3GPP TSG-RAN WG2 Meeting #123 R2-230xxxx

Toulouse, France, August 21-25, 2023

Agenda Item: 7.7.4.2

Source: CMCC

Title: Report of [Post122][114][NR NTN Enh] Unchanged PCI (CMCC)

Document for: Discussion and Decision

# 1 Introduction

The HO signaling overhead reduction is one important topic of the R18 NR NTN due to the frequent (seconds, tens of seconds or hundreds seconds of HO frequency) and unavoidable handover for a large number of UEs. And PCI unchanged (i.e. no handover) is an effective solution to reduce signaling overhead. Further, in RAN2 121bis meeting, we have agreed that in quasi-earth fixed cell case, for hard satellite switch in the same SSB frequency and same gNB (no key change), satellite switching without PCI changing (not requiring L3 mobility) is supported.



Figure 1 PCI unchanged in quasi-earth fixed cell case

And in last meeting, RAN1 has also confirmed the feasibility about hard satellite switching in the reply LS R1-2306210, as follows:

***Question 1:*** *For**hard satellite switching without PCI change, if RAN1 identifies any major technical issues?*

***Reply:***

*RAN1 discussed the resynchronization of UE when hard switching, given that new common TA, K\_mac, ephemeris and cell-specific K-offset are applied during resynchronization to new satellite.*

*From RAN1 perspective, no feasibility issue is identified for hard satellite switching without PCI change.*

Hence, to progress the discussion on unchanged PCI, this offline discussion aims to address the left issue and reach some agreements for unchanged PCI in 7.7.4.2 as follows:

** [Post122][114][NR NTN Enh] Unchanged PCI (CMCC)**

Scope: Discuss aspects related to satellite switch with no PCI change. e.g. re-synchronization aspects

Intended outcome: Summary of the email discussion

Deadline: August 5th 10:00 UTC

# 2 Discussion

## How does UE re-sync to a new satellite

In the last RAN2 meeting, we have some discussions on how does UE re-sync to a new satellite, and reach the agreement as follows:

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).

Therefore, for re-synchronize time, we could extract the following candidate solutions:

**Option 1:** Introduce a new “t-Start” (corresponding to incoming satellite starts providing coverage for the serving cell)

**Option 2:** Introduce a new t-gap (time duration between the current serving satellite and the incoming satellite starts providing coverage for the serving cell)

**Option 3:** reuse t-service (i.e. no other IE) with the condition that the gap is very short/zero

**Question 1: Please provide your preferred option listed. If you have any other preferred option, please provide it in the table and your argument.**

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| **Company** | **Preferred option** | **Comments** |
| OPPO | Revised option 2 | Introduce a new t-gap (time duration between the current serving satellite stopping providing coverage for the serving cell and the incoming satellite starting providing coverage for the serving cell)  Option 1 will consume more bits than option 2.  Option 3 does not indicate exact time when UE can re-synchronize with the new satellite, which may complicate UE’s implementation. |
| Huawei, HiSilicon | Option 3 | We think the unchanged PCI is mainly suitable for short/zero/negligible gap scenarios.  With Option 3, UE simply performs re-synchronization upon t-Service, there is nothing complicated.  NR NTN has never discussed discontinuous coverage case, and assuming a gap will complicate UE implementation from our perspective. |
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Summary:

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If new parameter (t-star or t-gap) is supported, we need to discuss how to provide it to UE, simply, both system information and dedicated signaling could be considered.

**Question 2: If new parameter (t-star or t-gap) is supported, which option is companies’ preference to provide the time information?**

**Option 1: System information (e.g. SIB1, SIB19)**

**Option 2: Dedicated signaling (e.g. *RRCReconfiguration* )**

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| **Company** | **Preferred option** | **Comments** |
| OPPO | Option 1 | System information is sufficient as the time when the new satellite starts providing coverage for the serving cell is common for all UEs. |
| Huawei, HiSilicon | Option 1 |  |
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Summary:

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As mentioned in some companies’ contribution, UE needs to know that it is in a scenario where PCI does not change after satellite switch, and additional indication (explicit or implicit) from network is needed. However, considering we have discussed the re-synchronize time, the exact indication manner (i.e. explicit or implicit) may be depend on the final solution in Q1. For example, if new parameter(t-start or t-gap) is supported, implicit manner may be enough while explicit manner is needed if we reuse the t-service, because UE maybe still not clear whether the current scenario is PCI unchanged scenario only with the t-service.

