**3GPP TSG-RAN WG4 Meeting # 96-e R4-20xxxx**

**Electronic Meeting, 17-28 Aug., 2020**

**Agenda item: 7.15.3.1**

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for [97e][326] NR\_HST\_Demod\_UE

**Document for:** Information

# Introduction

This email discussion focuses on UE demodulation for NR HST, including agenda 7.15.3.1.1~7.15.3.1.5. Five topics are included in total, including transmission schemes, HST-SFN, HST single tap, muti-path fading channel, and other general open issues mentioned in companies’ contributions.

The email discussion is based on the approved way forward in last meeting: R4-2012668 WF on Rel-16 NR HST UE demodulation.

According to last meeting, the work split is provided as follows:

|  |  |  |
| --- | --- | --- |
|  | | **Responsibility** |
| Simulation results summary for NR-HST demodulation | | Huawei, HiSilicon |
| CR on HST-SFN requirements | FDD | Intel |
| TDD | CMCC |
| CR on HST-single tap and multi-path fading channel requirements | FDD | Qualcomm |
| TDD | Huawei, HiSilicon |
| CR on propagation condition on high speed train scenario | | Intel |
| CR on FRC | | Ericsson |
| CR on applicability | | Huawei, HiSilicon |
| CR on release independent | | CMCC |
| CR on HST DPS transmission scheme | | Huawei, HiSilicon |

The targets of email discussion for 1st round and 2nd round are:

* 1st round: discuss the open issues and strive to minimize the open issues, and provide comments on the CRs
* 2nd round: according to 1st round discussion, discuss left open issues for 2nd round, and strive to minimize the open issues, and strive to approve CRs.

# Topic #1: Requirements for DPS transmission scheme(s)

*Agenda 7.15.3.1.1*

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **TDoc** | **Title** | **Source** | **Proposals/ Observations** |
| [**R4-2014633**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014633.zip) | View on NR HST demod | Qualcomm, Inc. | Proposal 1: Introduce the following applicability rules to DPS schemes:  (1) If UE passed both HST-SFN and HST single tap tests, DPS 1a is not applicable.  (2) If UE passed both HST-SFN and HST single tap tests, DPS 1b is not applicable.  Proposal 2: Every RRH has to transmit QCL’ed SSB and TRS for every TCI state used in the DPS schemes. |
| [**R4-2015602**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015602.zip) | Summary of ideal and impairment results for NR HST demodulation requirements | Huawei, HiSilicon |  |
| [**R4-2014216**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014216.zip) | Discussion on DPS transmission scheme in HST | Apple | Proposal 1: In test setup for DPS 1a, PDSCH associated with TCI #0 is transmitted during the slots from 0 to (n-1) + HARQ needed time + 3ms.  Proposal 2: Number of active TCI states in DPS transmission mode 1b case is 2.  Proposal 3: in step 3, TE transmits PDCCH and PDSCH associated with TCI #0 from TRP#1 from slot 0 to n-1 +  HARQ needed time + 3ms  Proposal 4: Option 1 “The switch command is transmitted via MAC CE, the corresponding PDSCH carrying that MAC CE should be ensured to be decoded successfully and lower MCS should be used, such as MCS 4” is recommended.  Proposal 5: For DPS transmission mode 1a, PDCCH/PDSCH are DTXed from the time gNB indicate MAC CE TCI state switch + HARQ processing time + 3ms, to the time UE received and processed the first TRS from the new TRP. |
| [**R4-2014553**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014553.zip) | Views on UE demodulation requirements for DPS transmission scheme for NR HST | Intel Corporation | Proposal #1: Define performance requirements for DPS Tx scheme with 2 and 3 active TCI states.  Proposal #2: Use MCS 17 for HST DPS performance test cases.  Proposal #3: Schedule PDSCH in TDD special slots.  Proposal #4: Use same SNR point for all DPS Tx schemes requirements definition. To do this the following test setup should be performed:  - Skip PDSCH allocation on slots with TRS transmission  - Skip PDSCH data allocation on slots from n to m, where n slots are equivalent to time that needed to pass middle point between two RRH and m is a slot which corresponds to HARQ needed time on MAC CE command in DPS scheme 1a.  Proposal #5: Consider MCS 4 for PDSCH which carries MAC CE command  Proposal #6: Define the following applicability rule: If UE passed HST-SFN requirements it does not need to be tested in HST-DPS.  Proposal #7: Define the following applicability rule: If UE passed HST DPS requirements with more than 1 active TCI state it does not need to be tested in HST-DPS with smaller number of active TCI states. |
| [**R4-2014563**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014563.zip) | CR to TS 38.101-4: Propagation conditions for HST scenarios | Intel Corporation |  |
| [**R4-2014701**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014701.zip) | Further discussion on DPS for NR HST | CMCC | it is not preferred to introduce applicability rule between DPS and HST-SFN requirements. |
| [**R4-2014704**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014704.zip) | Simulation results for DPS transmission scheme | CMCC |  |
| [**R4-2015020**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015020.zip) | UE demodulation requirements for DPS transmission scheme | ZTE Corporation | Proposal 1: Use MCS13 for HST-DPS test case.  Proposal 2: Scheduled in special slots and the special slot configuration as S: 6D 4G 4U.  Proposal 3: UE can skip HST-DPS scheme 1a/1b if UE pass HST-SFN test cases. |
| [**R4-2015603**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015603.zip) | CR on HST DPS requirements | Huawei, HiSilicon |  |
| [**R4-2015604**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015604.zip) | Discussion on UE performance requirements for DPS transmission scheme | Huawei, HiSilicon | Proposal 1: For test setup for DPS 1a, modify test setup as following:  − PDSCH associated with TCI #(k mod 2) (k=0,1,2,…) is transmitted in slot from max((2k-1)n + HARQ needed time + 3ms + first TRS + TRS processing, 0) to ((2k+1)n-1) + HARQ needed time + 3ms + first TRS + TRS processing, where n slots are equivalent to time that needed to pass middle point between two RRHs, N slots is equivalent to time that needed to pass second RRH. And k is the RRH number in the channel model.  Proposal 2: For DPS 1a, PDSCH should be scheduled in special slots.  Proposal 3: Use MCS 17 for DPS 1a.  Proposal 4: Only define PDSCH performance requirements with 2 active TCI states.  Proposal 5: For scenario with 3 active TCI states, TE transmits PDSCH associated with TCI #1 from TRP#1 from slot n to N  Proposal 6: For DPS requirements definition, besides the 70% maximum throughput, define an extra test metric that,  − for DPS 1a, UE should meet probability of 99% (ACK and NACK) transmission for all PDSCH scheduled at each switching time point of (2k+1)n + HARQ needed time + 3ms + first TRS + TRS processing during the test  − for DPS 1b with 2 active TCI states, UE meet probability of 99% (ACK and NACK) transmission for all PDSCH scheduled at each switching time point of (2k+1)n + HARQ needed time + 3ms during the test  − for DPS 1b with more than 2 active TCI state, UE meet probability of 99% (ACK and NACK) transmission for all PDSCH scheduled at each switching time point of (2k+1)n+1 during the test |
| [**R4-2015605**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015605.zip) | Simulation results on UE performance requirements for DPS 1a transmission scheme | Huawei, HiSilicon |  |
| [**R4-2015812**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015812.zip) | PDSCH demodulation requirements for HST-DPS | Ericsson | Proposal 1: Set MCS13/Rank2 for HST-DPS.  Proposal 2: Not schedule PDSCH in TDD special slots for HST-DPS TDD tests.  Observation 1: UE cannot decode PDSCH even with lower MCS such as MCS4 during the period from the time gNB switches TCIs for PDCCH/PDSCH transmission to the time UE receives the TRS from the new RRH.  Proposal 3: TE keeps the PDCCH/PDSCH scheduling with the same MCS (e.g., MCS13) during the period gNB indicates MAC CE TCI state switch to the time UE receive the first TRS from the new RRH. |

