**3GPP TSG-RAN WG4 Meeting # 98-e R4-2103767**

**Electronic Meeting, Jan. 25-Feb. 5, 2021**

**Agenda item: 11.6.3**

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for [98e][328] NR\_HST\_FR1\_Demod

**Document for:** Information

# Introduction

This email discussion focuses on UE demodulation for Rel-17 NR HST, including agenda 11.6.3.1~11.6.3.3. Two topics are included in total, including PDSCH requirements for CA scenarios and enhanced transmission schemes.

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: PDSCH requirements for CA scenarios

*Agenda 11.6.3.2*

## Companies’ contributions summary

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| **TDoc** | **Title** | **Source** | **Proposals/ Observations** |
| [R4-2100858](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100858.zip) | General discussion on NR HST UE demodulation for FR1 CA scenario | CMCC | Proposal 1: for HST-SFN conditions, both HST-SFN joint transmission and DPS transmission are considered to support CA.  Proposal 2: both 2RX and 4RX are considered to support CA for HST.  Proposal 3: the CA combinations specified in Rel-16 WI on NR performance requirement enhancement can be reused for NR FR1 HST CA, the detailed CA combinations are:  • FDD 15 kHz + TDD 30 kHz CA  • FDD 15 kHz + TDD 15 kHz CA  • TDD 15 kHz + TDD 30 kHz CA  • FDD 15 kHz + FDD 15 kHz CA  • TDD 30 kHz + TDD 30 kHz CA  Proposal 4: to support HST CA, PDSCH requirements on single carrier of following bandwidth need to be specified:  • for 15KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50} MHz  • for 30KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 90, 100} MHz  Proposal 5: for CA scenario, reuse the modulation format and code rate adopted for PDSCH requirements specification in Rel-16 NR HST WI, the details are:  • for HST-SFN joint transmission, 16QAM, 0.48 is used  • for DPS, 64QAM, 0.43 is used |
| [R4-2101260](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101260.zip) | Views on NR HST CA PDSCH performance requirements | Intel Corporation | Proposal #1: For HST PDSCH CA tests use same framework for CA configuration selection as defined for normal PDSCH CA tests.  Proposal #2: Define HST PDSCH CA requirements only for the following CA duplex modes:  • FDD 15 kHz + FDD 15 kHz  • TDD 30 kHz + TDD 30 kHz  • FDD 15 kHz + TDD 30 kHz  Proposal #3: For HST PDSCH CA tests 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.  Proposal #4: Define HST PDSCH CA requirements for all supported in Rel-15 channel bandwidths.  Proposal #5: Make HST PDSCH CA requirements release independent from Rel-15.  Proposal #6: Define HST CA requirements only for HST-SFN JT and HST-SFN DPS with one active TCI state. Further discuss applicability rule to reduce the test efforts.  Proposal #7: Use same PDSCH, PDSCH DMRS, MCS, Rank, CSI-RS configurations, TDD pattern and channel model parameters for HST CA requirements as in corresponding single carrier requirements.  Proposal #8: Reuse HARQ process number and k1 values for HST CA requirements as in normal CA requirements.  Proposal #9: Use same applicability rule for Pcell configuration for HST CA requirements as in normal CA requirements. |
| [R4-2101308](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101308.zip) | Discussion on PDSCH CA scenarios for NR UE HST FR1 performance requirements | Huawei, HiSilicon | Proposal 1: Only define 500km/h performance requirements for CA.  − Reuse Maximum Doppler shift and corresponding configuration from Rel-16 HST-SFN requirements.  − Reuse SNR for FDD 10MHz/15kHz and TDD 40MHz/30kHz SCS and run simulation for other cases.  Proposal 2: Others parameters such as PUCCH format for HARQ-ACK feedback, number of HARQ process, K1 values for different CCs, and applicability rule for different CA configurations and bandwidth combination sets can be reused from NR Rel-16 normal CA.  Proposal 3: Define HST FR1 CA requirements based on the following simulation assumption.   |  |  | | --- | --- | | Parameter | Value | | Antenna configuration | 2x2; 2x4 | | DMRS type | type 1 | | Number of DMRS symbols | DMRS 1+1+1 | | TDD pattern | DDDSU, S: 10D+2G+2U for 15 kHz SCS;  7DS2U, S: 6D+4G+4U for 30 kHz SCS | | MCS | MCS 13 based on 64QAM table | | Propagation condition | HST-SFN | | TRS periodicity | 10 ms, 2 slot pattern | | PDSCH mapping | Type A, Start symbol 2, Duration 12 | | Ds and Dmin | Ds = 700m, Dmin = 150m | | Rank | Rank = 2 | | Bandwidth & SCS | 5, 10,15,20,30,40,50MHz for FDD and TDD 15 kHz SCS;  5, 10,15,20,30,40,50,60,70,80,90,100MHz for TDD 30 kHz SCS | | Maximum Doppler shift | 870 Hz for 15 kHz SCS; 1667 Hz for 30 kHz SCS | | Testing metric | SNR @ 70% of maximum throughput | |
| [R4-2101370](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101370.zip) | Views on HST CA tests for FR1 | NTT DOCOMO, INC. | Proposal 1: For FDD, consider at least FDD 15kHz  Proposal 2: For TDD, consider at least TDD 30kHz  Proposal 3: Target maximum Doppler frequency under HST-SFN scenario in the tests are as follows.  – For FDD 15kHz : 870Hz  – For TDD 30kHz : 1667Hz |
| [R4-2101439](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101439.zip) | PDSCH demodulation requirements for CA with HST-SFN scenario | Ericsson | Proposal 1: Define PDSCH CA demodulation requirements with HST-SFN scenario (joint transmission) with the combination of following component carriers:  • CBW=5, 10, 15, 20, 25, 30, 40, and 50MHz for FDD SCS=15kHz  • CBW=5, 10, 15, 20, 25, 30, 35, 40, 50, 60, 80, 90, and 100MHz for TDD SCS=30kHz  • RAN4 will discuss whether to define TDD SCS=15kHz or not.  Proposal 2: Apply the Rel-16 HST-SFN channel model parameters to PDSCH CA demodulation requirements with HST-SFN:   |  |  |  | | --- | --- | --- | | Parameters | SCS=15kHz | SCS=30kHz | | **Ds (inter-RRH distance)** | **700 m** | **700 m** | | **Dmin (distance between RRH and UE)** | **150 m** | **150 m** | | **v (UE velocity)** | **500 km/h** | **500 km/h** | | **fd (maximum Doppler shift)** | **870 Hz** | **1667 Hz** |   Proposal 3: Reuse the test setup of Rel-16 single carrier HST-SFN requirements for CA scenario.  • Antenna configuration: 2x2 and 2x4  • MCS: 13 (64QAM table)  • Rank 2  • DMRS Type 1 and 2 additional DM-RS symbols  • For TDD, use TDD pattern of 7D1S2U with S=6DL:4GP:4UL  o No PDSCH data transmission in the special slots  • TRS periodicity: 10ms  Proposal 4: Introduce new UE capability of demodulationEnhancement for SCell.  Proposal 5: Introduce new network-assisted signalling highSpeedDemodFlag to inform HST-SFN deployment for SCell. |

## Open issues summary

### Test parameters for CA scenario

**Issue 1-1-1: Target speed**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Huawei):* Only define 500km/h performance requirements for CA.
* ***Reuse Maximum Doppler shift and corresponding configuration from Rel-16 HST-SFN requirements.(*** ***870 Hz for 15 kHz SCS; 1667 Hz for 30 kHz SCS)***
* ***Reuse SNR for FDD 10MHz/15kHz and TDD 40MHz/30kHz SCS and run simulation for other cases.***
  + *Option 2 (DOCOMO, Ericsson, Intel):* Target maximum Doppler frequency under HST-SFN scenario in the tests are as follows.
* ***For FDD 15kHz : 870Hz***
* ***For TDD 30kHz : 1667Hz***
* Recommended WF
  + Can we agree with the following recommended WF?
    - Reuse Maximum Doppler shift and corresponding configuration from Rel-16 HST-SFN requirements.( 870 Hz for 15 kHz SCS; 1667 Hz for 30 kHz SCS)
    - Reuse SNR for FDD 10MHz/15kHz and TDD 40MHz/30kHz SCS and run simulation for other cases.

