**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-2105992**

**Electronic Meeting, Apr. 12-20, 2021**

**Agenda item: 8.6.3**

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for [98-bis-e][321] NR\_HST\_FR1\_Demod

**Document for:** Information

# Introduction

This email discussion focuses on UE demodulation for Rel-17 NR HST, including agenda 8.6.3.1~8.6.3.3. Two topics are included in total, including PDSCH requirements for CA scenarios and enhanced transmission schemes. The agreed way forward in previous meeting is in R4-2103876.

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
* 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 the WF.

# Topic #1: Work Plan

*Agenda 8.6.1*

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **TDoc** | **Title** | **Source** | **Proposals/ Observations** |
| [**R4-2104946**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104946.zip) | Updated work plan for enhancement for NR high speed train scenario in FR1  (demod part) | CMCC | This contribution provides updated work plan for enhancement for NR high speed train scenario in FR1. |

## Open issues summary

### Work plan for FR1 HST demod part

**Issue 1-1: Work plan (demod part)**

According to the revised WID, the demodulation part shall be finalized by September 2022 (RAN #97).

Companies please check the updated work plan for demodulation part in [**R4-2104946**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104946.zip)**.**

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | Issue 1-1:  We are fine with the work plain for the demodulation part. The demodulation part may complete earlier depending on the progress, but it is important to keep the work scope as specified in the current WID. |
| **CMCC** | We are OK with the demodulation part of the WP. |
| **Intel** | Same view as Ericsson. |
| **Qualcomm** | Same view as Ericsson. |

## 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** |
| **Issue 1-1-1: Work plan (demod part)** | The demod part of work plan R4-2104946 is agreeable. |

# Topic #2 PDSCH requirements for CA scenarios

*Agenda 8.6.3.2*

## Companies’ contributions summary

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| **TDoc** | **Title** | **Source** | **Proposals/ Observations** |
| [**R4-2104844**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104844.zip) | On PDSCH CA Requirements in HST | Apple | Proposal #1: Introduce requirements for CA for HST-DPS with one active TCI state only.  Proposal #2: Define applicability rule for CA requirements in HST scenario as - If UE supports demodulationEnhancement-r16, only HST-SFN JT requirements shall apply, otherwise HST-DPS requirements shall apply for CA.  Proposal #3: Do not introduce requirements in HST for FDD 15KHz + TDD 15KHz CA and TDD 15 kHz + TDD 30 kHz CA.  Proposal #4: Use same applicability rule on CA duplex mode for HST CA as CA CQI requirements.  Channel Model for HST-DPS  *Observation #1: The deployment parameters for HST-SFN JT and HST-DPS are the same, yet HST-DPS doesn’t consider time varying path power or delay.*  *Observation #2: With modified channel model for HST-DPS with time varying path power or delay, we observe 2dB degradation in performance for 2x2.*  *Observation #3: For HST-DPS the visibility is 1 RRH and UE will not be able to measure L1-RSRP or track TRS from next RRH prior to TCI state switch.*  Proposal #5: RAN4 further evaluates if HST-DPS channel model is practical in actual deployment and update the channel model if necessary. |
| [**R4-2104939**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104939.zip) | Simulation results for HST-SFN joint transmission for CA scenario | CMCC |  |
| [**R4-2104948**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104948.zip) | Discussion on FR1 HST UE demodulation for CA scenario | CMCC | *Observation 1: HST-SFN joint transmission scheme and DPS transmission scheme are different transmission schemes, it is doubtful to say that passing one test implies also passing the other test.*   * *Based on discussion in Rel-16 NR HST WI, different UE have different implementation on the frequency tracking of these two transmission schemes* * *DPS scheme provides better performance, while HST-SFN joint transmission scheme requires advanced receiver.*   *Proposal 1: considering that HST-SFN joint transmission scheme and DPS transmission scheme are different transmission schemes, not sure whether we can specify the applicability rule between HST-SFN joint transmission scheme and DPS transmission scheme for CA scenario.*  *Proposal 2: for SCS configuration for CA scenario to be considered and applicability rule for SCS configuration, we provide two options to move forward:*   * *Option 1: FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA are covered, and the applicability rule between CA scenario with TDD 15 kHz SCS and CA scenario with TDD 30 kHz SCS specified in Rel-16 can be reused* * *Option 2: FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA are precluded, and no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA (i.e. it is not preferred to reuse CA CQI applicability rule to PDSCH CA normal demodulation requirements)*   *Proposal 3: it is proposed that Rel-17 FR1 HST PDSCH CA requirements are release independent from Rel-15.* |
| [**R4-2104976**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104976.zip) | Views on HST CA tests for FR1 | NTT DOCOMO, INC. | Proposal 1: Target maximum Doppler frequency under DPS transmission scheme are as follows.   * For FDD 15kHz : 870Hz * For TDD 30kHz : 1667Hz   Proposal 2: Apply the following test applicability rules.   * If UE pass Rel-17 DPS CA tests, Rel-17 HST-SFN CA tests can be skipped * If UE pass Rel-17 HST-SFN CA tests, Rel-17 DPS CA tests can be skipped   Observation 1: If there are no technical issues in the future discussion, the HST-SFN CA and DPS CA requirements should be treated as release independent from Rel-15. |
| [**R4-2106431**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106431.zip) | Views on HST CA PDSCH performance requirements | Intel Corporation | Proposal #1: Define HST CA requirements with DPS Tx scheme.  Proposal #2: Reuse applicability rule from DPS single carrier to CA and define new one as: UE can skip single carrier test case if it has passed corresponding CA test case.  Proposal #3: If UE supports HST JT scheme, it can be tested only with this Tx scheme in CA mode, otherwise CA requirements with DPS Tx scheme should be applied.  Proposal #4: Do not define HST PDSCH CA requirements with TDD 15 kHz duplex mode.  Proposal #5: For HST PDSCH CA tests define the following applicability rule on CA duplex modes for testing: If UE supports both FDD 15 kHz + TDD 30 kHz and FDD 15 kHz + FDD 15 kHz CA duplex modes, apply requirements only to the first one.  Proposal #6: Make HST PDSCH CA requirements release independent from Rel-15.  Proposal #7: Do not define new network assistant signalling and UE capability for HST CA operation. |
| [**R4-2106808**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106808.zip) | Discussion on PDSCH CA scenarios for NR UE HST FR1 performance requirements | Huawei, HiSilicon | Observation 1: Existing HST network assisted signaling and UE capability can cover CA scenario.  Proposal 1: For HST-DPS, considering DPS with both one and two active TCI(s). Reuse the applicability rule between the two DPS schemes from single carrier.  Proposal 2: Define applicability rule that UE has passed DPS CA requirements can skip SFN CA requirements.  Proposal 3: PDSCH is not scheduled on ‘S’ slots under HST-SFN propagation condition for HST CA requirements.  Proposal 4: Do not consider TDD 15 kHz for HST CA requirements.  Proposal 5: Reuse CA CQI applicability rule on CA duplex modes for testing.  Proposal 6: Not define release independent for HST CA requirements.  Proposal 7: Do not introduce extra UE capability or network-assisted signaling for SCell for HST CA scenario. |
| [**R4-2106809**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106809.zip) | Simulation results for PDSCH CA scenarios for NR UE HST FR1 performance requirements | Huawei, HiSilicon |  |
| [**R4-2106862**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106862.zip) | Initial simulation result of PDSCH for CA in HST | Ericsson |  |
| [**R4-2106863**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106863.zip) | PDSCH demodulation requirements for CA with HST-SFN scenario | Ericsson | Proposal 1: Define PDSCH demodulation requirements for HST-DPS for CA with the applicability rule.  Proposal 2: If UE is capable of HST-SFN advanced receiver (for CA) and UE passes the PDSCH with HST-SFN CA requirements, the UE can skip the PDSCH with HST-DPS CA requirements.  Proposal 3: For PDSCH CA demodulation in HST, RAN4 defines the following combinations only:  • FDD SCS=15kHz + FDD SCS=15kHz  • TDD SCS=30kHz + TDD SCS=30kHz  • FDD SCS=15kHz + TDD SCS=30kHz  Observation 1: highSpeedDemodFlag-r16 can be configured for SCell.  Proposal 4: Not to introduce a new network-assisted signaling to inform HST-SFN deployment for SCell.  Proposal 5: RAN4 confirm Rel-16 UE capability signaling demodulationEnhancement can be applicable for PDSCH CA scenario also.  Proposal 6: RAN4 need to discuss further the new UE demodulation requirements for HST-SFN CA are release independent Rel-15 or not, depending on the applicability of Rel-16 UE capability for HST-SFN advanced receiver.  Proposal 7: RAN4 need to discuss further the new UE demodulation requirements for HST-DPS CA are release independent Rel-15 or not. |
| [**R4-2107041**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107041.zip) | Views on FR1 HST PDSCH CA Tests | Qualcomm Incorporated | Proposal 1: If UE passes the FR1 HST PDSCH CA tests for HST-SFN scheme, tests with HST-DPS scheme can be skipped.  Proposal 2: Do not define FR1 HST PDSCH CA tests for Duple/SCS combinations involving TDD 15kHz.  Proposal 3: Reuse CA CQI applicability rule on CA duplex modes for testing: If UE supports both FDD 15 kHz + TDD 30 kHz and FDD 15 kHz + FDD 15 kHz CA duplex modes, FDD 15kHz + FDD 15kHz CA tests can be skipped. |
| R4-2104923 | Discussion on PDSCH requirements for CA in FR1 HST | ZTE Corporation | Proposal 1 : It could define CA requirements for DPS scheme.  Proposal 2 : Do not define a new HST network assisted signaling or UE capability for HST CA scenario |

