**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item: 8.17.2.1**

**Source:** Moderator (CMCC)

**Title:** Email discussion summary for RAN4#94e\_#TBA\_NR\_HST\_Demod\_UE

**Document for:** Information

# Introduction

This email discussion focuses on UE demodulation for NR HST, including agenda 8.17.2.1.1~8.17.2.1.5. Five topics are included in total, including transmission schemes, HST-SFN, HST single tap, muti-path fading channel, and other general open issues mentioned in companies’ contributions.

The 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

# Topic #1: Scenarios and transmission schemes

*Agenda 8.17.2.1.1*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2002072**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002072.zip) | Qualcomm Incorporated | Proposal 1: Do not consider Transmission schemes 1 and 3 for defining new requirements. Transmission scheme 2 should be discussed as part of eMIMO WI first and only consider in HST WI if HST WI still has sufficient TUs left for this discussion.  Proposal 2: Use +/-0.1ppm frequency error when determining maximum Doppler frequency for HST-SFN.  Proposal 3: Use maximum Doppler frequency of 851Hz for FDD 15kHz SCS under HST-SFN scenario.  Proposal 4: Use maximum Doppler frequency of 1500Hz for TDD 30kHz SCS under HST-SFN scenario.  Proposal 5: Use maximum Doppler frequency of 1250Hz for FDD 15kHz SCS under HST single tap scenario.  Proposal 6: Do not define requirements for target speed of 350km/h under HST-SFN scenario.  Proposal 7: Do not test UE under HST single tap and HST multi-path scenarios, if UE passes the requirements for HST-SFN. |
| [**R4-2000366**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000366.zip) | Intel Corporation | Proposal #1: Define demodulation requirements for DPS scheme 1a and discuss details of the test configuration.  Proposal #2: Consider transmission scheme 1b in a later stage of this WI.  Proposal #3: Further discuss simulation assumption and methodology to analyse performance benefits of NC-JT scheme in application to HST-SFN deployment.  Proposal #4: Conclude that transmission scheme with distributed TRS transmission provides performance benefits for HST scenarios.  Proposal #5: Conclude that transmission scheme with joint data and distributed DMRS transmissions provides performance benefits for HST scenarios. |
| [**R4-2001357**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001357.zip) | Ericsson | Proposal 1: RAN4 does not define the PDSCH demodulation requirement with Transmission scheme 3 in Rel-16 HST WI.  Proposal 2: RAN4 should discssus whether to define PDSCH demodulation requirements with multi-DCI (Transmission scheme 2) under Rel-16 eMIMO WI performance.  Observation 1: It is feasible to test the DPS with HST-SFN channel model without CRI/L1-RSRP feedback.  Proposal 3: RAN4 need discuss further the motivation to define new PDSCH demodulation requirements assuming DPS in HST WI. |
| [**R4-2001454**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001454.zip) | Huawei, HiSilicon | Observation: Transmission scheme of joint transmission + Distributed TRS does not belong to NR Rel-15 and NR Rel-16 work scope.  Proposal 1: Only define performance requirements for transmission scheme 1b for DPS  Proposal 2: Define performance requirements related to transmission scheme 2 in NR Rel-16 eMIMO WI  Proposal 3: Not consider transmission scheme 3 in the NR Rel-16 HST enhancements WI |

## Open issues summary

### Transmission scheme 1a and 1b

**Agreements in RAN4#93 meeting:**

* DPS transmission scheme 1a is feasible in HST scenario for both UE and BS. Whether to define new requirements and tests for DPS transmission scheme 1a are FFS.
* DPS transmission scheme 1b is feasible in HST scenario for both UE and BS. Whether to define new requirements and tests for DPS transmission scheme 1b are FFS.
* Transmission scheme 1 - DPS: PDSCH is only transmitted from one TRP at one time
  + Transmission scheme 1a: UE only needs to track 1 TCI state (detail can be found in R4-1911003)
  + Transmission scheme 1b: UE needs to track more than 1 TCI states (detail can be found in R4-1911091)

**Issue 1-1: Whether to define new requirements and tests for DPS transmission scheme 1**

* Proposals
  + Option 1 (Qualcomm): Do not consider Transmission schemes 1 a and 1b for defining new requirements
  + Option 2 (Intel): Define demodulation requirements for DPS scheme 1a, consider transmission scheme 1b in a later stage of WI.
  + Option 3 (Ericsson): RAN4 need discuss further the motivation to define new PDSCH demodulation requirements assuming DPS in HST WI.
  + Option 4 (Huawei): Only define performance requirements for transmission scheme 1b for DPS
* Recommended WF
  + 4 companies discuss issue 1-1, and hold different opinions. Moderator feels it is difficult to move forward due to the current situation, and would like to suggest more companies provide comments and possible compromise in order to move forward.