**Question 3: Do companies agree that if new parameter (t-start or t-gap) is supported, implicit indication manner is enough?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
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**Question 4: Do companies agree that if t-service is reused, explicit indication manner is needed?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes |  |
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To synchronize to the new satellite after switch, for RACH-based solution, both 2-step RA and 4-step RA could be considered. Then considering the long RTT in NTN system, maybe 2-step RA should have a higher priority.

**Question 5: Do companies agree that to perform synchronization to the new satellite after switch, 2-step RA could be supported firstly considering the long RTT in NTN system?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | No need for any prioritization | Whether 4-step RACH or 2-step RACH can be up to network’s configuration. |
| Huawei, HiSilicon |  | Agree with OPPO |
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Further, for selection of CBRA and CFRA, CFRA could also be prioritized due to the long propagation delay characteristic in NTN system.

**Question 6: Do companies agree that CFRA could be supported firstly due to the long propagation delay characteristic in NTN system?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO | No need for any prioritization | In some cases, CFRA may not even be affordable for so many UEs to switch satellite within short period.  Whether CFRA or CBRA can be up to network’s configuration. |
| Huawei, HiSilicon |  | Agree with OPPO |
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On the other hand, some companies propose to combine the RACH-less procedure with PCI unchanged solution in NTN system.

**Question 7: Do companies agree that the RACH-less procedure can be combined with PCI unchanged solution in NTN system?**

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| **Company** | **Yes/No** | **Comments** |
| OPPO |  | Not sure about this. This PCI unchanged solution (not requiring L3 mobility as agreed by RAN2) seems to have something different from RACH-less HO’s design in which RRC handover command will carry target cell’s NTA information and other CG/DG-related configurations. For PCI unchanged solution, we seems not to rely on RRC signaling that much. |
| Huawei, HiSilicon | Yes | We don’t see an issue here.  1) NTA is assumed to be zero, which is the same with the NTA for inter-satellite RACH-less HO with changed PCI;  2) UE monitors the PDCCH of target cell for UL grant;  3) After t-Service, the UE performs downlink synchronization with the new satellite, and T304 is stopped if MAC indicates the successful reception of a PDCCH with UE C-RNTI from the target cell. |
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## Backward compatibility issue

In addition, backward compatibility issue should also be considered as companies mentioned. If current scenario is PCI unchanged case, the legacy UEs who are not able to identify the indication mentioned above form NW, they might still perform handover procedure(i.e. L3 mobility), or leverage BFR procedure.

**Question 8: For back-ward compatibility, which option is companies’ preference?**

**Option 1: Perform intra-cell handover procedure (i.e. L3 mobility)**

**Option 2: Reuse BFR procedure**

**Option 3: other solution**

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| **Company** | **Preferred option** | **Comments** |
| OPPO |  | No sure about the question. It seems there is nothing we can do to optimize for legacy UEs other than using existing procedures, e.g. intra-cell HO, RLF and re-establishment, etc. In any case, there is no standard impact. |
| Huawei, HiSilicon | Option 1 |  |
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Summary:

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# **3 Summary**

Summary:

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# **4 Conclusion**

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

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

# 5 References

1. R2-2304836 Further discusison on service link switching with unchanged PCI vivo discussion Rel-18
2. R2-2304899 Discussion on unchanged PCI scenario CATT discussion Rel-18 NR\_NTN\_enh-Core
3. R2-2305152 Satellite switch\_PCI change without L3 handover NEC discussion Rel-18 NR\_NTN\_enh-Core
4. R2-2305197 Satellite switch enhancements for NTN Qualcomm Incorporated discussion Rel-18 NR\_NTN\_enh-Core
5. R2-2305599 Discussion on handover enhancements for NTN CMCC discussion Rel-18 NR\_NTN\_enh-Core
6. R2-2305676 Discussion on handover enhancements for NTN-NTN mobility Xiaomi discussion
7. R2-2305937 Satellite switching without PCI change InterDigital discussion Rel-18 NR\_NTN\_enh-Core
8. R2-2306156 NTN specific handover enhancement Apple discussion Rel-18 DUMMY
9. R2-2306296 Consideration on HO enhancements in NTN ZTE corporation, Sanechips discussion Rel-18 NR\_NTN\_enh-Core

# 6 Contact information

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