## Open issues summary

### Test parameters for CA scenario

**Issue 2-1-1: Transmission schemes**

* Agreements in RAN4#98e meeting:
* Define HST CA requirements for HST-SFN joint transmission
* FFS whether to define HST CA requirements for DPS transmission scheme (with one active TCI state and/or two active TCI states)
  + It’s RAN4 common understanding DPS scheme can achieve better performance compared to joint transmission schemes and no advanced received required for HST deployment.
  + Candidate option for further discussion:
    - It’s RAN4 recommendation to include DPS scheme into FR1 HST WI, and further discuss whether test cases need to specified or not, and if specified, test applicable rules will be specified to ensure only one scheme will be verified for CA cases for UE.
* Agreements in RAN#91e meeting:
  + Specify the UE demodulation requirements for CA scenario with the same target speed (up to 500km/h) and carrier frequency (up to 3.6 GHz) as Rel-16 NR HST for HST-SFN joint transmission scheme and DPS transmission scheme.
    - Requirements/tests applicability rules should be discussed in order to minimize the testing burden.
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Apple): Introduce requirements for CA for HST-DPS with one active TCI state only.
  + Option 2 (Huawei, Intel): For HST-DPS, considering DPS with both one and two active TCI(s). Reuse the applicability rule between the two DPS schemes from single carrier.
* Recommended WF
  + More discussion is needed.

**Issue 2-1-2: Special slot configuration**

* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Huawei): PDSCH is not scheduled on ‘S’ slots under HST-SFN propagation condition for HST CA requirements.
* Recommended WF
  + Can we agree that PDSCH is not scheduled on “S” slot under HST-SFN propagation condition?

**Issue 2-1-3: SCS configurations**

* Agreements in RAN4#98e meeting:
* *At least cover following cases:*
  + *FDD 15 kHz + FDD 15 kHz*
  + *TDD 30 kHz + TDD 30 kHz*
  + *FDD 15 kHz + TDD 30 kHz*
* *FFS whether following need to be included or not:*
  + *FDD 15 kHz + TDD 15 kHz CA*
  + *TDD 15 kHz + TDD 30 kHz CA*
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Apple, Intel, Huawei, Ericsson, Qualcomm): Do not introduce requirements in HST for FDD 15KHz + TDD 15KHz CA and TDD 15 kHz + TDD 30 kHz CA.
  + Option 2 (CMCC): FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA are covered, and the applicability rule between CA scenario with TDD 15 kHz SCS and CA scenario with TDD 30 kHz SCS specified in Rel-16 can be reused
  + Option 3 (CMCC): FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA are precluded, and no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA (i.e. it is not preferred to reuse CA CQI applicability rule to PDSCH CA normal demodulation requirements)
* Recommended WF
  + 5 companies support not defining TDD 15KHz for CA scenario. 1 company propose two options and would like to discuss TDD 15KHz together with the applicability rule for SCS configuration (issue 2-2-1). More discussion is needed.

### Applicabiliy rule

**Issue 2-2-1: Applicability rule for SCS configuration**

* Agreements in RAN4#98e meeting:
  + FFS whether reuse CA CQI applicability rule on CA duplex modes for testing: If UE supports both FDD 15 kHz + TDD 30 kHz and FDD 15 kHz + FDD 15 kHz CA duplex modes, apply requirements only to the first one
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Apple, Intel, Huawei, Qualcomm): Use same applicability rule on CA duplex mode for HST CA as CA CQI requirements.
  + Option 2 (CMCC): Do not reuse CA CQI applicability rule to PDSCH CA normal demodulation requirements
* Recommended WF
  + More discussion is needed.

**Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**

* Agreements in RAN#91e meeting:
  + Specify the UE demodulation requirements for CA scenario with the same target speed (up to 500km/h) and carrier frequency (up to 3.6 GHz) as Rel-16 NR HST for HST-SFN joint transmission scheme and DPS transmission scheme.
    - Requirements/tests applicability rules should be discussed in order to minimize the testing burden.
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Apple, Intel, Ericsson, Qualcomm): Define applicability rule for CA requirements in HST scenario as - If UE supports demodulationEnhancement-r16, only HST-SFN JT requirements shall apply, otherwise HST-DPS requirements shall apply for CA.
  + Option 2 (CMCC): considering that HST-SFN joint transmission scheme and DPS transmission scheme are different transmission schemes, not sure whether we can specify the applicability rule between HST-SFN joint transmission scheme and DPS transmission scheme for CA scenario.
  + Option 3 (DOCOMO):
    - If UE pass Rel-17 DPS CA tests, Rel-17 HST-SFN CA tests can be skipped
    - If UE pass Rel-17 HST-SFN CA tests, Rel-17 DPS CA tests can be skipped
  + Option 4 (Huawei):
    - Define applicability rule that UE has passed DPS CA requirements can skip SFN CA requirements.
* Recommended WF
  + More discussion is needed.

**Issue 2-2-3: Applicability rule between single carrier and CA**

* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Intel): UE can skip single carrier test case if it has passed corresponding CA test case.
* Recommended WF
  + More discussion is needed.

### Release independent

**Issue 2-3-1: Release independent**

* Agreements in RAN4#98e meeting:
  + FFS whether HST PDSCH CA requirements can be release independent from Rel-15
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (CMCC, DOCOMO, Intel): it is proposed that Rel-17 FR1 HST PDSCH CA requirements are release independent from Rel-15.
  + Option 2 (Huawei): Not define release independent for HST CA requirements.
  + Option 3 (Ericsson):
    - RAN4 need to discuss further the new UE demodulation requirements for HST-SFN CA are release independent Rel-15 or not, depending on the applicability of Rel-16 UE capability for HST-SFN advanced receiver.
    - RAN4 need to discuss further the new UE demodulation requirements for HST-DPS CA are release independent Rel-15 or not.
* Recommended WF
  + More discussion is needed.