**Issue 1-2: Test setup of transmission scheme 1**

* Proposals
  + Option 1 (Ericsson): Since the HST-SFN channel model changes the strongest path (TRP) according to the simulated UE position, TE knows the strongest path based on Ds. This means, for example, TE can transmit PDSCH from TRP#0 for distance from 0m to 500m, TRP#1 for distance from 500m to 1500m, TRP#2 for distance from 1500m to 2500, etc. With this deterministic selection, it is possible to simulate the DPS without CRI/L1-RSRP feedback from UE.
  + Option 2 (Intel): For Scheme 1a when only one active TCI state is configured TCI state switching is triggered by MAC CE. In this case test procedure may be as follows:

1. UE is configured with two different TCI states associated with two different RRHs
2. PDSCH associated with TCI #0 is transmitted during the slots from 0 to (n-1) + HARQ needed time + 3ms + first TRS + TRS processing time
3. In slot n test equipment start triggering TCI state switching command by MAC CE scheduling
4. PDSCH associated with TCI #1 is transmitted in slots from n + HARQ needed time + 3ms + first TRS + TRS processing time to N.

* Recommended WF
  + 2 companies discuss the test setup of transmission scheme 1. Both of them conclude that it is feasible to test demodulation performance for transmission scheme 1 without L1 RSRP/CRI feedback. Moderator would like to suggest the way forward as following, and encourage companies to provide comments.
    - ***It is feasible to test the transmission scheme 1 without CRI/L1-RSRP feedback.***

### Transmission scheme 2

**Agreements in RAN4#93 meeting:**

* Further study feasibility and performance benefits of transmission scheme 2 when its details are finalized by RAN1
* Transmission scheme 2 - PDSCH is jointly transmitted from two or more adjacent TRPs scheduled by multi-DCI(detail can be found in R4-1911091)

**Issue 1-3: Transmission scheme 2**

* Proposals
  + Option 1 (Qualcomm): Transmission scheme 2 should be discussed as part of eMIMO WI first and only consider in HST WI if HST WI still has sufficient TUs left for this discussion.
  + Option 2 (Intel): Further discuss simulation assumption and methodology to analyse performance benefits of NC-JT scheme in application to HST-SFN deployment.
  + Option 3 (Ericsson): RAN4 should discssus whether to define PDSCH demodulation requirements with multi-DCI (Transmission scheme 2) under Rel-16 eMIMO WI performance.
  + Option 4 (Huawei): Define performance requirements related to transmission scheme 2 in NR Rel-16 eMIMO WI
* Recommended WF
  + 4 companies discuss transmission scheme 2. 3 of them mentioned that study transmission scheme in eMIMO WI is more appropriate. Moderator would like to suggest the following two options for further discussion, and encourage companies to provide comments.
    - ***Option 1: Discuss transmission scheme 2 in eMIMO WI first, then discuss transmission scheme 2 in HST-SFN deployment scenario later in HST WI***
    - ***Option 2: Discuss transmission scheme 2 in eMIMO WI (including HST-SFN deployment scenario)***

### Transmission scheme 3

**Agreements in RAN4#93 meeting:**

* Transmission scheme 3
  + Further check whether Rel-16 eMIMO WI can support transmission scheme 3
    - If it is supported in Rel-16 eMIMO WI, further study feasibility and performance benefits of transmission scheme 3 in Rel-16 HST WI when its details are finalized by RAN1
    - If it is not supported in Rel-16, no requirements are defined in Rel-16 HST WI. Companies can bring analysis on the performance benefits and feasibility
* Transmission scheme 3 - Joint transmission + Distributed reference signal (detail can be found in R4-1911003)
  + joint transmission + Distributed TRS
  + joint transmission + Distributed DMRS

**Issue 1-4: Transmission scheme 3**

* Proposals
  + Option 1 (Qualcomm, Ericsson, Huawei): Do not consider Transmission schemes 3 for defining new requirements
  + Option 2 (Intel): transmission scheme with distributed TRS/DMRS transmission provides performance benefits for HST scenarios.
* Recommended WF
  + Rel-16 eMIMO WI does not support transmission scheme 3, moderator suggests to follow last meeting agreement:
    - ***Transmission scheme 3 is not supported in Rel-16, no requirements are defined in Rel-16 HST WI. Companies can bring analysis on the performance benefits and feasibility***

