**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 |
| Huawei, HiSilicon | Issue 1-1: The existing performance requirements for single-tap and the agreed scenario HST-SFN are exactly same as LTE. The NR specific features to bring better performance for NR HST are not covered yet, especially transmission 1b is an important and practical scenario. For 1a and 1b, only define performance requirements for transmission scheme 1b for DPS is enough, because tracking 2 TCI states can bring better performance compared to tracking 1 TCI state, also if UE can track two TCI states, it definitely can support to track one TCI state.  Issue 1-2: We are ok with the recommended WF. At the same time, we want to give some clarification for 1b test setup: the only difference between 1a and 1b is to activate 2 TCI states by using MAC CE “TCI States Activation/Deactivation for UE-specific PDSCH MAC CE” at the same with UE configured with two different TCI states associated with two different TRPs.  Issue 1-3: We are fine with recommended Option 1.  Multi-TRP transmission scheme is an important enhancements in NR Rel-16 eMIMO WI, there are many aspects needs to be discussed to decide the specific test parameters and the core part will be completed by March, 2020, considering limited high speed train performance requirements, i.e. only single tap related, are defined in NR Rel-15, to speed up the high speed train WI work and guide the real testing as early as possible, it is better to focus on the DPS transmission scheme and discuss this transmission scheme in the upcoming NR Rel-16 eMIMO WI.  Issue 1-4: For the recommended WF, we agree that transmission scheme 3 is not supported in Rel-16 and no requirements can be defined in Rel-16 HST WI. It is under study of RAN1 Rel-17 FeMIMO WI, company can bring analysis on performance benefits and feasibility to RAN1 directly. |
| Intel | **Issue 1-1: Whether to define new requirements and tests for DPS transmission scheme 1**  It is necessary to define UE demodulation requirements for DPS transmission scheme due to the following reasons:  - From UE demodulation perspective the channel propagation conditions are not same as HST Single tap model due to frequency jump in switching point. The receive processing is not same as in HST-SFN scenario since UE receives only one PDSCH at each time. We cannot guarantee reliable performance using HST single tap and HST-SFN test cases and need to define specific test  - The RRM TCI state switching performance test case do not allow to verify demodulation performance in HST DPS scenario since it is defined for another channel model and only for FR2  - Considering scheme 1a and 1b it is reasonable to start from 1a since supporting of 1b is not a mandatory feature. The main difference between these schemes is TCI state switching delay. Same time, in the worst case 1a requires 21ms + TRS periodicity which is rather negligible to overall test time and will not impact the UE performance. Moreover, we can switch off PDSCH scheduled slots during the TCI state switching period to avoid impact on performance.  **Issue 1-2: Test setup of transmission scheme 1**  Both Options 1 and 2 describe possible test procedure for DPS which do not require L1-RSPR measurements and reporting. Option 1 describes TCI state switching specifically for HST-SFN deployment. Same time Option 2 is more details description of 1a test case. Suggest combining these two options for test definition.  **Issue 1-3: Transmission scheme 2**  Taking into account limited time in eMIMO WI and left time in HST WI, we agree with proposed Option by CMCC: *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: Transmission scheme 3**  Our observations show that transmission schemes with distributed RS transmission outperforms JT in HST scenario. In this case, we would like to capture the following in agreements:  - Transmission scheme 3 is not supported in Rel-16, no requirements are defined in Rel-16 HST WI.  - Some companies show that transmission schemes 3 provide performance benefits for HST scenario compare to JT. |