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

* Proposals in RAN4#98e meeting:
  + *Option 1 (CMCC): for HST-SFN conditions, both HST-SFN joint transmission and DPS transmission need to be considered to support CA*
  + *Option 2 (Intel):* *Define HST CA requirements only for HST-SFN JT and HST-SFN DPS with one active TCI state. Further discuss applicability rule to reduce the test efforts.*
  + *Option 3 (Ericsson): Define PDSCH CA demodulation requirements with HST-SFN scenario (joint transmission).*
* Recommended WF
  + Define HST CA requirements for HST-SFN joint transmission
  + Define HST CA requirements for HST-SFN DPS with one active TCI state.
  + Further discuss on how to define CA requirements for HST-SFN DPS with two active TCI states
  + Further discuss on the applicability rule.

**Issue 1-1-3: Antenna configurations**

* Proposals in RAN4#98e meeting:
  + *Option 1 (CMCC, Huawei, Ericsson): 2x2 and 2x4*
* Recommended WF
  + Can we agree with the following recommended WF?
    - Antenna configuration: 2x2 and 2x4

**Issue 1-1-4: SCS configurations**

* Proposals in RAN4#98e meeting:
  + *Option 1 (CMCC): Same as Rel-16 CA normal demodulation*
* ***FDD 15 kHz + TDD 30 kHz CA***
* ***FDD 15 kHz + TDD 15 kHz CA***
* ***TDD 15 kHz + TDD 30 kHz CA***
* ***FDD 15 kHz + FDD 15 kHz CA***
* ***TDD 30 kHz + TDD 30 kHz CA***
  + *Option 2 (Intel): Same as Rel-16 CA CQI*
* FDD 15 kHz + FDD 15 kHz
* TDD 30 kHz + TDD 30 kHz
* FDD 15 kHz + TDD 30 kHz
  + *Option 3 (Ericsson): RAN4 will discuss whether to define TDD SCS=15kHz or not.*
* Recommended WF
  + 3 companies discuss this issue. 1 company propose to keep the same configuration as Rel-16 CA normal demodulation (option 1), 1 company propose to keep the same configuration as Rel-16 CA CQI test (Option 2). More discussion is needed.

**Issue 1-1-5: Bandwidth combination configurations**

* Proposals in RAN4#98e meeting:
  + *Option 1 (CMCC, Huawei, Intel, Ericsson):*
* ***for 15KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50} MHz***
* ***for 30KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 90, 100} MHz***
* Recommended WF
  + Can we agree with the following bandwidth combination configurations for CA HST-SFN?
    - for 15KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50} MHz
    - for 30KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 90, 100} MHz

**Issue 1-1-6: HARQ process**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel, Huawei):*
* ***Reuse HARQ process number and k1 values for HST CA requirements as in normal CA requirements.***
* Recommended WF
  + Can we agree to reuse HARQ process number and k1 values for HST CA requirements as in normal CA requirements?

**Issue 1-1-7: MCS and Rank, and other test setup**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel, Huawei, Ericsson, CMCC):*
* ***Use same PDSCH, PDSCH DMRS, MCS, Rank, CSI-RS configurations, TDD pattern and channel model parameters for HST CA requirements as in corresponding single carrier requirements.***
* Recommended WF
  + Use the following test setup as the baseline for further discussion

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| --- | --- |
| Parameter | Value |
| DMRS type | type 1 |
| Number of DMRS symbols | DMRS 1+1+1 |
| TDD pattern | DDDSU, S: 10D+2G+2U for 15 kHz SCS;  7DS2U, S: 6D+4G+4U for 30 kHz SCS |
| MCS | For JT: MCS 13 based on 64QAM table  For DPS:MCS 17 based on 64QAM table |
| TRS periodicity | 10 ms, 2 slot pattern |
| PDSCH mapping | Type A, Start symbol 2, Duration 12 |
| Ds and Dmin | Ds = 700m, Dmin = 150m |
| Rank | Rank = 2 |
| Testing metric | SNR @ 70% of maximum throughput |

### Applicabiliy rule

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

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel): For HST PDSCH CA tests 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.*
* Recommended WF
  + This issue is related to the SCS configurations for CA. Suggest to discuss later when we reach agreements on the SCS configurations

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

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel, Huawei): Use same applicability rule for Pcell configuration for HST CA requirements as in normal CA requirements.*
* Recommended WF
  + Can we agree with the following recommended WF?
    - Use same applicability rule for Pcell configuration for HST CA requirements as in normal CA requirements.

### Release independent

**Issue 1-3-1: release independent**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel): Make HST PDSCH CA requirements release independent from Rel-15.*
* Recommended WF
  + HST SFN single carrier requirements are release independent from Rel-15 as well as normal PDSCH CA requirements. Can we agree with HST PDSCH CA requirements are release independent from Rel-15?

### UE capability and network-assisted signalling

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

* Proposals in RAN4#98e meeting:
  + *Option 1 (Ericsson): UE capability and network assisted signalling defined in Rel-16 are only applicable for NR Pcell or NR PScell. UE needs additional capability to support the advanced receiver for HST-SFN joint transmission in SCell .*
    - *Introduce new UE capability of demodulationEnhancement for SCell.*
    - *Introduce new network-assisted signalling highSpeedDemodFlag to inform HST-SFN deployment for SCell.*
* Recommended WF
  + More discussion is needed