### UE capability and network-assisted signalling

**Issue 2-4-1: UE capability and network-assisted signalling**

* Agreements in RAN4#98e meeting:
* FFS whether existing HST network assisted signaling and UE capability can cover CA scenario
* Proposals in RAN4#98bis-e meeting:
  + *Option 1 (Intel, Huawei, Ericsson, ZTE):* Do not define new network assistant signalling and UE capability for HST CA operation
* Recommended WF
  + Do not define new network assistant signalling and UE capability for HST CA operation
  + Rel-16 network assistant signalling and UE capability signalling can be applicable for PDSCH CA scenario

### Channel Model

**Issue 2-5-1: Channel model for HST-DPS**

* Proposals in RAN4#98bise meeting (R4-2104844, Apple):
  + Observation #1: The deployment parameters for HST-SFN JT and HST-DPS are the same, yet HST-DPS doesn’t consider time varying path power or delay.
  + Observation #2: With modified channel model for HST-DPS with time varying path power or delay, we observe 2dB degradation in performance for 2x2.
  + Observation #3: For HST-DPS the visibility is 1 RRH and UE will not be able to measure L1-RSRP or track TRS from next RRH prior to TCI state switch.
  + Proposal #5: RAN4 further evaluates if HST-DPS channel model is practical in actual deployment and update the channel model if necessary.
* Recommended WF
  + Companies please provide your views on the new proposal for HST-DPS channel model.