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Issue 1-1: In our opinion, transmission scheme 1a and 1b are already covered from baseband perspective under HST single tap and HST-SFN scenarios. We should not combine RRM and Demod aspects of UE by switching TRPs based on UE feedback in the middle of the test. We think that Ericsson also agrees with this assessment in their paper. So, in our opinion, we should not define any requirements for transmission scheme 1a and 1b.  Issue 1-2: We agree with the conclusion in recommended WF. However, whether we define the requirements or not depends on the outcome of Issue 1-1.  Issue 1-3: We are ok with Option 1 or leaving both options open in this meeting.  Issue 1-4: We are ok with recommended WF. |
| CMCC | Issue 1-1: from our point of view, it is better to have requirements for transmission scheme 1 since it is a feasible deployment. Compared with HST single tap, at least the test setup is different. As for the requirements, if companies share the similar view that the requirements of HST single tap can be reused for transmission scheme 1, may be no new requirements is needed, and we just need to say in the spec that the requirements of HST single tap are applied to transmission scheme 1.  Issue 1-2: We are OK with the recommended WF  Issue 1-3: we agree that transmission scheme 2 has larger scope in eMIMO WI, not only FR1 but also FR2, and low speed UE is considered. Since the requirements defined in eMIMO WI will be applied to a more general scenario, we are not sure whether the channel model introduced in high speed scenario will be considered or not. We would like to provide another option:  *Option 3: Discuss transmission scheme 2 with high speed scenario in NR HST WI, discuss transmission scheme 2 with non-high speed scenario in eMIMO WI*  Issue 1-4: We are OK with the recommended WF |

## 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.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

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

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Requirements for HST-SFN

*Agenda 8.17.2.1.2*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000634**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000634.zip) | CMCC | Observation 1: Compared with the theoretical limit (e.g. 1.75KHz for HST-SFN with 30KHz SCS), if the maximum doppler shift is 1667Hz, there is margin of 83Hz, which can be used for UE DL frequency error and other error.  Proposal 1: for HST-SFN with 30 KHz SCS, the DL maximum Doppler frequency is proposed to be 1667 Hz.  Proposal 2: for HST-SFN with 15 KHz SCS, the DL maximum Doppler frequency is proposed to be 851 Hz.  Proposal 3: for HST single tap with 15 KHz SCS, the DL maximum Doppler frequency is proposed to be 1250 Hz.  Proposal 4: it is proposed to use MCS 13 for the case of Rank 2.  Proposal 5: it is proposed to use MCS 17 for the case of Rank 1.  Proposal 6: for HST-SFN, both 2x2 and 2x4 are tested and applicability rule can be considered. |
| [**R4-2002072**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002072.zip) | Qualcomm Incorporated | Proposal 1: Do not consider Transmission schemes 1 and 3 for defining new requirements. Transmission scheme 2 should be discussed as part of eMIMO WI first and only consider in HST WI if HST WI still has sufficient TUs left for this discussion.  Proposal 2: Use +/-0.1ppm frequency error when determining maximum Doppler frequency for HST-SFN.  Proposal 3: Use maximum Doppler frequency of 851Hz for FDD 15kHz SCS under HST-SFN scenario.  Proposal 4: Use maximum Doppler frequency of 1500Hz for TDD 30kHz SCS under HST-SFN scenario.  Proposal 5: Use maximum Doppler frequency of 1250Hz for FDD 15kHz SCS under HST single tap scenario.  Proposal 6: Do not define requirements for target speed of 350km/h under HST-SFN scenario.  Proposal 7: Do not test UE under HST single tap and HST multi-path scenarios, if UE passes the requirements for HST-SFN. |
| [**R4-2000303**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000303.zip) | Samsung | In this contribution we provide simulation results for HST- single tap channels. |
| [**R4-2000367**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000367.zip) | Intel Corporation | Proposal #1: Define UE demodulation requirements for HST-SFN JT scenario under assumption of follow strongest frequency tracking strategy.  Proposal #2: Do not take into account 0.1 ppm frequency estimation error in max supported Doppler frequency determination.  Proposal #3: Use the following max Doppler frequencies for HST-SFN JT requirements:  - TDD 30 kHz SCS: 1667 Hz  - FDD 15 kHz SCS: 875 Hz  Proposal #4: Choose MCS 13 for both 15 kHz and 30 kHz SCS test cases for HST-SFN JT demodulation requirements definition. |
| [**R4-2000949**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000949.zip) | NTT DOCOMO, INC. | Observation 1: Effective maximum Doppler spread between two taps is 1.84\*fD,max.  Observation 2: FTL compensation range with FDD 15 kHz = 1750Hz - 0.1ppm\*CF.  Observation 3: FTL compensation range with TDD 30 kHz = 3500Hz - 0.1ppm\*CF.  Observation 4: For FDD 15kHz, 851Hz can be compensated when we consider UE oscillator error (±0.1ppm).  Observation 5: For TDD 30kHz, 1702Hz can be compensated when we consider UE oscillator error (±0.1ppm).  Observation 6: Use the actual UE oscillator error value to determine the maximum Doppler frequency. If we consider about actual UE oscillator error value, higher maximum Doppler frequency can be compensated compared to our analysis.  Observation 7: We prefer to discuss the maximum Doppler frequency value which is calculated by using agreed Ds and Dmin value.  Proposal 1: Target Doppler frequency in the HST-SFN test as follows.  • Maximum Doppler frequency  – For TDD 30 KHz SCS, 500km/h  • Option 2: 1667Hz  – For FDD 15 KHz SCS, 500km/h  • Option 2: 875Hz  • Option 3: 851Hz  Proposal 2: Introduce the requirement for 350 km/h and the target maximum Doppler frequency as follows.  • Maximum Doppler frequency  – For TDD 30 KHz SCS, 350km/h  • 1167Hz  – For FDD 15 KHz SCS, 350km/h  • 681Hz |
| [**R4-2001497**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001497.zip) | Huawei, HiSilicon | Observation 1: ±0.1ppm frequency error contains UE DL frequency error which we concern about and also, UE UL frequency error which is no influence in UE demodulation performance.  Observation 2: Considering the worst case, UE DL frequency error is 0.1ppm or -0.1ppm.  Observation 3: For SFN, maximum frequency tracking capability is not affected by FTL error no matter where UE is.  Observation 4: For MCS 17, all the cases are not feasible.  Proposal 1: No need to consider ±0.1ppm UE DL frequency error and other errors.  Proposal 2: Adopt maximum Doppler shift 870Hz for FDD, 1667Hz for TDD.  Proposal 3: Adopt MCS 13 for SFN. |
| [**R4-2000304**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000304.zip) | Samsung | Observation 1: The SNR with 70% TP for MCS17 is not achievable under Doppler value with 1500Hz and 1667Hz for TDD  Observation 2: The SNR with 70% TP for MCS17 is very high under Doppler value with 875Hz for FDD.  Proposal 1: Only specify the requirement for MCS 4 and MCS 13 for TDD  Proposal 2: Define the HST requirement under Doppler value with 712Hz |