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| **CMCC** | **Issue 1-1-1: Target speed**  We support the recommended WF. According to the WID, the CA requirements will be specified for HST-SFN conditions, and the same target speed is up to 500km/h, the carrier frequency is up to 3.6 GHz, which is the same as Rel-16 NR HST. Based on this, it is OK to reuse the maximum doppler shift from Rel-16 HST-SFN requirements.  **Issue 1-1-2: Transmission schemes**  Option 1, both HST-SFN joint transmission and DPS transmission (DPS 1a and DPS 1b) are considered to support CA. According to the WID, HST-SFN conditions are considered to support CA for high speed train scenario. In Rel-16 NR HST WI, both HST-SFN joint transmission and DPS transmission (DPS 1a and DPS 1b) are considered for HST-SFN conditions, since both of them are important deployment for high speed train scenario. Base on above consideration, both HST-SFN joint transmission and DPS transmission (DPS 1a and DPS 1b) need to be considered to support CA.  **Issue 1-1-3: Antenna configurations**  We are OK with the recommended WF  **Issue 1-1-4: SCS configurations**  Option 1. Based on the agreements in Rel-16 WI on NR performance requirement enhancement, for FR1 NR CA, PDSCH requirements are specified for 5 cases includes FDD 15 kHz + TDD 30 kHz CA, FDD 15 kHz + TDD 15 kHz CA, TDD 15 kHz + TDD 30 kHz CA, FDD 15 kHz + FDD 15 kHz CA, TDD 30 kHz + TDD 30 kHz CA. considering different operator may have different deployment, all of these combinations is suggested to be reused for NR FR1 HST CA.  **Issue 1-1-5: Bandwidth combination configurations**  We are OK with the recommended WF  **Issue 1-1-7: MCS and Rank, and other test setup**  We are OK with the recommended WF  **Issue 1-3-1: release independent**  We support the recommended WF, HST PDSCH CA requirements are release independent from Rel-15.  **Issue 1-4-1: UE capability and network-assisted signalling**  Rel-16 HST WI focus on NR Pcell or NR PScell, accordingly, the related UE capability and network-assisted signalling are applied for NR Pcell or NR PScell. To support CA in HST, new UE capability and network-assisted signalling may be needed. |
| **Ericsson** | **Issue 1-1-1: Target speed**  Support the recommended WF.  **Issue 1-1-2: Transmission schemes**  In our understanding, ‘PDSCH demodulation requirements for HST-SFN conditions’ in WI means ‘joint transmission’ as it is specified in TS38.101-4 V16.4.0 5.2.2.1.9/5.2.2.2.9; HST-DPS is another transmission scheme which uses SFN deployment scenario.  So we prefer option 3: This WI only consider PDSCH CA demodulation requirements with HST-SFN scenario with joint transmission.  **Issue 1-1-3: Antenna configurations**  Support the recommended WF.  **Issue 1-1-4: SCS configurations**  We support option 2.  In Rel-16 PDSCH CA, RAN4 has already defined the PDSCH CA with TDD SCS=15kHz. We don’t think it is necessary to include TDD SCS=15kHz for HST-SFN.  **Issue 1-1-5: Bandwidth combination configurations**  Support the recommended WF.  **Issue 1-1-6: HARQ process**  Support the recommended WF.  **Issue 1-1-7: MCS and Rank, and other test setup**  Support the recommended WF.  **Issue 1-2-1: Applicability rule for SCS configuration**  Agree this can be discussed later.  **Issue 1-2-2: Applicability rule for PCell configuration**  Support the recommended WF.  **Issue 1-3-1: release independent**  We suggest RAN4 come back after RAN4 agree with the scope of this WI.  **Issue 1-4-1: UE capability and network-assisted signalling**  We are fine RAN4 come back after RAN4 agree with the scope of this WI. |
| **ZTE** | **Issue 1-1-1: Target speed**  We agree with the Recommended WF  **Issue 1-1-2: Transmission schemes & Issue 1-1-3: Antenna configurations**  We agree with the Recommended WF  ~~In our understanding, in SFN and DPS scenarios with 2Tx and Rank 2, there is only one PDSCH scheduled by one DCI for transmission, so it takes up all Tx for the transmission of the PDSCH. We want to specify the CA in HST to increase the throughput, but it`s only one CC used in CA transmission in SFN and DPS at the same time because of the configuration of antenna and Rank, which could not be our expectation.~~  ~~We could further discuss to redefined the configuration of Tx and Rank to support two or more CC transmitted in SFN and DPS.~~  @Intel We have some error understanding on configuration of RRH for CA before reading your comments. We revised our comments and thank you for your clarification.  **We agree with the Recommended WF**  **Issue 1-1-4: SCS configurations**  We support option 1 in principle but the workload could be reduced if TDD = 15Khz is not defined.  **Issue 1-1-5: Bandwidth combination configurations**  We agree with the Recommended WF  **Issue 1-1-7: MCS and Rank, and other test setup**  We agree with the Recommended WF but the Rank could be further discussed.  **Issue 1-2-2: Applicability rule for PCell configuration**  We agree with the Recommended WF |
| **Huawei, HiSilicon** | **Issue 1-1-1: Target speed**  Agree with the recommended WF  **Issue 1-1-2: Transmission schemes**  We have the same understanding about the HST-SFN with Ericsson based on the discussion in NR Rel-16 FR1 HST and LTE HST-SFN, it is totally different transmission for HST-SFN and DPS. So we prefer Option 3.  **Issue 1-1-3: Antenna configurations**  Agree with the recommended WF  **Issue 1-1-4: SCS configurations**  We are also OK with Option 2 considering that only FDD 15kHz and TDD 30kHz are defined in Rel-16 FR1 HST and the typical NR real deployment scenarios.  **Issue 1-1-5: Bandwidth combination configurations**  Agree with the recommended WF  **Issue 1-1-6: HARQ process**  Agree with the recommended WF  **Issue 1-1-7: MCS and Rank, and other test step**  Agree with the recommended WF  **Issue 1-2-1: Applicability rule for SCS configuration**  Agree with the recommended WF  **Issue 1-2-2: Applicability rule for PCell configuration**  Agree with the recommended WF  **Issue 1-3-1: release independent**  For release independent, it is not clear whether there is any influence on demodulation/RRM part at the current stage, we prefer to discuss this issue later.  **Issue 1-4-1: UE capability and network-assisted signalling**  For UE capability, as per TS 36.306, there is only two field related to demodulation in HST scenario, no additional UE capability defined to support LTE HST-SFN CA scenario for demodulation requirements:   |  | | --- | | *4.3.33.2 demodulationEnhancements-r14*  *This field defines whether the UE supports advanced receiver in SFN scenario as specified in TS 36.101 [6].*  *4.3.33.5 demodulationEnhancements2-r16*  *This field defines whether the UE supports further enhanced demodulation requirements to support 500km/h velocity in HST-SFN scenario as specified in TS 36.101 [6]. A UE indicating support of demodulationEnhancements2-r16 shall also indicate support of demodulationEnhancements-r14.* |   For Rel-16 NR HST, network-assisted signalling is defined that “*ServingCellConfigCommon*->*highSpeedConfig-r16*->*highSpeedDemodFlag-r16*” that is applicable for both PCell and SCell. For our understanding, the Rel-16 defined signalling already cover the scenario for CA without any new signalling to be introduced.  Therefore, we don’t think it is necessary to introduce any new UE capability or new network-assisted signalling from demodulation performance requirements point of view. |
| **Qualcomm** | **Issue 1-1-1: Target speed**  Ok with recommended WF.  **Issue 1-1-2: Transmission schemes**  As far as we understand, the WID’s scope is limited to HST-SFN conditions which is just HST-SFN JT scheme. Also, HST-SFN is the toughest scheme for HST. So, we prefer to only define the requirements for HST-SFN JT scheme.  **Issue 1-1-3: Antenna configurations**  Ok with recommended WF.  **Issue 1-1-4: SCS configurations**  We prefer option 2. There is no need to define CA requirements for all possible combinations.  **Issue 1-1-5: Bandwidth combination configurations**  Ok with recommended WF.  **Issue 1-1-6: HARQ process**  Ok with recommended WF.  **Issue 1-1-7: MCS and Rank, and other test setup**  Ok with recommended WF. As a reminder, we would also like to add 1dB margin to all CA requirements for HST-SFN JT similar to single carrier requirements.  **Issue 1-2-1: Applicability rule for SCS configuration**  Prefer Option 1.  **Issue 1-2-2: Applicability rule for PCell configuration**  Ok with recommended WF.  **Issue 1-3-1: release independent**  Prefer to discuss this once CA requirements are clear.  **Issue 1-4-1: UE capability and network-assisted signalling**  As far as we understood the signalling and UE capability in RAN2 spec, it is generic to whether it is PCell or SCell. So, we don’t think that new capability/signalling is needed for CA. |
| **Intel** | **Issue 1-1-1: Target speed**  Support the recommended WF.  **Issue 1-1-2: Transmission schemes**  We support recommended WF. HST-SFN is a deployment scenario when several RRHs share same cell Id. For this scenario we define two set of requirements: with Joint Tx and with DPS Tx scheme. Both of them can be configured in HST-SFN deployment and we should ensure proper CA performance for both of them.  Also, we suggest using only DPS Tx scheme with 1 active TCI state for CA requirements definition. If UE support more than 1 it will be tested in single carrier with 2 TCI states and with CA DPS with 1 TCI state which is enough from performance verification point of view.  **Issue 1-1-3: Antenna configurations**  Can ZTE explain what is the difference between Normal CA and HST CA test procedures considering that in Normal CA a 2x2 antenna configuration with Rank 2 is used?  **Issue 1-1-4: SCS configurations**  After HST CA requirements introduction UE will need to pass both Normal CA and HST CA requirements. From HST demodulation processing there is no difference between different CA duplex modes. In this case we can make prioritization and reduce test efforts. Option 2 captures the most typical configurations which are used in Rel-15/16 UE requirements. Support Option 2.  **Issue 1-1-5: Bandwidth combination configurations**  Support the recommended WF.  **Issue 1-1-7: MCS and Rank, and other test setup**  Support the recommended WF.  **Issue 1-2-2: Applicability rule for PCell configuration**  Support the recommended WF.  **Issue 1-3-1: release independent**  Agree to discuss this later.  **Issue 1-4-1: UE capability and network-assisted signalling**  According to 38.331 IE ServingCellConfigCommon contains highSpeedConfig-r16. In this case we have network assisted signalling for Scell also.  Specific HST CA capability is also not needed since there should be no differentiation between HST CA and HST single carrier from specific to HST receive algorithm implementation. |
| **docomo** | **Issue 1-1-1: Target speed**  **We support the recommended WF**  **Issue 1-1-2: Transmission schemes**  **We support the recommended WF. Same time, we understand that it may be necessary to discuss whether to include DPS in this WID.**  **Issue 1-1-3: Antenna configurations**  **We support the recommended WF**  **Issue 1-1-5: Bandwidth combination configurations**  **We support the recommended WF**  **Issue 1-1-6: HARQ process**  **We support the recommended WF**  **Issue 1-1-7: MCS and Rank, and other test setup**  **We support the recommended WF**  **Issue 1-2-1: Applicability rule for SCS configuration**  **We support the recommended WF**  **Issue 1-2-2: Applicability rule for PCell configuration**  **We support the recommended WF**  **Issue 1-3-1: release independent**  **We support the recommended WF** |
| **Apple** | **Issue 1-1-1: Target speed**  We support the recommended WF.  **Issue 1-1-2: Transmission schemes**  Option 3: We support to define requirements with CA for HST-SFN for joint transmission scheme alone. Based on the WID, the objective is to define requirements in CA for HST-SFN JT scheme. We don’t support introducing requirements for DPS transmission scheme in CA.  **Issue 1-1-3: Antenna configurations**  We support the recommended WF.  **Issue 1-1-4: SCS configurations**  Option 2: It covers the typical Rel15 configurations used. We don’t see the necessity to introduce tests for all combinations introduced for PDSCH CA requirements.  **Issue 1-1-5: Bandwidth combination configurations**  We support the recommended WF.  **Issue 1-1-6: HARQ process**  We support the recommended WF.  **Issue 1-1-7: MCS and Rank, and other test setup**  We support the recommended WF. The table needs to be revised based on the agreed transmission schemes and SCS configurations.  **Issue 1-2-1: Applicability rule for SCS configuration**  We support the recommended WF.  **Issue 1-2-2: Applicability rule for PCell configuration**  We support the recommended WF.  **Issue 1-3-1: release independent**  We recommend to postpone discussion on release independence to when some testcases are agreed upon/ defined. |

