**3GPP TSG RAN WG1 #114 R1-230xxxx**

**Toulouse, France, August 21st –25th, 2023**

**Agenda Item: 9.9**

**Source: Moderator (CATT)**

**Title: Discussion on RAN2 LS reply on unchanged PCI**

**Document for: Discussion and Decision**

# Introduction

In the RAN1 #113 meeting, after RAN1 group discussion, one LS document (R1-2306210) is replied to RAN2 about hard satellite switching for the LS from RAN2[1]. The detalied content is as follows:

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| **Question 1:** Forhard 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.  |

In this meeting, it is expected that RAN1 can reach the conclusion for soft satellite switching.

# First round discussion

##  RRM measurement and SSB configuration

For RRM measurement, Huawei[2], CATT[4], CMCC[5] and Nokia[6] all provided the analysis for the SSB configuration of two satellites. With suitable configuration and assisted information to UE, UE is able to differentiate the satellite configuration and make RRM measurement without the collision. Based on companies’ contributions, the moderator formulates the following proposal on the RRM measurement.

**Proposal 1: Assistant information for RRM measurement of neighboring satellite can be informed to UE in soft satellite switching case.**

Companies are encouraged to provide comments for this proposal.

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| **Company** | **Comment** |
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## Interference issue

When two satellites are configured with same PCI, it is possible to introduce the interference for two neighboring satellites. However, if same gNB is used to control two satellites, the interference can be avoided with suitable coordination between two satellites. For example, resource allocation can be assigned with TDM or FDM way for two neighboring satellites. Huawei[2], CATT[4], CMCC[5] and OPPO[7] made detailed analysis and gave the conclusion for interference resolving. Therefore, the moderator formats the following proposals for interference issue.

**Proposal 2: Interference issue between two satellites can be resolved by the gNB with the proper implementation.**

Companies are encouraged to provide comments for this proposal.

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## Draft Reply LS

From RAN2 LS, the feedback on the feasibility to support soft satellite switching without PCI change is to be replied. Based on the contribution,

**Question 1:** Is it feasible for soft satellite switching without PCI change from RAN1 perspective?

**Reply:**

RAN1 has analyzed the UE behavior and gNB coordination in soft satellite switching and observed that it is feasible for soft satellite switching based on the following assumptions:

* Assistant information for RRM measurement of neighboring satellite can be informed to UE.
* Interference issue between two satellites is resolved by the gNB with the proper implementation.

Companies are encouraged to provide comments for above reply.

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# For Online discussion

# References

1. R2-2304273, RAN2, LS on unchanged PCI
2. R1-2306488 Further discussion on the reply of soft-satellite switching, Huawei, HiSilicon
3. R1-2306705 Discussions on RAN2 LS on unchanged PCI VIVO
4. R1-2307021 Discussion on RAN2 LS reply on unchanged PCI CATT
5. R1-2307168 Discussion on RAN2 LS on unchanged PCI CMCC
6. R1-2307249 On soft satellite switch with unchanged PCI Nokia
7. R1-2307547 Discussion RAN2 LS on unchanged PCI OPPO

# Appendix

## Companies’ proposals and observations

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| Contributions number  | Company  | Proposal and observations |
| R1-2306448 | Huawei | ***Observation 1: Interference avoidance/mitigation between two satellites can be done by gNB implementation.******Observation 2: RRM measurement of the SSB from target satellite is needed for soft satellite switching, but UE does not need to measure two satellites simultaneously.******Observation 3: For RRM, switching time based assistance information from the network side can be indicated to UE for soft-satellite switching.*** ***Observation 4: UE behaviour is the same for the soft-satellite switching and the hard-satellite switching.*** ***Proposal 1: RAN1 informs RAN2 that interference could happen between the signals relayed by the source satellite and the destination satellite, however, it is feasible to resolve/mitigate the interference issue from RAN1 perspective.*** |
| R1-2306705 | VIVO | ***Observations 1:**** ***Soft satellite switching would introduce interference between signals from 2 different satellites and it’s hard to introduce additional mechanism to mitigate the interference.***

***Proposal 1:**** ***RAN1 sends an LS reply to RAN2 based on the draft reply provided in Table 1.***
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| R1-2307021 | CATT | ***Observation 1: In soft satellite switching, UE will only connect to one satellite.*** ***Observation 2: UE behavior is different between soft satellite switching and hard satellite switching.*** ***Observation 3: If RRM measurement before soft satellite switching is needed, that is one new procedure.*** ***Observation 4: With resource separation for two neighboring satellites, the interference issue can be resolved through network implementation. For cell specific signal and resource allocation including SSB, SIB and PRACH, TDM based resource isolation can be used for two satellites. For UE specific signal and resource allocation, FDM based resource isolation can be used.******Proposal 1: From RAN1 perspective, with proper resource coordination between serving satellite and upcoming satellite and defining suitable switching procedure, soft satellite switching without PCI change is feasible.*** |
| R1-2307168 | CMCC | ***Observation 1:******The interference of traffic channels under soft satellite switching can be avoided through scheduling.*** ***Observation 2:******Multiple SSBs can be used to distinguish different satellites in soft satellite switching without PCI change and solving the issue of SSB collisions.*** ***Proposal 1:******From RAN1 perspective, soft satellite switching without PCI change is feasible.***  |
| R1-2307249 | Nokia | ***Proposal 1: For soft cell switch with same PCI, the SSBs should be non-overlapping in time/frequency******Proposal 2: For soft cell switch with same PCI, UE should be provided assistance information for being able to detect the SSB of the new serving cell/satellite.******Proposal3: RAN1 to provide the following text as LS response to RAN2: RAN1 discussed the resynchronization of UE when soft cell/satellite switching while maintaining same PCI, additionally to the UE being provided information on new common TA, K\_mac, ephemeris and cell-specific K-offset are applied during resynchronization to new satellite, the UE is further being provided information on any potential time/frequency offset that may be needed to locate the SSB of the new cell/satellite.*** |
| R1-2307547 | OPPO | ***Proposal 1: RAN1 replies RAN2 with the following response:******From RAN1 perspective the soft satellite switching can be supported without issue if the following assumptions hold:***1. ***UE behavior is the same for hard and soft satellite switching cases.***
2. ***The potential interference caused by soft satellite switching can be handled by the network.***
3. ***UE is not required to be synchronized with two satellites simultaneously.***
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