## Open issues summary

### Maximum doppler frequency

**Agreements in RAN4#93 meeting:**

* Maximum Doppler frequency
  + For TDD 30 KHz SCS, 500km/h
    - Option 1: 1500Hz
    - Option 2: 1667Hz
  + For FDD 15 KHz SCS, 500km/h
    - Option 1: 712Hz
    - Option 2: 875Hz
    - Option 3: 851Hz
  + FFS on whether +-0.1ppm UE DL frequency error or lower value should be used when determine the maximum Doppler frequency
  + Further discuss on the estimation error methodology and other errors

**Issue 2-1: Maximum Doppler frequency for 30KHz 500km/h**

* Proposals
  + Option 1 (CMCC, Intel, DOCOMO, Huawei): 1667Hz
  + Option 2 (Qualcomm): 1500Hz
* Recommended WF
  + 5 companies discuss issue 2-1, 4 companies propose 1667Hz, 1 company propose 1500Hz. Moderator would like to suggest companies check whether 1667Hz is acceptable.

**Issue 2-2: Maximum Doppler frequency for 15KHz 500km/h**

* Proposals
  + Option 1 (CMCC, Qualcomm, DOCOMO): 851Hz
  + Option 2 (Intel, DOCOMO): 875Hz
  + Option 3 (Huawei): 870Hz
  + Option 4 (Samsung): 712Hz
* Recommended WF
  + 7 companies discuss issue 2-2, 3 companies propose 851Hz including two operators. Moderator would like to suggest companies check whether 851Hz is acceptable.

**Issue 2-3: ppm assumption for UE DL frequency error**

* Proposals
  + Option 1 (Qualcomm): +/-0.1ppm frequency error
  + Option 2 (Intel, DOCOMO, Huawei): do not consider +/-0.1ppm frequency error
* Recommended WF
  + 4 companies discuss issue 2-3, 3 companies propose to not consider +/- 0.1ppm frequency error. Since issue 2-3 is tightly related to Issue 2-1 and 2-2, moderator suggests focus on discussing Issue 2-1 and 2-2.

**Issue 2-4: Maximum doppler frequency for 350km/h**

* Proposals
  + Option 1 (DOCOMO):
    - 1167Hz for 30KHz
    - 681Hz for 15KHz
* Recommended WF
  + Since there is no agreement on whether to introduce 350km/h requirements, on this issue, moderator would like to suggest companies provide comments on the maximum Doppler frequency values under the assumption that 350km/h requirements are agreed to be introduced. Whether to introduce 350km/h requirements will be discussed separately.

### MCS

**Agreements in RAN4#93 meeting:**

* MCS (for Rank 2)
  + Option 1: MCS4
  + Option 2: MCS13
  + Option 3: MCS17
  + MCS should be decided based on whether the maximum throughput can be achieved

**Issue 2-5: MCS for HST-SFN (Rank 2)**

* Proposals
  + Option 1(CMCC, Intel, Huawei): MCS 13
  + Option 2 (Samsung): MCS 4 and MCS 13 for TDD 30KHz
* Recommended WF
  + 4 companies discuss Issue 2-5, all of them think MCS 13 is feasible to achieve the maximum throughput, 1 company also propose MCS4. Moderator suggests to agree on **MCS 13** if there is no objection.