| Samsung | **Issue 1-1: Whether to define new requirements and tests for DPS transmission scheme 1**  We prefer the option 1  Regarding with option 1a, from demodulation requirement perspective, the requirement is same with single tap, only considering with RRM impact on TCI state switching.  Regarding with option 2a, from demodulation requirement perspective, the requirement is same with single tap, only considering with RRM impact on TCI state activate  **Issue 1-2: Test setup of transmission scheme 1**  We prefer the option 1 and the recommended WF.  Form demodulation requirement perspective, it is feasible to test setup of transmission schemes1, with deterministic selection.  Regarding to option 2, we are not sure whether the related TCI state active and TCI state switching requirement can be verified from demodulation requirement. The related TCI state requirement should be belonged to the scope of RRM.  '  **Issue 1-3: Transmission scheme 2**  We prefer the option 3 and the “Discuss transmission scheme 2 in eMIMO WI first,” in the recommended WF for option 1, the scope of transmission scheme 2 in eMIMO WI is targeting non-high speed scenario.  Transmission scheme2 is supported in NR eMIMO for general scenario. The related requirement should be discussed in the NR eMIMO WI.  Whether transmission scheme2 can support high Doppler scenario need to be further study. Meanwhile, we are not sure whether the gain can be achieved under high Doppler scenario with non-coherent transmission, compared with traditional joint transmission.  Regarding option 2: we are not ok. Considering there is no objective in the NR eMIMO WI to support high speed scenario. In case to support high speed scenario, there may be some new design or enhancement for high speed scenario. Considering the NR eMIMO is pure WI leading in RAN1, and the core part of eMIMO is completed by March, it is impossible to revise the objective of WI to study the RAN1 impact with high speed in Rel-16, which has impact on the schedule of NR eMIMO WI. Considering there is an objective of enhancement to high speed scenario for Rel-17 eMIMO WI, we suggest to discuss transmission 2 for high speed in later release.  Considering the left time of HST, there are still many open issue existed for basic HST deployment, such as single tap, SFN. While for transmission scheme 2 based on multi-DCI, the related issue, such as new PDSCH scheduling, rate matching, PDCCH scheduling, My suggestion is to focus on the open issue of basic HST deployment. No requirement of transmission 2 in HST WI. Meanwhile, the requirement of transmission 2 is targeting with non-high speed scenario in NR eMIMO WI without changed the related WID.  **Issue 1-4: Transmission scheme 3**  We are OK with recommended WF. Since transmission scheme3 is not supported in Rel-16 eMIMO, it belongs to the objective of Rel-17 eMIMO, aiming to enhancement to support HST-SFN deployment scenario. |
| Ericsson | Issue 1-1: We support Option 1. If we agree with the deterministic TRP switching test in Issue 1-2, from the UE demodulation point of view, we don’t see any difference between the single tap scenario in Topic #3 and DPS.  Issue 1-2: We support the recommended way forward.  Issue 1-3: We prefer Option 2. Since it is the same transmission mode but the difference is the UE speed, it is natural to define the requirements under the same WI.  Issue 1-4: We support the recommended way forward by the moderator. At the moment, we are not sure how RAN1 designs the physical layer for Rel-17 FeMIMO. It could be same as transmission mode 3 we discussed so far; it could be different. Our preference is RAN4 does not have any action in Rel-16 HST WI performance part. |
| vivo | Issue 1-1: For DPS, we foreseen that it should be an important NR HST deployment scenario, and suggest to prioritize the requirement discussion regarding to this scenario. We understand the logic to reuse single-tap requirement and test cases, but note that those requirements are based on simulations considering mostly tunnel scenario, with smaller Ds and Dmin. We are not sure if these requirements are directly applicable to DPS. Therefore, in our view, one possible way to move forward is to **adopt option 1 for HST-SFN, and enhance related requirement in HST single-tap for DPS if necessary**.  For selection of 1a or 1b, in our view, if issue 1-2 can move forward, we can define requirements and test cases for both 1a and 1b for different UE capability.  Issue 1-2: We support the recommended way forward.  Issue 1-3: In our view, R16 eMIMO enhancement is targeting on different scenario, and its performance is not promising for HST. Anyway, we prefer option 2 in the moderator’s WF: ***Discuss transmission scheme 2 in eMIMO WI (including HST-SFN deployment scenario)***  Issue 1-4: We support the recommended way forward. Scheme 3 should be discussed in RAN1. |