### 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 1-1-1: Target speed** | 8 companies discuss this issue and agree with the recommended WF. So moderator propose the following agreements.  **Tentative Agreement:**  **** Reuse Maximum Doppler shift and corresponding configuration from Rel-16 HST-SFN requirements.( 870 Hz for 15 kHz SCS; 1667 Hz for 30 kHz SCS)   Reuse SNR for FDD 10MHz/15kHz and TDD 40MHz/30kHz SCS and run simulation for other cases. |
| **Issue 1-1-2: Transmission schemes** | 8 companies discuss this issue, 1 company support option1, 3 companies support option2, and 4 companies support option3.  o Option 1 (CMCC): for HST-SFN conditions, both HST-SFN joint transmission and DPS transmission need to be considered to support CA  o Option 2 (Intel, ZTE, DOCOMO): Define HST CA requirements only for HST-SFN JT and HST-SFN DPS with one active TCI state. Further discuss applicability rule to reduce the test efforts.  o Option 3 (Ericsson, Huawei, Qualcomm, Apple): Define PDSCH CA demodulation requirements with HST-SFN scenario (joint transmission).  Companies seem have different views on the WID scope regarding the following objective. Whether DPS is included in the HST-SFN conditions.  ***“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 conditions.”***  **Tentative Agreement:**  **Define HST CA requirements for HST-SFN joint transmission**  **Recommended WF for 2nd round:**  Since there is different understanding on the WID scope. Moderator suggests focusing on the technical discussion on whether to define HST CA requirements for HST-SFN DPS transmission scheme (with one active TCI state and/or two active TCI states).  If consensus is reached, WID modification may be needed to clarify the scope. |
| **Issue 1-1-3: Antenna configurations** | All companies agree with the recommended WF. Moderator suggests the following agreement.  **Tentative Agreement:**   Antenna configuration: 2x2 and 2x4 |
| **Issue 1-1-4: SCS configurations** | 7 companies discuss this issue, 2 support option 1 and 5 support option 2. The main difference is whether to define TDD 15KHz related SCS combination.  o Option 1 (CMCC, ZTE): Same as Rel-16 CA normal demodulation  • FDD 15 kHz + TDD 30 kHz CA  • FDD 15 kHz + TDD 15 kHz CA  • TDD 15 kHz + TDD 30 kHz CA  • FDD 15 kHz + FDD 15 kHz CA  • TDD 30 kHz + TDD 30 kHz CA  o Option 2 (Intel, Ericsson, Huawei, Qualcomm, Apple): Same as Rel-16 CA CQI  • FDD 15 kHz + FDD 15 kHz  • TDD 30 kHz + TDD 30 kHz  • FDD 15 kHz + TDD 30 kHz  **Recommended WF for 2nd round:**  Continue to discuss the above two options in 2nd round. Proponents of option 1 are encouraged to provide justification and necessity to define TDD 15KHz for HST CA scenario. |
| **Issue 1-1-5: Bandwidth combination configurations** | All companies agree with the recommended WF. Moderator suggests the following agreements:  **Tentative Agreement:**   for 15KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50} MHz   for 30KHz SCS, specify PDSCH requirements on single carrier of BW of {5, 10, 15, 20, 25, 30, 40, 50, 60, 80, 90, 100} MHz |
| **Issue 1-1-6: HARQ process** | 6 companies discuss this issue and agree with the recommended WF. Moderator suggests the following agreements:  **Tentative Agreement:**  • Reuse HARQ process number and k1 values for HST CA requirements as in normal CA requirements. |
| **Issue 1-1-7: MCS and Rank, and other test setup** | 7 companies discuss this issue and agree to use the recommended WF as baseline. 1 company comment that rank can be further discussed, 1 company comment that the table may need to be revised based on the agreed transmission schemes and SCS configurations. And 1 company propose to add 1 dB margin to all CA requirements for HST-SFN JT similar to single carrier requirements.  Moderator suggests following agreements:  **Tentative Agreement:**  Use the following test setup as the baseline. Rank can be further discussed. Some revision may be needed according to the agreed transmission schemes and SCS configurations.   |  |  | | --- | --- | | Parameter | Value | | DMRS type | type 1 | | Number of DMRS symbols | DMRS 1+1+1 | | TDD pattern | DDDSU, S: 10D+2G+2U for 15 kHz SCS;  7DS2U, S: 6D+4G+4U for 30 kHz SCS | | MCS | For JT: MCS 13 based on 64QAM table  For DPS:MCS 17 based on 64QAM table | | TRS periodicity | 10 ms, 2 slot pattern | | PDSCH mapping | Type A, Start symbol 2, Duration 12 | | Ds and Dmin | Ds = 700m, Dmin = 150m | | Rank | Rank = 2 (can be further discussed) | | Testing metric | SNR @ 70% of maximum throughput |   **Recommended WF for 2nd round:**  Further discuss the following proposal in 2nd round:  Add 1 dB margin to all CA requirements for HST-SFN JT similar to single carrier requirements. |
| **Issue 1-2-1: Applicability rule for SCS configuration** | **Tentative Agreement:**  o This issue is related to the SCS configurations for CA. Discuss later when we reach agreements on the SCS configurations |
| **Issue 1-2-2: Applicability rule for PCell configuration** | All companies agree with the recommended WF. Moderator suggests the following agreements.  **Tentative Agreement:**   Use same applicability rule for Pcell configuration for HST CA requirements as in normal CA requirements. |
| **Issue 1-3-1: release independent** | 7 companies discuss this use, 2 companies support to HST PDSCH CA requirements are release independent from Rel-15. 5 companies propose to discuss this issue later.  **Tentative Agreement:**  o Postpone the release independent discussion |
| **Issue 1-4-1: UE capability and network-assisted signalling** | 3 companies commented that existing RAN2 signalling are generic to whether it is PCell or SCell, so no new capability/signalling is needed for CA.  **Recommended WF for 2nd round:**  Companies please further check whether existing HST network assisted signaling and UE capability can cover CA scenario. |