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | Issue 2-1-1:  Option 2. We prefer to use the same applicability rule as single carrier case.  Issue 2-1-2:  Support the recommended WF.  Issue 2-1-3:  Option 1. RAN plenary agreed to include DPS for PDSCH CA demodulation requirements, but WID also adds the note the requirements/tests applicability rules should be discussed in order to minimize the testing burden. Since RAN4 has already included TDD 15kHz in Rel-16 PDSCH CA demodulation, we don’t need to repeat it for Rel-17 HST scenario.  Issue 2-2-2:  Option 1 or Option 3. We understand Rel-16 HST does not define the applicability rule between HST-DPS and HST-SFN JT. But we are discussing the CA scenario. We think it is possible to consider the applicability rule between CA HST-SFN JT and CA HST-DPS.  We are also fine with Option 3, because it is more generic, and we think this option includes both Options 1 and 4.  Issue 2-2-3:  We need discuss the applicability of CA case and single carrier case carefully, depending on the conclusion of the applicability between CA HST-SFN and CA HST-DPS.  This is our preference:   * If UE pass Rel-17 DPS CA tests:   + Rel-17 HST-SFN CA tests can be skipped.   + Rel-16 DPS single carrier tests can be skipped.   + Rel-16 HST-SFN single carrier tests should be passed if UE has capability. * IF UE pass Rel-17 HST-SFN CA tests:   + Rel-17 DPS CA tests can be skipped.   + Rel-16 HST-SFN single carrier tests can be skipped.   + Rel-16 DPS single carrier tests should be passed.   We may need to check the impact to other HST test cases such as HST single tap etc.  Issue 2-3-1:  Option 3. First we need to confirm whether the UE capability of HST-SFN advanced receiver can be applicable for CA. If yes, we are fine the HST-SFN CA demodulation requirements are release independent from Rel-15 (or Rel-16 if companies have concern).  Issue 2-4-1:  Support the recommended WF.  Issue 2-5-1:  We agree with the observations by Apple, but we prefer to keep the existing SNR definition for HST-DPS. If RAN4 need to update the HST-DPS according to the actual deployment, we think RAN4 also need to update the existing HST single tap model since this model keeps the same delay and path power.  Also the existing RAN4 UE demodulation requirements use the SNR to achieve 30%/70% of the maximum throughput, so we would like to keep the same signal power level during the tests, if UE receives PDSCH only from one transmission point. |
| **CMCC** | **Issue 2-1-1: Transmission schemes**  Support option 2. Both DPS 1a and DPS 1b need to be supported. And the applicability rule between the two DPS schemes specified for single carrier can be reused to reduce the number of test cases that UE need to pass.  **Issue 2-1-2: Special slot configuration**  We are OK with option1. Considering that PDSCH is not scheduled on ‘S’ slots under HST-SFN propagation condition for single carrier, this can be reused for CA.  **Issue 2-1-3: SCS configurations**  Both option 2 and option 3 are OK for us. We would like to suggest to discuss the SCS configuration and applicability rule together. In Rel-16 CA, 5 SCS configurations are supported with applicability rule for TDD 15KHz SCS, but no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA. For HST, if TDD 15KHz SCS is considered, the applicability rule specified for TDD 15KHz SCS in Rel-16 can be reused to reduce the number of test cases. Or if TDD 15KHz SCS is not considered for HST, there is no any applicability rule. We are not OK to use CA CQI applicability rule to PDSCH CA normal demodulation requirements.  **Issue 2-2-1: Applicability rule for SCS configuration**  Option 2. As mentioned in issue 2-1-3, in Rel-16 CA, there is no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA. We do not understand why we use CA CQI applicability rule to PDSCH CA normal demodulation requirements.  **Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**  We understand companies’ consideration to reduce the number of test cases. We are open to discuss the applicability rule. But we are not sure how to specify the applicability rule. DPS scheme may provide better performance, while HST-SFN joint transmission scheme requires advanced receiver. And as discussed in Rel-16, different UE may have different implementation on these two schemes. Not sure we can say that passing one test implies also passing the other test.  **Issue 2-2-3: Applicability rule between single carrier and CA**  Considering that the test cases for single carrier are for the functionality verification. It is not preferred to define applicability rule between single carrier and CA.  **Issue 2-3-1: Release independent**  Option 1. HST is very important scenario and it is suggested that the CA for HST can be release independent from Rel-15 to improve the both system performance and UE experience.  **Issue 2-4-1: UE capability and network-assisted signalling**  We are OK with the recommended WF. |
| **DCM** | **Issue 2-1-1: Transmission schemes**  We support option 2.  **Issue 2-1-2: Special slot configuration**  We support the recommended WF.  **Issue 2-2-1: Applicability rule for SCS configuration**  We support Option2. As CMCC mentioned above, there is no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA in Rel-16 PDSCH CA. In terms of the reduction of tests, we believe that it is sufficient to introduce the applicability rule between HST-SFN CA tests and HST-DPS CA tests.  **Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**  Since HST-DPS requirements with one active TCI is mandatory tests, we are sorry that our proposal is not clear. The proposal we wanted to express is the same as Option 1. Thus, we prefer to support Option1 and remove Option3.  **Issue 2-3-1: Release independent**  We support Option1.  **Issue 2-4-1: UE capability and network-assisted signalling**  We support the recommended WF. |
| **Intel** | **Issue 2-1-1: Transmission schemes**  We support Option 2. It is important to have ability to verify proper receive processing in case UE supports more than one active TCI states and network configure corresponding DPS Tx scheme. From test load, we can reuse applicability rule from SC, that only one DPS Tx scheme can be tested if UE supports both. Also, there is no additional RAN4 simulation efforts to define CA requirements for both since same required SNR is applicable for both DPS Tx schemes due to generic test design.  **Issue 2-1-2: Special slot configuration**  Support the recommended WF.  **Issue 2-1-3: SCS configurations**  We believe that there is no need to reuse all SCS configurations from Normal CA test cases to HST CA test cases. From receive processing perspective there is no specific HST processing for different duplex/SCS configurations and RAN4 should define minimum number of requirements to guarantee proper HST operation for CA scenario considering that basic operation in CA mode is already covered by Normal CA requirements. Option 1 is a good trade-off between test coverage and test load. Support Option 1.  **Issue 2-2-1: Applicability rule for SCS configuration**  Support Option 1. If UE supports both FDD 15 kHz + TDD 30 kHz and FDD 15 kHz + FDD 15 kHz CA duplex modes, then both will be tested during the Normal CA testing procedure. For HST CA we think it is sufficient to consider only one of them.  **Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**  If UE supports both Tx schemes, then both will be tested with SC test cases. To reduce CA test efforts, we can agree to skip one of them from CA HST testing. All Tx schemes will be covered, and minimum HST CA performance will be guaranteed in this case.  As for option 3, we are not clear how to choose Tx scheme for testing if UE supports both. It is more straightforward to consider JT if UE supports advanced receiver and DPS otherwise. At current stage we support Option 1 but can also further discuss option 3.  **Issue 2-2-3: Applicability rule between single carrier and CA**  We agree with Ericsson that it is better to discuss this issue after reaching agreement on issue 2-2-2. At current stage we are not clear how to choose DPS or JT for CA testing if UE supports both, hence we suggest the following applicability rule structure for further discussion:   * If UE is capable of demodulationEnhancement-r16 and pass Rel-17 HST-SFN CA tests:   + Rel-17 DPS CA tests can be skipped.   + Rel-16 HST-SFN single carrier tests can be skipped.   + Rel-16 DPS single carrier tests should be tested.   + Rel-15/16 HST Single tap tests can be skipped except Rel-16 FDD (same as Rel-16 applicability rule) * If UE is not capable of demodulationEnhancement-r16 and pass Rel-17 HST-DPS CA tests:   + Rel-17 HST-SFN CA tests should not be tested.   + Rel-16 HST-SFN tests should not be tested.   + Rel-16 DPS single carrier tests can be skipped.   **Issue 2-3-1: Release independent**  We prefer to leave this issue open. There was a good point mentioned by Huawei in their contribution that we can define HST CA requirements in release independent manner only if both Demod and RRM requirements can be release independent. From demod perspective we agree that it is possible, but we need to wait RRM room decision.  We suggest agreeing that HST CA Rel-17 requirements will be defined in release independent manner only if both RRM and demod requirements can be release independent. We do not see value to define one of them in release independent manner in case another one is not.  **Issue 2-4-1: UE capability and network-assisted signalling**  Support the recommended WF.  **Issue 2-5-1: Channel model for HST-DPS**  We agree that DPS channel model should be updated to make second RRH visible for L1-RSPR reporting and second TCI state pre-tracking. It can be done by definition of additional notes.   However, we do not want to re-define existing requirements and hence do not support adding of path loss and propagation delay to the DPS channel model. First of all, Rel-16 HST WI has already completed and we are not sure that sufficient number of companies will contribute for Rel-16 requirements re-definition. Also, adding the path loss and propagation delay will just shift SNR point but will not add additional functionality to test DPS Tx scheme. So, we do see benefits of re-defining the channel model in this way. |
| **Huawei, HiSilicon** | **Issue 2-1-1: Transmission schemes**  We prefer Option 2, it is reasonable to define HST-DPS CA performance requirements for DPS scheme with both one and two active TCI(s) by reusing the existing applicability rule considering the corresponding HST-DPS single carrier requirements defined for DPS with both one and two active TCIs in Rel-16. At the same time, the test effort is not increased since only one DPS scheme will be tested with the existing applicability rule.  **Issue 2-1-2: Special slot configuration**  Option 1. To keep consistent with HST-SFN single carrier performance requirements configuration.  **Issue 2-1-3: SCS configurations**  We prefer Option 1. It is not necessary to repeat the testing of support different SCS combinations in HST scenarios, it was covered by Rel-16 CA requirements.  **Issue 2-2-1: Applicability rule for SCS configuration**  We prefer Option 1.  **Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**  We prefer Option 4. It is RAN4’s common understanding that SFN transmission scheme need more complex processing but worse performance can be observed compared to DPS. So the question can be raised that why an UE use more complex processing to achieve worse performance?  Also like Ericsson pointed out that it is possible to consider the applicability rule between CA HST-SFN JT and CA HST-DPS considering more complexity processing for NR compared to LTE.  **Issue 2-2-3: Applicability rule between single carrier and CA**  This issues should be discussed together with Issue 2-2-2. The proposal from Ericsson about the test applicability between CA/single carrier for HST-SFN and HST-DPS is acceptable to reduce the testing burden.  For the question raised by Intel, there are similar test applicability rules defined, if UE passed test A, test B can be skipped. It is up to UE to choose HST-SFN or HST-DPS for testing, TE will provide such choice before UE choose which tests to run.  **Issue 2-3-1: Release independent**  In Rel-16 LTE HST enhancement WI, *highSpeedEnhMeasFlagSCell* is introduced for RRM SCell measurement enhancement. Currently in Rel-17 NR HST WI, whether RRM measurement enhancement for SCell to be specified is still under discussion, maybe stricter RRM measurement requirements will be specified that is a higher challenge for UE implementation. Also considering LTE HST CA requirements are not release independent, we prefer to not define release independent for NR HST CA requirements.  **Issue 2-4-1: UE capability and network-assisted signalling**  Option 1.  **Issue 2-5-1: Channel model for HST-DPS**  Actually all channel models defined in HST do not reflect the real deployment perfectly. There is no big issue since it is convenient for the test by normalization power, i.e. fix the SNR.  SSB and TRS is transmitted all the time for DPS transmission scheme as per the latest specification. Also as per R4-2012668, reported L1-RSRP measurements are not tested. So we don’t think it is necessary to modify the HST-DPS channel model. |
| **ZTE** | **Issue 2-1-1: Transmission schemes**  We would like to support option 2. we also think DPS should contain scheme 1a and 1b, test case can be reduced by the applicability rule between this two scheme.  **Issue 2-1-2: Special slot configuration**  Agree with the Recommended WF.  **Issue 2-1-3: SCS configurations**  We would like to support option 1.  For option 2, it also seems to reduce the test burden but new requirement need to be defined because TDD15KHz have not been defined for HST-JT and DPS scheme. if company strongly think it is needed to define TDD15KHz, we also can compromise to this option.  **Issue 2-4-1: UE capability and network-assisted signalling**  Agree with the Recommended WF. |
| **Apple** | **Issue 2-1-1: Transmission schemes**  We support option 1. We don’t see the necessity to introduce requirements in CA for 2 active TCI states. If we follow the same applicability rule as single CC, there will be lot of tests for the UE. The WID clearly states that testing burden shall be reduced.  **Issue 2-1-2: Special slot configuration**  We support the recommended WF.  **Issue 2-1-3: SCS configurations**  We support option 1.  **Issue 2-2-1: Applicability rule for SCS configuration**  We support option 1.  **Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**  We support Option 1. HST-SFN needs additional UE capability whereas DPS with single TCI state switch doesn’t.  **Issue 2-2-3: Applicability rule between single carrier and CA**  We support the idea in general. Need more discussion based on concusion of Issue 2-2-2.  **Issue 2-3-1: Release independent**  We don’t support to define CA requirements as release independent from Rel-15. We further need to discuss/ conclude if additional capability signalling, or network assistance is required for demod for HST-SFN JT in CA mode before agreeing to make requirement release independent.  **Issue 2-4-1: UE capability and network-assisted signalling**  We need some time to check and will provide comment.  **Issue 2-5-1: Channel model for HST-DPS**  To Ericsson: The deployment parameters for single tap HST and HST-SFN are very different. For HST SFN JT we consider time varying path power and delay, but not for HST-DPS, which have same deployment parameters. It doesn’t seem reasonable for HST-DPS. We are likely seeing more optimistic results due to such assumptions.  To Intel: Companies are already providing results for different CBW for CA case, we don’t think running the single carrier CBW would be a huge overhead in case its needed.  Our main concern is that by assuming an unrealistic channel model, we might be seeing highly optimistic results which might not be realizable in actual deployment. We understand that path power with single tap only changes the operating SNR. But we think we should look into the path delay. It would be unrealistic to assume that path delay is 0 through the entire track and also for the case of 2 active TCI states where UE tracks from 2 TRPs. |
| **Qualcomm** | **Issue 2-1-1: Transmission schemes**  No strong preference. Ok with option 2 if requirements are same for both cases, similar to single carrier tests.  **Issue 2-1-2: Special slot configuration**  Ok with Option 1.  **Issue 2-1-3: SCS configurations**  Prefer Option 1. Same comment as other companies. Testing of different CA combinations is already covered in Rel-16 PDSCH CA tests and focus here is to test HST performance.  **Issue 2-2-1: Applicability rule for SCS configuration**  Prefer Option 1. Same comment as Issue 2-1-3. Also, as RAN4 will only define single carrier requirements, all requirements will get tested with Option 1.  **Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**  Prefer Option 1. HST-SFN demod algorithm is more complex than HST-DPS. For Option 2, both Tx schemes are already verified in single carrier case. Also, it is very unlikely that UE supporting HST-SFN will fail HST-DPS test since HST-SFN demod algorithm is much more advanced. For Option 3 and 4, UEs will always choose to skip HST-SFN CA tests since that requires more advanced receiver. So, UEs can indicate HST-SFN capability by just passing a single carrier test and not being tested for higher CBWs on multiple CCs, which may require more processing cycles compared to HST-DPS.  **Issue 2-2-3: Applicability rule between single carrier and CA**  Similar view as other companies. This should be discussed based on outcome of Issue 2-2-2, so that it is clear which single carrier tests can be skipped.  **Issue 2-3-1: Release independent**  Ok with Option 1.  **Issue 2-4-1: UE capability and network-assisted signalling**  Ok with recommended WF.  **Issue 2-5-1: Channel model for HST-DPS**  With time-varying path power, SNR will be varying along the track. Then, it will be difficult to define the requirements at fixed SNR. Even for HST-SFN, total power is kept at 0dB. As DPS will only have single path, we believe that TTL should be able to correct that drift in practice. For L1-RSRP measurements, RAN4 had decided to not mix RRM measurements with demod test. As TCI state switch is deterministic for HST-DPS and any transmission during TCI state switch is discarded for statistics calculation, this should not impact the existing requirements. So, we are ok to keep HST-DPS model as it is. |