### Atenna configuration

**Agreements in RAN4#93 meeting:**

* Simulation Assumption
  + 2x2, 2x4

**Issue 2-6: Antenna configuration for HST-SFN**

* Proposals
  + Option 1(CMCC): both 2x2 and 2x4 are tested and applicability rule can be considered.
* Recommended WF
  + both 2x2 and 2x4 are tested and applicability rule can be considered

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Issue 2-1: As we mentioned in our paper, delay spread for TDD case is double of CP length which is not the case for single tap case. So, we think that HST-SFN Doppler should be less than the Doppler for sing le tap. So, we would like to still support defining requirements with 1500Hz.  Issue 2-5: We are ok to choose anyone of MCS 4 or MCS 13.  Issue 2-6: We prefer to say that applicable rule “will” be considered as we have done for other demod test cases. |
| CMCC | Issue 2-5: we are OK with moderator’s suggest to adopt MCS 13 |

## 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.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: Requirements for HST single tap

*Agenda 8.17.2.1.3*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000634**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000634.zip) | CMCC | Observation 1: Compared with the theoretical limit (e.g. 1.75KHz for HST-SFN with 30KHz SCS), if the maximum doppler shift is 1667Hz, there is margin of 83Hz, which can be used for UE DL frequency error and other error.  Proposal 1: for HST-SFN with 30 KHz SCS, the DL maximum Doppler frequency is proposed to be 1667 Hz.  Proposal 2: for HST-SFN with 15 KHz SCS, the DL maximum Doppler frequency is proposed to be 851 Hz.  Proposal 3: for HST single tap with 15 KHz SCS, the DL maximum Doppler frequency is proposed to be 1250 Hz.  Proposal 4: it is proposed to use MCS 13 for the case of Rank 2.  Proposal 5: it is proposed to use MCS 17 for the case of Rank 1.  Proposal 6: for HST-SFN, both 2x2 and 2x4 are tested and applicability rule can be considered |
| [**R4-2002072**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002072.zip) | Qualcomm Incorporated | Proposal 1: Do not consider Transmission schemes 1 and 3 for defining new requirements. Transmission scheme 2 should be discussed as part of eMIMO WI first and only consider in HST WI if HST WI still has sufficient TUs left for this discussion.  Proposal 2: Use +/-0.1ppm frequency error when determining maximum Doppler frequency for HST-SFN.  Proposal 3: Use maximum Doppler frequency of 851Hz for FDD 15kHz SCS under HST-SFN scenario.  Proposal 4: Use maximum Doppler frequency of 1500Hz for TDD 30kHz SCS under HST-SFN scenario.  Proposal 5: Use maximum Doppler frequency of 1250Hz for FDD 15kHz SCS under HST single tap scenario.  Proposal 6: Do not define requirements for target speed of 350km/h under HST-SFN scenario.  Proposal 7: Do not test UE under HST single tap and HST multi-path scenarios, if UE passes the requirements for HST-SFN. |
| [**R4-2000368**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000368.zip) | Intel Corporation | Proposal #1: For 15 kHz SCS test case use maximum Doppler frequency equal to 870 Hz  Proposal #2: Define UE demodulation requirements under assumption that UE is informed on HST Single tap conditions  Proposal #3: Use already agreed NR HST RRM enhancement network assistance signalling to inform UE on HST Single tap conditions. Provide this signalling to UE during the HST Single tap demodulation test  Proposal #4: Ask RAN2 to design NR HST RRM enhancement network assistance signalling in more generic form  Proposal #5: For both 15 kHz and 30 kHz SCS in Single tap HST test cases use MCS 17 |
| [**R4-2000950**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000950.zip) | NTT DOCOMO, INC. | Proposal 1: Target Doppler frequency in the Single-tap test as follows.  • Maximum Doppler frequency  – For 15KHz SCS, 500km/h  • Option 1: 1250Hz  Proposal 2: Introduce the multi-shot TRS-based requirements is baseline. |
| [**R4-2001358**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001358.zip) | Ericsson | Proposal 1: Do not introduce any additional network assisted signaling for HST single tap scenario.  Proposal 2: For PDSCH demodulation requirements with the HST single tap, define requirements under the assumption UE is aware on HST single tap conditions and can adjust time/frequency tracking algorithms. It is up to UE implementation how to detect the condition. |
| [**R4-2001455**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001455.zip) | Huawei, HiSilicon | Observation 1: To align with BS, it is suitable to set the maximum Doppler shift 870Hz.  Observation 2：There is no enough margin for UE for maximum Doppler shift greater than 875Hz for 15kHz SCS if UE is configured with DRX or at some bad situations, such as a lower SNR.  Observation 3：It is needed to define maximum Doppler shift less than 875Hz.  Observation 4: For single-tap, both MCS 13 and 17 are feasible. MCS 13 has better performance considering balance between throughput and SNR.  Proposal 1: For single-tap scenario, it is proposed to adopt maximum Doppler shift 870Hz for FDD 15 kHz.  Proposal 2: Adopt MCS 13 for single-tap. |
| [**R4-2001736**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001736.zip) | Ericsson | Observation 1: FDD 15kHz SCS at 1250Hz doppler does not degrade demodulation performance compared to 875Hz doppler.  Observation 2: 1Tx antenna does not change demodulation performance significantly compared to 2Tx antennas. |
| [**R4-2001457**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001457.zip) | Huawei, HiSilicon | Observation 1: With the number of shots increases, the maximum residual frequency error and the time UE compensating residual frequency error also increases.  Observation 2: There is almost no influence in testing metric for different number of shots, although with the different residual frequency error.  Proposal 1: Define requirements based on worst case since there is almost no performance improvement for different number of shots.  Proposal 2: Whether to use single-shot or to use multi-shot depends on UE implement and should not be limited.  Proposal 3: No need to define additional network assistance for single-tap. |