## Open issues summary

### Test parameters for DPS scheme 1a

**Issue 1-1: MCS**

* Agreements in RAN4#96e meeting: *MCS*
  + *Option 1: MCS 13 based on 64QAM table (same as HST-SFN)*
  + *Option 2: MCS 17 based on 64QAM tables*
* Proposals in RAN4#97e meeting:
  + *Option 1 (ZTE, Ericsson): MCS 13 based on 64QAM table (same as HST-SFN)*
  + *Option 2 (Intel, Huawei): MCS 17 based on 64QAM tables*
* Recommended WF
  + 4 companies discuss this issue, 2 companies support option1 and 2 companies support option2. In order to move forward, moderator suggests companies provide your views on the above two options, and make a decision based on majority view after 1st round discussion

**Issue 1-2: Scheduling in TDD special slot**

* Agreements in RAN4#96e meeting:
  + *PDSCH is scheduled in DL, FFS for special slots*
* Proposals in RAN4#97e meeting:
  + *Option 1 (Intel, Huawei): Schedule PDSCH in TDD special slots.*
  + *Option 2 (ZTE): Scheduled in special slots and the special slot configuration as S: 6D 4G 4U.*
  + *Option 3 (Ericsson): Not schedule PDSCH in TDD special slots for HST-DPS TDD tests*
* Recommended WF
  + 4 companies discuss this issue, 3 companies support to schedule PDSCH in TDD special slots, 1 company support to not schedule PDSCH in special slots. Moderator suggests companies check whether the following recommended WF is acceptable:
    - *Scheduled PDSCH in TDD special slots and the special slot configuration as S: 6D 4G 4U.*

### Transmission scheme 1b

***Agreements in RAN4#96e meeting:***

* *Number of active TCI states in DPS transmission scheme 1b*
  + *Option 1: with 2 active TCI states.*
  + *Option 2: with 2 and more than 2 active TCI states.*

**Issue 1-3: Number of active TCI states in DPS transmission scheme 1b**

* Agreements in RAN4#96e meeting: *Number of active TCI states in DPS transmission scheme 1b*
  + *Option 1: with 2 active TCI states.*
  + *Option 2: with 2 and more than 2 active TCI states.*
* Proposals in RAN4#97e meeting:
  + *Option 1 (Apple, Huawei): with 2 active TCI states.*
  + *Option 2 (Intel): with 2 and 3 active TCI states.*
* Recommended WF
  + 3 companies discuss this issue, 2 companies support to define test case with 2 active TCI states, 1 companies support to define test case with 2 and 3 active TCI state. Since this is the last meeting for this WI, can we agree with option 1 to define test case with 2 active TCI states for DPS transmission scheme 1b?