*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 |

## Discussion on 2nd round (if applicable)

### Open issues summary

### 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** |
|  |  |

# Topic #2: Enhanced transmisison schemes

*Agenda 11.6.3.3*

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **TDoc** | **Title** | **Source** | **Proposals/ Observations** |
| [**R4-2100859**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100859.zip) | Discussion on NR HST UE demodulation for enhanced transmission scheme | CMCC | Observation 1: transmission scheme 2 will improve the throughput, and it is possible deployment for the high speed train scenario.  Observation 2: The PDSCH demodulation requirements specified in Rel-16 eMIMO WI cannot be applied to high speed scenario.  Proposal 1: It is necessary to specify the PDSCH requirements for transmission scheme 2 in HST scenario to guarantee the performance. |
| [**R4-2101261**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101261.zip) | Views on NR HST PDSCH performance requirements for multi-DCI based Tx scheme | Intel Corporation | Proposal 1: Discuss simulation assumption and methodology to analyse performance benefits of multi-DCI based Tx scheme in application to HST multi-RRH deployment.  Proposal 2: Adopt HST-SFN propagation conditions (Doppler, delay, power profiles) as independent channel models to explicitly model multi-RRH Tx.  Proposal 3: Use same HST-SFN channel model parameters as used for Rel-16 HST requirements for multi-DCI Tx scheme analysis: Ds = 700m; Dmin=150m; max Doppler frequency 870 Hz and 1667 Hz for 15 kHz and 30 kHz SCS respectively.  Proposal 4: Single FFT operation should be assumed as baseline UE implementation  Observation 1: In Rel-16 multi-TRP performance requirements SSB is transmitted only from one TRP and ideal time synchronization between transmission points is assumed.  Proposal 5: Non-ideal synchronization between RRHs should be considered as a baseline assumption  Proposal 6: Consider JT and DPS Tx schemes as a reference performance for comparison  Proposal 7: Consider overlapped and non-overlapped PDSCHs allocations between different RRHs.  Proposal 8: Consider MCS 4, 13 and 17 as a baseline assumption for further evaluations.  Observation 2: In HST-SFN scenario with multi-DCI based Tx scheme large demodulation performance degradation is observed between codewords transmitted from different RRHs. For all considered MCS values performance gap is not less than 10 dB at 70% @ max throughput.  Observation 3: Performance analysis of multi-DCI based Tx scheme in HST deployments may not reflect real performance if fixed MCS Tx is assumed.  Proposal 9: Bring performance results collecting at different train positions:  1. Near the one RRH  2. In the middle region between RRHs  3. On the half of the track |
| [**R4-2101309**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101309.zip) | Discussion on enhanced transmission schemes for NR HST demodulation | Huawei, HiSilicon | Proposal 1: To determine whether to specify the PDSCH requirements for NC-JT, RAN4 evaluate performance difference between NC-JT and DPS with the following assumption.  Proposal 2: C-JT requirements, the following test setup can be considered.  − For UE support 2 active TCI, MAC-CE based TCI switching, interruption exists  − Two RRHs of RRH#(2k) and RRH#(2k+1) are assumed, and SSB#(k mod 2) is transmitted from TRP#(2k), where k=0,1, 2, …  − UE is configured with TCI#(2k mod 4) and TCI#((2k+1) mod 4) that are associated with TRS#(2k mod 4) and TRS#((2k+1) mod 4) 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)  − At slot#(k\*n), TE actives TCI#(k mod 4) and TCI#(k+1 mod 4) for PDCCH with coresetPoolIndex#(k mod 2) and coresetPoolIndex#(k+1 mod 2) transmitted from RRH#(k) and RRH#(k+1) by “TCI State Indication for UE-specific PDCCH MAC CE” command with the field of CORESET ID set to 0 and 1 respectively, where n is the number of slots between two RRH  − PDSCH associated with TCI #(k mod 4) is transmitted from RRH#(k mod 4) in slot from max((k-1)n + 1 + HARQ needed time + 3ms + first TRS + TRS processing time, 0) to (k+1)n + HARQ needed time + 3ms.  − For UE supports more than 2 active TCI, MAC-CE based TCI switching, no interruption exists  − Two RRHs of RRH#(2k) and RRH#(2k+1) are assumed, and SSB#(k mod 2) is transmitted from TRP#(2k), where k=0,1, 2, …  − UE is configured with TCI#(2k mod 4) and TCI#((2k+1) mod 4) that are associated with TRS#(2k mod 4) and TRS#((2k+1) mod 4) 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)  − At slot#(k\*n), TE activates TCI#(k mod 4), TCI#(k+1 mod 4) and TCI#(k+2 mod 4) for PDSCH at the same time by “TCI States Activation/Deactivation for UE-specific PDSCH MAC CE” and actives TCI#(k mod 4) and TCI#(k+1 mod 4) for PDCCH with coresetPoolIndex#(k mod 2) and coresetPoolIndex#(k+1 mod 2) transmitted from RRH#(k) and RRH#(k+1) by “TCI State Indication for UE-specific PDCCH MAC CE” command with the field of CORESET ID set to 0 and 1 respectively, where n is the number of slots between two RRH;  − PDSCH associated with TCI #(k mod 4) is transmitted from RRH#(k mod 4) in slot from max((k-1)n + 1 + HARQ needed time + 3ms + first TRS + TRS processing time, 0) to (k+1)n + HARQ needed time + 3ms. |
| [**R4-2101440**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101440.zip) | PDSCH demodulation requirements with enhanced transmission schemes in HST scenario | Ericsson | Proposal 1: Define multi-DCI PDSCH transmission requirement with HST-SFN deployment scenario. |

## Open issues summary

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

* Proposals in RAN4#98e meeting:
  + *Option 1 (CMCC, Ericsson): Specify the PDSCH requirements for transmission scheme 2 in HST scenario to guarantee the performance.*
  + *Option 3 (Huawei): To determine whether to specify the PDSCH requirements for NC-JT, RAN4 evaluate performance difference between NC-JT and DPS with the following assumption.*
* Recommended WF
  + It seems that more evaluation is needed before we make the decision. More discussion is needed

**Issue 2-2: Channel model**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel):* 
    - *Adopt HST-SFN propagation conditions (Doppler, delay, power profiles) as independent channel models to explicitly model multi-RRH Tx.*
    - *Use same HST-SFN channel model parameters as used for Rel-16 HST requirements for multi-DCI Tx scheme analysis: Ds = 700m; Dmin=150m; max Doppler frequency 870 Hz and 1667 Hz for 15 kHz and 30 kHz SCS respectively.*
  + *Option 2 (Ericsson, Huawei): reuse the HST-SFN channel model (TS38.101-4 B.3.2) and parameters for multi-DCI based PDSCH transmission requirements, where the number of visible RRHs are 2.*

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| --- | --- | --- |
| Parameters | SCS=15kHz | SCS=30kHz |
| Ds (inter-RRH distance) | 700 m | 700 m |
| Dmin (distance between RRH and UE) | 150 m | 150 m |
| v (UE velocity) | 500 km/h | 500 km/h |
| fd (maximum Doppler shift) | 870 Hz | 1667 Hz |

* Recommended WF
  + Ds=700m, Dmin=150m, max Doppler frequency: 870Hz for 15KHz, 1667Hz for 30KHz
  + More discussion is needed on the channel model

**Issue 2-3: Time/frequency errors and assumptions on UE synchronization**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel):* 
    - *Single FFT operation should be assumed as baseline UE implementation.*
    - *Non-ideal synchronization between RRHs should be considered as a baseline assumption.*
* Recommended WF
  + More discussion is needed

**Issue 2-4: Reference performance for comparison**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel): Consider JT and DPS Tx schemes as a reference performance for comparison.*
  + *Option 2 (Huawei): RAN4* evaluate performance difference between NC-JT and DPS.
* Recommended WF
  + More discussion is needed.