## 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:* |

*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

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| --- | --- | --- |
| **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 |

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| Huawei, HiSilicon | Issue 2-1: We prefer Option 1 (1667Hz).  Issue 2-2: We prefer Option 1 (870Hz). From our analysis, firstly we do not think that +/- 0.1ppm frequency error should be considered, secondly the performance requirements defined by RAN4 is used to test the product, it should be meaningful and consistent with the UL to make the whole performance feasible from NR system point of view, not paper work, i.e. 870Hz that is the half of maximum Doppler of 1740Hz for BS side for 15kHz SCS.  We think that RAN4 should first reach consensus about whether there is any impact of ±0.1ppm first, and then discuss Doppler based that. we have detailed analysis:  At the UE side, UE receives signals with carrier frequency from gNB and then UE estimates the Rx frequency according to from several RRUs. Then UE calculates Tx frequency according to . So we can get the following equation:  It can be understood that ±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. However, neither of them is defined alone in specs. Normally, UE DL frequency error can be reduce to about 10Hz after frequency offset compensation. Considering the worst case, UE DL frequency error is assumed to be ±0.1ppm. Note that UE only estimate one simultaneously, the frequency error is +0.1ppm or -0.1ppm.  For one path, frequency tracking compensation value should be near maximum Doppler shift (875Hz or -875Hz). For two path or more, frequency tracking compensation value should be in somewhere between [-875Hz, 875Hz] which depends on UE implementation based on power of different path.  Without considering UE UL frequency error, the Doppler spread is calculated by negative maximum Doppler and positive maximum Doppler , i.e. . However, assuming the UE UL frequency error is x, the Doppler spread is calculated by , and x, i.e. . It is to say maximum frequency tracking capability is not affected by UE UL frequency error since Doppler spread is no change even if there is UE UL frequency error exists.  Issue 2-3: As analyzed in Issue 2-2, no need to consider ±0.1ppm frequency error and should be discussed firstly before discussion on Maximum Doppler shift.  Issue 2-4: Maybe it is better that RAN4 first discussion Issue 5-2 before discussion the related maximum Doppler shift.  Issue 2-5: We are ok with MCS 13 recommended by moderator.  Issue 2-6: We are ok with Option 1. |
| Intel | **Issue 2-1: Maximum Doppler frequency for 30KHz 500km/h**  Option 2 (1500 Hz) was derived assuming some impact of max channel delay on UE performance. Same time it is not clear how Doppler frequency is associated with impact of max channel delay. In this case we ask other companies to provide more technical details on this aspect. At current stage we prefer Option 1 (1667)  **Issue 2-2: Maximum Doppler frequency for 15KHz 500km/h**  Based on our results there is no performance difference between scenarios with 851 and 875 Hz max Doppler frequencies. In this case we prefer to have requirements with higher Doppler frequency. Same time we think it is reasonable to align UE and BS scenarios. Therefore, both Options 2 (875) and Option 3 (870) are acceptable for us  **Issue 2-3: ppm assumption for UE DL frequency error**  Based on our evaluations the max frequency estimation error is negligible and less than 15 Hz for SNR > 0 dB. Therefore, we should not consider 0.1PPM error in determination of max supported Doppler frequency.  **Issue 2-4: Maximum doppler frequency for 350km/h**  This value depends on at least DMRS configuration and requires preliminary link level analysis. Prefer to discuss necessity of HST-SFN requirements for 350 km/h first  **Issue 2-5: MCS for HST-SFN (Rank 2)**  No need to define requirements for different MCS values. The test purpose is to verify proper UE receive processing and higher MCS value is more suitable for this purpose. Prefer Option 1 (MCS 13).  **Issue 2-6: Antenna configuration for HST-SFN**  Agree with Option 1. |
| Samsung | **Issue 2-1: Maximum Doppler frequency for 30KHz 500km/h**  We support with option 2 with 1500Hz. In terms of 70% TP, both 1500Hz and 1667Hz are feasible. While for 1667Hz, the maximum throughput cannot achieved.  **Issue 2-2: Maximum Doppler frequency for 15KHz 500km/h**  We are ok with option 1, based on our results, The SNR with 70% TP for MCS17 is very high under Doppler value with 875Hz for FDD.  **Issue 2-4: Maximum doppler frequency for 350km/h**  Depend on whether 350km/h for SFN is needed.  **Issue 2-5: MCS for HST-SFN (Rank 2)**  We are OK with MCS 13 recommended WF by moderator.  **Issue 2-6: Antenna configuration for HST-SFN**  We are OK with recommended WF by moderator. |
| NTT DOCOMO, INC. | Issue 2-1: We prefer Option 1. Opponent of option 2 pointed out that the signals from neighboring cell doesn’t fit in CP length. However, if we consider distance between TRPs, interference from farthest cell is much less, e.g., 20 dB, than signal from serving cell. Thus, we think the issue can be negligible.  Issue 2-2: For sake of progress, we can accept any of options 1, 2 and 3. If it is not possible to achieve peak throughput, we can accept changing MCS.  Issue2-3: We prefer Option 2.  Issue2-4: we are OK with moderator’s suggestion. Our comments is described in Issue 5-2.  Issue2-5: From the improvement of cellular coverage, we prefer MCS 4 since requirement for MCS 4 can be tested at low SNR.  Issue2-6: we are OK with moderator’s suggestion. |

## 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”* |

# 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. |

|  |  |
| --- | --- |
| Huawei, HiSilicon | Issue 3-1: We prefer Option 2 (870Hz). To align with BS, it is suitable to set the maximum Doppler shift 870Hz. If greater than 870Hz is defined for UE side, then the BS side will receive signal with Doppler greater than 1740Hz which is maximum Doppler BS side can solve as per the agreement last meeting. This will lead to UE performance degradation. Therefore, it is needed for UE to align with BS and makes the NR HST performance requirements defined in NR Rel-16 meaningful and feasible for the whole NR system, not paper work. If some higher requirements need to be defined in the future, RAN4 can design the corresponding requirements as per the real request.  In addition, 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. It is needed to define maximum Doppler shift less than 875Hz.  Issue 3-2: MCS 17 is acceptable for us.  Issue 3-3: As per our proposal (Option 4), 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. |
| Intel | **Issue 3-1: Maximum Doppler frequency for 15KHz 500km/h**  From UE demodulation perspective we can support much higher value then option 1 (1250 Hz) since TRS capability is limited by 1750 Hz. In this case the reason to consider 1250 Hz is not clear. The option 2 (870 Hz) is more reasonable in this case since in real system we cannot consider separately UE and BS max supported Doppler frequency and overall system performance will be poor if UE operates on higher than 870 Hz Doppler frequency. Prefer Option 2.  **Issue 3-2: MCS for HST single tap (Rank 1)**  There is no problem to define requirements with MCS 17 since there are many PDSCH demodulation test cases defined for 64QAM. Prefer to use MCS 17 if HST RRM signaling will be provided during the demodulation test. Otherwise, we cannot guarantee reliable performance for some UEs with both considered MCS values (see Issue 3-3)  **Issue 3-3: The assumption of HST single tap requirements**  We agree that each UE may have its own implementation of frequency tracking. Our evaluations show that UEs with conventional multi-shot tracking cannot reach max throughput in HST Single tap conditions with 500 km/h speed and using of single-shot tracking is more reasonable. We did not see this problem in Rel-15 since Rel-15 HST single tap requirements were defined for less Doppler frequencies: 750 Hz and 1000 Hz.  Potentially UE can detect HST single tap conditions, but it is easier to provide network assistance signaling. This option does not lead to increased UE complexity and does not suffer from detection errors. Same time, we can reuse already defined HST RRM network assistance signaling.  For simulation results alignment it is reasonable to keep specific TRS processing up to UE implementation.  We suggest the following agreement for discussion: *Do not mandate the specific TRS processing for requirement definition and left it up to company decision. Provide HST RRM signaling during the demodulation test to inform UE about HST conditions.* |
| Samsung | **Issue 3-1: Maximum Doppler frequency for 15KHz 500km/h**  We prefer option 2 (870Hz), to align with BS side,  **Issue 3-2: MCS for HST single tap (Rank 1)**  We are ok with MCS 17  **Issue 3-3: The assumption of HST single tap requirements**  We are ok option 1 in option B with recommend WF by moderator. Whether adjustment the timing/frequency offset estimation should be belonged to UE implementation. |
| Ericsson | Issue 3-1: We are ok with 1250Hz Doppler for FDD 15kHz  Issue 3-2: We are ok with MCS17  Issue 3-3: We are ok to define the requirements based on the worst case. It is up to UE implementation how to use the configured TRS for their time/frequency tracking. Companies can bring the worst-case results, then RAN4 sets the requirements based on the averaging. |
| NTT DOCOMO, INC. | Issue3-1: We support Option 1, since 1750Hz can be compensated by TRS. The value of 875 Hz is based on requirements of BS (1740 Hz). However, BS performance can be improved in the future based on implementation effort. In addition, Rel.16 LTE HST single-tap requirements support maximum Doppler frequency of 972Hz. NR should be better than LTE.  Issue3-2: We prefer Option1.  Issue 3-3: Introduce the multi-shot TRS-based requirements is baseline. |
| vivo | Issue3-1: We support Option 1. The max Doppler requirements does not necessarily need to be aligned between BS and UE.  Issue3-3: We support to define requirements for the worst case. Whether to use single-shot or multi-shot is UE implementation. |

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

*Agenda 8.17.2.1.4*

## Companies’ contributions summary

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| **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? |
| Huawei, HiSilicon | Issue 4-1: We prefer Rank 1 only. The performance for Rank 2 is not either feasible or bad, as per our simulation results, Rank 2 with MCS 13 and MCS 17 are not feasible.  Issue 4-2: For Rank1, we prefer MCS 13. As per our simulation results, Rank 1 with MCS 17 cannot achieve the maximum throughput, the working point is a little low and lower throughput for MCS 4.  Issue 4-3: We are fine with Option 1.  Issue 4-4: Whether transmit PDSCH in special slots or not is both OK for us. |
| Intel | **Issue 4-1: Rank for multi-path fading channel**  Agree on Option 3 (Rank 1) considering that Rank2 + 2 additional DMRS symbols is mandatory with capability signaling feature.  **Issue 4-2: MCS for multi-path fading channel**  With practical channel estimation we can support MCS 17 with less than 1.5 dB degradation compare to perfect channel estimation. Prefer MCS 17 for requirement definition.  **Issue 4-3: Antenna configuration for multi-path fading channel**  Agree with recommended WF.  **Issue 4-4: scheduling in TDD special slot for multi-path fading** Agree with observation and proposal. Potentially HST-SFN performance in special slot may also degrade. Suggest checking this issue for HST-SFN JT. |
| Samsung | **Issue 4-1: Rank for multi-path fading channel**  We prefer rank1, based on our results. All the MCS are feasible.  **Issue 4-2: MCS for multi-path fading channel**  MCS4, 13, and MCS 17 are feasible for Rank1, we prefer to selection one of them for Rank1 requirements  MCS 4 only for Rank2 if rank2 agreed  **Issue 4-3: Antenna configuration for mutli-path fading channel**  We are ok with recommend WF  **Issue 4-4: scheduling in TDD special slot for multi-path fading**  We prefer to align with normal PUSCH assumption in Rel-15, considering the impact is minor. |
| Ericsson | Issue 4-1: We are ok to choose Rank1  Issue 4-2: If we choose Rank 1, we see no issue with setting a High MCS (17) if there is not much performance degradation between 2Rx, and 4Rx. We have seen up to 8dB degradation comparing 4Rx with 2Rx, so we prefer not to choose MCS which would significantly degrade 2Rx performance.  Issue 4-3: Ok with 2x2, and 2x4  Issue 4-4: [Comment to CMCC], for multipath fading frequency offset error correction from TRS cannot solely be used in correcting the doppler frequency. Under LOS conditions (AWGN HST single tap) the TRS can be used to correct the frequency offset error. But with multipath we need both TRS, and DMRS for frequency offset estimation. With 1 symbol DMRS, we cannot do doppler estimation. Therefore, the demodulation of the special slot is simply not possible. |
| NTT DOCOMO, INC. | Issue4-1: We prefer Option3.  Issue4-2: It is important to make cellular coverage and to optimize the performance. We prefer MCS 4 and MCS 17.  Issue4-3: We are OK with moderator’s suggestion.  Issue4-4: We need further simulation on this issue. |

## 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** |
| #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 #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. |
| Huawei, HiSilicon | Issue 5-1: Considering the signaling for support HST-SFN to be introduce in release 16 core specification, it is not feasible to make HST-SFN as release independent from Release 15.  Issue 5-2: We prefer Option 1. Do not define requirements for target speed of 350km/h. For UE passing the performance requirements for 500km/h definitely support 350km/h related, no need to duplicate the testing, also performance requirements for 300km/h were defined.  Issue 5-3: We are ok with Option 1. |
| Intel | **Issue 5-1: Release independent issue**  Agree to define HST fading requirements in release independent manner. For HST Single tap we have same view as at this stage we cannot agree to define requirements in release independent manner since Rel-16 RRM signaling is one of the potential options to provide UE information on HST Single tap conditions. For HST-SFN it is not reasonable to define requirements in this manner since anyway all Rel-15 UE will skip this test.  **Issue 5-2: Target speed for HST-SFN**  The advanced UE receive processing in HST-SFN does not depend on the speed and will be same for 350 km/h and 500 km/h. Same time, in the previous meeting it was agreed to have single capability signaling for HST-SFN with up to 500 km/h. Therefore, if UE supports HST-SFN then it should pass requirements for 500 km/h and there is no reason to pass requirements for 350 km/h.  Prefer Option 1.  **Issue 5-3: Test applicability for different channel models**  The UE receive processing and test motivation are different for all three scenarios. In HST-SFN UE needs to properly track big frequency jump and handle two opposite taps. In HST fading the main limitation factor is accuracy of max Doppler spread estimation. Same time in HST Single tap proper UE frequency tracking is verified when Doppler frequency quickly changes.  We cannot guarantee reliable performance in two others tests if UE will pass third test case. In this case prefer to not define any applicability rules between these tests |
| Samsung | **Issue 5-1: Release independent issue**  We prefer not to define HST related requirement in release independent manner, since both the signals for RRM and Demod are introduced in Rel-16.  **Issue 5-2: Target speed for HST-SFN**  We prefer option1, If UE can support with SFN with 500km/h, Considering there is no different receiver processing for SFN, we prefer there is no requirement for SFN with 350km/h  **Issue 5-3: Test applicability for different channel models**  We prefer option1, In LTE Rel-16 HST, we also have the same applicability rule. T HST-500 test is not applicable to UE that has passed HST-SFN-500 test. |
| Ericsson | Issue 5-1: Since HST-SFN joint transmission needs the network signaling, it should be from Rel-16.  Not strong view for single tap since RAN4 has already introduced HST-Single with 300km/h. If we consider HST single 500km/h is a extension of HST single, it should be applicable from Rel-16.  We are ok to define the multi-path fading test as the release independence from Rel-15.  Issue 5-3: In our understanding the purpose of three tests, i.e., HST single, HST multi-path, and HST-SFN, is different. We prefer to apply all three test cases. |
| NTT DOCOMO, INC. | Issue5-1: Define Rel.16 HST requirements, i.e., HST-SFN, single tap and multi-path fading, as release independent from Release 15.  Issue5-2: In the discussion of Issue 2-5 (HST-SFN 500 km/h), MCS 17 is not feasible to achieve the maximum throughput. We prefer to define MCS 17 requirements for 350km/h to optimize the performance.  Issue5-3: Three models (HST-SFN, Single-tap and multi-path) are different in terms of propagation scenarios. We prefer to apply all three tests. |
| vivo | Issue5-1: For the requirements that requires signaling support, it is difficult to revise R15 RRC at this stage. Therefore, both HST-SFN and HST-singletap should be supported from R16.  Fine to support HST-multipath in a release independent manner.  Issue5-2: We prefer option 1. But some compromise can be considered. If significant performance gain can be achieved for 350km/h compared to that of 500km/h, we can add some test cases with a note indicating that it should be applied for 350km/h. |

## 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”* |