### CRs/TPs comments collection

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| **CR tdoc number** | **Comments collection** |
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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** |
| **Issue 2-1-1: Transmission schemes** | * + Option 1 (Apple): Introduce requirements for CA for HST-DPS with one active TCI state only.   + Option 2 (Huawei, Intel, Ericsson, CMCC, DCM, QC): For HST-DPS, considering DPS with both one and two active TCI(s). Reuse the applicability rule between the two DPS schemes from single carrier.   7 companies discuss this issue, 6 companies support option2. 1 company has concern on option 2 due to the number of test cases. Moderator recommends agreeing on option2 first, and further discussing the applicability rule between CA and single carrier.  **Tentative Agreement:**   * + For HST-DPS, considering DPS with both one and two active TCI(s). Reuse the applicability rule between the two DPS schemes from single carrier.   + Further discuss the applicability rule between single CC and CA (issue 2-2-3). |
| **Issue 2-1-2: Special slot configuration** | **Tentative Agreement:**   * + PDSCH is not scheduled on ‘S’ slots under HST-SFN propagation condition for HST CA requirements. |
| **Issue 2-1-3: SCS configurations**  **Issue 2-2-1: Applicability rule for SCS configuration** | * + Option 1 (Apple, Intel, Huawei, Ericsson, Qualcomm): Do not introduce requirements in HST for FDD 15KHz + TDD 15KHz CA and TDD 15 kHz + TDD 30 kHz CA.   + Option 2 (CMCC): FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA are covered, and the applicability rule between CA scenario with TDD 15 kHz SCS and CA scenario with TDD 30 kHz SCS specified in Rel-16 can be reused   + Option 3 (CMCC): FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA are precluded, and no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA (i.e. it is not preferred to reuse CA CQI applicability rule to PDSCH CA normal demodulation requirements)   5 companies support option1 and 2 companies support option2. Moderator recommends discussing issue 2-1-3 together with issue 2-2-1.  **Recommended WF for 2nd round:**  Discuss issue 2-1-3 and 2-2-1 together. Further discuss the following options during 2nd round   * + Option 1: Do not introduce requirements in HST for FDD 15KHz + TDD 15KHz CA and TDD 15 kHz + TDD 30 kHz CA. If UE supports both FDD 15 kHz + TDD 30 kHz and FDD 15 kHz + FDD 15 kHz CA duplex modes, apply requirements only to the first one (i.e. use the same applicability rule on CA duplex mode for HST CA as CA CQI requirements).   + Option 2: Introduce requirements in HST for FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA, and the applicability rule between CA scenario with TDD 15 kHz SCS and CA scenario with TDD 30 kHz SCS specified in Rel-16 can be reused   + Option 3: Do not introduce requirements in HST for FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA, and no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA (i.e. it is not preferred to reuse CA CQI applicability rule to PDSCH CA normal demodulation requirements) |
| **Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme** | * + Option 1 (Apple, Intel, Ericsson, Qualcomm, DCM): Define applicability rule for CA requirements in HST scenario as - If UE supports demodulationEnhancement-r16, only HST-SFN JT requirements shall apply, otherwise HST-DPS requirements shall apply for CA.   + Option 2 (CMCC): considering that HST-SFN joint transmission scheme and DPS transmission scheme are different transmission schemes, not sure whether we can specify the applicability rule between HST-SFN joint transmission scheme and DPS transmission scheme for CA scenario.   + ~~Option 3 (DOCOMO):~~     - ~~If UE pass Rel-17 DPS CA tests, Rel-17 HST-SFN CA tests can be skipped~~     - ~~If UE pass Rel-17 HST-SFN CA tests, Rel-17 DPS CA tests can be skipped~~   + Option 4 (Huawei):     - Define applicability rule that UE has passed DPS CA requirements can skip SFN CA requirements.   5 companies support option1, 1 company support option4, and DCM proposed to remove option3.  **Recommended WF for 2nd round:**  Further discuss whether to define applicability rule between HST-SFN joint transmission and DPS transmission scheme. If the applicability rule is defined, consider following options.  Option 1: Define applicability rule for CA requirements in HST scenario as - If UE supports demodulationEnhancement-r16, only HST-SFN JT requirements shall apply, otherwise HST-DPS requirements shall apply for CA.  Option 2: Define applicability rule that UE has passed DPS CA requirements can skip SFN CA requirements. |
| **Issue 2-2-3: Applicability rule between single carrier and CA** | * + Option 1 (IntelHuawei): UE can skip single carrier test case if it has passed corresponding CA test case.   + Option 2 (Ericsson) * If UE pass Rel-17 DPS CA tests:   + Rel-17 HST-SFN CA tests can be skipped.   + Rel-16 DPS single carrier tests can be skipped.   + Rel-16 HST-SFN single carrier tests should be passed if UE has capability. * IF UE pass Rel-17 HST-SFN CA tests:   + Rel-17 DPS CA tests can be skipped.   + Rel-16 HST-SFN single carrier tests can be skipped.   + Rel-16 DPS single carrier tests should be passed.   + Option 3 (CMCC): Do not define applicability rule between single carrier and CA.   + Option 4 (Apple, Qualcomm): Need more discussion based on conclusion of Issue 2-2-2.   6 companies support to define applicability rule between single carrier and CA in general. But the detailed applicability rule need more discussion based on conclusion of issue 2-2-2.  **Tentative Agreement:**  Discuss applicability rule between single carrier and CA later based on the conclusion of applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme. |
| **Issue 2-3-1: Release independent** | * + Option 1 (CMCC, DOCOMO, Intel, Qualcomm): it is proposed that Rel-17 FR1 HST PDSCH CA requirements are release independent from Rel-15.   + Option 2 (Huawei, Apple): Not define release independent for HST CA requirements.   + Option 3 (Ericsson):     - RAN4 need to discuss further the new UE demodulation requirements for HST-SFN CA are release independent Rel-15 or not, depending on the applicability of Rel-16 UE capability for HST-SFN advanced receiver.     - RAN4 need to discuss further the new UE demodulation requirements for HST-DPS CA are release independent Rel-15 or not.   + Option 4 (Intel): We suggest agreeing that HST CA Rel-17 requirements will be defined in release independent manner only if both RRM and demod requirements can be release independent.   Companies’ views are diverse. One concern for release independent is whether new UE capability signalling  **Recommended WF for 2nd round:**  Further discuss the release independent issue considering following aspects:   * + - 1. Whether additional new UE capability signaling or network assistance is required       2. Whether RRM requirements are release independent or not       3. Independent from which release, Rel-15 or Rel-16? |
| **Issue 2-4-1: UE capability and network-assisted signalling** | 6 companies support the recommended WF, while 1 company needs time to check.  **Recommended WF for 2nd round:**  Further check the following recommended WF in 2nd round:   * + Do not define new network assistant signalling and UE capability for HST CA operation   + Rel-16 network assistant signalling and UE capability signalling can be applicable for PDSCH CA scenario |
| **Issue 2-5-1: Channel model for HST-DPS** | Whether to update the HST-DPS channel model (adding path loss and propagation delay)?  YES (Apple)  NO (Ericsson, Intel, Huawei, Qualcomm)  Majority companies prefer to keep existing HST-DPS channel model. Since this is the 1st meeting to see this proposal, maybe more time is needed for companies to check.  **Recommended WF for 2nd round:**  More discussion is needed. |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on FR1 HST demodulation | CMCC |
| #2 | Simulation results summary for FR1 HST CA demodulation | Ericsson |