## Open issues summary

### Maximum doppler frequency

**Agreements in RAN4#93 meeting:**

* Maximum Doppler frequency
  + For 15KHz SCS, 500km/h
    - Option 1: 1250Hz
    - Option 2: 875Hz

**Issue 3-1: Maximum Doppler frequency for 15KHz 500km/h**

* Proposals
  + Option 1 (CMCC, Qualcomm, DOCOMO): 1250Hz
  + Option 2 (Intel, Huawei): 870Hz
* Recommended WF
  + 5 companies discuss issue 3-1, 3 companies propose 1250Hz, 2 companies propose 870Hz. The reason behind 870Hz is align with the maximum Doppler frequency of BS (1740Hz). Also 1 company’s simulation results show performance at 1250Hz doppler is not degraded compared to 875Hz doppler. Moderator would like to suggest companies comment on whether to align the maximum Doppler frequency between BS and UE is needed.

### MCS

**Agreements in RAN4#93 meeting:**

* MCS ( for Rank 1)
  + Option 1: MCS 17
  + Option 2: MCS 13
  + MCS should be decided based on whether the maximum throughput can be achieved

**Issue 3-2: MCS for HST single tap (Rank 1)**

* Proposals
  + Option 1 (CMCC, Intel): MCS 17
  + Option 2 (Huawei): MCS 13
* Recommended WF
  + 3 companies discuss issue 3-2, 2 companies propose MCS17, 1 company propose MCS13. All companies confirm that MCS 17 can achieve the maximum throughput. Moderator suggests companies check whether MCS 17 is acceptable.

### Single tap requirements definition

**Agreements in RAN4#93 meeting:**

* Option A: Define requirements based on worst case and UE performs multi-shot TRS-based time/freq tracking
* Option B: Define requirements under assumption UE is aware on HST single tap conditions and can adjust time/freq tracking algorithms
  + Further study how UE can become aware on conditions
    - Option 1: UE detects the conditions
    - Option 2: Rely on agreed NR HST RRM enhancement network assistance signaling
    - Option 3: Additional network assistance is provided
* Further study UE demodulation performance under HST single tap conditions for the case of single-shot and multi-shot TRS-based tracking

**Issue 3-3: The assumption of HST single tap requirements**

* Proposals
  + Option 1 (Ericsson): Define requirements under the assumption UE is aware on HST single tap conditions and can adjust time/frequency tracking algorithms. It is up to UE implementation how to detect the condition.
    - Option B Option 1 from last meeting agreement
  + Option 2 (DOCOMO): Introduce the multi-shot TRS-based requirements is baseline.
    - Option A from last meeting agreement
  + Option 3 (Intel): Define requirements under the assumption that UE is informed on HST single tap conditions, and rely on agreed NR HST RRM enhancement network assistance signalling
    - Option B Option 2 from last meeting agreement
  + Option 4 (Huawei): Define requirements based on the worst case, whether to use single-shot or multi-shot depends on UE implement and should not be limited. No need to define additional network assistance for single-tap
* Recommended WF
  + 3 companies discuss on issue 3-3, and hold different opinions. Good news is no company support to define additional network assistance signalling. So moderator would like to remove Option 3 of Option B, and suggest more companies provide comments on the following options
    - Option A: Define requirements based on worst case and UE performs multi-shot TRS-based time/freq tracking
    - Option B: Define requirements under assumption UE is aware on HST single tap conditions and can adjust time/freq tracking algorithms
      * Further study how UE can become aware on conditions
        + Option 1: UE detects the conditions
        + Option 2: Rely on agreed NR HST RRM enhancement network assistance signaling

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Issue 3-1: As HST single tap is easier channel than HST-SFN, our preference is to choose a higher Doppler compared to HST-SFN. So, we prefer to defjne the requirements for 1250Hz.  Issue 3-2: We are ok with MCS 17.  Issue 3-3: We prefer to just say “Define requirements based on worst case” and remove “UE performs multi-shot TRS-based time/freq tracking” since every UE has its own implementation and worst case can vary from UE to UE. Then, each company can provide simulation results based on what they think their worst case performance is. |
| CMCC | Issue 3-1: In Rel-15, for 15KHz, the maximum doppler shift is 750Hz, option 2 of 870Hz is close to the existing doppler shift. Considering higher doppler shift is supported by the physical layer design, we prefer 1250Hz.  Issue 3-3: Prefer to define requirements based on the worst case and network assistance is not needed. |