**Issue 2-5: PDSCHs allocations between different RRHs**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel): Consider overlapped and non-overlapped PDSCHs allocations between different RRHs*
  + *Option 2 (Ericsson, Huawei): 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.*
* Recommended WF
  + More discussion is needed

**Issue 2-6: MCS**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel): Consider MCS 4, 13 and 17 as a baseline assumption for further evaluations.*
  + *Option 2 (Ericsson, Huawei): MCS: 17 (64QAM table)*
* Recommended WF
  + More discussion is needed

**Issue 2-7: Other parameters**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel, Huawei):* 
    - *Antenna configuration: 2x2 and 2x4*
    - *Rank 2*
      * *DMRS ports 1000/1001 from TRP #(2i)*
      * *DMRS ports 1002/1003 from TRP #(2i+1)*
    - *DMRS Type 1 and 2 additional DM-RS symbols*
    - *For TDD, use TDD pattern of 7D1S2U with S=6DL:4GP:4UL*
      * *No PDSCH data transmission in the special slots*
    - *TRS periodicity: 10ms*
* Recommended WF
  + More discussion is needed

**Issue 2-8: Link adaptation and statistic calculation**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Intel): Bring performance results collecting at different train positions:*

*1. Near the one RRH*

*2. In the middle region between RRHs*

*3. On the half of the track*

* Recommended WF
  + More discussion is needed

**Issue 2-9: Test setup for transmission scheme 2**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Huawei): If RAN4 agree to define NC-JT requirements, the following test setup can be considered.*
    - *For UE support 2 active TCI, MAC-CE based TCI switching, interruption exists*
      * *Two RRHs of RRH#(2k) and RRH#(2k+1) are assumed, and SSB#(k mod 2) is transmitted from TRP#(2k), where k=0,1, 2, …*
      * *UE is configured with TCI#(2k mod 4) and TCI#((2k+1) mod 4) that are associated with TRS#(2k mod 4) and TRS#((2k+1) mod 4) 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)*
      * *At slot#(k\*n), TE actives TCI#(k mod 4) and TCI#(k+1 mod 4) for PDCCH with coresetPoolIndex#(k mod 2) and coresetPoolIndex#(k+1 mod 2) transmitted from RRH#(k) and RRH#(k+1) by “TCI State Indication for UE-specific PDCCH MAC CE” command with the field of CORESET ID set to 0 and 1 respectively, where n is the number of slots between two RRH*
      * *PDSCH associated with TCI #(k mod 4) is transmitted from RRH#(k mod 4) in slot from max((k-1)n + 1 + HARQ needed time + 3ms + first TRS + TRS processing time, 0) to (k+1)n + HARQ needed time + 3ms.*
    - *For UE supports more than 2 active TCI, MAC-CE based TCI switching, no interruption exists*
      * *Two RRHs of RRH#(2k) and RRH#(2k+1) are assumed, and SSB#(k mod 2) is transmitted from TRP#(2k), where k=0,1, 2, …*
      * *UE is configured with TCI#(2k mod 4) and TCI#((2k+1) mod 4) that are associated with TRS#(2k mod 4) and TRS#((2k+1) mod 4) 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)*
      * *At slot#(k\*n), TE activates TCI#(k mod 4), TCI#(k+1 mod 4) and TCI#(k+2 mod 4) for PDSCH at the same time by “TCI States Activation/Deactivation for UE-specific PDSCH MAC CE” and actives TCI#(k mod 4) and TCI#(k+1 mod 4) for PDCCH with coresetPoolIndex#(k mod 2) and coresetPoolIndex#(k+1 mod 2) transmitted from RRH#(k) and RRH#(k+1) by “TCI State Indication for UE-specific PDCCH MAC CE” command with the field of CORESET ID set to 0 and 1 respectively, where n is the number of slots between two RRH;*
      * *PDSCH associated with TCI #(k mod 4) is transmitted from RRH#(k mod 4) in slot from max((k-1)n + 1 + HARQ needed time + 3ms + first TRS + TRS processing time, 0) to (k+1)n + HARQ needed time + 3ms.*
* Recommended WF
  + Suggest discussing later after RAN4 reach agreements on whether to define transmission 2 requirements.

**Issue 2-10: Applicability and capability signalling**

* Proposals in RAN4#98e meeting:
  + *Option 1 (Ericsson): For the multi-DCI based transmission requirements in HST-SFN,* 
    - *UE does not require to be capable of demodulationEnhancement and gNB does not need to configure highSpeedDemodFlag.*
    - *UE should be capable of multiDCI-MultiTRP.*
    - *No new UE capability signaling and network assigned signaling are necessary.*
* Recommended WF
  + More discussion is needed.

## Companies views’ collection for 1st round

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| **Company** | **Comments** |
| **CMCC** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  We support option 1. On one hand, transmission scheme 2 will improve the throughput, and it is possible deployment for the high speed train scenario. On the other hand, considering that the high speed related parameters, e.g. the high doppler shift of 1667Hz for 30KHz SCS, is not considered, the PDSCH demodulation requirements specified in Rel-16 eMIMO WI cannot be applied to high speed scenario. Based on above consideration, it is necessary to specify the PDSCH requirements for transmission scheme 2 in HST scenario to guarantee the performance.  **Issue 2-4: Reference performance for comparison**  For the comparison, we have one question for clarification: how to determine there is performance gain or not. Some companies propose to use JT and/or DPS Tx schemes as a reference performance for comparison. In our understanding, different TB is transmitted from different RRH simultaneously for transmission scheme 2, taking 2 RRH as an example, 2 TBs will be transmitted simultaneously for transmission scheme 2, while only one TB is transmitted for JT and DPS. Since the number of TB is different, how to perform the comparison? |
| **Ericsson** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  We prefer option 1, but we are open for evaluation. In this case we suggest to agree with the simulation assumption to evaluate the mDCI-based transmission performance in HST condition.  We are also wondering the criteria for decision as CMCC questioned above. So it is also important to decide the criteria to define the requirements to avoid the same discussion in the next meeting.  Similar to CMCC’ comments, we should point out the PDSCH channel bits and TB size could be different between mDCI-based transmission and HST-DPS/HST-SFN due to the different TCI configuration and DMRS ports assignment.  **Issue 2-2: Channel model**  We support the recommended WF, and we believe option 1 and option 2 are same.  **Issue 2-3: Time/frequency errors and assumptions on UE synchronization**  We are fine with this proposal since it is the same assumption as Rel-16 eMIMO multi-DCI transmission. If the intension is to set frequency offset and/or timing offset between two RRHs, however, we should discuss the actual values later, because it is not clear the performance impact in the high speed scenario. We should not exclude the option no frequency offset and no time offset case.  [20210127] Regarding the reception timing difference from two RRHs for multi-DCI based transmission, we have the same observation as Samsung. We need to set channel model parameters (e.g., Ds and/or Dmin) especially for SCS=30kHz carefully so that the reception timing difference from RRHs should not exceed CP.  **Issue 2-4: Reference performance for comparison**  We want to understand the intention of there options. Does this mean RAN4 compare the PDSCH demodulation performance of:  1) mDCI-based transmission vs. HST-SFN joint transmission,  2) mDCI-based transmission vs. HST-DPS ?  **Issue 2-5: PDSCHs allocations between different RRHs**  Option 2.  **Issue 2-6: MCS**  We proposed Option 2 (MCS17 Rank 2) because we intended to reuse HST-DPS set setup.  But if we compare mDCI-based transmission with HST-SFN, we should assume MCS13 Rank 2.  **Issue 2-7: Other parameters**  Support Option 1 as the starting point.  **Issue 2-8: Link adaptation and statistic calculation**  We prefer a simple test setup, because the purpose of test is to verify the UE demodulation performance. We prefer to use the fixed FRC for PDSCH demodulation requirements.  **Issue 2-9: Test setup for transmission scheme 2**  We are fine with the recommended WF.  **Issue 2-10: Applicability and capability signalling**  We can come back later when RAN4 agree with the scope of this WI. |
| **ZTE** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  **We support option 3 to evaluate the performance of transmission scheme 2.** |
| **Huawei, HiSilicon** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  Further evaluation is needed. Considering same rank (2+2 can be assumed for NC-JT, 2 can be assumed for others) and MCS (13 can be assumed for NC-JT vs SFN, 17 can be assumed for NC-JT vs DPS), channel bits and total payload size for all codewords can be almost same with the assumption of non-overlapping resource allocation. We think it is feasible to consider 70% maximum throughput as criteria.  **Issue 2-2: Channel model**  Maybe we can agree that Ds=700m, Dmin=150m. For the maximum Doppler frequency, we prefer to discuss it after agreements are reached for Issue 2-3 since Doppler/timing offset may exceed maximum UE capability if we add extra time/frequency errors under HST condition.  **Issue 2-3: Time/frequency errors and assumptions on UE synchronization**  We agree that single FFT operation should be assumed as baseline UE implementation.  For synchronization between RRHs, unlike in eMIMO WI, very large time/frequency (both positive and negative) can be observed for HST-SFN channel model. Therefore we prefer not to add extra time/frequency errors otherwise Doppler/timing offset may exceed maximum UE capability.  **Issue 2-4: Reference performance for comparison**  Same Issue 2-1, considering same rank (2+2 can be assumed for NC-JT, 2 can be assumed for others) and MCS (13 can be assumed for NC-JT vs SFN, 17 can be assumed for NC-JT vs DPS), channel bits and total payload size for all codewords can be almost same with the assumption of non-overlapping resource allocation. We think it is feasible to consider 70% maximum throughput as criteria.  **Issue 2-5: PDSCHs allocations between different RRHs**  We prefer Option 2, i.e. same parameters as defined for Rel-16 eMIMO WI.  **Issue 2-6: MCS**  We prefer MCS 13 and MCS 17 for evaluation, i.e. same value as for HST-SFN and HST-DPS performance requirements defined in Rel-16 NR HST.  **Issue 2-7: Other parameters**  OK with Option 1 for evaluation.  **Issue 2-8: Link adaptation and statistic calculation**  We prefer fixed MCS during the test rather than different MCS configured at different positions relative to RRH. The whole track range is considered for statistic calculation when performance is compared between NC-JT and other Rel-16 defined scenarios.  **Issue 2-9: Test setup for transmission scheme 2**  We are OK to discuss this issue later.  **Issue 2-10: Applicability and capability signalling**  This can be discussed later after clear work scope is decided. |
| **Samsung** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  We are fine to consider this scheme for HST. Transmission scheme 2 was introduced for NR eMIMO WI, to further improve the spectrum efficiency, while it is not targeting for high speed scenario. Before we agree to introduce the related requirement, we suggest to make further evaluation  **Issue 2-2: Channel model**  Generally, we are fine with option 2. For the Doppler value, it can be as starting point for feasibility check, considering the time/frequency error assumption, and resource allocation scheme.  **Issue 2-3: Time/frequency errors and assumptions on UE synchronization**  Regarding time/frequency synchronization assumption, RAN1 design for multi-TRP/Panel transmission following the assumption that “the UE may assume that the UE may receive DL transmission from multiple TRP within a CP with single/multiple FFT windows”.  During eMIMO discussion, it was agreed to design proper test cases in receiver implementation agnostic manner, meanwhile the requirements defined should be based on the assumption with single FFT operation.  For 15KHz, considering the worst case of time offset for DL transmission received from two RRH is within the CP, single FFT operation is reasonable  For 30KHz. given the Ds=700, the maximum delay can equal to 2.3us if UE near the one RRH, where the timing offset for DL transmission received from two RRH almost equals CP, which may result in the ISI. We are not sure whether single FFT operation is still feasible for this case?  **Issue 2-4: Reference performance for comparison**  We prefer option2 ,  **Issue 2-5: PDSCHs allocations between different RRHs**  For NR eMIMO WI, only non-overlap resource allocation is considered for requirement of multi-DCI based multi-TRP. we prefer to reuse as starting point. For overlap resource allocation, depending on IC receiver or MMSE IRC assumption.  **Issue 2-6: MCS**  We prefer to use the same MCS defined in DPS or SFN as starting point for feasibility checking  **Issue 2-7: Other parameters**  We are ok with Option 1 as the starting point.  **Issue 2-8: Link adaptation and statistic calculation**  We prefer to apply the same test setup as Rel-16 HST with fixed FRC to verify the UE demodulation performance  **Issue 2-9: Test setup for transmission scheme 2**  We are fine with the recommended WF.  **Issue 2-10: Applicability and capability signalling**  We are fine with the recommended WF. |
| **Qualcomm** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  In our opinion, assuming same simulation assumptions as in eMIMO WI, this scheme can be looked as CA with each TRP following similar to HST-DPS or HST single-tap. So, we don’t expect much benefit due to this scheme compared to HST-DPS and HST-single tap under same total CBW/SCS/MCS/Rank/Doppler etc. So, we are ok to study it but we are not in favour of defining these requirements at this point.  **Issue 2-2: Channel model**  Ok with recommended WF.  **Issue 2-3: Time/frequency errors and assumptions on UE synchronization**  We can reuse similar assumptions as in eMIMO WI.  **Issue 2-4: Reference performance for comparison**  We at least would want to compare mDCI scheme with HST-DPS. We are neutral for comparing it with HST-SFT JT.  **Issue 2-5: PDSCHs allocations between different RRHs**  Prefer Option 2.  **Issue 2-6: MCS**  We are ok to evaluate MCS 13 and MCS17 for this study.  **Issue 2-7: Other parameters**  Ok with Option 1 as the starting point.  **Issue 2-8: Link adaptation and statistic calculation**  We prefer to look at the overall performance rather than focusing on specific points on the train track.  **Issue 2-9: Test setup for transmission scheme 2**  Ok with recommended WF.  **Issue 2-10: Applicability and capability signalling**  It can be decided later if RAN4 agrees to define any new requirements. |
| **Intel** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  Support Option 3. In Rel-16 HST there were no conclusions on benefits and applicability of Tx scheme 2 for HST-SFN. Preliminary study is needed to confirm that there are benefits of using Tx 2 in HST. If performance benefits will not be identified comparing to Rel-16 Tx schemes (JT and DPS) there is no need to define such requirements since there will be no reasons to deploy Tx scheme 2 in real networks.  **Issue 2-2: Channel model**  As we see companies have same view on channel model and both options capture similar proposals. At this stage we can agree on Ds and Dmin values and take Rel-16 Doppler frequency assumptions as baseline.  **Issue 2-3: Time/frequency errors and assumptions on UE synchronization**  As for single FFT operation, we believe that in this WI we should follow Rel-16 RAN1/RAN4 assumptions and do not consider implementations with more than one FFT windows.  As Samsung pointed out there can be locations between two RRHs where signal from far RRH exceeds CP length. However, where propagation time exceeds CP length, receive signal power will be quite small hence probably multi-DCI Tx scheme will not be enabled in such locations.  We suggest considering single FFT operation and further analyse issue with high receive timing difference for multi-DCI Tx scheme in HST-SFN deployments. Potentially it can be a factor that can preclude any benefits of this Tx scheme.  As for non-synchronized Tx, we prefer to adopt eMIMO Rel-16 approach and evaluate performance with time and frequency offsets between RRHs. Similar assumptions should be used for JT or DPS if we agree to compare performance with them. As for concrete values, as baseline we can use eMIMO Rel-16 values but not precluded others.  **Issue 2-4: Reference performance for comparison**  We should agree on KPI metrics to conclude on Tx scheme 2 performance benefits. For reference we suggest considering JT and/or DPS Tx schemes since it is a common understating, that they are typical schemes for HST deployment.  As for KPI we suggest considering at least the following options:   * Max achievable throughput across all scheduled TB.   + Different train locations and SNR points should be analysed.  (Based on our initial analysis, in the location near the RRH it might be challenging to decode TB transmitted from far RRH – in this case max achievable throughput is same as in DPS or HT scheme and there is no need to configure multi-DCI Tx scheme. Further study is needed.)) * SNR at 70% @max achievable throughput * Max supported Doppler frequency   **Issue 2-5: PDSCHs allocations between different RRHs**  We support option 1 for study stage. It is not clear what allocation approach can bring more benefits and we should consider both of them for study. For requirements definition we can consider only one.  **Issue 2-6: MCS**  We support option 1 for study stage. These MCS values a be considered as baseline just to align results between companies. MCS 4 should not be precluded since it can be used for TB transmitted from far RRH to make more reliable Tx.  **Issue 2-7: Other parameters**  We can consider option 1 as baseline assumption for analysis.  **Issue 2-8: Link adaptation and statistic calculation**  We do not propose to consider link adaption during the test. Test case should be defined with fixed MCS value. Same time from analysis perspective we think fixed MCS approach does not allow to show all benefits of multi-DC Tx scheme. Fixed MCS approach should be captured as baseline for performance analysis, but link adaption should also be captured as possible approach to encourage companies to take look on it  As for statistic calculation, in real filed it is possible to configure different Tx schemes in different train locations to optimize total performance. We might expect that multi-DCI Tx will bring performance benefits in the middle area between two RRHs by increasing total throughput. Same time near the RRH we can expect poor demodulation performance for PDSCH transmitted from far RRH and hence there is no need to waste resources to enable multi-DCI Tx at this area.  In this case averaged performance across whole railway track might not indicate real gains of such scheme. We propose to bring results for different locations to have clear picture of Tx scheme 2 applicability for HST-SFN deployment.  **Issue 2-9: Test setup for transmission scheme 2**  We are fine with recommended WF.  **Issue 2-10: Applicability and capability signalling**  Prefer to comeback to this issue later after conclusion of performance analysis. |
| **Apple** | **Issue 2-1: Whether to specify PDSCH requirements for transmission scheme 2**  We recommend to first study and evaluate the performance with transmission scheme 2 before specifying requirements.  **Issue 2-2: Channel model**  We are fine with the recommended WF to use the same parameters as HST-SFN.  Regarding the channel model, we don’t think it will be same as HST-SFN with 2 visible RRHs for each TRP. For each TRP, it would be a single tap, rather than 2 taps.  **Issue 2-3: Time/frequency errors and assumptions on UE synchronization**  We can assume single FFT operation as in other multi-TRP transmission schemes in eMIMO. The non-ideal synchronization between RRHs needs further discussion whether its applicable in HST SFN deployment.  **Issue 2-4: Reference performance for comparison**  We should evaluate performance with multi DCI transmission scheme against HST-SFN JT and HST SFN DPS transmissions schemes.  **Issue 2-5: PDSCHs allocations between different RRHs**  We support option 2 to consider non-overlapped allocation.  **Issue 2-6: MCS**  We propose to use the same MCS as in existing HST-SFN tests.  **Issue 2-7: Other parameters**  We are fine to use them as baseline assumptions.  **Issue 2-8: Link adaptation and statistic calculation**  We should evaluate performance based on overall throughput rather than at different points along the track.  **Issue 2-9: Test setup for transmission scheme 2**  We are fine with the recommended WF. As a baseline we should first look at case with 2 active TCI states.  **Issue 2-10: Applicability and capability signalling**  We can discuss this once we agree to define requirements. |