## Discussion on 2nd round (if applicable)

### Open issues summary

**Issue 2-1-3: SCS configurations**

**Issue 2-2-1: Applicability rule for SCS configuration**

* + Option 1: Do not introduce requirements in HST for FDD 15KHz + TDD 15KHz CA and TDD 15 kHz + TDD 30 kHz CA. If UE supports both FDD 15 kHz + TDD 30 kHz and FDD 15 kHz + FDD 15 kHz CA duplex modes, apply requirements only to the first one (i.e. use the same applicability rule on CA duplex mode for HST CA as CA CQI requirements).
  + Option 2: Introduce requirements in HST for FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA, and the applicability rule between CA scenario with TDD 15 kHz SCS and CA scenario with TDD 30 kHz SCS specified in Rel-16 can be reused
  + Option 3: Do not introduce requirements in HST for FDD 15 kHz + TDD 15 kHz CA and TDD 15 kHz + TDD 30 kHz CA, and no applicability rule for FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA and FDD 15 kHz + TDD 30 kHz CA (i.e. it is not preferred to reuse CA CQI applicability rule to PDSCH CA normal demodulation requirements)

**Recommended WF:**

Further discuss the above options

**Issue 2-2-2: Applicability rule for HST-SFN joint transmission scheme and DPS transmission scheme**

Option 1: Define applicability rule for CA requirements in HST scenario as - If UE supports demodulationEnhancement-r16, only HST-SFN JT requirements shall apply, otherwise HST-DPS requirements shall apply for CA.

Option 2: Define applicability rule that UE has passed DPS CA requirements can skip SFN CA requirements.

**Recommended WF:**

Further discuss whether to define applicability rule between HST-SFN joint transmission and DPS transmission scheme. If the applicability rule is defined, which option do you prefer?

**Issue 2-3-1: Release independent**

* + Option 1 (CMCC, DOCOMO, Intel, Qualcomm): it is proposed that Rel-17 FR1 HST PDSCH CA requirements are release independent from Rel-15.
  + Option 2 (Huawei, Apple): Not define release independent for HST CA requirements.
  + Option 3 (Ericsson):
    - * RAN4 need to discuss further the new UE demodulation requirements for HST-SFN CA are release independent Rel-15 or not, depending on the applicability of Rel-16 UE capability for HST-SFN advanced receiver.
      * RAN4 need to discuss further the new UE demodulation requirements for HST-DPS CA are release independent Rel-15 or not.
  + Option 4 (Intel): We suggest agreeing that HST CA Rel-17 requirements will be defined in release independent manner only if both RRM and demod requirements can be release independent.

**Recommended WF:**

Further discuss the release independent issue considering following aspects:

1. Whether additional new UE capability signaling or network assistance is required
2. Whether RRM requirements are release independent or not
3. Independent from which release, Rel-15 or Rel-16?

**Issue 2-4-1: UE capability and network-assisted signalling**

* + Do not define new network assistant signalling and UE capability for HST CA operation
  + Rel-16 network assistant signalling and UE capability signalling can be applicable for PDSCH CA scenario

**Recommended WF:**

Further check the above proposal.

**Issue 2-5-1: Channel model for HST-DPS**

* Proposals in RAN4#98bise meeting (R4-2104844, Apple):
  + Observation #1: The deployment parameters for HST-SFN JT and HST-DPS are the same, yet HST-DPS doesn’t consider time varying path power or delay.
  + Observation #2: With modified channel model for HST-DPS with time varying path power or delay, we observe 2dB degradation in performance for 2x2.
  + Observation #3: For HST-DPS the visibility is 1 RRH and UE will not be able to measure L1-RSRP or track TRS from next RRH prior to TCI state switch.
  + Proposal #5: RAN4 further evaluates if HST-DPS channel model is practical in actual deployment and update the channel model if necessary.

**Recommended WF:**

Further discuss whether to update the HST-DPS channel model?

### Open issues

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| **Company** | **Comments** |
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## 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 #3: Enhanced transmisison schemes

*Agenda 8.6.3.3*

## Companies’ contributions summary

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| **TDoc** | **Title** | **Source** | **Proposals/ Observations** |
| [**R4-2104845**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104845.zip) | On Enhanced transmission schemes for HST | Apple | Observation #1: The performance with multi-DCI transmission scheme is comparable to DPS for HST.  Proposal #1: Do not introduce requirements with enhanced transmission scheme for HST.  Proposal #2: RAN4 further discuss the channel model for multi-TRP transmission in HST. |
| [**R4-2106432**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106432.zip) | Views on HST PDSCH performance requirements for multi-DCI based Tx scheme | Intel Corporation | Observation #1: Propagation conditions for each PDSCH scheduled in multi-DCI based Tx scheme in Rel-16 HST-SFN deployment are determined by two tap channel model with time-variant characteristics.  Observation #2: Propagation conditions with multi-DCI Tx scheme and JT scheme are quite similar.  Proposal #1: Do not define performance requirements for multi-DCI based Tx scheme in HST-SFN scenario. |
| [**R4-2106810**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106810.zip) | Discussion on enhanced transmission schemes for NR UE HST FR1 performance requirements | Huawei, HiSilicon | Proposal 1: Do not consider full overlapping or partially overlapping cases for multi-DCI based multi-TRP.  Proposal 2: Use changed SNR for different time and different RRH for the non-overlapping case, if multi-DCI based multi-TRP requirements are defined.  Proposal 3: Do not scheduled PDSCH in ‘S’ slot, if multi-DCI based multi-TRP requirements are defined.  Proposal 4: Do not consider extra time/frequency offset or calculate them into the total frequency/time offset to ensure the total frequency/time offset is within the UE capability, if multi-DCI based multi-TRP requirements are defined.  Proposal 5: Use total maximum frequency offset of 870Hz for 15KHz SCS, 1667Hz for 30 KHz SCS respectively, if multi-DCI based multi-TRP requirements are defined.  Proposal 6: Do not define requirements multi-DCI based multi-TRP under HST scenario. |
| [**R4-2106811**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106811.zip) | Simulation results for evaluations of enhanced transmission schemes for NR UE HST FR1 performance requirements | Huawei, HiSilicon | Observation 1: Bad performance using multi-DCI based multi-TRP when UE near the RRH.  Observation 2: DPS is better than multi-DCI based multi-TRP all the time from the perspective of throughput.  Observation 3: Total frequency offset over than 870Hz for 15 kHz SCS will cause the “frequency wrap” then leads to the significant performance degradation.  Observation 4: Maximum throughput cannot achieved for multi-DCI based multi-TRP with MCS 17 and TDD 30 kHz regardless the value of timing offset. |
| [**R4-2106864**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106864.zip) | PDSCH demodulation requirements with enhanced transmission schemes in HST scenario | Ericsson | Observation 1: mDCI-based PDSCH transmission cannot achieve the maximum throughput when the HST-SFN channel model is applied.  Observation 2: Larger time difference between two TRPs in HST-SFN channel model degrades the UE demodulation performance for the multi-DCI based transmission.  Observation 3: mDCI-based transmission scheme with HST-SFN deployment scenario shows worse performance compared with HST-SFN JT/HST-DPS scenario.  Proposal: RAN4 need more discussion/study whether to define mDCI-based transmission in HST-SFN deployment scenario. |
| [**R4-2107043**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107043.zip) | Views on FR1 HST Enhanced Transmission Schemes | Qualcomm Incorporated | Proposal 1: Use HST-DPS scheme as reference for evaluating Multi-DCI scheme for FR1 HST.  Proposal 2: Use SNR at 70% of max achievable throughput as evaluation metric for Multi-DCI scheme.  ~~Proposal 3: Do not consider non-overlapping allocation for evaluation of Multi-DCI scheme for FR1 HST.~~ |
| [**R4-2107092**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107092.zip) | Discussion on multi-DCI transmission scheme for FR1 HST | MediaTek inc. | Observation 1: When UE is near one RRH, there is a large power imbalance for two TBs and the received SNR for one of two TBs is very low.  Observation 2: When UE is near one RRH, the maximum reception timing difference from two RRHs for multi-DCI based transmission is close to the CP length for SCS=30kHz.  Proposal 1: Fixed MCS simulation is not proper for performance evaluation and we may need further discussion about the performance evaluation method. |

## Open issues summary

**Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**

* Agreements in RAN4#98e meeting:
  + Firstly, focus on the study and evaluate the performance benefits of transmission scheme 2 in HST-SFN deployment comparing to other transmission schemes.
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Apple, Intel, Huawei): Do not introduce requirements for multi-DCI based transmission scheme for HST
  + Option 2 (Ericsson): RAN4 need more discussion/study whether to define mDCI-based transmission in HST-SFN deployment scenario
* Recommended WF
  + Suggest following last meeting agreements. More evaluation is needed.

**Issue 2-2: Deployment Parameters**

* Agreements in RAN4#98e meeting:
  + Set Ds=700m and Dmin=150m as baseline
  + Take maximum Doppler frequency “870Hz for 15KHz SCS, 1667Hz for 30KHz SCS” as baseline
    - Further check whether Doppler/timing offset may exceed maximum UE capability with the assumption of Non-ideal synchronization
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Huawei):
    - Use total maximum frequency offset of 870Hz for 15KHz SCS, 1667Hz for 30 KHz SCS respectively, if multi-DCI based multi-TRP requirements are defined.
    - Do not consider extra time/frequency offset or calculate them into the total frequency/time offset to ensure the total frequency/time offset is within the UE capability, if multi-DCI based multi-TRP requirements are defined
* Recommended WF
  + Can we agree with the following recommended WF?
    - Set Ds=700m and Dmin=150m as baseline
    - Take maximum Doppler frequency “870Hz for 15KHz SCS, 1667Hz for 30KHz SCS” as baseline

**Issue 2-3: Reference performance for comparison**

* Agreements in RAN4#98e meeting:
  + Option 1: mDCI-based transmission vs. HST-SFN joint transmission
  + Option 2: mDCI-based transmission vs. HST-DPS
  + Other options are not precluded
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Qualcomm): Use HST-DPS scheme as reference for evaluating Multi-DCI scheme for FR1 HST.
* Recommended WF
  + More discussion is needed.

**Issue 2-4: PDSCHs allocations between different RRHs**

* Agreements in RAN4#98-e meeting:
  + Baseline assumption for evaluation: reuse the same PRB allocation as Rel-16 eMIMO multi-DCI based transmission, i.e., overlapped in time domain but not overlapped in frequency domain
  + FFS whether to consider both overlapped and non-overlapped PDSCHs allocations between different RRHs for performance analysis
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Huawei, Qualcomm): Do not consider full overlapping or partially overlapping cases for multi-DCI based multi-TRP.
  + ~~Option 2 (Qualcomm): Do not consider non-overlapping allocation for evaluation of Multi-DCI scheme for FR1 HST.~~
* Recommended WF
  + More discussion is needed

**Issue 2-5: SNR definition**

* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Huawei): Use changed SNR for different time and different RRH for the non-overlapping case, if multi-DCI based multi-TRP requirements are defined.
* Recommended WF
  + More discussion is needed

**Issue 2-6: MCS**

* Agreements in RAN4#98e meeting:
  + MCS 13 and MCS 17 as baseline assumption for further evaluations
  + For mDCI-based transmission vs. HST-SFN joint transmission, use MCS13
  + For mDCI-based transmission vs. HST-DPS, use MCS 17
  + Note: which MCS is adopted depends on the outcome of the discussion on Reference performance for comparison
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (MTK): Fixed MCS simulation is not proper for performance evaluation and we may need further discussion about the performance evaluation method.
* Recommended WF
  + More discussion is needed

**Issue 2-7: Evaluation Criteria**

* Agreements in RAN4#98e meeting:
* Option 1: Max achievable throughput across all scheduled TB
  + Different train locations and SNR points should be analyzed
* Option 2: SNR at 70% @max achievable throughput
* Option 3: Max supported Doppler frequency
* Other options are not precluded
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Qualcomm): Use SNR at 70% of max achievable throughput as evaluation metric for Multi-DCI scheme.
* Recommended WF
  + More discussion is needed

**Issue 2-8: Special slot configuration**

* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Huawei): Do not scheduled PDSCH in ‘S’ slot, if multi-DCI based multi-TRP requirements are defined.
* Recommended WF
  + Can we agree with above option1?

**Issue 2-9: Channel model**

* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Apple): Further discuss channel model for mTRP transmission in HST-SFN
* Recommended WF
  + Discuss along with issue 2-5-1.

## Companies views’ collection for 1st round

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Issue 2-1:  According to our evaluation, we don’t see performance benefit with mDCI-based transmission in HST-SFN scenario, compared with Rel-16 HST-SFN JT and DPS.  We support Option 1, not introduce PDCSH demodulation requirements for multi-DCI based transmission scheme for HST. |
| **CMCC** | **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**  We prefer option 2. More discussion/evaluation is necessary. Currently, companies’ evaluation is based on the fixed MCS. Considering that the performance of multi-DCI depends on the UE position along the railway, fixed MCS may be not suitable. It is proposed to consider the link adaptation approach, which, according to the agreed WF in last meeting, is agreed to be considered if benefits with fixed MCS will not be observed for multi-DCI Tx scheme comparing to other schemes  **Issue 2-2: Deployment Parameters**  We are OK with the recommended WF.  **Issue 2-3: Reference performance for comparison**  It is preferred to take both HST-SFN joint transmission and HST-DPS scheme as reference for evaluating.  **Issue 2-6: MCS**  We are OK with option 1. As we mentioned in issue 2-1, the performance of multi-DCI depends on the UE position along the railway, in this case, fixed MCS may be not suitable. It is proposed to consider the link adaptation approach, which, according to the agreed WF in last meeting, is agreed to be considered if benefits with fixed MCS will not be observed for multi-DCI Tx scheme comparing to other schemes.  **Issue 2-7: Evaluation Criteria**  Firstly, option 2 (SNR at 70% of max achievable throughput) could be one of the evaluation metrics. Except SNR at 70% of max achievable throughput, we think that option 1(different train locations and SNR points) also need to be considered, since the performance of multi-DCI depends on the UE position along the railway, e.g. the performance of mDCI at the middle point of two RRHs is better that when UE is near one RRH. |
| **Intel** | **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**  We do not observe any performance benefits with multi-DCI Tx scheme in HST scenario. Even with link adaption approach provided performance will be worse than with DPS Tx scheme. In DPS TX scheme we can allocate the all available resources with MCS 17 (as Rel-16 requirements). Same time with multi-DCI TX scheme only half of the resources will be scheduled with MCS 17 and remaining half with less MCS index that in results leads to less max provided throughput. Link adaptation approach can only confirm that multi-DCI Tx scheme can work in HST. There are not benefits of configuring this scheme for HST hence we do not believe it will be used in practice. Support option 1 to agree that no need to define performance requirements. |
| **Huawei, HiSilicon** | **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**  We prefer Option 1. If companies have strong view on multi-DCI based multi-TRP, we are OK to further evaluate whether there is any gain by using other metric.  **Issue 2-2: Deployment Parameters**  We are OK with Option 1.  **Issue 2-3: Reference performance for comparison**  We are OK with Option 1.  **Issue 2-4: PDSCHs allocations between different RRHs**  We are OK with Option 1.  **Issue 2-5: SNR definition**  We are OK with Option 1.  **Issue 2-6: MCS**  Same as Issue 2-1, if companies have strong view on multi-DCI based multi-TRP, we are OK to further evaluate whether there is any gain at other metric. But finally fixed MCS should be used for mTRP requirements definition as per agreements in last meeting if it is agreed to introduce mTRP requirements.  **Issue 2-7: Evaluation Criteria**  As companies’ evaluation, there is no benefit under all three candidate options for mTRP. Other evaluation metric should be considered if finally further evaluation will be conducted.  **Issue 2-8: Special slot configuration**  We are OK with Option 1.  **Issue 2-9: Channel model**  Channel model for mTRP should be further discussed to consider the factor for the ratio of power received from different TRP. But we prefer to discuss this issue later when we agree to define mTRP requirements. |
| **MediaTek** | **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**  We prefer Option 1. According to observations provided in our contribution and simulation results provided by other companies, we do not see the benefit of multi-DCI transmission scheme compared with HST-SFN and DPS under the scenario of HST. |
| **Apple** | **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**  Based on evaluation results from all companies, there is no performance benefit of introducing multi-DCI transmission in HST-SFN. We support option 1 and agree that no further evaluation is needed. If single tap channel with no varying SNR is considered, we might not even see any benefit of link adaptation. Also, we don’t believe a large delta in power levels between TRP is a suitable case for mTRP transmission. |
| **Qualcomm** | **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**  Support Option 1. Same view as Apple/MediaTek/Huawei/Intel/Ericsson. |

### CRs/TPs comments collection

## 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** |
| **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme** | * + Option 1 (Apple, Intel, Huawei, Ericsson, MTK, QC): Do not introduce requirements for multi-DCI based transmission scheme for HST   + Option 2 (CMCC): RAN4 need more discussion/study whether to define mDCI-based transmission in HST-SFN deployment scenario   Majority companies support option1, 1 company support option2 and think more evaluation is necessary. And 1 company is open to discuss if any gain is observed.  **Recommended WF for 2nd round:**  Companies please check whether following recommended WF is acceptable:  More evaluation is needed. Consider specifying PDSCH requirements for multi-DCI transmission scheme only if any performance benefit is observed. |
| **Issue 2-2: Deployment Parameters** | **Tentative Agreement:**  **Use following parameters for evaluation:**   * + - Set Ds=700m and Dmin=150m as baseline     - Take maximum Doppler frequency “870Hz for 15KHz SCS, 1667Hz for 30KHz SCS” as baseline |
| **Issue 2-3: Reference performance for comparison** | * + Option 1 (Qualcomm): Use HST-DPS scheme as reference for evaluating Multi-DCI scheme for FR1 HST.   + Option 2 (CMCC): take both HST-SFN joint transmission and HST-DPS scheme as reference for evaluating.   **Tentative Agreement:**  **Consider following reference performance for comparison**  **Option 1: mDCI-based transmission vs. HST-DPS**  **Option 2: mDCI-based transmission vs. HST-SFN joint transmission and HST-DPS** |
| **Issue 2-4: PDSCHs allocations between different RRHs** | **Tentative Agreement:**  Do not consider full overlapping or partially overlapping cases for multi-DCI based multi-TRP. |
| **Issue 2-5: SNR definition**  **Issue 2-6: MCS**  **Issue 2-7: Evaluation Criteria**  **Issue 2-8: Special slot configuration**  **Issue 2-9: Channel model** | **Not much feedback in 1st round, companies can continue to provide comments in 2nd round.**  **Recommended WF for 2nd round:**  **Further discuss these issues during 2nd round.** |

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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

**Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**

**Recommended WF:**

Companies please check whether following recommended WF is acceptable:

More evaluation is needed. Consider specifying PDSCH requirements for multi-DCI transmission scheme only if any performance benefit is observed.

**Issue 2-5: SNR definition**

* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Huawei): Use changed SNR for different time and different RRH for the non-overlapping case, if multi-DCI based multi-TRP requirements are defined.
* Recommended WF
  + More discussion is needed

**Issue 2-6: MCS**

* Agreements in RAN4#98e meeting:
  + MCS 13 and MCS 17 as baseline assumption for further evaluations
  + For mDCI-based transmission vs. HST-SFN joint transmission, use MCS13
  + For mDCI-based transmission vs. HST-DPS, use MCS 17
  + Note: which MCS is adopted depends on the outcome of the discussion on Reference performance for comparison
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (MTK): Fixed MCS simulation is not proper for performance evaluation and we may need further discussion about the performance evaluation method.
* Recommended WF
  + More discussion is needed

**Issue 2-7: Evaluation Criteria**

* Agreements in RAN4#98e meeting:
* Option 1: Max achievable throughput across all scheduled TB
  + Different train locations and SNR points should be analyzed
* Option 2: SNR at 70% @max achievable throughput
* Option 3: Max supported Doppler frequency
* Other options are not precluded
* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Qualcomm): Use SNR at 70% of max achievable throughput as evaluation metric for Multi-DCI scheme.
* Recommended WF
  + More discussion is needed

**Issue 2-8: Special slot configuration**

* Proposals in RAN4#98bis-e meeting:
  + Option 1 (Huawei): Do not scheduled PDSCH in ‘S’ slot, if multi-DCI based multi-TRP requirements are defined.
* Recommended WF
  + Can we agree with above option1?

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| MediaTek | **Issue 2-1: Whether to specify PDSCH requirements for multi-DCI transmission scheme**  We think multi-DCI transmission scheme is not suitable for the scenario of HST and share the same view with most companies that RAN4 do not need to define PDSCH requirement for multi-DCI transmission scheme.  For both evaluation options mentioned below, DPS will outperform multi-DCI transmission scheme as Intel mentioned in the first round comments.  **Issue 2-5: SNR definition and Issue 2-6: MCS**  We do not prefer to define PDSCH requirements for multi-DCI transmission scheme. However, we can provide our views for Issue 2-5 and 2-6.  For multi-DCI transmission with non-overlapping scheduling, the SNR of two TBs from two RRHs are varied along the track. Hence, we think it is necessary to consider the SNR variation to compare performance gain of multi-DCI transmission with HST-SFN and DPS. There could be two possible options for evaluation.   * Option 1: Vary the SNR according to the location of UE and fix the MCS along the track. * Option 2: Vary the SNR according to the location of UE and vary the MCS along the track.   For either option, we can compare the throughput of HST-SFN and DPS to multi-DCI transmission scheme at some location, e.g, middle of RRH or the location closed to RRH. We think option 2 is more realistic as the MCS should varied with operating SNR. However, option 1 is simpler as for option 2 we need to discuss how to determine the index of MCS along the track. At last, we would like to emphasize that the above mentioned options are used for evaluation of performance gain and we do think fixed MCS should be used for requirement definition.  **Issue 2-7: Evaluation Criteria**  We do not prefer to define PDSCH requirements for multi-DCI transmission scheme but we can agree to Option 1 if it is determined to specify PDSCH requirements for multi-DCI transmission scheme.  **Issue 2-8: Special slot configuration**  We do not prefer to define PDSCH requirements for multi-DCI transmission scheme but we can agree to Option 1 if it is determined to specify PDSCH requirements for multi-DCI transmission scheme. |

## Summary on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
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# Recommendations for Tdocs

## 1st round

**New tdocs**

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| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on FR1 HST demodulation | CMCC |  |
| Summary for FR1 HST demodulation results | Ericsson |  |

**Existing tdocs**

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| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2104946 | Updated work plan for enhancement for NR high speed train scenario in FR1  (demod part) | CMCC | The demod part of work plan R4-2104946 is agreeable. |  |