### Test setup for DPS transmission scheme 1a

***Agreements in RAN4#96e meeting:***

1. Two RRH s of RRH#(2k) and RRH#(2k+1) are assumed, and SSB#0 is transmitted from both TRPs, where k is the RRH number with k=0,1, 2, …
   * UE is configured with TCI#(k mod 2) and TCI#(k+1 mod 2) that are associated with TRS#(k mod 2) and TRS#(k+1 mod 2) transmitted from RRH#(2k) and RRH#(2k+1) respectively by RRC signalling tci-StatesToAddModList in the PDSCH-Config and tci-PresentInDCI is not configured;
   * All the configured TCI states are known to UE. UE is configured with NZP-CSI-RS resource for L1-RSRP measurements by RRC signaling nzp-CSI-RS-ResourceSet within the CSI-ResourceConfig and periodic CSI reporting by setting reportConfigType to periodic and reportQuantity to cri-RSRP (Note: reported L1-RSRP mesurements are not tested)
2. TE actives TCI #0 for PDCCH by “TCI State Indication for UE-specific PDCCH MAC CE”;
3. PDSCH associated with TCI #0 is transmitted during the slots from 0 to (n-1) + HARQ needed time + 3ms + first TRS + TRS processing time;
4. In slot n TE start triggering TCI state switching command to TCI #1 by “TCI State Indication for UE-specific PDCCH MAC CE”;
5. PDSCH associated with TCI #1 is transmitted in slots from n + HARQ needed time + 3ms + first TRS + TRS processing time to N.

PDSCH associated with TCI #(k mod 2) (k=0,1,2,…) is transmitted in slot from max((2k-1)n, 0) to ((2k+1)n-1) + HARQ needed time + 3ms + first TRS + TRS processing, where n slots are equivalent to time that needed to pass middle point between two RRHs, N slots is equivalent to time that needed to pass second RRH. And k is the RRH number in the channel model.

**Issue 1-4: Modified step 3 for transmission scheme 1a**

* Proposals
  + Option 1 (Apple): In test setup for DPS 1a, PDSCH associated with TCI #0 is transmitted during the slots from **0 to (n-1) + HARQ needed time + 3ms**.
* Recommended WF
  + Companies please provide your comments based on the proposal of modified step 3

**Issue 1-5: Modified test setup for transmission scheme 1a**

* Proposals
  + **Option 1 (Huawei): PDSCH associated with TCI #(k mod 2) (k=0,1,2,…) is transmitted in slot from max((2k-1)n + HARQ needed time + 3ms + first TRS + TRS processing, 0) to ((2k+1)n-1) + HARQ needed time + 3ms + first TRS + TRS processing, where n slots are equivalent to time that needed to pass middle point between two RRHs, N slots is equivalent to time that needed to pass second RRH. And k is the RRH number in the channel model.**
* Recommended WF
  + Companies please provide your comments based on the modified test setup proposal

### Test setup for DPS transmission scheme 1b

**Issue 1-6: Transmission scheme 1b with 2 active TCI states**

* Agreements in RAN4#96e meeting:
* Test setup for transmission scheme 1b
  + Use following as baseline for DPS transmission scheme 1b test setup (agreement in last meeting)
  + for scenario with 2 active TCI states

(total 2 active TCI states): PDCCH TCI state switching delay caused by MAC CE, but less than DPS 1a with pre-tracking of second TCI state and only HARQ needed time + 3ms delay is needed, UE tracks 2 active TCI states in advance so that UE can quickly get better Doppler shift estimation for the second TRP compared to DPS 1a.

* 1. UE is configured with two different TCI states (TCI #0 and TCI #1) associated with two different RRHs by RRC signalling tci-StatesToAddModList in the PDSCH-Config and tci-PresentInDCI is not configured;
  2. TE activates TCI #0 and TCI #1 for PDSCH at the same time by “TCI States Activation/Deactivation for UE-specific PDSCH MAC CE” and activates TCI #0 for PDCCH by “TCI State Indication for UE-specific PDCCH MAC CE” command with the field of CORESET ID set to 0;
  3. TE transmits PDCCH and PDSCH associated with TCI #0 from TRP#1 from slot 0 to n-1;
  4. In slot n TE start triggering TCI state switching command to TCI #1 by “TCI State Indication for UE-specific PDCCH MAC CE”;
  5. TE transmits PDCCH and PDSCH associated with TCI #1 from TRP#2 from slot n [+ HARQ needed time + 3ms] to N.

where n slots are equivalent to time that needed to pass middle point between two RRHs, N slots is equivalent to time that needed to pass second RRH

* Proposals
  + Option 1 (Apple): **In step 3, TE transmits PDCCH and PDSCH associated with TCI #0 from TRP#1 from slot 0 to n-1 + *HARQ needed time + 3ms***
* Recommended WF
  + Companies please provide your comments based on the proposal of modified step 3. And other than step 3, are there any new comments for this test setup?

**Issue 1-7: Transmission scheme 1b with 3 active TCI states**

* Agreements in RAN4#96e meeting:
  + - *for scenario with 3 active TCI states*

*(Total 3 active TCI states): No PDCCH TCI state switching delay by using MAC CE, but 3 active TCI states to track, UE needs to report supporting of maxNumberActiveTCI-PerBWP = n4*

* + - * 1. *UE is configured with three different TCI states (TCI #0, TCI #1 and TCI #2) associated with two different RRHs by RRC signalling tci-StatesToAddModList in the PDSCH-Config;*
        2. *TE activates TCI #0 and TCI #1 for PDSCH at the same time by “TCI States Activation/Deactivation for UE-specific PDSCH MAC CE” and activates TCI #2 for PDCCH by “TCI State Indication for UE-specific PDCCH MAC CE” command with the field of CORESET ID set to 0;*
        3. *TE transmits PDCCH associated with TCI#2 from TRP#1 and TRP#2 from slot 0 to N*
        4. *DCI contains pointer to TCI#0 from slot 0 to n-1 and pointer to TCI#1 from slot n to N*
        5. *TE transmits PDSCH associated with TCI #0 from TRP#0 from slot 0 to n-1*
        6. *TE transmits PDSCH associated with TCI #1 from TRP#1 from slot [n or n+1] to N*

*where n slots are equivalent to time that needed to pass middle point between two RRHs, N slots is equivalent to time that needed to pass second RRH*

* Proposals
  + Option 1 (Huawei): **For scenario with 3 active TCI states, TE transmits PDSCH associated with TCI #1 from TRP#1 from slot n to N (step 6)**
* Recommended WF
  + If test case with 3 active TCI states are introduced, can we agree with the above test setup with updated step 6 (from n to N)?