## 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** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: Requirements for multi-path fading channels

*Agenda 8.17.2.1.4*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000305**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000305.zip) | Samsung | Observation 1: The SNR with 70% TP for MCS 17 is not achievable under Doppler value with Rank2 for both FDD and TDD with 2x2 antenna configuration  Observation 2: The SNR with 70% TP for MCS 13 is high under Doppler value 1200Hz with Rank2 with 2x2 antenna configuration in TDD  Proposal 1: Specify the requirement with MCS4, MCS13 and MCS 17 for Rank1, MCS4 for Rank2. |
| [**R4-2000369**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000369.zip) | Intel Corporation | Proposal #1: Use one of the following combinations of the MCS and Rank for HST multi-path requirements definition:  Option 1: MCS 17 and Rank 1 for both 15 and 30 kHz SCS  Option 2: MCS 13 and Rank 2 for both 15 and 30 kHz SCS  Proposal #2: Define HST multi-path demodulation requirements for both 2x2 and 2x4 antenna configurations. |
| [**R4-2000951**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000951.zip) | NTT DOCOMO, INC. | **Observation 1: 70% maximum throughput can be achieved with a reasonable SNR with TDD Rank 1**   |  |  |  |  | | --- | --- | --- | --- | | **Antenna configuration** | **Rank** | **MCS** | **SNR @ 70% maximum Throughput (dB)** | | 2x2 | 1 | 4 | -2.7 | | 13 | 5.8 | | 17 | 9.6 | | 2x4 | 4 | -5.8 | | 13 | 2 | | 17 | 5.5 |   **Proposal: Performance requirements for HST under multi-path fading channel should be designed with Rank=1, since rank2 is mandatory with capability signaling for 2 additional DM-RS.** |
| [**R4-2001456**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001456.zip) | Huawei, HiSilicon | Observation 1: For rank 1, it is not feasible for MCS 17 for 2Tx2Rx since it cannot achieve 70% maximum throughput. Observation 2: For rank 2,  - It is not feasible for MCS 13, 17 for 2Tx2Rx since it cannot achieve 70% maximum throughput  - It is not feasible for MCS 17 for 2Tx4Rx since it cannot achieve maximum throughput.  Proposal 1: Adopt MCS 13 and rank 1 for multi-path fading channel performance requirements. |
| [**R4-2001737**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001737.zip) | Ericsson | Observation 1: In the special slot for the selected TDD pattern, the number of DMRS symbols will be DMRS 1.  Observation 2: The number of DMRS symbols in special slot is not sufficient for the HST scenario.  Observation 3: There are two tests that do not achieve maximum throughput, TDD test case 5 and 6 in Table 3-2.  Proposal 1: For PDSCH with TDD configuration, we shall not schedule data in the special slot in order to achieve maximum throughput. |

## Open issues summary

### MCS and Rank

**Agreements in RAN4#93 meeting:**

* Rank
  + Option 1: Rank = 1
  + Option 2: Rank = 2
  + Note: rank1 is mandatory, rank2 is mandatory with capability signalling
* MCS
  + Option 1: MCS4
  + Option 2: MCS13
  + Option 3: MCS17
  + Note: MCS should be discussed together with rank assumption

**Issue 4-1: Rank for multi-path fading channel**

* Proposals
  + Option 1 (Samsung): both rank1 and rank2.
  + Option 2 (Intel): rank1 or rank2
    - MCS 17 and Rank 1 for both 15 and 30 kHz SCS
    - MCS 13 and Rank 2 for both 15 and 30 kHz SCS
  + Option 3 (DOCOMO, Huawei): Rank=1
* Recommended WF
  + 4 companies discuss issue 4-1, 1 companies propose both rank1 and rank2, two companies propose only rank1. Moderator would like to suggest agree on rank=1 first, and suggest companies provide comments on whether to define rank=2.

**Issue 4-2: MCS for multi-path fading channel**

* Proposals
  + Option 1 (Samsung):
    - MCS4, MCS13 and MCS 17 for Rank1
    - MCS4 for Rank2.
  + Option 2 (Intel):
    - MCS 17 for Rank 1
    - MCS 13 for Rank 2
  + Option 3 (Huawei): MCS 13 for rank=1
* Recommended WF
  + 3 companies discuss on issue 4-2. MCS depends on whether the maximum throughput can be achieved. To summarize the proposals, Moderator would like to suggest companies comments on the following options:
    - For rank 1
      * Option 1: MCS=4
      * Option 2: MCS =13
      * Option 3: MCS=17
    - For rank 2
      * Option 1: MCS=4
      * Option 2: MCS=13

### Antenna configuration

**Simulation Assumption in RAN4#93 meeting:**

* 2x2 and 2x4

**Issue 4-3: Antenna configuration for mutli-path fading channel**

* Proposals
  + Option 1 (Intel): Define HST multi-path demodulation requirements for both 2x2 and 2x4 antenna configurations.
* Recommended WF
  + Define HST multi-path demodulation requirements for both 2x2 and 2x4 antenna configurations.