### 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 transmission scheme 2** | **Tentative Agreement:**  **First focus on the study and evaluate the performance for transmission scheme 2.** |
| **Issue 2-2: Channel model** | 5 companies are general OK with the proposed channel model. 11 company has different views on the channel model (for each TRP, it would be a single tap, rather than 2 taps).  Moderator suggest following agreement:  **Tentative Agreement:**  Set Ds=700m and Dmin=150m as baseline  Take maximum Doppler frequency “870Hz for 15KHz, 1667Hz for 30KHz” as baseline:  **Recommended WF for 2nd round:**  Further discuss the channel model in 2nd round:  Reuse the HST-SFN channel model (TS38.101-4 B.3.2) and parameters for multi-DCI based PDSCH transmission requirements |
| **Issue 2-3: Time/frequency errors and assumptions on UE synchronization** | 6 companies discuss this issue. 5 companies agree that the single FFT operation should be assumed as baseline UE implementation, same as eMIMO assumption. 1 company think it is not sure whether single FFT operation is still feasible for HST scenario.  **Recommended WF for 2nd round:**  Further discuss in 2nd round whether single FFT operation can still be assumed as baseline UE implementation for HST scenario  Further discuss whether non-ideal synchronization between RRHs should be considered as a baseline assumption. |
| **Issue 2-4: Reference performance for comparison** | Most companies agree to have reference performance for comparison. It seems at least companies agree to consider compare m-DCI based transmission scheme with HST-DPS. Further discussion on whether the compassion between m-DCI based transmission scheme with HST-SFN is needed.  Also, in addition to 70% @max achievable throughput, more criterias are proposed:   * Max achievable throughput across all scheduled TB.   + Different train locations and SNR points should be analysed.  (Based on our initial analysis, in the location near the RRH it might be challenging to decode TB transmitted from far RRH – in this case max achievable throughput is same as in DPS or HT scheme and there is no need to configure multi-DCI Tx scheme. Further study is needed.)) * SNR at 70% @max achievable throughput * Max supported Doppler frequency   **Recommended WF for 2nd round:**  Further discuss in 2nd round:  For reference performance for comparison, further discuss in 2nd round whether to only choose option 2 or both?  Option 1: mDCI-based transmission vs. HST-SFN joint transmission,  Option 2: mDCI-based transmission vs. HST-DPS  For evaluation criteria, further discuss whether the following aspects are needed in 2nd round:   * Max achievable throughput across all scheduled TB.   + Different train locations and SNR points should be analysed.  (Based on our initial analysis, in the location near the RRH it might be challenging to decode TB transmitted from far RRH – in this case max achievable throughput is same as in DPS or HT scheme and there is no need to configure multi-DCI Tx scheme. Further study is needed.)) * SNR at 70% @max achievable throughput * Max supported Doppler frequency |
| **Issue 2-5: PDSCHs allocations between different RRHs** | *1 company support option1, 5 companies support option2.*   * + *Option 1 (Intel): Consider overlapped and non-overlapped PDSCHs allocations between different RRHs*   + *Option 2 (Ericsson, Huawei, Samsung, Qualcomm, Apple): 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.*   **Tentative Agreement:**  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.  **Recommended WF for 2nd round:**  Further discuss in 2nd round whether overlapped and non-overlapped PDSCHs allocations between different RRHs can be considered for performance analysis. |
| **Issue 2-6: MCS** | It seems companies agree to exclude MCS4. For MCS 13 and 17, most companies agree to use them as baseline for evaluation. And the same value as for HST-SFN and HST-DPS should be used considering the performance comparison.  **Recommended WF for 2nd round:**  Further discuss the following proposals in the 2nd round:   * MCS 13 and 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: Reference performance for comparison depends on the outcome of issue 2-4. |
| **Issue 2-7: Other parameters** | All companies agree to use option 1 as the baseline assumption for evaluation.  **Tentative Agreement:**  Use following parameters as the baseline assumption for evaluation.   * + - *Antenna configuration: 2x2 and 2x4*     - *Rank 2*       * *DMRS ports 1000/1001 from TRP #(2i)*       * *DMRS ports 1002/1003 from TRP #(2i+1)*     - *DMRS Type 1 and 2 additional DM-RS symbols*     - *For TDD, use TDD pattern of 7D1S2U with S=6DL:4GP:4UL*       * *No PDSCH data transmission in the special slots*     - *TRS periodicity: 10ms* |
| **Issue 2-8: Link adaptation and statistic calculation** | 5 companies prefer to use fixed FRC to verify UE demodulation performance. 1 company think link adaption should also be capture as possible approach to encourage companies to take look on it.  **Recommended WF for 2nd round:**  Further discuss the following recommended WF in 2nd round:   * Use fixed FRC to define PDSCH demodulation requirements. * Fixed MCS approach is the baseline for performance analysis * Further discuss on whether to link adaption should also be captured as possible approach |
| **Issue 2-9: Test setup for transmission scheme 2** | **Tentative Agreement:**  o Discuss later after RAN4 reach agreements on whether to define transmission 2 requirements. |
| **Issue 2-10: Applicability and capability signalling** | **Tentative Agreement:**  o Discuss later after RAN4 reach agreements on whether to define transmission 2 requirements. |

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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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## Summary on 2nd round (if applicable)

### Open issues summary

### 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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