### Statistics during the switching time for both DPS 1a and 1b

***Agreements in RAN4#96e meeting:***

* Statistics during the switching time for both DPS 1a and 1b
  + Option 1: The switch command is transmitted via MAC CE, the corresponding PDSCH carrying that MAC CE should be ensured to be decoded successfully and lower MCS should be used, such as MCS 4.
  + Option 2: PDCCH/PDSCH are DTXed from the time gNB indicates MAC CE TCI state switch to the time UE receive the first TRS from the new TRP.
  + Option 3: Use same SNR point for all DPS Tx schemes requirements definition:
    - Skip PDSCH allocation on slots with TRS transmission
    - Skip PDSCH allocation on slots from n to m, where n slots are equivalent to time that needed to pass middle point between two RRH and m is a slot which corresponds to HARQ needed time on MAC CE command in DPS scheme 1a.
  + Other options are not precluded.

**Issue 1-8: Switch command**

* Proposals
  + Option 1 (Apple, Intel): The switch command is transmitted via MAC CE, the corresponding PDSCH carrying that MAC CE should be ensured to be decoded successfully and lower MCS should be used, such as MCS 4.
  + Option 2 (Ericsson):
    - UE cannot decode PDSCH even with lower MCS such as MCS4 during the period from the time gNB switches TCIs for PDCCH/PDSCH transmission to the time UE receives the TRS from the new RRH.
    - TE keeps the PDCCH/PDSCH scheduling with the same MCS (e.g., MCS13) during the period gNB indicates MAC CE TCI state switch to the time UE receive the first TRS from the new RRH.
* Recommended WF
  + 3 companies discuss this issue. 2 companies support switch command with lower MCS4, 1 company’s simulation results show even with MCS4 UE cannot decode PDSCH during the switch period, and suggest keep the same MCS during the switch.
  + Companies please provide your views based on above options.

**Issue 1-9: PDCCH and PDSCH setting during the transition time**

* Proposals
  + Option 1 (Apple): For DPS transmission mode 1a, PDCCH/PDSCH are DTXed from the time gNB indicate MAC CE TCI state switch + HARQ processing time + 3ms, to the time UE received and processed the first TRS from the new TRP.
  + Option 2 (Intel):
    - Use same SNR point for all DPS Tx schemes requirements definition:
    - Skip PDSCH allocation on slots with TRS transmission
    - Skip PDSCH allocation on slots from n to m, where n slots are equivalent to time that needed to pass middle point between two RRH and m is a slot which corresponds to HARQ needed time on MAC CE command in DPS scheme 1a.
* Recommended WF
  + Companies please provide your views based on above options.

**Issue 1-10: Extra test metric for DPS requirements**

* Proposals
  + Option 1 (Huawei): For DPS requirements definition, besides the 70% maximum throughput, define an extra test metric that,
    - for DPS 1a, UE should meet probability of 99% (ACK and NACK) transmission for all PDSCH scheduled at each switching time point of (2k+1)n + HARQ needed time + 3ms + first TRS + TRS processing during the test
    - for DPS 1b with 2 active TCI states, UE meet probability of 99% (ACK and NACK) transmission for all PDSCH scheduled at each switching time point of (2k+1)n + HARQ needed time + 3ms during the test
    - for DPS 1b with more than 2 active TCI state, UE meet probability of 99% (ACK and NACK) transmission for all PDSCH scheduled at each switching time point of (2k+1)n+1 during the test
* Recommended WF
  + Companies please provide your views on this extra test metric for DPS requirements.

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| **Huawei** | **Issue 1-1: MCS**  We prefer Option 2, i.e. MCS 17.  As per simulation results provided by companies, MCS 17 with Rank 2 is feasible for DPS, no technical reason to preclude MCS 17, also it is not necessary to align with SFN considering that they are separate test case.  **Issue 1-2: Scheduling in TDD special slot**  We prefer Option 1, i.e. Schedule PDSCH in TDD special slots.  As per theory analysis, the performance become worse in special slot for SFN or multi-path fading channel since that only one column of DMRS cannot handle large Doppler spread well when UE performs channel estimation and other procedures. However, in DPS scenario, there is no large Doppler spread, therefore the performance should not be deteriorated significantly. Also the simulation results support the above point.  **Issue 1-3: Number of active TCI states in DPS transmission scheme 1b**  For DPS 1b, there will not exist TCI state switching delay if UE supports more than two active TCI states tracking while switching delay of HARQ needed time + 3ms is needed if UE supports two active TCI states, but considering the UE capability to support more than 2 active TCI states and the WI completion date, it is fine for us to only define performance requirements for DPS 1b with 2 active TCI states.  **Issue 1-4&1-5&1-6: Modified step 3 for transmission scheme 1a & Modified test setup for transmission scheme 1a & Transmission scheme 1b with 2 active TCI states**  For DPS 1a, it is feasible for both the current and modified version since there is undefined UE behaviour during the time period from UE decode TCI switching command correctly to the first TRS is processed completely. In addition, if we consider unified scheduling for “DPS 1a” and “DPS 1b with 2 TCI states”, it is more feasible to transmit PDCCH/PDSCH associated with new scheduled TCI state for that time period. Therefore, we slightly prefer that:   * + In test setup for **both “DPS 1a” and “DPS 1b with 2 TCI states”**,     - PDSCH associated with TCI #0 is transmitted during the slots from **0 to (n-1) + HARQ needed time + 3ms**.     - PDSCH associated with TCI #1 is transmitted in slots from **n + HARQ needed time + 3ms ~~+ first TRS + TRS processing time~~ to N**.   The generalized version can be:   * + For **both “DPS 1a” and “DPS 1b with 2 TCI states”**, PDSCH associated with TCI #(k mod 2) (k=0,1,2,…) is transmitted in slot from max((2k-1)n + HARQ needed time + 3ms, 0) to ((2k+1)n-1) + HARQ needed time + 3ms, where n slots are equivalent to time that needed to pass middle point between two RRHs, N slots is equivalent to time that needed to pass second RRH. And k is the RRH number in the channel model.   **Issue 1-7: Transmission scheme 1b with 3 active TCI states**  We prefer Option 1, i.e. For scenario with 3 active TCI states, TE transmits PDSCH associated with TCI #1 from TRP#1 from slot n to N (step 6).  In our view, slot n is suitable considering that UE is tracking active TCIs for both TRP#0 and TRP#1, no additional 1 slot is needed for UE to switch TCI state.  **Issue 1-8: Switch command**  We prefer Option 1, i.e. The switch command is transmitted via MAC CE, the corresponding PDSCH carrying that MAC CE should be ensured to be decoded successfully and lower MCS should be used, such as MCS 4.  It is necessary to ensure TCI switch command can be decoded 100% correctly considering FRC to be determined.  For Option 2, in our view, MCS 4 should be used only for the slot that TCI switch command is scheduled.  **Issue 1-9: PDCCH and PDSCH setting during the transition time**  Same view as Issue 1-4&1-5&1-6.  For the last item of Option 2, for DPS 1a, it can reworded: PDSCH can be scheduled in slots from **n + HARQ needed time + 3ms** to **n + HARQ needed time + 3ms + first TRS + TRS processing time** but skipped for performance statistics.  **Issue 1-10: Extra test metric for DPS requirements**  We prefer Option 1 to verify UE behaviour to properly process the TCI state switching. |

### CRs/TPs comments collection

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| --- | --- |
| **CR tdoc number** | **Comments collection** |
| [**R4-2014563**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014563.zip) **(Intel)** |  |
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| **CR tdoc number** | **Comments collection** |
| [**R4-2015603**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015603.zip) **(Huawei)** | . |
|  |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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| --- | --- |
|  | **Status summary** |
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| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
|  |  |
|  |  |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

### Open issues summary

### Open issues

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| --- | --- |
| **Company** | **Comments** |
|  |  |

## Summary on 2nd round (if applicable)

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| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
|  |  |

# Topic #2: Requirements for HST-SFN

*Agenda 7.15.3.1.2*

## Companies’ contributions summary

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| --- | --- | --- |
| **TDoc** | **Title** | **Source** |
| [**R4-2014562**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014562.zip) | CR to TS 38.101-4: HST-SFN FDD performance requirements | Intel Corporation |
| [**R4-2014690**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014690.zip) | CR on HST-SFN requirements for TDD | CMCC |
| [**R4-2014696**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014696.zip) | CR on release independent for Rel.16 NR HST UE demodulation requirements | CMCC |
| [**R4-2014698**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014698.zip) | CR on release independent for Rel.16 NR HST UE demodulation requirements | CMCC |
| [**R4-2015813**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015813.zip) | Simulation results of PDSCH with HST-SFN | Ericsson |

## Open issues summary

## Companies views’ collection for 1st round

### CRs/TPs comments collection

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| **CR tdoc number** | **Comments collection** |
| [**R4-2014690**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014690.zip) **(CMCC)** |  |
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| **CR tdoc number** | **Comments collection** |
| [**R4-2014562**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014562.zip) **(Intel)** |  |
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| **CR tdoc number** | **Comments collection** |
| [**R4-2014696**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014696.zip) **(CMCC)** |  |
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| **CR tdoc number** | **Comments collection** |
| **R4-2014698 (CMCC)** |  |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
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*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

## Discussion on 2nd round (if applicable)

### Open issues summary

### *Open issues*

## Summary on 2nd round (if applicable)

# Topic #3: Requirements for HST single tap

*Agenda 7.15.3.1.3*

## Companies’ contributions summary

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| **TDoc** | **Title** | **Proposals / Observations** |
| [**R4-2015606**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015606.zip) | CR on HST single-tap and HST multi-path fading requirements | Huawei, HiSilicon |
| [**R4-2016108**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016108.zip) | CR to TS38.101-4: Addition of Rel-16 HST FRCs | Ericsson |
| [**R4-2016500**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016500.zip) | CR on FDD HST Single-Tap and Multipath Fading Requirements | Qualcomm Incorporated |

## Open issues summary

## Companies views’ collection for 1st round

### CRs/TPs comments collection

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| **CR tdoc number** | **Comments collection** |
| [**R4-2015606**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015606.zip) **(Huawei)** |  |
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| **CR tdoc number** | **Comments collection** |
| [**R4-2016108**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016108.zip) **(Ericsson)** |  |
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| **CR tdoc number** | **Comments collection** |
| [**R4-2016500**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016500.zip) **(Qualcomm)** |  |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
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*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
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## Discussion on 2nd round (if applicable)

### Open issues summary

### Open issues

## Summary on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
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# Topic #4: Requirements for multi-path fading channels

*Agenda 7.15.3.1.4*

## Companies’ contributions summary

## Open issues summary

# Topic #5: Applicability rule

## Companies’ contributions summary

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| **TDoc** | **Title** | **Source** | **Proposals / Observations** |
| [**R4-2014217**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014217.zip) | Discussion on applicability rule for HST test | Apple | Proposal 1: If a UE support R16 HST-SFN,  • If a UE pass HST-SFN test cases, then the UE can skip R15 and R16 HST single tap test  • If a UE pass HST-SFN test cases, then the UE can skip HST multiple-path test  • If a UE pass HST-SFN test cases, then the UE can skip HST-DPS scheme 1a/1b  Proposal 2: If a UE does not support R16 HST-SFN,  • For DPS:  • If a UE declared supporting > 1 TCI states, the UE will pass scheme 1b and skipped HST single tap test cases and scheme 1a test cases  • If a UE only support 1 TCI state, the UE need to pass both scheme 1a and HST single tap test cases and skip scheme 1b test cases  • Multi-path FDD: Rel-15 multi-path fading with TDLC300-100 (Table 5.2.2.1.1-3 Test 1-2 and Table 5.2.3.1.1-3 Test 1-2) is not applicable for a UE that passes Rel-16 multi-path fading tests TDLC300-600 for FDD  • Multipath TDD: Rel-15 multi-path fading with TDLC300-100 (Table 5.2.2.2.1-3 Test 1-2 and Table 5.2.3.2.1-3 Test 1-2) is not applicable for a UE that passes Rel-16 multi-path fading tests TDLC300-1200 for TDD |
| [**R4-2014700**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014700.zip) | Discussion on applicability rule for UE demodulation requirements for NR HST | CMCC | Proposal 1:  • it is not preferred to define applicability rule between Rel-15 TDLC300-100 multi-path fading tests and Rel-16 TDLC300-600 for FDD  • it is not preferred to define applicability rule between Rel-15 TDLC300-100 multi-path fading tests and Rel-16 TDLC300-1200 for TDD  Proposal 2: it is not preferred to define applicability rule between HST-SFN and HST multi-path fading. |
| [**R4-2015313**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015313.zip) | Views on HST applicability rules | NTT DOCOMO, INC. | Observation 1: In LTE, UE must pass HST single-tap@300km/h and multi-path fading requirements regardless of whether UE support the advanced-receiver or not.  Proposal 1: Consider following option for test applicability between HST-SFN and HST single tap   Option 1: Skip the Rel-15 HST single tap test, if UE passes the requirements for HST-SFN  Proposal 2: Consider following option for test applicability between HST-SFN and HST multi-path fading   Option 2: Do not define any applicability rules between HST-SFN and HST multi-path fading performance test cases  Proposal 3: Consider following option for test applicability between different Doppler frequencies for the same channel model  For FDD:   Option 1: no applicability rule  For TDD:   Option 1: no applicability rule |
| [**R4-2015607**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015607.zip) | CR on applicability rules for HST scenarios | Huawei, HiSilicon |  |
| [**R4-2015608**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015608.zip) | Discussion on applicability rules for different scenarios | Huawei, HiSilicon | Proposal 1: If finally requirements for DPS 1b is defined with only 2 active TCI states, then UE can declare supporting 1, 2 TCI states.  − If UE declared supporting > 1 TCI states, UE will pass scheme 1b and skipped HST single tap test cases and scheme 1a test cases  − If UE only support 1TCI state, UE need to pass both scheme 1a and HST single tap test cases and skip scheme 1b test cases  If finally requirements for DPS 1b is defined with both 2 active TCI states and more than 2 active TCI states, then UE can declare supporting 1, 2 or 4 TCI states.  − If UE declared supporting 4 TCI states, UE will pass scheme 1b with more than 2 TCI states and skipped HST single tap test cases and other DPS test cases  − If UE declared supporting 2 TCI states, UE will pass scheme 1b with 2 TCI states and skipped HST single tap test cases and other DPS test cases  − If UE only support 1TCI state, UE need to pass both scheme 1a and HST single tap test cases and skip scheme 1b test cases  Proposal 2: Do not define any applicability rule between HST SFN and HST DPS scenario.  Proposal 3: Skip both Rel-15 and Rel-16 HST single tap test, if UE passes the requirements for HST-SFN.  Proposal 4: Do not define any applicability rules between HST-SFN and HST multi-path fading performance test cases.  Proposal 5: Adopt Option 2 for both FDD and TDD, i.e. Rel-15 multi-path fading tests with TDLC300-100 are not applicable for UE that passes Rel-16 multi-path fading tests TDLC300-600. |
| [**R4-2015814**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015814.zip) | Applicability rule for PDSCH demodulation requirements in HST WI | Ericsson | Proposal 1: For UE supporting > 1 TCI states, and that passes HST-DPS 1b, both Rel-15/16 HST single tap test cases and scheme 1a test cases can be skipped.  Proposal 2: For UE supporting only 1 TCI states, and that passes HST-DPS 1a, both Rel-15/16 HST single tap test cases and scheme 1b test cases can be skipped.  Proposal 3: For UE capable of HST-SFN demodulation and it passes HST-SFN requirements, Rel-15/16 HST single tap tests can be skipped.  Proposal 4: Do not define any applicability rules between HST-SFN and HST multi-path fading performance test cases  Proposal 5: Not introduce applicability rules between Rel-15 multi-path fading with TDLC300-100 and Rel-16 multi-path fading tests TDLC300-600 (FDD) and TDLC300-1200 (TDD).  If RAN4 agree with the applicability rules above, we should point Rel-15/16 HST single tap tests may be always skipped. RAN4 may need to discuss whether to define a rule UE performs at least one of HST single tap tests.  Proposal 6: RAN4 may need to ensure at least one of HST single tap requirements are tested. |

## Open issues summary

### Test applicability between HST-SFN, HST single tap and HST multi-path fading performance test cases

**Agreements in RAN4#96e meeting:**

* Test applicability between HST-SFN and HST single tap
  + Do not test UE under HST single-tap, if UE passes the requirements for HST-SFN.
    - Option 1: Skip the Rel-15 HST single tap test, if UE passes the requirements for HST-SFN
    - Option 2: Skip both Rel-15 and Rel-16 HST single tap test, if UE passes the requirements for HST-SFN
* Test applicability between HST-SFN and HST multi-path fading
  + Option 1: Do not test UE under HST multi-path scenarios, if UE passes the requirements for HST-SFN.
  + Option 2: Do not define any applicability rules between HST-SFN and HST multi-path fading performance test cases

**Issue 5-1: Test applicability between HST-SFN and HST single tap**

* Proposals
  + Option 1 (DOCOMO): Skip the Rel-15 HST single tap test, if UE passes the requirements for HST-SFN
  + Option 2 (Apple, Huawei, Ericsson): Skip both Rel-15 and Rel-16 HST single tap test, if UE passes the requirements for HST-SFN
* Recommended WF
  + 4 companies discuss this issue, 3 of them support option2. Moderator suggests companies check whether option2 is agreeable.

**Issue 5-2: Test applicability between HST-SFN and HST multi-path fading**

* Proposals
  + Option 1 (Apple): Do not test UE under HST multi-path scenarios, if UE passes the requirements for HST-SFN.
  + Option 2 (DOCOMO, CMCC, Huawei, Ericsson): Do not define any applicability rules between HST-SFN and HST multi-path fading performance test cases
* Recommended WF
  + 5 companies discuss this issue, 4 of them support option2. Moderator suggests companies check whether option2 is agreeable.

### Test applicability between different Doppler frequencies for the same channel model

**Agreements in RAN4#96e meeting:**

* Test applicability between different Doppler frequencies for the same channel model
  + For FDD
    - Define applicability rule for TDLB100-400
      * Rel-15 multi-path fading with TDLB100-400 (Table 5.2.2.1.1-3 Test 1-1 and Table 5.2.3.1.1-3 Test 1-1) is not applicable for UE that passes Rel-16 multi-path fading tests TDLC300-600 for FDD
    - FFS whether to define applicability rule for TDLC300-100
      * Option 1: no applicability rule
      * Option 2: Rel-15 multi-path fading with TDLC300-100 (Table 5.2.2.1.1-3 Test 1-2 and Table 5.2.3.1.1-3 Test 1-2) is not applicable for UE that passes Rel-16 multi-path fading tests TDLC300-600 for FDD
  + For TDD
    - Not define any applicability rule for TDLB100-400 multi-path fading tests between Rel-15 and
    - FFS whether to define applicability rule for TDLC300-100
      * Option 1: no applicability rule
      * Option 2: Rel-15 multi-path fading with TDLC300-100 (Table 5.2.2.2.1-3 Test 1-2 and Table 5.2.3.2.1-3 Test 1-2) is not applicable for UE that passes Rel-16 multi-path fading tests TDLC300-1200 for TDD

**Issue 5-3: Test applicability between different Doppler frequencies for the same channel model**

* Proposals
  + Option 1 (Apple, Huawei):
    - For FDD:
      * Option 2: Rel-15 multi-path fading with TDLC300-100 (Table 5.2.2.1.1-3 Test 1-2 and Table 5.2.3.1.1-3 Test 1-2) is not applicable for UE that passes Rel-16 multi-path fading tests TDLC300-600 for FDD
    - For TDD:
      * Option 2: Rel-15 multi-path fading with TDLC300-100 (Table 5.2.2.2.1-3 Test 1-2 and Table 5.2.3.2.1-3 Test 1-2) is not applicable for UE that passes Rel-16 multi-path fading tests TDLC300-1200 for TDD
  + Option 2 (CMCC, DOCOMO, Ericsson)
    - For FDD
      * Option 1: no applicability rule
    - For TDD
      * Option 1: no applicability rule
* Recommended WF
  + 5 companies discuss this issue, 3 of them support to not define applicability rule for TDLC300-100. Companies please check whether the following recommended WF is agreeable.
  + For FDD
    - ***(Last meeting agreement)*** Define applicability rule for TDLB100-400
      * Rel-15 multi-path fading with TDLB100-400 (Table 5.2.2.1.1-3 Test 1-1 and Table 5.2.3.1.1-3 Test 1-1) is not applicable for UE that passes Rel-16 multi-path fading tests TDLC300-600 for FDD
    - Not define any applicability rule for TDLC300-100
  + For TDD
    - ***(Last meeting agreement)*** Not define any applicability rule for TDLB100-400 multi-path fading tests
    - Not define any applicability rule for TDLC300-100 multi-path fading tests

### Test applicability for DPS schemes

***Agreements in RAN4#96e meeting:***

* *Introduce DPS transmission scheme 1b test cases with test applicable rules which can be further discussed among below options*
  + *Option 1:*
    - *If UE declared supporting > 1 TCI states, UE will pass scheme 1b and skipped HST single tap test cases and scheme 1a test cases*
    - *If UE only support 1TCI state, UE need to pass both scheme 1a and HST single tap test cases and skip scheme 1b test cases*
  + *Option 2:* 
    - *If UE pass HST-SFN test cases, then UE can skip HST-DPS scheme 1a/1b*

**Issue 5-4: Applicability rules between HST-SFN, single tap and DPS schemes**

* Proposals
  + *Option 1 (Intel, ZTE, Apple):* 
    - *If UE passed HST-SFN requirements it does not need to be tested in HST-DPS.*
  + *Option 2 (CMCC, Huawei):*
    - *Do not introduce applicability rule between DPS and HST-SFN requirements*
  + *Option 3 (Ericsson)*
    - *If UE passed HST-DPS 1a or 1b, both Rel-15/16 HST single tap test cases can be skipped.*
  + *Option 4 (Qualcomm): Introduce the following applicability rules to DPS schemes:*
    - *If UE passed both HST-SFN and HST single tap tests, DPS 1a is not applicable.*
    - *If UE passed both HST-SFN and HST single tap tests, DPS 1b is not applicable.*
* Recommended WF
  + 7 companies discuss this issue. Option4 is same as option1, since we already agreed HST single tap can be skipped if UE passed HST-SFN. Companies please comment based on following options:
    - *Option 1 (Intel, ZTE, Apple):* 
      * *If UE passed HST-SFN requirements it does not need to be tested in HST-DPS.*
    - *Option 2 (CMCC, Huawei):*
      * *Do not introduce applicability rule between DPS and HST-SFN requirements*
    - *Option 3 (Ericsson)*
      * *If UE passed HST-DPS 1a or 1b, both Rel-15/16 HST single tap test cases can be skipped.*

**Issue 5-5: Applicability rules between DPS with 1 and more than 1 active TCI state**

* Proposals
  + *Option 1 (Intel):* 
    - *If UE passed HST DPS requirements with more than 1 active TCI state it does not need to be tested in HST-DPS with smaller number of active TCI states.*
  + *Option 2 (Apple, Huawei, Ericsson):*
    - *If a UE declared supporting > 1 TCI states, the UE will pass scheme 1b and skipped HST single tap test cases and scheme 1a test cases*
    - *If a UE only support 1 TCI state, the UE need to pass both scheme 1a and HST single tap test cases and skip scheme 1b test cases*
* Recommended WF
  + 4 companies discuss this issue, option2 is more detailed proposal compared to option1. Companies please check whether option2 is agreeable.
    - *Option 2 (Apple, Huawei, Ericsson):*
      * *If a UE declared supporting > 1 TCI states, the UE will pass scheme 1b and skipped HST single tap test cases and scheme 1a test cases*
      * *If a UE only support 1 TCI state, the UE need to pass both scheme 1a and HST single tap test cases and skip scheme 1b test cases*

### Others

**Issue 5-6: HST single tap requirements**

* Proposals
  + *Option 1 (Ericsson): Rel-15/16 HST single tap tests may be always skipped. RAN4 may need to discuss whether to define a rule UE performs at least one of HST single tap tests.*
* Recommended WF
  + Depending on the outcome of applicability rule discussion, Rel-15/16 HST single tap tests may be always skipped. If so, do companies think RAN4 should discuss whether to define a rule UE performs at least one of HST single tap tests?

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| **Huawei** | **Issue 5-1: Test applicability between HST-SFN and HST single tap**  We prefer Option 2 since that HST-SFN cases have more strict requirements comparing to single-tap.  **Issue 5-2: Test applicability between HST-SFN and HST multi-path fading**  We prefer Option 2.  **Issue 5-3: Test applicability between different Doppler frequencies for the same channel model**  We prefer Option 1.  For both FDD and TDD, we can regard Rel-16 TDLC300-600 cases as higher requirements comparing to Rel-15 TDLC300-100 cases since there is similar test configuration between them but Rel-16 TDLC300-600 cases have same or larger Delay spread and Doppler spread.  **Issue 5-4: Applicability rules between HST-SFN, single tap and DPS schemes**  We prefer Option 2 and Option 3.  For the applicability between SFN and DPS, as per the agreement reached in RAN4#95e meeting, it is agreed that “*Define RAN4 requirements with the assumption of frequency tracking up to UE implementation*”. From our understanding, it cannot distinguish whether large Doppler jump can be observed or not at the middle point of two RRUs since it is up to UE implementation. We believe that gradual Doppler shift change without large Doppler jump is more typical implementation since that the performance for tracking a synthesized frequency is better than that for tacking the strongest tap as per our evaluation. It can be seen that the performance under large Doppler jump cannot be ensured although UE has passed the HST-SFN cases with above typical UE implementation. Therefore, we don’t think it is proper to define such applicability rule.  For Option 1 and Option 4, as per our contribution R4-2007233, the difference between SFN and DPS cases are:   * Different channel model and test setup * Different TCI state processing * Different Doppler trajectory and Doppler shift estimation capability   Therefore, we do not think Option 1 and Option 4 are suitable.  **Issue 5-5: Applicability rules between DPS with 1 and more than 1 active TCI state**  We prefer Option 2.  **Issue 5-6: HST single tap requirements**  There is no technical reason that at least one of HST single tap tests is needed. Considering DPS cases have more strict requirements comparing to single-tap, we do not think it is necessary to keep at least one of HST single tap tests. |

### CRs/TPs comments collection

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| **CR tdoc number** | **Comments collection** |
| [**R4-2015607**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015607.zip) **(Huawei)** |  |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary** |
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*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
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## Discussion on 2nd round (if applicable)

### Open issues summary

### Open issues

## Summary on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
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