### Others

**Issue 4-4: scheduling in TDD special slot for multi-path fading**

* Proposals
  + For PDSCH with TDD configuration, we shall not schedule data in the special slot in order to achieve maximum throughput.
* Recommended WF
  + Moderator would like companies to check and comment whether maximum throughput can be achieved when special slot is scheduled under multi-path fading channel.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Issue 4-1: We prefer to define the requirements only for Rank1 as Rank2 performance doesn’t look very good with this high Doppler.  Issue 4-2: We are ok with either of MCS 4,13 or 17 for Rank 1.  Issue 4-3: We should also add that an applicability rule will be defined for 2Rx vs 4Rx.  Issue 4-4: We are ok not to schedule grant on S slot as we have only one DMRS symbol for this high Doppler in S slot and that results in worse performance. |
| CMCC | Issue 4-4: We have one question for clarification. Since this issue is pointed out under multi-path fading channel, if companies confirm this issue, we are wondering whether it only exists in the multi-path fading channel? Or this issue needs to be considered in other channels, e.g. HST single tap, HST-SFN? |

## 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.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #5: Others

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000948**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000948.zip) | NTT DOCOMO, INC. | Proposal: Define Rel.16 HST requirements, i.e., HST-SFN, single-tap and multi-path fading, as release independent from Release 15. |
| [**R4-2002072**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002072.zip) | Qualcomm Incorporated | Proposal 1: Do not consider Transmission schemes 1 and 3 for defining new requirements. Transmission scheme 2 should be discussed as part of eMIMO WI first and only consider in HST WI if HST WI still has sufficient TUs left for this discussion.  Proposal 2: Use +/-0.1ppm frequency error when determining maximum Doppler frequency for HST-SFN.  Proposal 3: Use maximum Doppler frequency of 851Hz for FDD 15kHz SCS under HST-SFN scenario.  Proposal 4: Use maximum Doppler frequency of 1500Hz for TDD 30kHz SCS under HST-SFN scenario.  Proposal 5: Use maximum Doppler frequency of 1250Hz for FDD 15kHz SCS under HST single tap scenario.  Proposal 6: Do not define requirements for target speed of 350km/h under HST-SFN scenario.  Proposal 7: Do not test UE under HST single tap and HST multi-path scenarios, if UE passes the requirements for HST-SFN. |

## Open issues summary

### Release independent issue

**Issue 5-1: Release independent issue**

* Proposals
  + Define Rel.16 HST requirements, i.e., HST-SFN, single-tap and multi-path fading, as release independent from Release 15.
* Recommended WF
  + This is the first time RAN4 discuss release independent issue for HST. Moderator would like to suggest more companies provide your comments on this issue.

### Target speed

**Agreements in RAN4#93 meeting:**

* For HST-SFN,
  + Introduce requirements for target speed of 500km/h
  + FFS on whether to introduce requirements for target speed of 350km/h.
    - Further discuss on the maximum Doppler, MCS and other parameters for 350km/h

**Issue 5-2: Target speed for HST-SFN**

* Proposals
  + Option 1 (Qualcomm): Do not define requirements for target speed of 350km/h
  + Option 2 (DOCOMO): Introduce requirements for target speed of 350km/h
* Recommended WF
  + This issue has been discussed for several meetings. In order to move forward, moderator would like to suggest more companies provide comments and possible compromise considering operators’ request as well as limiting test numbers.

### Test applicability

**Issue 5-3: Test applicability for different channel models**

* Proposals
  + Option 1 (Qualcomm): Do not test UE under HST single tap and HST multi-path scenarios, if UE passes the requirements for HST-SFN.
* Recommended WF
  + Moderator would like to suggest more companies provide comments on the test applicability issue.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Issue 5-1: For HST-SFN, we can’t have release independence because signaling related to HST-SFN is only defined in Rel-16. For HST-ST, we can have release independence if we don’t define HST-ST requirements based on awareness of HST-ST scenario because that again requires Rel-16 signalling. We are ok to have release independence for multi-path fading.  Issue 5-2: We prefer not to define requirements for 350km/h because we have already agreed to define requirements for 500km/h which will be more stringent. |
| CMCC | Issue 5-1: From our point of view, Rel.16 HST requirements, i.e., HST-SFN, single-tap and multi-path fading, can be release independent from Release 15.  We would like to provide some background. In Rel-14 LTE HST, the Rel-14 HST requirements are release independent from Rel-13. For the signalling issue mentioned by Qualcomm, since the signalling is cell-specific configured, it has no impact on the release independent.  Issue 5-2: We prefer to define requirements for 350km/h to optimize the performance under 350km/h since the maximum doppler shift is lower. When we specify the requirements for 350km/h, higher MCS can be considered. |

## 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.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |