broadcast smtc) | For neighbor cell measurement, SMTC is given because UE is not synchronized with the neighbor cell and it has to measure SSBs within the indicated smtc window. While for the serving cell, UE has to synchronize with the serving cell by searching SSBs. Therefore, similar to performing HO where *ssb-PositionsInBurst* and ssb-periodicityServingCell are given in ServingCellConfigCommon, *ssb-PositionsInBurst* for the target satellite should be provided in SIB19 so that UE can search the SSB based on the SSB pattern, assuming ssb-periodicityServingCell shall not change for the same serving cell. The offset caused by PDD can be calculated by UE based one target satellite ephemeris and handled by UE based on serving cell existing smtc. So no need to broadcast additional smtc. |
| CATT | See comments | As per our replies in QA2-1 we think the SMTC in this question is coupled with the time-offset option in Question A4-1. So whether to configure offset/SMTC depends on the conclusion of QA4-1.If we agree to configure time offset/SMTC, e.g., for soft satellite switch case, the info should be provided in SIB19.  |
| Vivo | Comments | As per our reply in Question A2-2, SMTC configuration of target satellite cannot be provided by the network in advance. UE-based adjustment is preferable.  |
| Qualcomm | Option 1 | We should avoid any dedicated signaling for this solution. |
| Lenovo | Option 1 |  |
| ZTE | Option 3, no need to provide SMTC configuration | Per our comments in QA2-1-QA2-2, there is no need to broadcast SMTC, UE can adjust it autonomously. |
| Huawei, HiSilicon | Option 1 |  |
| Nokia | Option 1 | Option 2 does not make sense, if our aim here is to reduce the signalling. Thus, SIB-based option to be pursued. |
| LGE | Option 1 with comments | The SMTC of target satellite only can be provided in soft satellite swiching case. |
| Sequans | Option 1 |  |
| Fujitsu | Opion 1 | If SMTC can be adjusted by UE in Q2-2, we think dedicated signalling is not needed and it should be provide in SIB19.  |
| Xiaomi | Option 3 | The SMTC of target satellite is not needed, UE could adjust the SMTC for target satellite. |
| Apple | Option 1 |  |
| CMCC | Option 1 | If we agree to configure time offset/SMTC, e.g., for soft satellite switch case, the info should be provided in SIB19. And if the SMTC is not change when satellite switch, an indication can be provided in SIB 19. |

**Summary:**

The views from the participants on whether the SMTC configuration options can be summarized as follows:

Support option 1: Ericsson/QC/Lenovo/Huawei, HiSilicon/Nokia/LGE/Sequans/Fujitsu/Apple/CMCC(10/15)

Support option 3: Samsung/CATT/vivo/ZTE/Xiaomi (no need to broadcast smtc) (5/15)

Five companies think SMTC of target satellite is not needed to provide, UE could adjust the SMTC based on NW assistance information(e.g. ephemeris and common TA parameters ). However, there are 10 companies perfer to adopt SIB message to convey the SMTC configuration of target satellite. Therefore, the rapporteur recommend the majority’s view as agreed conclusion:

**Proposal 4: the SMTC configuration of target satellite should be provided in SIB19 (if needed). FFS whether an indication to indicate the SMTC configuration of target satellite is same with that of serving satellite can be provided in SIB19.**

### **Issue 3: Hard or soft switch indication**

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| RAN2#123bis agreement:* *Only 1 target satellite information (i.e. NTN-config) of serving cell is provided in SIB19. FFS on exact signalling*
 |

We agreed to introduce an indication to inform UE it is hard switch or soft switch case, with FFS if explicit or implicit.

#### **Question A3: Please provide your preferred indication manner, explicit or implicit?**

* Option 1: explicit indication, i.e. 1 bit indication whether it’s the soft switching or hard switching
* Option 2: implicit indication via the presence of T-start related configuration, e.g. soft switching if T-start is configured.
* Option 3: Other?

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| --- | --- | --- |
| **Company** | **Option**  | **Comments** |
| Ericsson | Option 2. Implicit. | The value of t-start w.r.t. t-service is sufficient indication for the type of switch. |
| Samsung | Option 2  | Agree with Ericsson, t-start with an earlier time than t-service indicates soft switch, t-start with the same value as t-service indicates hard switch. For hard switch, t-start can also be used as the trigger for switch. |
| CATT | Option 2 | If t-start is absent, the case is hard satellite switch with coverage gap is zero. Otherwise, the case is soft satellite, and the start serving time of the target satellite is t-start. |
| Vivo | Option 2 | The presence of T-start can implicitly indicate that soft satellite switching will happen. |
| Qualcomm  | Option 2 |  |
| Lenovo | Option 2 | T-start (and possibly its relation with t-Service) is sufficient. |
| ZTE | Option 2 |  |
| Huawei, HiSilicon | Option 2 | Agree with CATT.Absence of t-Start means hard satellite switching, and presence of t-Start means soft satellite switching. |
| Nokia | Modified Option 2 or Option 3 | The value of t-gap could indicate that (negative value can be used to signal the soft-switching case while positive or close to zero indicates hard-switching scenario). |
| LGE | Option 2 |  |
| Sequans | Option 2 |  |
| Fujitsu | Option 2 | Same view with the supporting companies. |
| Xiaomi | Option 2 |  |
| Apple | Option 2 |  |
| CMCC | Option 2 | With the new parameter introduced, implicit manner is sufficient. |

**Summary:**

Support option 2: Ericsson/Samsung/CATT/Vivo/Qualcomm/Lenovo/ZTE/Huawei, HiSilicon/Nokia/LGE/Sequans/Fujitsu/Xiaomi/Apple/CMCC (15/15)

Support option 3: Nokia (1/15)

One company provide a modified option 2 using t-gap: The value of t-gap could indicate that (negative value can be used to signal the soft-switching case while positive or close to zero indicates hard-switching scenario).

**Proposal 5: Support implicit indication (e.g. soft switching if T-start is configured.) to inform UE it is hard switch or soft switch case.**

### **Issue 4: Target satellite SSB aspects**

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| RAN2#123bis agreement:* At least soft satellite switching, network provides SSB information of target satellite to UE. FFS on the details: options include e.g. indicating a time offset/information or indicating a different SSB index for the target satellite (FFS for Hard satellite switch)
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At least soft satellite switching, network provides SSB information of target satellite to UE is agreed. And the detail target SSB information is FFS, and the following options could be the discussion baseline based on our discussion in RAN2 #123bis meeting:

**Option 1:** Indicating a time offset/information for the target satellite

**Option 2:** Indicating a different SSB index for the target satellite

#### **Question A4-1: Please provide your preferred option about target satellite SSB information in soft switch.**

**Option 1:** Indicating a time offset/information for the target satellite

**Option 2:** Indicating a different SSB index for the target satellite

**Option 3:** Other?

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred option** | **Comments** |
| Ericsson | Option 2 | From RAN1 LS, network can solve by implementation the SSB collision for the soft switch scenario. However, the way in which the problem is solved determines the type of signaling that RAN2 needs to design.We think that there is no need to change SMTC configuration upon the cell switch. Hence, Option 2 is more efficient and aligned with current design: bitmap based on SSB index to indicate which SSB is transmitted/should be measured. |
| Samsung | Option 3 (*ssb-PositionsInBurst* of the target satellite) | *ssb-PositionsInBurst* gives the SSB pattern, it indicates the time domain positions of the transmitted SS-blocks in a half frame with SS/PBCH blocks as defined in TS 38.213 [13], clause 4.1. It also allows NW to indicate a different set of SSB indexes for the target satellite.  |
| CATT | Option 1 | For option 2, configure different SSB index for the target satellite may cause reconfiguration of SSB configuration related info, e.g., TCI state, after satellite switching. And this, in the other way around, eats up the overhead saving brought by the unchanged PCI operation. For example, the SSB indexes configured for source satellite are #0 and #1, so the TCI state is associated with SSB index #0 and #1. If the SSB index configured for target satellite are #2 and #3, the TCI state should be reconfigured to be associated with SSB index #2 and #3. This will result in RRC reconfiguration procedure which does not fit with the motivation of unchanged PCI. |
| vivo | Option 2 | In our understanding, Opt 1 is infeasible. This is because a cell-specific offset cannot precisely compensate UE’s specific PDD. As a result, the UE cannot distinguish whether an SSB is from source or target due to the overlapping. For Op2, after satellite switching, the NW can send MAC CEs to update the TCI state/Pathloss reference/Spitial relation (i.e. the NW preconfig TCI state/Pathloss reference/Spitial relation for both source and target, and use MAC CE to update the state). RRC reconfiguration is not needed.  |
| Qualcomm | Option 1+Option 2 | After further think, it seems SSB index indication is not very critical. What is critical for faster SSB detection is what is time offset of the SSB at ULSRP between source and target satellite, then UE will detect the SSB. In this sense, option 1 is sufficient.However, Option 1 + Option 2 is also useful in case of multiple SSBs from target and network wants UE to select a specific SSB. |
| Lenovo | Option 2 | A different SSB index is straight-forward. |
| ZTE | Option 2 | Same view as Ericsson |
| Huawei, HiSilicon | Option 3, SMTC configuration is enough | We think these two agreements are somewhat overlapping:1. SMTC configuration of target satellite needs further discussion:

 FFS on whether and how to provide the SMTC configuration of target satellite. FFS on how to handle the SMTC adjustment. 1. We support soft satellite switching in Rel-18
2. There will be an indication (FFS if explicit or implicit) whether hard switch or soft switch is used.
3. At least soft satellite switching, network provides SSB information of target satellite to UE. FFS on the details: options include e.g. indicating a time offset/information or indicating a different SSB index for the target satellite (FFS for Hard satellite switch)

If the SMTC windows of the previous satellite and the incoming satellite are not overlapping, there would be no SSB confusion issue. Therefore the simplest solution is to provide SMTC configuration of the incoming satellite.The alternative is overlapping SMTC windows with different SSB indexes as proposed by some companies. But we think this solution is beyond R2 scope, and should not be pursued. |
| Nokia | Option 3  | This is a cross-WG topic and should be decided together with RAN1. However, what we need to take care of is to maintain the time orthogonality when the UE temporarily receives the signal from two transmission points (belonging theoretically to the same cell). The interval between different SSB indexes being transmitted is inferior to 1 ms. A time offset can be easily “overrun” by the difference in PDD between the UE and the two satellites. Maybe it’s a case for considering separation in frequency. In our view RAN1 must be involved in this discussion.  |
| LGE | Option 1 with comments | The UE may have to perform autonomous SMTC adjustment for target satellite as we answered in QA2-1. With Option 2, the UE cannot perform such adjustment. Option 1 implies that the SSB burst of target satellite have different position from SSB burst of the source satellite. In our understanding, the UE knows which SSB burst is from target satellite with time offset/information of target satellite. |
| Sequans | Option 3 | Similar understanding as HW. That looks simpler and is in RAN2 scope. Regarding the index, feasibility should be checked further, we are not sure how to avoid overlapping with that solution.  |
| Fujitsu | Option 2 | It is more straight forward option. |
| Xiaomi | Opiton 3 | It seems this issue should be discussed by RAN1. |
| Apple | Option 2 or Option 3 indicated by Samsung  | We think Option 2 and Option 3 proposed by Samsung are in the same direction. Option3 (*ssb-PositionsInBurst* of the target satellite) proposed by Samsung is the detailed information related to how to provide the SSB index in Option 2. So we agree with Samsung that we can provide *ssb-PositionInBurst* of the target satellite.  *ssb-PositionsInBurst CHOICE {* *shortBitmap BIT STRING (SIZE (4)),* *mediumBitmap BIT STRING (SIZE (8)),* *longBitmap BIT STRING (SIZE (64))* *}* |
| CMCC | Option 2 | Option 2 is straightforwardFor option 1, time offset/information may be cell-specific parameter which is not apply to all the UE in the cell considering different distance or propagation delay to the satellite. |

**Summary:**

**The opinions from the participants seem to be quite diverse, and can be summarized as follows:**

Support option 1: CATT/LGE (2/15)

Support option 2: Ericsson/vivo/Lenovo/ZTE/Fujitsu/Apple/CMCC (7/15)

Support option 1+2: QC (1/15)

Support option 3: Samsung(*ssb-PositionsInBurst* of the target satellite)/Huawei, HiSilicon(SMTC configuration is enough)/Nokia(involve RAN1)/Sequans(same as HW)/Xiaomi(need RAN1 discuss)/Apple(same as Samsung) (6/15)

As our discussion in last meeting, for soft satellite switch, the target satellite SSB information could be up to RAN2 and candidate options include e.g. indicating a time offset/information or indicating a different SSB index for the target satellite. Then based on companies’ comments above, we could further discuss the following options:

**Option 1:** Indicating a time offset/information for the target satellite

**Option 2:** Indicating a different SSB index for the target satellite

**Option 3:** *ssb-PositionsInBurst* of the target satellite

**Option 4:** option 1+2

**Option 5:** SMTC configuration is enough

**Proposal 6: For soft satellite switch, regarding the target satellite SSB information, we could further discuss the following options:**

**Option 1:** Indicating a time offset/information for the target satellite

**Option 2:** Indicating a different SSB index for the target satellite

**Option 3:** *ssb-PositionsInBurst* of the target satellite

**Option 4:** option 1+2

**Option 5:** SMTC configuration is enough

Then for hard satellite switch, there is no interference issue between source and target satellite, maybe we could consider to keep flexibility and whether provide target SSB information is up to NW implementation. If NW provide target SSB information, the same mechanism as in soft satellite switch is adopted.

#### **Question A4-2: For hard satellite switch, do companies agree the same SSB information of the target satellite should be provided?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Ericsson | No | This is not necessary. SSB information does not need to change upon a hard switch since there are no collisions. Even if it does change, legacy mechanism such as *ssb-PositionsInBurst* and *ssb-ToMeasure* shall be used to indicate the SSB information. |
| Samsung | Yes | *ssb-PositionsInBurst* for the target cell can be provided if SSB information is changed for hard switch, and it shall be provided for soft switch.  |
| CATT | No | For hard satellite switch, the NW does not need to broadcast SSB via source satellite and target satellite with an offset. Hence, the UE could estimate the time window of SSB provided by the target satellite based on the ephemeris and common TA info. The mechanism to be concluded for soft satellite switch is not needed in hard satellite switch case. |
| vivo | No | Same view with Ericsson. For hard satellite switch, there is no interference issue between source and target satellite regarding the SSB detecting. |
| Qualcomm | No |  |
| Lenovo | No | Not needed for hard switch. |
| ZTE | No |  |
| Huawei, HiSilicon | Yes but… | We think this is duplicated with the target SMTC configuration. |
| Nokia | May not be needed | However, we prefer to have a unified approach to soft- and hard-switching scenario, wherever possible. |
| LGE | No |  |
| Sequans | No | Not needed |
| Fujitsu | No |  |
| Xiaomi | No |  |
| Apple  | No |  |
| CMCC | No | Not needed |

**Summary:**

Yes: Samsung/Huawei, HiSilicon (2/15)

No: Ericsson/CATT/vivo/QC/Lenovo/ZTE/Nokia/LGE/Sequans/Fujitsu/Xiaomi/Apple /CMCC (13/15)

The majority views go for that SSB information is not needed for hard satellite switch.

**Proposal 7: For hard satellite switch, there is no need to provide the SSB information of the target satellite. (13/15)**

### **Issue 5: T-start aspects**

|  |
| --- |
| RAN2#123bis agreement:* We introduce a T-start which indicates the earliest occasion when the UE can start synchronizing with target satellite (actual signalling is FFS). In soft switch scenario, T-start of target satellite is earlier than T-service of source satellite (FFS if T-start is also used for hard satellite switch)
 |

We agreed to introduce a T-start which indicates the earliest occasion when the UE can start synchronizing with target satellite for soft satellite switch case with FFS actual signaling, and T-start of target satellite is earlier than T-service of source satellite.

#### **Question A5-1: Please provide your comments on FFS actual signaling about T-start for soft satellite switch.**

**Option 1:** Introduce the new configuraiton of T-start

**Option 2:** Introduce the new configuraiton of T-gap, UE can aquire the T-start of target satellite based on T-gap and T-service of source satellite. (T-start = T-service – T-gap).

**Option 3:** other?

|  |  |  |
| --- | --- | --- |
| **Company** | **Option**  | **Comments** |
| Ericsson | Option 2 | T-gap of ASN.1 type INTEGER is a more flexible approach which can cover a range of scenarios. For instance, T-gap=0 may indicate immediate hard switch (negligible interruption), T-gap>0 can indicate a small coverage interruption, and t-gap<0 indicates soft switch. |
| Samsung | Option 1  | T-start is more straightforward, that can indicate any time before, equal to, or after t-service, and does not depends on t-service.  |
| CATT | Option 1 | If option 1 is adopted, the format of t-Start can be determined quickly. It can be defined in format of UTC, same as the *t-Service*, shown below. t-Service-r17 INTEGER (0..549755813887) OPTIONAL, -- Need RBut if option 2 is adopted, we need to discuss the value range and step of t-Gap, which may need checking with RAN1.Considering that we only have one meeting left and there are a lot of essential issues to discuss, we support option1. |
| vivo | Option 1 | Option 1 is more straightforward. |
| Qualcomm | Option 2 | Option 1 adds overhead. Option 2 seems reasonable as this gap is supposed to be small. We prefer not to have positive gap for HARD satellite switch to avoid any impact to other working groups.As long as the range we define for the gap is small, and keep spare values for future extension of larger values, the positive gap is fine. |
| Lenovo | Option 1 | T-start is more straight-forward and is also flexible even than the t-gap which could be limited by value range. |
| ZTE | Option 1 | Share the same view as Samsung and CATT |
| Huawei, HiSilicon | Option 2 with revisions | We think t-Start/t-Gap is only needed for soft switching scenario, not needed for hard satellite switching.And in this case, we would prefer a solution with smaller signaling overhead, e.g. t-Gap. But the name should be modified, it is actually “t-Overlapping”. |
| Nokia | Option 2 | This gives the full flexibility, works in soft- and hard-switching scenario and is most signalling-efficient (no need to provide the absolute time value for t-start).  |
| LGE | Option 1 | Prefer Option 1 but we can go to majority view. |
| Sequans | Option 2 with revisions | Agree with HW. We should not reopen the discussion on signaling a positive gap. |
| Fujitsu | Option 1 | Agree with CATT |
| Xiaomi | Option 2 |  |
| Apple |  | We are fine with either option, and can go for majority view.  |
| CMCC | Option 2 |  |

**Summary:**

Support option 1:Samsung/CATT/vivo/Lenovo/ZTE/LGE(accept go to majority view)/Fujitsu/Apple/CMCC (9/15)

Support option 2: Ericsson/QC/Huawei, HiSilicon/Nokia/Sequans/Xiaomi/Fujitsu/Apple/CMCC (9/15)

The company's views are just evenly divided, and several companies could accept to go for majority. **Proposal 8: The detail signaling of t-star can be discussed online.**

#### **Question A5-2: Do you think T-start should be also provided for hard satellite switch?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No**  | **Comments** |
| Ericsson | Yes | We don’t see any technical reasons to preclude using t-start/t-gap in hard switches. |
| Samsung | Yes | T-start equal to t-service can indicate a hard switch. As we have agreed for hard switch, a switch trigger indication is needed on top of t-service, t-start can be used as the switch trigger. In this way, we allow a unified procedure of hard and soft switch.  |
| CATT | No | We have no time to consider the case of hard satellite switch with coverage gap is not zero. |
| Vivo | No | RAN2 has agreed that t-Service is used for hard satellite switch, there is no need to introduce other mechanisms. Moreover, the presence of T-start can be used by UE to decide whether is hard satellite switch or soft satellite switch case. |
| Qualcomm | No | We prefer only negative gap for now and avoid complexity of work. Small positive gap can be ignored. |
| Lenovo | Neutral | We are fine to have no restriction on this (in case other scenario e.g., T-start is late than T-service, is considered in future) |
| ZTE | Yes | Since T-start is needed for soft switch, it could be possible to use it as well for hard switch (by configuring the same value as t-service), which means unified UE behavior to reacquire SIB19 for both soft/hard switch satellite change. In such case, presence of target satellite info/SSB info in PCI unchanged scenario will be implicit indication that it is for soft satellite switch. But this also implies reverse of previous agreements that t-start shall be earlier than t-service.  |
| Huawei, HiSilicon | No | Agree with CATT. |
| Nokia | Yes | T-gap should be used. Could be configured to zero, if that is feasible in certain scenarios. As said before, a unified approach to soft and hard-switching should be attempted. |
| LGE | Yes | We prefer to have no restriction on T-start.  |
| Sequans | No |  |
| Fujitsu | Yes | OK to introduce it for hard switching but need to update t-start can be indicated timing after t-service. |
| Xiaomi | No |  |
| Apple | Neutral | T-gap for soft-switch is the nagtive gap (i.e. T-service > T-start)If T-gap is applied for hard switch case, we will support positive T-gap (i.e. T-service < T-start) .  |
| CMCC | No  |  |

**Summary:**

Yes: Ericsson/Samsung/ZTE/Nokia/LGE/Fujitsu (6/15)

No: CATT/Vivo/Qualcomm/Huawei, HiSilicon/Sequans/Xiaomi/CMCC (7/15)

Neutral: Lenovo(fine to have no restriction on this)/Apple (2/15)

**Proposal 9: Further discuss whether T-start is needed for hard satellite switch.**

## 2.1 UE operation (Part B)

## 2.1 UE operation (Part B)

### 2.2.1. UE operation during the satellite switching procedure

For both RACH-based and RACH-less satellite switching procedure, the change of serving satellite will lead to changes in the propagation delay and the channel condition of the serving cell from UE perspective. Therefore, it will introduce some impact on MAC operation and RRM measurement operation.

Regarding the impact on MAC operation, due to the pathloss change, UE may need to report the PHR based on new pathloss after satellite switching.

**Proposal 1: During satellite switching procedure, UE initiates PHR reporting after satellite switching.**

#### **Question B-1: Do you agree with the proposal 1?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | Rely on legacy PHR triggering is sufficient. |
| Samsung | No | Agree with Ericsson |
| CATT |  | The UE reports PHR after satellite switching, if path loss has changed more than a threshold, e.g. *phr-Tx-PowerFactorChange*.But we keep it open on whether this is an essential feature having to be introduced at this stage. |
| vivo | No | The legacy trigger condition can be reused for PHR reporting (i.e. the pathloss is changed beyond threshold), no new trigger condition is needed. |
| Qualcomm | See comments | However, the UE should trigger TA report MAC CE or PDD report. For PHR we also think legacy mechanism is sufficient. |
| Lenovo | No | legacy PHR triggering is ok |
| ZTE | No | Agree with Ericsson |
| Huawei, HiSilicon | No | Agree with Ericsson. |
| Nokia | Based on the existing trigger | Does that mean that there should be new triggering for PHR, related to RACH-less Unchanged PCI switching? If the path loss between inbound and outbound satellites is above a given threshold then the PHR will be triggered (so legacy behaviour will apply). |
| Sequans | No | Rely on legacy seems enough. |
| Fujitsu | No | Agree with Ericsson. |
| Xiaomi | No |  |
| CMCC | No | Agree with Ericsson |

**Summary:**

All companies think it’s sufficient to reply on legacy PHR procedure, and some companies assume UE should initiate TA reporting upon satellite switching.

**Proposal B-1: PHR procedure is not impacted by the satelliete switching procedure.**

**Proposal B-1a (for discussion): Discuss whether UE triggers TA reporting upon satellite switching.**

Regarding the impact on RRM measurement, due to the change of radio condition of the serving cell, UE may need to reset all the serving cell related measurement , i.e. reset L3 filter for the serving cell’s RRM measurement and reset RLM, but there will be no impact on neighbor cell’s measurement.

**Proposal 2: During satellite switching procedure, UE re-initiates all the serving cell related measurement, e.g. reset L3 filter for serving cell RRM measurement and reset the RLM.**

#### **Question B-2: Do you agree with the proposal 2?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | See comments | We understand the reasons behind the proposal, but it is unclear to us where or how to capture this behavior in the specification. In legacy, UE is not mandated to discard samples as the UE knows that the "old samples" of the old serving cell may be reported as neighbor cell later after handover completion. Here, the situation is different; we assume that *measConfig* does not need to be released since source and target cell are the same cell, and the configuration is generated by the CU which does not change. However, there should be a common understanding between UE and network of where *measObject* reported samples come from. |
| Samsung | Yes |  |
| CATT | Yes |  |
| vivo | No | After satellite switching, the measurement results generally become better, and then “IS” will be indicated to clear RLF. There is no bad consequence even though the UE doesnot reset RRM or RLF. Moreover, the NW knows when satellite switching happens, it can be based on the NW implementation not using the measurement report for the serving cell under such a case. We fail to see a big motivation to have this enhancement.  |
| Qualcomm | Yes, see comments | It may be better not to use old satellite measurements for L3 filtering. However, this should not impact the measurement variables and reporting, i.e., only about L3 filtering window. |
| Lenovo | Yes with comments | We think this can be UE implementation. |
| ZTE | See comments  | If it is up to UE implementation, there seems no specs impact. |
| Huawei, HiSilicon | No | The RAN2 spec impact is unclear, the measurement samples are not defined in the RAN2 spec. Also, in TN intra-cell HO there is no UE behavior of “discarding samples”. |
| Nokia | Y | The UE shall reset L3 filtering and discard the measurements for the serving cell. The UE should be also not expected to perform measurements during the t-gap (e.g. RLM).  |
| LGE | Yes | It is essential to prevent unexpected problem due to L3 filter/RLM from old satellite. |
| Sequans | Yes |  |
| Fujitsu | Yes | It is reasonable as the measurement samples from old satellite may cause cell quality degradation and trigger unnecessary measurement event. |
| Xiaomi | Yes |  |
| CMCC | See comments  | The UE need reset L3 filtering and discard the measurements on the cell of the last satellite and the UE is capable of identifying the different measurement results from two cells . However, it can be up to UE implementation or be defined in TS38.214. |

**Summary:**

Majority view is to support proposal 2, but the impact on RAN2 spec is unclear. Some companies think it could be up to UE implementation or defined in RAN1 spec.

**Proposal B-2: During satellite switching procedure, UE should reset the L3 filter for serving cell RRM measurement and RLM, and it’s up to UE implementation (i.e. no RAN2 spec impact).**

A failure detection timer should be introduced to protect the failure case, which is similar as HOF timer (T304). The timer is started when UE starting the satellite switching and stopped when the sync procedure successful to the target satellite is successfully completed. When the failure timer expires, UE will initiate the UE connection reestablishment procedure.

**Proposal 3: Introduced timer based failure detection mechanism for satellite switching procedure.**

#### **Question B-3: Do you agree with the proposal 3?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | The premise of supporting this feature is not to introduce a switching procedure requiring the UE to send switching complete message to confirm the switch and have minimum spec impact. Legacy mechanisms (RLF and Re-establishment) not specific for mobility procedure apply, no need for enhancements. |
| Samsung | No | Legacy RLF and RRC re-establishment can work. |
| CATT | No | A new timer is not needed. The failure detection of the unchanged PCI procedure can be well handled by current RLF mechanisms, e.g., T310 and max number of preamble transmission. |
| vivo | Yes | Upon service link switching occurs, all the UE in the cell needs to re-synchronize to the new satellite. Due to the limited resources on the network side, there is a high probability that one RACH process will fail for UEs at the cell edge or UEs with poor coverage. If we rely on RACH failure to determine satellite switching procedure failure, these UEs have a high probability of experiencing satellite switching procedure failure and then performing RRC connection re-establishment in the cell where the failure occurred. In order to save signaling overhead to a greater extent, timer based failure detection mechanism should be introduced. |
| Qualcomm | No but see comments | As long as we define UE should trigger to report TA report MAC CE or PDD report upon successful satellite synchronization to let network know UE is ready, existing RLF mechanism works. |
| Lenovo | No | And we agree with Qualcomm that UE should trigger TA report upon successful satellite synchronization. |
| ZTE | No | We can relay on legacy RLM procedure |
| Huawei, HiSilicon | No | Agree with Samsung. |
| Nokia | No | Why do we need a new timer for this purpose? Why not to rely on the existing T310 (if RLF occurs, then RRC Reestablishment is pursued). |
| LGE | No | Agree with QC. |
| Sequans | No | Legacy RLF/Reestab should be used. |
| Fujitsu | No | Use legacy RLF handling. |
| Xiaomi | No | Reuse the legacy RLF and RRC re-establishment. |
| CMCC | No | Legacy RLF and RRC re-establishment are enough. No timer is needed. |

**Proposal 4: When the satellite switching failure is detected, UE initiates the UE connection reestablishment procedure.**

#### **Question B-4: Do you agree with the proposal 4?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | See answer to B-3. Legacy mechanisms apply. |
| Samsung | No | Satellite switch failure can be detected by RLF and RRC re-establishment can work. |
| CATT | Yes | Follow current RLF procedures. |
| vivo | Yes |  |
| Qualcomm | No | See our response in B-3. |
| Lenovo | No |  |
| ZTE | No |  |
| Huawei, HiSilicon | No |  |
| Nokia | Yes | But not based on the new timer, as argued in B-3. |
| Sequans | No | Legacy RLF/Reestab should be used. |
| Fujitsu | Yes | This question is ambiguous, the UE initiates reestablishment procedure regardless of detection mechanism of satellite switching failure. |
| Xiaomi | No |  |
| CMCC | No |  |

**Summary:**

Almost all companies think the legacy RLF and RRC connection reestablishment procedure can be used for the satellite switching failure detection and recovery.

**Proposal B-3: The satellite switching failure is detected by the legacy RLF mechanism, i.e no need to introduce new timer based failure detection mechanism.**

**Proposal B-4: UE initiates the UE connection reestablishment procedure when the satellite switching failure is detected.**

### 2.2.2.RACH-less satellite switching

RAN2 agreed to support satellite switching without RACH procedure. To support this RACH-less satellite switching procedure, some open issues need to be addressed.

1. UE capability

From UE capability perspective, the support of NR RACH-less HO is optional. Similarly, the support of RACH-less SAT switching should be also defined as optional UE capability.

**Proposal 5: It’s the optional UE capability to support the RACH-less satellite switching procedure.**

#### **Question B-5: Do you agree with the proposal 5?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | Unchanged PCI RACH-less is not a feature that the network will configure. In fact, there is no dedicated configuration for this kind of unchanged PCI switch. Hence, the use of RACH-less is up to UE implementation. If the UE has already a configured grant and can calculate and pre-compensate TA, then it can use RACH-less access in the target satellite. If the UE does not already have a configured grant, the gNB could issue a dynamic grant after the UE acquires sync of the target satellite, by this the UE also needs not to perform RACH in the target satellite.  |
| Samsung | No | We think only a UE capability of PCI unchanged satellite switch is needed. RACH-less switch does not require additional UE capability because it’s within the same serving cell and whether RACH is performed or not is per NW configuration. If NW indicates rach-based switch, UE initiates RACH when switching to the target satellite; if NW indicates rach-less switch (e.g., by giving N\_TA), UE does not perform RACH and re-synchronize by using N\_TA. |
| CATT | Yes | And it should be a capability with signalling. The NW needs to know which UE should be scheduled after successful RACH. |
| vivo | No | Satellite switching without RACH procedure is not the same as RACH-less satellite switching procedure. We don’t support RACH-less satellite switching.In our understanding, the main scenario in which satellite switching without RACH procedure is that the RTT of UE does not change after service link switching, UE does not need to re-synchronize to the serving cell. In other words, the satellite switch is senseless for UE, no new UE behavior is not needed. |
| Qualcomm | No | We also think this is just about whether to transmit UL signal in the configured resources or trigger RACH to inform network. These are existing procedures. |
| Lenovo | No |  |
| ZTE | No | NW can based on unchanged PCI capability to decide whether to to schedule UE with or without RACH. There is no additional capability required for UE to skipped RACH in this case. |
| Huawei, HiSilicon | Yes | We think “UEs supporting unchanged PCI” and “UEs supporting unchanged PCI without performing RACH” have different behaviours, so a UE capability is needed to differentia these two kinds of UEs.1) Unchanged PCI with RACH:In this case, the TAT should be stopped at t-Service, and then started when receiving the TA command in RAR during RACH procedure, as in legacy.2) Unchanged PCI without performing RACHIn this case, the TAT can be restarted at t-Service. |
| Nokia | Yes | If the intention is to say “there is a separate capability for RACH-less”, in addition to “satellite switching with unchanged PCI” capability. We think the capability is needed (we cannot say it is a legacy behaviour, like many suggest) at least due to the soft-switching scenario (if the UE is to receive the UL grant before the t-service of the outbound satellite).  |
| LGE | No | Agree with Ericsson. |
| Fujitsu | No | In unchanged PCI, even if support of RACH-less satellite switching is provided in UE capability, the network operation is the same due to there is no dedicated L3 signalling. Hence, no need to separate capabilites. |
| Xiaomi | No | If UE supports RACH-less handover and unchanged PCI, UE should support unchanged PCI without performing RACH.[Rapp] I assume the view is UE can have the separate capabilities for RACH-less and RACH-based satellite switching; but the capability of the RACH-less satellite switching can be implicitly indiated by other capbilites (i.e. RACH-less HO capability).  |
| CMCC | Yes | From our perspective, “UEs supporting unchanged PCI” and “UEs supporting unchanged PCI without performing RACH” are separate UE capability. |
| Apple | Yes |  |

**Summary:**

Company’s views are quite diverse. 6 companies support the separate capabilities for RACH-less and RACH-based satellite switching; and 8 companies think UE supporting satellite switching procedure should always support RACH-less and RACH-based case.

**Proposal B-5 (for discussion): Discuss whether UE that supports satellite switching is mandatory to support RACH-less satellite switching.**

1. Network configuration

From network side, whether to enable the RACH-less satellite switching should be based on network configuration. Since the satellite switching is not L3 based mobility, using RRC dedicated signaling for such configuration should be avoided as much as possible, and we can only rely on SIB19 to provide such configuration.

**Proposal 6: RACH-less satellite switching procedure is configured in SIB19.**

#### **Question B-6: Do you agree with the proposal 6?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | Same reasoning as in B-5. |
| Samsung | Yes  | N\_TA for RACH-less PCI unchanged switch should be provide in SIB19. |
| CATT | Yes |  |
| vivo | No | See our reply to Question B-5. |
| Qualcomm | No but see comments | But we need to discuss whether there is forced RACH trigger upon satellite switch. This anyway can be provided in HO command. |
| Lenovo | No |  |
| Huawei, HiSilicon | Yes | But we think it should be a very simple indication.N\_TA is not needed, because in unchanged PCI case the UE should assume N\_TA = 0 (same N\_TA is only suitable for intra-satellite scenarios). |
| Nokia | Y | It should be SIB-based. |
| LGE | No |  |
| Fujitsu | Yes |  |
| Xiaomi | No |  |
| CMCC | Yes | It should be SIB-based. |
| Apple | Yes |  |

**Summary:**

Company’s views are quite diverse. 7 companies support the RACH-less configuration in SIB19 (proposal 6), and 6 companies donot support the configuration.

If network doesnot explicitly provide the RACH-less configuration in SIB, we may need to further discuss teh following two open issues:

* Issue 1: How does the UE determine whether to trigger RACH-less or RACH-based procedure?
* Issue 2: Does the network always support the RACH-less apprach for satellite switching? In other words, if network only starts providing services to UE via target satellite upon receiving preamble/RACH procedure, it’s better for network to inform UE not to initiate RACH-less procedure.

Since the method of the explicit RACH-less configuration can avoid the further discussion, and it is more convenient for UE and network implementation, rapporteur would like to propose to consider the explicit configuration.

**Proposal B-6 (for discussion): Support the explicit configuration of RACH-less satellite switching in SIB19.**

**Proposal B-6a (for discussion): If proposal B-6 is not agreed, RAN2 is proposed to discuss the following two issues:**

* **Issue 1: How does the UE determine whether to trigger RACH-less or RACH-based procedure?**
* **Issue 2: Does the network always support the RACH-less apprach for satellite switching?**

When UE receives the SIB19 with RACH-less satellite switching configuration, if UE doesnot support RACH-less procedure, UE will still perform RACH-based satellite switching procedure.

**Proposal 7: If UE does not support RACH-less satellite switching, UE will only perform RACH-based procedure regardless of whether the network configured RACH-less or RACH-based satellite switching procedure.**

#### **Question B-7: Do you agree with the proposal 7?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | This proposal is formulated under the assumption that B-5 and B-6 are agreed. If the network wants the UE to perform RACH, it can just send a PDCCH order after the switch, otherwise it can issue a dynamic grant or let UE continue to use CG if already available. |
| Samsung | No  | See B-5  |
| CATT | Yes |  |
| vivo | No | See our reply to Question B-5. |
| Qualcomm |  | It is not clear if there was any new specific different behavior other than existing PUSCH/PUCCH vs RACH triggers, which requires new UE capability. |
| Lenovo | No |  |
| Huawei, HiSilicon | Yes | In this case UE shall start RACH upon t-Service. |
| Nokia | Yes | The target satellite (providing the cell with unchanged PCI) should expect the UEs to access either via RACH or RACH-less.  |
| LGE | No |  |
| Fujitsu | Yes |  |
| Xiaomi | Yes |  |
| CMCC | Yes |  If UE does not support RACH-less satellite switching, traditional RACH is needed. |
| Apple | Yes |  |

**Summary:**

Company’s views are quite diverse. 7 companies support proposal 7, and 5 companies which do not support the explicit RACH-less configuration donot support proposal 7.

Proposal B-7 is proposed to be discussed after proposal B-6 and proposal B-5.

If Proposal B-6 is agreed and if RACH-less satellite switching is optional UE capability in Proposal B-5, Proposal B-7 can be agreed directly.

**Proposal B-7 (discussed after proposal B-5 and B-6): If UE does not support RACH-less satellite switching, UE will only perform RACH-based procedure regardless of whether the network configured RACH-less or RACH-based satellite switching procedure.**

1. UE operation during RACH-less satellite switching
* UL grant for the 1st UL transmission towards target satellite

During RACH-less satellite switching, in order to provide the UL grant for the 1st UL transmission towards target satellite, we can follow the same design as RACH-less HO and rely on dynamic grant or pre-configured grant.

* Option 1: dynamic grant

In RACH-less HO, network can provide UE the beam for the dynamic grant reception from the target cell in RACH-less HO command.

For satellite switching scenario, since the serving satellite changes, the beam situation providing coverage has also changed. In this procedure, the beam information should be cell specific or satellite specific, so network can provide the beam information for the dynamic grant reception in target satellite in SIB19.

* Option 2: preconfigured grant

In RACH-less HO, network provides the beam and the associated preconfigured grant of target cell in UE dedicated RRC signaling.

For satellite switching procedure, since the serving cell does not change, we can consider using the legacy configured grant for this purpose, and UE does not need to release it after satellite switching. For example, network may provide two configured grant configurations associated to the different SSBs. When UE switches to the target satellite, and UE detect a good SSB#1 from the target satellite, UE can select the configured grant associated with SSB#1 for 1st UL transmission.

**Proposal 8: For RACH-less satellite switching, network may indicate the beam info for the dynamic grant reception in target satellite in SIB19, and UE starts monitoring the dynamic UL grant via the indicated beam after performing DL sync in the target satellite.**

#### **Question B-8: Do you agree with the proposal 8?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | If the serving and target cells are configured in the same way (same SSB frequency), we do not see a need for further indications. In addition, the transmission beam can be indicated in DCI providing the dynamic UL grant just like in legacy. |
| Samsung  | No | Agree with Ericsson, no need of separate CG or DG for 1st UL transmission because there is no first UL transmission for PCI unchanged switch. UE simply follow serving cell configuration and applies the dedicated resource for normal DL/UL transmission. So no additional beam indication is needed. |
| CATT | No | P8 above is per UE configuration, which does not fit the motivation of unchanged PCI to save signaling overhead. On the other hand, we assume the beam coverage can be unchanged after satellite switch by NW implementation. So the activated TCI state for UE is unchanged. |
| vivo | No | See our reply to Question B-5. |
| Qualcomm | No | This is PCI unchanged case, i.e., same cell, same current ressources are available for UE to use. |
| Lenovo | No |  |
| ZTE | No | Unchanged PCI with RACH skipped is different from RACH-less HO, there is no need to transmit RRCRecofigurationComplete message and no need to pre-allocated UL grant for UE in this case. UE only needs to reacquire SIB19 to do precompensation and re-sync to serving cell if configured by NW, while the rest is the same as staying in connected mode for the same serving cell.  |
| Huawei, HiSilicon | No | Agree with Ericsson’s bubble comment. The “unchanged PCI without performing RACH” is different from the normal RACH-less procedure, NW does not need to schedule UL grant for RRCReconfigurationComplete. |
| Nokia | Y | But it remains unclear how the NW shall know which users need the UL via target satellites’ DL, if dedicated signalling is to be avoided.  |
| LGE | No |  |
| Fujitsu | No | No need new UE/NW behaviours, the UE can follow the DG or CG after satellite switching as in legacy. |
| Xiaomi | No |  |
| CMCC | No | Unchanged PCI without performing RACH is not exactly same as RACH-less HO. |

**Summary:**

Almost all companies think UE just follows serving cell configuration and applies the dedicated resource for normal DL/UL transmission as that in source satellite, and no additional beam indication for the 1st UL transmission in target satellite is needed. One company raises a question that how network knows which UE needs the UL grant via the target satellite during RACH-less satellite switching. Rapporteur’s undertanding is that for RACH-less satellite switching, UE may transmit SR via PUCCH to request the UL grant and network can therefore know that this UE has ready for the transmission/reception via the target satellite.

**Proposal B-8: For RACH-less satellite switching, no additional beam information is provided to UE for the UL transmission in target satellite.**

**Proposal 9: For RACH-less satellite switching procedure, network may provide the configured grant and associated to beam info via RRC dedicated signaling, and UE selects the configured grant based on the detected SSB from the target satellite.**

#### **Question B-9: Do you agree with the proposal 9?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | Same reasoning as in B-5 |
| Samsung  | No | Agree with Ericsson, no need of separate CG or DG for 1st UL transmission because there is no first UL transmission for PCI unchanged switch. UE simply follow serving cell configuration and applies the dedicated resource for normal DL/UL transmission. So no additional CG is needed. |
| CATT | No | P9 above is per UE configuration, which does not fit the motivation of unchanged PCI to save signaling overhead. And the CG configured via source satellite can be used directly. |
| vivo | No | See our reply to Question B-5. |
| Qualcomm | No |  |
| Lenovo | No |  |
| ZTE | No | See comments for B-8 |
| Huawei, HiSilicon | No | Same comment as in the previous question. |
| Nokia | N | Perhaps it would be easier if configured grant is not a part of the scheme. Otherwise, like stated in P9, dedicated signaling needs to be involved, etc.  |
| LGE | No |  |
| Fujitsu | No |  |
| CMCC | No |  |

**Summary:**

All companies think that it’s not necessary for network to provide the preallcoated UL grant as that in RACH-less HO to UE for the 1st UL transmission in target satellite. Companies also think the configured grant in current serving cell can be directly used for the UL transmission in target satellite.

**Proposal B-9: For RACH-less satellite switching, there is no dedicated preallocated UL grant provided to UE for the 1st UL transmission in target satellite.**

* Fallback to RACH-based satellite switching

In NTN RACH-less HO, if the RSRP value of the beam associated for the 1st UL grant is lower than a threshold, UE will fall back to RACH-based HO.

The fallback design is also applicable for the RACH-less satellite switching. If no beam associated to the UL grant in target satellite has good quality, UE cannot acquire the valid UL grant for the 1st UL transmission, and UE has to fallback to RACH in order to complete the satellite switching procedure.

**Proposal 10: For RACH-less satellite switching procedure, UE fallbacks to RACH-based satellite switching procedure if the beam associated to the UL grant in target satellite has RSRP value lower than a threshold.**

#### **Question B-10: Do you agree with the proposal 10?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | This procedure is not L3 RACH-less, hence network will not provide a dedicated configuration (e.g., RSRP threshold. It is up to UE implementation. Besides, there is no RSRP threshold and fallback to RACH based on the normal CG based UL transmission in RRC\_CONNECTED mode. Thus, there is no need for a new behavior if UE can follow normal UL transmission after the switch with unchanged PCI. |
| Samsung | No | Agree with Ericsson, no need of separate CG or DG for 1st UL transmission because there is no first UL transmission for PCI unchanged switch. UE simply follow serving cell configuration and applies the dedicated resource for normal DL/UL transmission. So no beam selection or fallback is needed. |
| CATT | No | Similar to our comments in QB-8, after satellite switch, the serving beam of the UE is unchanged. |
| vivo | No | See our reply to Question B-5. |
| Lenovo | No |  |
| ZTE | No | See comments for B-8 |
| Huawei, HiSilicon | No | Agree with Ericsson. |
| Nokia | No | We prefer not to consider the configured grant in this scheme (i.e. rely on dynamic grant if RACH-less access is used). |
| LGE | No |  |
| Fujitsu | No |  |
| Xiaomi | No |  |
| CMCC | No |  |

**Summary:**

Based on the discussion on previous prospoal B-8 and proposal B-9, there is no special handling on the UL grant for the 1st UL transmission in target satellite, therefore we donot need to consider the special fallback case as that for proposal 10.

**Proposal B-10: For RACH-less satellite switching, there is no case to fallback to RACH-based satellite switching procedure based on radio quality.**

* TA value for the 1st UL transmission

In NTN RACH-less HO, network can set the Nta value to 0 or same as source satellite in the RACH-less HO command to UE.

For RACH-less satellite switching, network can also provide the same information based on the deployment (e.g. set Nta as 0 if source and target satellite are not collocated together). Since it’s based on the deployment, it can be regarded as cell specific info and provided in SIB19.

**Proposal 11: For RACH-less satellite switching procedure, network can set Nta value to 0 or same as source in SIB19.**

#### **Question B-11: Do you agree with the proposal 11?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | Yes (see comment) | We understand that rapporteurs want to say that UE independently sets NTA to 0. For unchanged PCI, there’s no case where source and target belong to the same satellite. |
| Samsung | Yes |  |
| CATT | Yes |  |
| vivo | No | See our reply to Question B-5. |
| Qualcomm | Yes | As satellite has changed and TA has changed. But even for RACH-based, this should be applicable. |
| Lenovo | Yes |  |
| Huawei, HiSilicon | No | We think UE should assume N\_TA as zero (same N\_TA is only suitable for intra-satellite scenarios). |
| Nokia | Y |  |
| LGE | Yes |  |
| Fujitsu | Yes |  |
| Xiaomi | Yes |  |
| CMCC | Yes |  |

**Summary:**

All companies agree that the UE sets NTA value to 0 when switching to target satellie, and some companies indicate the NTA value same as source satellite is not possible for the satellite switching case. Rapporteur is also not sure about the applicable scenario of the same NTA between source and target satellite. Therefore, Rapporteur proposes to agree to set NTA value to 0 for the RACH-less satellite switching case.

**Proposal B-11: For RACH-less satellite switching procedure, UE sets Nta value to 0.**

* The message in the 1st UL transmission towards target satellite

In NR RACH-less HO and LTE RACH-less mobility, after UE switches to the target cell, UE will transmit the RRCReconfigurationComplete message to network.

For satellite switching procedure, it’s not L3 involved mobility, and the serving cell configuration doesnot changes. Therefore, it’s no need to transmit RRCReconfigurationComplete message, and UE can directly perform the data transmission/reception in target satellite.

**Proposal 12: For RACH-less satellite switching procedure, UE resumes the UE dedicated transmission/reception via the 1st UL grant towards to target satellite.**

#### **Question B-12: Do you agree with the proposal 12?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | Yes |  |
| Samsung | Yes with comment | There is no 1st UL grant, it’s just the same UE dedicated DL/UL resources for the same serving cell.  |
| CATT | Yes |  |
| vivo | No | See our reply to Question B-5. |
| Qualcomm |  | Not clear what is the 1st UL grant.We think whether be it RACH or PUCCH, UE has to send some UL signal to complete the switch. |
| Lenovo | Yes |  |
| Huawei, HiSilicon | No | The UE simply consider the serving cell as unchanged and the UE dedicated UL/DL transmission follows legacy behavior.Also, in the proposal, we cannot understand why only UL grant is mentioned while DL transmission is excluded. |
| Nokia |  | There is no L3 mobility, so no RRC complete message. However, the UE and NW need to be in sync regarding when the procedure is considered to be complete. Besides, the “UE resumes the UE dedicated transmission” needs to be clarified there.  |
| LGE |  | Agree with QC. |
| Fujitsu | Yes |  |
| Xiaomi |  | Not clear what is the 1st UL grant. |
| CMCC |  | The 1st UL grant description needs to clarify. |

**Summary:**

Companies may have concern on the descritption of 1st UL grant in target satellite. According to company’s comment, companies seems fine with the description that UE resumes the UE dedicated UL/DL transmission after UE aquires the DL sync of target satellite.

**Proposal B-12: For RACH-less satellite switching, UE resumes the UE dedicated UL/DL transmission after UE aquires the DL sync in target satellite.**

### 2.2.3. Coexistence with L3 mobility scheme

After network enables the satellite switching procedure, network can also decide trigger UE perform HO to other cell. And UE should follow the HO command and initiate HO procedure immediately.

**Proposal 13: After satellite switching scheme is enabled, if UE receives the HO command before the switching period or switching point, UE will initiate the HO procedure immediately.**

#### **Question B-13: Do you agree with the proposal 13?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | Yes | As a general rule, dedicated configuration takes precedence. |
| Samsung | Yes |  |
| CATT | Yes  |  |
| vivo | Yes | Agree with Ericsson. |
| Qualcomm | Yes |  |
| Lenovo | Yes |  |
| ZTE | Yes |  |
| Huawei, HiSilicon | Yes | NW is still allowed to HO the UE via legacy mechanism. |
| Nokia | Yes |  |
| LGE | Yes |  |
| Sequans | Yes |  |
| Fujitsu | Yes |  |
| Xiaomi | Yes |  |
| CMCC | Yes |  |

**Summary:**

All companies supports proposal13.

**Proposal B-13: If UE receive the HO command before UE initiates the satellite switching procedure (i.e. before the time point of satellite switching), UE will initiate the HO procedure immediately.**

For CHO scheme, since it is enabled in advanced, network may also possibly enable both CHO and satellite switching procedure at the same time. And in UE side, UE can just follow the condition evaluation to initiate the corresponding scheme, e.g. UE can initiate CHO when CHO condition is met, and initiate satellite switching when the satellite switching time is arrived. When both conditions are met, it could up to UE implementation to choose either one.

**Proposal 14: Both CHO and satellite switching procedure can be configured simultaneously.**

#### **Question B-14: Do you agree with the proposal 14?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | Yes |  |
| Samsung | Yes | NW should not configure CHO and PCI unchanged satellite switch for the same PCI, CHO should be for a different PCI. But this is up to NW implementation. |
| CATT | Yes | For the UE at cell edge, there may be requirement to configure location-based CHO to enhance its mobility. |
| vivo | Yes | As satellite switching is cell-specific, then the NW can configure CHO for a given UE to overwrite the satellite switching behavior.  |
| Qualcomm | Yes |  |
| Lenovo | Yes |  |
| ZTE | Yes | Since NW doesn’t know when UE will execute CHO when providing UE with CHO configuration, it is possible that CHO and unchanged PCI can be enabled at the same time. If so, UE is expected to perform the procedure based on which condition fulfills first. Furthermore, there is no restriction in current specs that the PCI of candidate CHO cell shall always be different from current serving, i.e., it is allowed in specs to configure CHO candidate cell with the same PCI as current serving cell. To avoid complexity, we understand this configuration is still consider as a l3 procedure, which is similar to intra-cell HO. |
| Huawei, HiSilicon | Yes |  |
| Nokia | Yes, but | We do not think it would be a popular approach to configure both simultaneously. If configured, the UE executes what is triggered first (e.g. based on the indicated time).  |
| LGE | Yes |  |
| Sequans | Yes |  |
| Fujitsu | Yes |  |
| Xiaomi | Yes |  |
| CMCC | Yes |  |

**Summary:**

All companies supports proposal14.

**Proposal B-14: Both CHO and satellite switching procedure can be configured simultaneously.**

**Proposal 15: When both CHO and satellite switching conditions are met, it's up to UE implementation to choose either one.**

#### **Question B-15: Do you agree with the proposal 15?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Y/N** | **Comments** |
| Ericsson | No | UE shall follow dedicated configuration. |
| Samsung | No | NW should not configure CHO and PCI unchanged satellite switch for the same PCI. |
| CATT | See comments | We prefer to perform the procedure whose condition is met firstly. Upon disconnecting to source satellite, when the UE switches to target satellite, the UE stops evaluating the conditions of CHO. |
| vivo | N | Following the logic of the current spec, it is generally dedicated signaling override broadcast signaling, so we think UE will choose to perform CHO procedure when both CHO and satellite switching conditions are met. |
| Qualcomm | See comments | Unless CHO is released or cancelled, UE should keep following the existing procedure. The network should not configure CHO for the same PCI.  |
| Lenovo | No | Dedicated signaling will override the broadcast signaling. |
| ZTE | See comments | Same view as CATT. UE is expected to perform the procedure based on which condition fulfills first.  |
| Huawei, HiSilicon | No | Agree with Samsung, if both are configured, they are not targeted at the same candidate cell, so the UE just evaluate them independently (i.e. if CHO execution condition is satisfied before t-Service, UE simply trigger the CHO).Not sure whether the question is focused on the scenario where “CHO execution condition is satisfied exactly upon t-Service”. If this is the case, we think the UE can follow unchanged PCI, because CHO execution will introduce additional signaling (during RA procedure, as R2 only agreed time-based CHO can be combined with RACH-less, no such agreement on other CHO events) and interruption. |
| Nokia | No | This is probably a corner case (as suggested above) and maybe we do not need to specify anything here.  |
| LGE | Yes |  |
| Sequans | No | Agree with Ericsson |
| Fujitsu | No | The network can avoid such situation. |
| Xiaomi | No | Share the same view as Samsung. |
| CMCC | No | The two solutions are applied to different scenarios. |

##### **Summary**

According to company’s inputs, rapporteur summarizes into 3 views as follows, and propose RAN2 to discuss.

* View 1: NW should not configure intra-cell CHO and satellite switching procedure simultanously.
* View 2: UE always follows the CHO;
* View 3: UE will initiate the procedure that triggers earlier; if both procedures are triggered at the same time, it's up to UE implementation.

**Proposal B-15a (for discussion): Intra-cell CHO and satellite switching procedure should not be configured simultaneously.**

**Proposal B-15b (for discussion): When both CHO and satellite switching procedure are configured, RAN2 is proposed to discuss which option should be adopted:**

* **Option 1: UE always follows CHO;**
* **Option 2: UE initiates the procedure that triggers earlier; it's up to UE implementation if both procedures are triggered at the same time.**

# **3 Summary**

***Rapporteur Summary:***

The options related to the exact signaling of the target satellite information can be summarized as follows:

* Option 1: Introduce one new target satellite configuration (e.g. *ntn-TargetSatConfig*), and provide the *NTN-config* of the target satellite in it.

**Ericsson/Samsung/CATT/vivo/QC/Lenovo/ZTE/Huawei,HiSilicon/LGE/Sequans/Fujitsu/Xiaomi/Apple/CMCC (14/15)**

* Option 2: Introduce one new target satellite configuration (e.g. *ntn-TargetSatConfig*), but for the provision of the target satellite’s *NTN-config*, it is not explicitliy provided in it, but rely on a pointer (e.g.targetSatInfo) to *NeighCellConfigList* (e.g.targetSatInfo) to aquire the NTN-config of the target satellite.

 **Samsung/Nokia (2/15)**

**Obviously, for the exact signaling of the target satellite information, for majority (14/15), option 1, i.e., to introduce one new target satellite configuration (e.g. ntn-TargetSatConfig), and provide the NTN-config of the target satellite in it can be accepted. Therefore, the rapporteur recommend the majority’s view as agreed conclusion:**

**Proposal 1: it is proposed to introduce one new target satellite configuration, e.g. *ntn-TargetSatConfig*, and provide the *NTN-config* of the target satellite in it for the the specific signaling format about the target satellite information in SIB19. (14/15)**

The views from the participants on whether the SMTC configuration of target satellite can be different from that in source seem to be quite diverse, and can be summarized as follows:

1. **For hard switch:**
	1. Yes (Samsung/vivo/QC/Lenovo/Huawei, HiSilicon/Nokia/LGE/Fujitsu/Xiaomi/CATT) (10/15)
	2. No (Ericsson/ZTE/Sequans/Apple/CMCC) (5/15)
2. **For soft switch:**
	1. Yes (Ericsson/Samsung/vivo/QC/Lenovo/ZTE/Huawei, HiSilicon/Nokia/LGE/Fujitsu/Xiaomi/CMCC/CATT) (13/15)
	2. Maybe (Sequans/Apple) (2/15)

And one company indicates that for hard switch, UE could estimate the time window of SSB provided by the target satellite based on the ephemeris and common TA info autonomously, no need of different SSBs. And for soft switch, NW could send the SSB with a time offset comparing with the source satellite. Considering the views from the participant, the rapporteur comments the following proposal:

**Proposal 2 : At least for soft switch, support SMTC configuration of target satellite can be different from that in source. (15/15) FFS for hard switch.(10/15)**

The views from the participants on whether the SMTC configuration adjustment should be handled by network or by UE can be summarized as follows:

Support option 2: Ericsson/vivo/QC/Lenovo/ZTE/Huawei, HiSilicon/LGE/Sequans/Fujitsu/Xiaomi/

Apple/CMCC (12/15)

Support option 1+2: Nokia (1/15)

Support option 3: Samsung(no need to broadcast smtc) (1/15)

One company indicates that UE could adjust the measurement timing window of the SSB of target satellite based on ephemeris and common TA parameter and via time offset configured by NW for soft switch.

**Therefore, the rapporteur recommend the majority’s view as agreed conclusion:**

**Proposal 3: SMTC configuration adjustment should be handled by UE. (12/15)**

The views from the participants on whether the SMTC configuration options can be summarized as follows:

Support option 1: Ericsson/QC/Lenovo/Huawei, HiSilicon/Nokia/LGE/Sequans/Fujitsu/Apple/CMCC(10/15)

Support option 3: Samsung/CATT/vivo/ZTE/Xiaomi (no need to broadcast smtc) (5/15)

Five companies think SMTC of target satellite is not needed to provide, UE could adjust the SMTC based on NW assistance information(e.g. ephemeris and common TA parameters ). However, there are 10 companies perfer to adopt SIB message to convey the SMTC configuration of target satellite. Therefore, the rapporteur recommend the majority’s view as agreed conclusion:

**Proposal 4: the SMTC configuration of target satellite should be provided in SIB19 (if needed). FFS whether an indication to indicate the SMTC configuration of target satellite is same with that of serving satellite can be provided in SIB19.**

The views from the participants on options of Hard or soft switch indication can be summarized as follows:

Support option 2: Ericsson/Samsung/CATT/Vivo/Qualcomm/Lenovo/ZTE/Huawei, HiSilicon/Nokia/LGE/Sequans/Fujitsu/Xiaomi/Apple/CMCC (15/15)

Support option 3: Nokia (1/15)

One company provide a modified option 2 using t-gap: The value of t-gap could indicate that (negative value can be used to signal the soft-switching case while positive or close to zero indicates hard-switching scenario).

**Proposal 5: Support implicit indication (e.g. soft switching if T-start is configured.) to inform UE it is hard switch or soft switch case.**

**The opinions from the participants seem to be quite diverse, and can be summarized as follows:**

Support option 1: CATT/LGE (2/15)

Support option 2: Ericsson/vivo/Lenovo/ZTE/Fujitsu/Apple/CMCC (7/15)

Support option 1+2: QC (1/15)

Support option 3: Samsung(*ssb-PositionsInBurst* of the target satellite)/Huawei, HiSilicon(SMTC configuration is enough)/Nokia(involve RAN1)/Sequans(same as HW)/Xiaomi(need RAN1 discuss)/Apple(same as Samsung) (6/15)

As our discussion in last meeting, for soft satellite switch, the target satellite SSB information could be up to RAN2 and candidate options include e.g. indicating a time offset/information or indicating a different SSB index for the target satellite. Then based on companies’ comments above, we could further discuss the following options:

**Option 1:** Indicating a time offset/information for the target satellite

**Option 2:** Indicating a different SSB index for the target satellite

**Option 3:** *ssb-PositionsInBurst* of the target satellite

**Option 4:** option 1+2

**Option 5:** SMTC configuration is enough

**Proposal 6: For soft satellite switch, regarding the target satellite SSB information, we could further discuss the following options:**

**Option 1:** Indicating a time offset/information for the target satellite

**Option 2:** Indicating a different SSB index for the target satellite

**Option 3:** *ssb-PositionsInBurst* of the target satellite

**Option 4:** option 1+2

**Option 5:** SMTC configuration is enough

Yes: Samsung/Huawei, HiSilicon (2/15)

No: Ericsson/CATT/vivo/QC/Lenovo/ZTE/Nokia/LGE/Sequans/Fujitsu/Xiaomi/Apple /CMCC (13/15)

The majority views go for that SSB information is not needed for hard satellite switch.

**Proposal 7: For hard satellite switch, there is no need to provide the SSB information of the target satellite. (13/15)**

**The opinions of the detail signaling of t-star from the participants seem to be quite diverse, and can be summarized as follows:**

Support option 1:Samsung/CATT/vivo/Lenovo/ZTE/LGE(accept go to majority view)/Fujitsu/Apple/CMCC (9/15)

Support option 2: Ericsson/QC/Huawei, HiSilicon/Nokia/Sequans/Xiaomi/Fujitsu/Apple/CMCC (9/15)

The company's views are just evenly divided, and several companies could accept to go for majority. **Proposal 8: The detail signaling of t-star can be discussed online.**

All companies think it’s sufficient to reply on legacy PHR procedure, and some companies assume UE should initiate TA reporting upon satellite switching.

**Proposal B-1: PHR procedure is not impacted by the satelliete switching procedure.**

**Proposal B-1a (for discussion): Discuss whether UE triggers TA reporting upon satellite switching.**

Majority view is to support proposal 2, but the impact on RAN2 spec is unclear. Some companies think it could be up to UE implementation or defined in RAN1 spec.

**Proposal B-2: During satellite switching procedure, UE should reset the L3 filter for serving cell RRM measurement and RLM, and it’s up to UE implementation (i.e. no RAN2 spec impact).**

Almost all companies think the legacy RLF and RRC connection reestablishment procedure can be used for the satellite switching failure detection and recovery.

**Proposal B-3: The satellite switching failure is detected by the legacy RLF mechanism, i.e no need to introduce new timer based failure detection mechanism.**

**Proposal B-4: UE initiates the UE connection reestablishment procedure when the satellite switching failure is detected.**

Company’s views are quite diverse. 6 companies support the separate capabilities for RACH-less and RACH-based satellite switching; and 8 companies think UE supporting satellite switching procedure should always support RACH-less and RACH-based case.

**Proposal B-5 (for discussion): Discuss whether UE that supports satellite switching is mandatory to support RACH-less satellite switching.**

Company’s views are quite diverse. 7 companies support the RACH-less configuration in SIB19 (proposal 6), and 6 companies donot support the configuration.

If network doesnot explicitly provide the RACH-less configuration in SIB, we may need to further discuss teh following two open issues:

* Issue 1: How does the UE determine whether to trigger RACH-less or RACH-based procedure?
* Issue 2: Does the network always support the RACH-less apprach for satellite switching? In other words, if network only starts providing services to UE via target satellite upon receiving preamble/RACH procedure, it’s better for network to inform UE not to initiate RACH-less procedure.

Since the method of the explicit RACH-less configuration can avoid the further discussion, and it is more convenient for UE and network implementation, rapporteur would like to propose to consider the explicit configuration.

**Proposal B-6 (for discussion): Support the explicit configuration of RACH-less satellite switching in SIB19.**

**Proposal B-6a (for discussion): If proposal B-6 is not agreed, RAN2 is proposed to discuss the following two issues:**

* **Issue 1: How does the UE determine whether to trigger RACH-less or RACH-based procedure?**
* **Issue 2: Does the network always support the RACH-less apprach for satellite switching?**

Company’s views are quite diverse. 7 companies support proposal 7, and 5 companies which do not support the explicit RACH-less configuration donot support proposal 7.

Proposal B-7 is proposed to be discussed after proposal B-6 and proposal B-5.

If Proposal B-6 is agreed and if RACH-less satellite switching is optional UE capability in Proposal B-5, Proposal B-7 can be agreed directly.

**Proposal B-7 (discussed after proposal B-5 and B-6): If UE does not support RACH-less satellite switching, UE will only perform RACH-based procedure regardless of whether the network configured RACH-less or RACH-based satellite switching procedure.**

Almost all companies think UE just follows serving cell configuration and applies the dedicated resource for normal DL/UL transmission as that in source satellite, and no additional beam indication for the 1st UL transmission in target satellite is needed. One company raises a question that how network knows which UE needs the UL grant via the target satellite during RACH-less satellite switching. Rapporteur’s undertanding is that for RACH-less satellite switching, UE may transmit SR via PUCCH to request the UL grant and network can therefore know that this UE has ready for the transmission/reception via the target satellite.

**Proposal B-8: For RACH-less satellite switching, no additional beam information is provided to UE for the UL transmission in target satellite.**

All companies think that it’s not necessary for network to provide the preallcoated UL grant as that in RACH-less HO to UE for the 1st UL transmission in target satellite. Companies also think the configured grant in current serving cell can be directly used for the UL transmission in target satellite.

**Proposal B-9: For RACH-less satellite switching, there is no dedicated preallocated UL grant provided to UE for the 1st UL transmission in target satellite.**

Based on the discussion on previous prospoal B-8 and proposal B-9, there is no special handling on the UL grant for the 1st UL transmission in target satellite, therefore we donot need to consider the special fallback case as that for proposal 10.

**Proposal B-10: For RACH-less satellite switching, there is no case to fallback to RACH-based satellite switching procedure based on radio quality.**

All companies agree that the UE sets NTA value to 0 when switching to target satellie, and some companies indicate the NTA value same as source satellite is not possible for the satellite switching case. Rapporteur is also not sure about the applicable scenario of the same NTA between source and target satellite. Therefore, Rapporteur proposes to agree to set NTA value to 0 for the RACH-less satellite switching case.

**Proposal B-11: For RACH-less satellite switching procedure, UE sets Nta value to 0.**

Companies may have concern on the descritption of 1st UL grant in target satellite. According to company’s comment, companies seems fine with the description that UE resumes the UE dedicated UL/DL transmission after UE aquires the DL sync of target satellite.

**Proposal B-12: For RACH-less satellite switching, UE resumes the UE dedicated UL/DL transmission after UE aquires the DL sync in target satellite.**

All companies supports proposal13.

**Proposal B-13: If UE receive the HO command before UE initiates the satellite switching procedure (i.e. before the time point of satellite switching), UE will initiate the HO procedure immediately.**

All companies supports proposal14.

**Proposal B-14: Both CHO and satellite switching procedure can be configured simultaneously.**

According to company’s inputs, rapporteur summarizes into 3 views as follows, and propose RAN2 to discuss.

* View 1: NW should not configure intra-cell CHO and satellite switching procedure simultanously.
* View 2: UE always follows the CHO;
* View 3: UE will initiate the procedure that triggers earlier; if both procedures are triggered at the same time, it's up to UE implementation.

**Proposal B-15a (for discussion): Intra-cell CHO and satellite switching procedure should not be configured simultaneously.**

**Proposal B-15b (for discussion): When both CHO and satellite switching procedure are configured, RAN2 is proposed to discuss which option should be adopted:**

* **Option 1: UE always follows CHO;**

**Option 2: UE initiates the procedure that triggers earlier; it's up to UE implementation if both procedures are triggered at the same time.**

# **4 Conclusion**

**List of proposals for agreement (if any):**

**Proposal A-1: it is proposed to introduce one new target satellite configuration, e.g. *ntn-TargetSatConfig*, and provide the *NTN-config* of the target satellite in it for the the specific signaling format about the target satellite information in SIB19. (14/15)**

**Proposal A-2 : At least for soft switch, support SMTC configuration of target satellite can be different from that in source. (15/15) FFS for hard switch.(10/15)**

**Proposal A-3: SMTC configuration adjustment should be handled by UE. (12/15)**

**Proposal A-4: the SMTC configuration of target satellite should be provided in SIB19 (if needed). FFS whether an indication to indicate the SMTC configuration of target satellite is same with that of serving satellite can be provided in SIB19.**

**Proposal A-5: Support implicit indication (e.g. soft switching if T-start is configured) to inform UE it is hard switch or soft switch case.**

**Proposal A-7: For hard satellite switch, there is no need to provide the SSB information of the target satellite. (13/15)**

***< UE operation during satellite switching>***

**Proposal B-1: PHR procedure is not impacted by the satelliete switching procedure.**

**Proposal B-2: During satellite switching procedure, UE should reset the L3 filter for serving cell RRM measurement and RLM, and it’s up to UE implementation (i.e. no RAN2 spec impact).**

**Proposal B-3: The satellite switching failure is detected by the legacy RLF mechanism, i.e no need to introduce new timer based failure detection mechanism.**

**Proposal B-4: UE initiates the UE connection reestablishment procedure when the satellite switching failure is detected.**

**Proposal B-8: For RACH-less satellite switching, no additional beam information is provided to UE for the UL transmission in target satellite.**

**Proposal B-9: For RACH-less satellite switching, there is no dedicated preallocated UL grant provided to UE for the 1st UL transmission in target satellite.**

**Proposal B-10: For RACH-less satellite switching, there is no case to fallback to RACH-based satellite switching procedure based on radio quality.**

**Proposal B-11: For RACH-less satellite switching procedure, UE sets Nta value to 0.**

**Proposal B-12: For RACH-less satellite switching, UE resumes the UE dedicated UL/DL transmission after UE aquires the DL sync in target satellite.**

***< Coexistence with L3 mobility scheme>***

**Proposal B-13: If UE receive the HO command before UE initiates the satellite switching procedure (i.e. before the time point of satellite switching), UE will initiate the HO procedure immediately.**

**Proposal B-14: Both CHO and satellite switching procedure can be configured simultaneously.**

**Proposal B-15a : Intra-cell CHO and satellite switching procedure should not be configured simultaneously.**

**Proposal B-15b : When both CHO and satellite switching procedure are configured, RAN2 is proposed to discuss which option should be adopted:**

* **Option 1: UE always follows CHO;**
* **Option 2: UE initiates the procedure that triggers earlier; it's up to UE implementation if both procedures are triggered at the same time.**

**List of proposals that require online discussions:**

**Proposal A-6: For soft satellite switch, regarding the target satellite SSB information, we could further discuss the following options:**

**Option 1:** Indicating a time offset/information for the target satellite

**Option 2:** Indicating a different SSB index for the target satellite

**Option 3:** *ssb-PositionsInBurst* of the target satellite

**Option 4:** option 1+2

**Option 5:** SMTC configuration is enough

**Proposal A-8: The detail signaling of t-star can be discussed online.**

**Proposal A-9: Further discuss whether T-start is needed for hard satellite switch.**

On Part B, the proposals captured are the following:

**Proposal B-1a (for discussion): Discuss whether UE triggers TA reporting upon satellite switching.**

***<RACH-less satellite switching>***

**Proposal B-5 (for discussion): Discuss whether UE that supports satellite switching is mandatory to support RACH-less satellite switching.**

**Proposal B-6 (for discussion): Support the explicit configuration of RACH-less satellite switching in SIB19.**

**Proposal B-6a (for discussion): If proposal B-6 is not agreed, RAN2 is proposed to discuss the following two issues:**

* **Issue 1: How does the UE determine whether to trigger RACH-less or RACH-based procedure?**
* **Issue 2: Does the network always support the RACH-less apprach for satellite switching?**

**Proposal B-7 (discussed after proposal B-5 and B-6): If UE does not support RACH-less satellite switching, UE will only perform RACH-based procedure regardless of whether the network configured RACH-less or RACH-based satellite switching procedure.**

# 5 References

1. RAN2-123bis - NR-NTN-IoT-NTN (Sergio)\_EOM
2. R2-2311319-[AT123bis][307][NR-NTN Enh] Unchanged PCI (Apple)

# 6 Contact information

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# 7 RAN2 agreements on unchanged PCI

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| RAN2#122 Agreements* t-Service in SIB19 can also be interpreted by Rel-18 UE in Connected mode to know that a satellite change or feeder link change happens
* In hard switch unchanged PCI scenario (i.e. no handover), the UE needs to know the time the UE attempts to re-synchronize. (FFS whether a new “t-Start” / a t-gap is needed or whether t-Service can be reused (i.e. no other IE) if the gap is very short/zero).
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| RAN2#123 Agreements* An explicit indication will be introduced to enable the unchanged PCI switch
* The unchanged PCI mechanism can be applied to the case where the coverage gap is zero or negligible (where there is no need to introduce t-gap or t-start). FFS whether we need to support scenarios that require the introduction of t-gap or t-start
* PCI unchanged procedure can be performed without performing RACH
* In the unchanged PCI case, the UE considers UL synchronization timer expired at t-Service (current cell stop time) to stop any UL operation. FFS on timeAlignmentTimer handling.
* In the unchanged PCI case, for RACH-based solution, the UE may trigger RACH immediately after DL synchronizing with the new satellite
* The UE specific Koffset, if configured, is not used after t-Service and the UE uses the cell specifc Koffset until the UE receives new differential Koffset MAC CE.
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| RAN2#123bis Agreements* We don’t consider the impact on Rel-17 UEs behavior (or Rel-18 UEs not supporting unchanged PCI) when defining the Rel-18 unchanged PCI solution
* Network provides the sync information of target satellite in advance to UE before satellite switching, via broadcast signalling
* RAN2 confirms satellite switching with unchanged PCI is only applicable on quasi-earth fixed system
* Only 1 target satellite information (i.e. NTN-config) of serving cell is provided in SIB19. FFS on exact signalling
* SMTC configuration of target satellite needs further discussion:
	+ FFS on whether and how to provide the SMTC configuration of target satellite.
	+ FFS on how to handle the SMTC adjustment.
* We support soft satellite switching in Rel-18
* There will be an indication (FFS if explicit or implicit) whether hard switch or soft switch is used.
* At least soft satellite switching, network provides SSB information of target satellite to UE. FFS on the details: options include e.g. indicating a time offset/information or indicating a different SSB index for the target satellite (FFS for Hard satellite switch)
* In soft satellite switching, UE can start synchronizing with target satellite before T-service of source satellite.
* We introduce a T-start which indicates the earliest occasion when the UE can start synchronizing with target satellite (actual signalling is FFS). In soft switch scenario, T-start of target satellite is earlier than T-service of source satellite (FFS if T-start is also used for hard satellite switch)
* For soft satellite switching, the exact time when the UE starts synchronizing with target satellite (between T-start and T-service) is up to UE implementation.
* UE is not required to connect to source satellite when the UE switches to target satellite.
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