[101e][318] NR_DL1024QAM_Demod_NWM - Version 0.0.8
RAN4

3GPP TSG-RAN WG4 Meeting #101-e **R4-2120733**

Electronic Meeting, 1 – 12 Nov 2021

Agenda item: 8.6.5, 8.6.5.1, 8.6.5.2, 8.6.5.3

Source: Moderator (Ericsson)

Title: Email discussion summary for [101e][318] NR_DL1024QAM_Demod

Document for: Information

1 Introduction

In this email thread for DL 1024QAM Demod, the following topics will be covered:

1. General (8.6.5.1)
2. PDSCH requirements (8.6.5.2)
3. CQI requirements (8.6.5.3)

2 Topic #1: General

2.1 Companies' contributions summary

Table 1:

T-doc number	Company	Proposals/Observations

R4-2118688	Ericsson	– RAN4#101-e, November 2021 (This meeting)
		  ○ Agree with the work plan for UE demodulation requirement part.
		  ○ Agree with the scope of UE demodulation and CSI reporting requirements.
		  ○ Agree with the initial simulation assumption for UE demodulation and CSI reporting requirements.
		– RAN4#101bis-e, January 2022
		  ○ Collect the initial simulation results for alignment.
		  ○ Narrow down the simulation assumption, if necessary, based on the initial simulation results.
		  ○ Decide the CR work split.
		– RAN4#102-e, February 2022
		  ○ Collect the simulation results.
		  ○ Finalize the test parameters for UE demodulation and CSI reporting requirements.
		  ○ Review the draft CRs for TS38.101-4.
		– RAN4#103, May 2022
		  ○ Collect the simulation results.
		  ○ Agree with the demodulation and CSI reporting requirements based on the simulation results

2.2 Open Issues Summary

Issue 1-1: Work plan

- Proposals
  - Option 1 (Ericsson):
    - RAN4#101-e, November 2021 (This meeting)
      - Agree with the work plan for UE demodulation requirement part.
      - Agree with the scope of UE demodulation and CSI reporting requirements.
      - Agree with the initial simulation assumption for UE demodulation and CSI reporting requirements.
    - RAN4#101bis-e, January 2022
      - Collect the initial simulation results for alignment.
      - Narrow down the simulation assumption, if necessary, based on the initial simulation results.
      - Decide the CR work split.
    - RAN4#102-e, February 2022
      - Collect the simulation results.
      - Finalize the test parameters for UE demodulation and CSI reporting requirements.
      - Review the draft CRs for TS38.101-4.
    - RAN4#103, May 2022
      - Collect the simulation results.
      - Agree with the demodulation and CSI reporting requirements based on the simulation results with impairments.
      - Agree with the CR for TS38.101-4.
- Recommended WF
    - Confirm the work plan

2.3 Companies' views collection for 1st round

2.3.1 Open issues

Feedback Form 1: Work plan

1 – Ericsson Japan K.K. We support this work plan.
2 – Qualcomm Technologies Int Agree with the proposed work plan

2.4 Summary for 1st round

2.4.1 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.

Issue 1-1 Work plan

Summary of 1st round discussion:

- Proposals
  - Option 1 (Ericsson, Qualcomm):
    - RAN4#101-e, November 2021 (This meeting)
      - Agree with the work plan for UE demodulation requirement part.
      - Agree with the scope of UE demodulation and CSI reporting requirements.
      - Agree with the initial simulation assumption for UE demodulation and CSI reporting requirements.
    - RAN4#101bis-e, January 2022
      - Collect the initial simulation results for alignment.
      - Narrow down the simulation assumption, if necessary, based on the initial simulation results.
      - Decide the CR work split.
    - RAN4#102-e, February 2022
      - Collect the simulation results.
      - Finalize the test parameters for UE demodulation and CSI reporting requirements.
      - Review the draft CRs for TS38.101-4.
    - RAN4#103, May 2022
      - Collect the simulation results.
      - Agree with the demodulation and CSI reporting requirements based on the simulation results with impairments.
      - Agree with the CR for TS38.101-4.

Tentative agreements:

- Agree on the work plan

Recommendations for 2nd round:

- No need for 2nd round discussion

2.5 Discussion in 2nd round

Moderator: no need for 2nd round based on the outcome of 1st round discussion

3 Topic #2: PDSCH requirements

3.1 Companies' contributions summary

T-doc number	Company	Proposals / Observations
R4-2117430	Apple	***Observation #1:*** *With 2 RX, the max throughput is only achieved with rank 1 and MCS 24.* ***Observation #2:*** *With 4RX and MCS24 max TP can be achieved with rank 2.* ***Observation #3:*** *With MCS 26 max TP can only be achieved with 4RX and rank 1.* **Proposal #1: Do not consider MCS 26 for further performance evaluation or requirements definition.** ***Observation #4****: It is feasible to use MCS 24, rank 1 with 2RX or rank 2 with 4RX for requirements definition.* **Proposal #2: Define PDSCH demod requirements with TDLA30-10 channel model. Further evaluate performance with different MIMO correlation if 4x4 is agreed.** **Proposal #3: Introduce CQI reporting requirements with 1024QAM in static channel.** **Proposal #4: Further discuss if CQI reporting requirements for 1024QAM are defined with rank 1 or rank 2.**

Figure 1:

<table>
<tr>
<td>R4-2118689</td>
<td>Ericsson</td>
<td>
Proposal 1: RAN4 defines PDSCH demodulation requirements with 1024QAM for FR1.
Proposal 2: Set the following parameters for PDSCH demodulation requirement with 1024QAM.

MCS25
Rank 1
Antenna configuration: 2x2 / 2x4 ULA Low
Propagation channel model: TDLA30-10
FDD SCS=15kHz with 10MHz and TDD SCS=30kHz with 40MHz.

Proposal 3: Assume Tx EVM 2.0% to derive the UE demodulation requirements with 1024QAM.
Proposal 4: RAN4 defines SDR requirements with 1024QAM MCS for FR1.
Proposal 5: Set MCS indexes for SDR test with 1024QAM based on the table below:
<table>
<tr><th>Maximum number of PDSCH MIMO layers</th><th>Maximum modulation format</th><th>Scaling factor</th><th>MCS (Upper bound)</th><th>MCS (Practical)</th></tr>
<tr><td>1</td><td>10</td><td>1</td><td>[25]</td><td rowspan="4">[25]</td></tr>
<tr><td>1</td><td>10</td><td>0.8</td><td>[21]</td></tr>
<tr><td>1</td><td>10</td><td>0.75</td><td>[19]</td></tr>
<tr><td>1</td><td>10</td><td>0.4</td><td>[9]</td></tr>
<tr><td>2</td><td>10</td><td>1</td><td>[25]</td><td rowspan="4">[25]</td></tr>
<tr><td>2</td><td>10</td><td>0.8</td><td>[21]</td></tr>
<tr><td>2</td><td>10</td><td>0.75</td><td>[19]</td></tr>
<tr><td>2</td><td>10</td><td>0.4</td><td>[9]</td></tr>
<tr><td>4</td><td>10</td><td>1</td><td>[25]</td><td rowspan="4">[25]</td></tr>
<tr><td>4</td><td>10</td><td>0.8</td><td>[21]</td></tr>
<tr><td>4</td><td>10</td><td>0.75</td><td>[21]</td></tr>
<tr><td>4</td><td>10</td><td>0.4</td><td>[10]</td></tr>
</table>
</td>
</tr>
</table>

Figure 2:

<table>
<tr>
<td>R4-2118026</td>
<td>Intel</td>
<td>

Proposal 1: RAN4 to define both normal demodulation requirements and SDR requirements for 1024QAM modulation

Proposal 2: RAN4 to adopt the values of $MCS^j_{upperbound}$ from Table 1 to be used to derive MCS for 1024QAM SDR requirements

Table 1. Look up table to derive MCS for 1024QAM

<table>
<tr><th>v^j_{Layers}</th><th>Q^j_m</th><th>f^j</th><th>$MCS^j_{upperbound}$</th><th>$MCS^j_{practical}$</th><th>MCS^j_{req}</th></tr>
<tr><td>1</td><td>10</td><td>1</td><td>25</td><td rowspan="4">TBD</td><td>TBD</td></tr>
<tr><td>1</td><td>10</td><td>0.8</td><td>21</td><td>TBD</td></tr>
<tr><td>1</td><td>10</td><td>0.75</td><td>19</td><td>TBD</td></tr>
<tr><td>1</td><td>10</td><td>0.4</td><td>9</td><td>TBD</td></tr>
<tr><td>2</td><td>10</td><td>1</td><td>25</td><td rowspan="4">TBD</td><td>TBD</td></tr>
<tr><td>2</td><td>10</td><td>0.8</td><td>21</td><td>TBD</td></tr>
<tr><td>2</td><td>10</td><td>0.75</td><td>19</td><td>TBD</td></tr>
<tr><td>2</td><td>10</td><td>0.4</td><td>9</td><td>TBD</td></tr>
</table>

Proposal 3: RAN4 to use the following typical test parameters and scenarios to design the new 1024QAM demodulation performance requirements:

FDD

CBW/SCS	10 MHz CBW / 15 kHz SCS
PDSCH configuration	Type A mapping, Start symbol 2, Duration 12
DMRS configuration	Type 1, Single symbol, additional DMRS: pos1
Antenna configuration	2x2 and 2x4, Low correlation
Number of MIMO layers	1

TDD

CBW/SCS	40 MHz CBW / 30 kHz SCS
PDSCH configuration	Type A mapping, Start symbol 2
TDD pattern	7D1S2U
DMRS configuration	Type 1, Single symbol, additional DMRS: pos1
Antenna configuration	2x2 and 2x4, Low correlation
Number of MIMO layers	1

Proposal 4: RAN4 to define demodulation performance requirements for 1024QAM under the following propagation conditions:

Option 1: TDLA30-10

Option 2: TDLD30-10

Proposal 5: For UE performance requirements with 1024QAM the Tx EVM shall be limited to 2%.

Proposal 6: Select between MCS 23-26 based on the simulation results under agreed assumptions

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</table>

Figure 3:

<table>
<tr>
<td>R4-2119024</td>
<td>Huawei</td>
<td>

Proposal 1: Define new performance requirements for NR DL 1024QAM for FR1 based on the evaluations by using the following simulation assumptions:

<table>
<tr><th>Parameters</th><th>Value</th></tr>
<tr><td>Channel bandwidth</td><td>10MHz for FDD 15kHz, 40MHz for TDD 30kHz</td></tr>
<tr><td>EVM</td><td>2.8% TX EVM</td></tr>
<tr><td>FRC</td><td>Rank 1/2, MCS 23/24/25/26</td></tr>
<tr><td>Propagation condition</td><td>TDLD30-5</td></tr>
<tr><td>Antenna configuration</td><td>2x2 ULA low, 2x4 ULA low</td></tr>
<tr><td>SSB configuration</td><td>Periodicity 20 ms, Allocated in first slot within 20ms</td></tr>
<tr><td>PDSCH configuration</td><td>Type A, Start symbol 2, Duration 12</td></tr>
<tr><td>DMRS configuration</td><td>Type 1, 1 additional DMRS, Single symbol</td></tr>
<tr><td>TRS configuration</td><td>20 ms periodicity, 2 slots, Offset 10 ms</td></tr>
<tr><td>TDD UL-DL pattern</td><td>7D1S2U with S=6:4:4 for TDD 30kHz</td></tr>
<tr><td>HARQ process number</td><td>4 for FDD 15kHz, 8 for TDD 30kHz</td></tr>
<tr><td>Transform precoding</td><td>CP-OFDM</td></tr>
<tr><td>Allocated RBs</td><td>Full BWP</td></tr>
<tr><td>PRB bundling</td><td>2</td></tr>
<tr><td>Precoding model</td><td>Random Precoding, per slot, WB granularity (codebook configuration Single panel Type 1)</td></tr>
<tr><td>Receiver type</td><td>MMSE-IRC</td></tr>
<tr><td>Test metric</td><td>70% of max TP</td></tr>
</table>

Proposal 2: Define SDR requirements for FR1 1024QAM. Perform simulation to find the maximum achievable MCS indexes for rank 1 and rank 2 separately.

</td>
</tr>
</table>

Figure 4:

<table>
<tr>
<td>R4-2119323</td>
<td>Qualcomm Incorporated</td>
<td>

Proposal 1: For FR1 1024QAM PDSCH Demodulation performance requirements, define tests for UE with 2 RX and 4 RX UE, with applicability rule that UE should be tested only for the largest number of supported RX.

Proposal 2: For FR1 1024QAM PDSCH Demodulation performance requirements, define performance requirements using Number of MIMO Layers = 1.

Proposal 3: For FR1 1024QAM SDR performance requirements, define performance requirements using Number of MIMO Layers = 1 and 2.

Proposal 4: For FR1 1024QAM PDSCH Demodulation performance requirements, agree on simulation assumptions using as reference the Tests currently included in 38.101-4 for FR1 256QAM (2RX UE: Table 5.2.2.1.1-3, Test 1-3 (FDD) and Table 5.2.2.2.1-3 (TDD), Test 1-3; 4RX UE: Table 5.2.3.1.1-3, Test 1-3 (FDD) and Table 5.2.3.2.1-3, Test 1-3 (TDD));

Proposal 5: Use Tx EVM reference value based on the outcome of the ongoing BS RF EVM requirement discussion (TxEVM=2.5% or 2.8%).

Proposal 6: For FR1 1024QAM PDSCH Demodulation performance requirements, in the simulation assumptions use MAX_1024_QAM MCS Table and consider MCS=23.

</td>
</tr>
</table>

Figure 5:

3.2 Open Issues Summary

Issue 2-1: Whether to define new PDSCH requirements for 1024QAM

- Proposals
  - Option 1: Yes (Ericsson, Apple, Intel, Huawei, Qualcomm)
    - Option 1a: Define tests for UE with 2 RX and 4 RX UE, with applicability rule that UE should be tested only for the largest number of supported RX (Qualcomm)

- Recommended WF
  - *Agree on defining new PDSCH requirements for 1024QAM, and discuss option 1a further*

Issue 2-2: MCS

- Proposals
    - Option 1: MCS25 (Ericsson)
    - Option 2: Do not consider MCS26 (Apple)
    - Option 3: Select between MCS 23-26 based on the simulation results under agreed assumptions (Intel, Huawei)
    - Option 4: Use MAX_1024_QAM MCS Table and consider MCS=23 (Qualcomm)

- Recommended WF
  - *Discuss further*

Issue 2-3: Rank

- Proposals
    - Option 1: Rank 1 (Ericsson, Intel, Qualcomm)
    - Option 2: Rank 1/2 (Huawei)

- Recommended WF
  - *Discuss further*

Issue 2-4: Antenna configuration

- Proposals
  - Option 1: 2x2 / 2x4 ULA Low (Ericsson, Intel, Huawei)

- Recommended WF
  - *Agree on option 1*

Issue 2-5: Propagation channel model

- Proposals
  - Option 1: TDLA30-10 (Ericsson, Apple, Intel)
    - Option 1a: TDLA30-10 and further evaluate performance with different MIMO correlation if 4x4 is agreed (Apple)
  - Option 2: TDLD30-10 (Intel)
  - Option 3: TDLD30-5 (Huawei)

- Recommended WF
  - *Discuss further*

Issue 2-6: SCS and Bandwidth

- Proposals
  - For FDD
    - Option 1: SCS=15kHz with 10MHz (Ericsson, Intel, Huawei)
  - For TDD
    - Option 1: SCS=30kHz with 40MHz (Ericsson, Intel, Huawei)

- Recommended WF
  - *Agree on option 1 for both FDD and TDD*

Issue 2-7: TDD pattern

- Proposals
    - Option 1: 7D1S2U (Intel)
        - Option 1a: 7D1S2U, with S=6:4:4 for TDD 30kHz (Huawei)

- Recommended WF
    - *Discuss further*

Issue 2-8: PDSCH configuration

- Proposals
    - For FDD
        - Option 1: Type A mapping, Start symbol 2, Duration 12 (Intel, Huawei)
    - For TDD
        - Option 1: Type A mapping, Start symbol 2 (Intel)

- Recommended WF
    - *Discuss further*

Issue 2-9: DMRS configuration

- Proposals
    - Option 1: Type 1, Single symbol, additional DMRS: pos1 (Intel, Huawei)

- Recommended WF
    - *Discuss further*

Issue 2-10: Tx EVM

- Proposals
    - Option 1: Assume Tx EVM 2.0% to derive the UE demodulation requirements with 1024QAM (Ericsson, Intel)

- Option 2: 2.8% (Huawei)
- Option 3: Use Tx EVM reference value based on the outcome of the ongoing BS RF EVM requirement discussion (TxEVM=2.5% or 2.8%) (Qualcomm)

- Recommended WF
  - *Discuss further*

Issue 2-11: Other PDSCH configurations

- Proposals
  - Option 1: Define new performance requirements for NR DL 1024QAM for FR1 based on the evaluations by using the following simulation assumptions: (Huawei)

Table 2:

Parameters	**Value**
SSB configuration	Periodicity 20 ms, Allocated in first slot within 20ms
TRS configuration	20 ms periodicity, 2 slots, Offset 10 ms
HARQ process number	4 for FDD 15kHz, 8 for TDD 30kHz
Transform precoding	CP-OFDM
Allocated RBs	Full BWP
PRB bundling	2
Precoding model	Random Precoding, per slot, WB granularity (code-book configuration Single panel Type 1)
Receiver type	MMSE-IRC
Test metric	70% of max TP

- Recommended WF
  - *Discuss further*

Issue 2-12: Whether to define SDR requirements

- Proposals
    - Option 1: Yes (Ericsson, Intel, Huawei, Qualcomm)

- Recommended WF
    - *Agree on defining SDR requirements*

Issue 2-13: MCS index for SDR test (if introduced)

- Proposals
    - Option 1: Set MCS indexes for SDR test with 1024QAM based on Table 1 (Ericsson)

Table 1 MCS indexes for SDR test with 1024QAM.

Table 3:

Maximum number of PDSCH MIMO layers	**Maximum modulation format**	**Scaling factor**	**MCS (Upper bound)**	**MCS (Practical)**
1	10	1	[25]	[25]
1	10	0.8	[21]	
1	10	0.75	[19]	
1	10	0.4	[9]	
2	10	1	[25]	[25]
2	10	0.8	[21]	
2	10	0.75	[19]	
2	10	0.4	[9]	
4	10	1	[25]	[25]
4	10	0.8	[21]	
4	10	0.75	[21]	
4	10	0.4	[10]	

Note: The final MCS is set from MIN(Upper bound MCS, Practical MCS)				

- Option 2: RAN4 to adopt the values of MCSjupperbound from Table 1 to be used to derive MCS for 1024QAM SDR requirements (Intel)

Table 1. Look up table to derive MCS for 1024QAM

v^j_{Layers}	Q^j_m	f^j	$MCS^j_{upperbound}$	$MCS^j_{practical}$	MCS^j_{req}
1	10	1	25	TBD	TBD
1	10	0.8	21		TBD
1	10	0.75	19		TBD
1	10	0.4	9		TBD
2	10	1	25	TBD	TBD
2	10	0.8	21		TBD
2	10	0.75	19		TBD
2	10	0.4	9		TBD

Figure 6:

- Option 3: Perform simulation to find the maximum achievable MCS indexes for rank 1 and rank 2 separately (Huawei, Qualcomm)

– Recommended WF

  - Note from the moderator: It is mentioned the demodulation requirements are specified up to MIMO rank is 2, according to WID RP-202886.
  - *Discuss further*

3.3 Companies' views collection for 1st round

3.3.1 Open issues

Feedback Form 2: Open issues for PDSCH requirements

1 – Apple GmbH

Issue 2-1: Whether to define new PDSCH requirements for 1024QAM

Yes, with the assumption that same applicability rules as existing test cases with other modulation order would apply to 1024QAm as well.

Issue 2-2: MCS

For SDR requirements higher MCS can be selected, like MCS 25. For PDSCH demod requirements MCS 24 may be suitable. We can further check based on simulation results and achievable TP.

Issue 2-3: Rank

For SDR: Rank 1,2

For PDSCH demod: Rank 1 would be sufficient, as we cannot achieve good performance in fading channel with 2 RX and 2 layers.

Issue 2-4: Antenna configuration
We support option 1/ recommended WF.

Issue 2-5: Propagation channel model

Option 1. We don't think LOS propagation conditions are suitable or practical for FR1. We dont think we should discuss MIMO correlation further if Option 1 is agreed for issue 2-4.

Issue 2-6: SCS and Bandwidth
Agree with recommended WF.

Issue 2-7 - 2-9. 2-11
Support option 1.

Issue 2-10: Tx EVM
We can further discuss based on the outcome of BS RF EVM discussion. But the TX EVM used for simulations should be smaller than the requirement in our understanding.

Issue 2-12: Whether to define SDR requirements
OPtion 1. Yes.

Issue 2-13: MCS index for SDR test (if introduced)
Option 3 and use option 2 as starting point. We dont see the need to introduce SDR requirements for upto 4 layers.

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2 – Ericsson Japan K.K.

Issue 2-1: Whether to define new PDSCH requirements for 1024QAM

Option 1. Regarding the applicability of 2Rx/4Rx, we think the existing applicability rule in TS38.101-4 5.1.1.2 is aligned with Option 1a.

Issue 2-2: MCS

Option 1. Because it is similar MCS to the existing 256QAM test case. But we are ok to evaluate the performance. We propose to evaluate MCS23, 24, and 25.

Issue 2-3: Rank

Option 1. Because the existing 256QAM test uses rank 1, we can reuse the same setup.

Issue 2-4: Antenna configuration

Agree with Option 1.

Issue 2-5: Propagation channel model

We prefer to TDLA30-10 as it is used in the existing 256QAM test.

Issue 2-6: SCS and Bandwidth

We are ok with Option 1.

Issue 2-7: TDD pattern

We are ok with Option 1.

Issue 2-8: PDSCH configuration

We are ok with Option 1.

Issue 2-9: DMRS configuration

We are ok with Option 1.

Issue 2-10: Tx EVM

We prefer Option 1 since it is the same assumption as LTE 1024QAM UE demodulation requirements.

Issue 2-11: Other PDSCH configurations

We are ok with Option 1.

Issue 2-12: Whether to define SDR requirements

We are ok with Option 1.

Issue 2-13: MCS index for SDR test (if introduced)

We propose to evaluate the practical MCS based on Intel proposal. We agree with Apple. We don't need to define MCS for rank 4.

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3 – HiSilicon Technologies Co. Ltd

Issue 2-1: Whether to define new PDSCH requirements for 1024QAM

Option 1. The existing applicability for different number of RX defined in TS 38.101-4 should be reused.

Issue 2-2: MCS

Option 3. Further simulation is needed until next meeting.

Issue 2-3: Rank

Considering only rank1 is selected for the existing 256QAM case, we are also OK with Option 1.

Issue 2-4: Antenna configuration

Option 1.

Issue 2-5: Propagation channel model

Option 3. As per WID, better channel conditions (e.g., LOS or LOS-like channels) with no mobility or very low mobility environment is expected for 1024QAM.

Issue 2-6: SCS and Bandwidth

Option 1.

Issue 2-7: TDD pattern

Option 1.

Issue 2-8: PDSCH configuration

Option 1.

Issue 2-9: DMRS configuration

Option 1.

Issue 2-10: Tx EVM

We are OK to discuss this issue after the conclusion are made from BS RF side. For the feasibility evaluation for MCS selection, the EVM value output from the BS RF discussion should be adopted. For the performance requirements definition, the EVM value can be further discussed.

Issue 2-11: Other PDSCH configurations

Option 1.

Issue 2-12: Whether to define SDR requirements

Option 1.

Issue 2-13: MCS index for SDR test (if introduced)

Option 2 and Option 3.

4 – Qualcomm Technologies Int

Issue 2-1: Whether to define new PDSCH requirements for 1024QAM

Support 1a;

Issue 2-2: MCS

We agree with Option 2 and should not consider MCS26. For PDSCH, we should avoid potential flooring introduced by Tx EVM but we can consider also MCS 24 in the simulation assumptions.

Issue 2-3: Rank

Support Option 1, to keep alignment with 256QAM.

Issue 2-4: Antenna configuration

We support the recommended WF;

Issue 2-5: Propagation channel model

Support Option 1, TDLA-30-10 to keep alignment with 256QAM tests. Also in LTE, 1024QAM requirements were introduced with fading channels (EPA5);

MIMO correlation should be discussed in Issue 2-4.

Issue 2-6: SCS and Bandwidth

We support the recommended WF;

Issue 2-7: TDD pattern

Support option 1a;

Issue 2-8: PDSCH configuration

Support option 1;

Issue 2-9: DMRS configuration

Support option 1;

Issue 2-10: Tx EVM

We support Option 3. We are not against Option 1, but a feedback on the feasibility by TE vendors should be required before we agree on this value otherwise the requirement might not be testable.

Issue 2-11: Other PDSCH configurations

Ok with option 1;

Issue 2-12: Whether to define SDR requirements

We support the recommended WF;

Issue 2-13: MCS index for SDR test (if introduced)

We support Option 3. Option 2 can be used as a starting assumption;

5 – ROHDE & SCHWARZ

Issue 2 -10: Tx EVM

We propose to follow the BS agreement and to not further tighten the requirement. For 1024QAM it is expected that high SNR values will be required, which will require higher output power from the test system, thus potentially worsen the signal quality from the gNodeB emulator.

6 – Intel Corporation (UK) Ltd

Issue 2-1: Whether to define new PDSCH requirements for 1024QAM

Support Option 1. The existing applicability rule in Section 5.1.1 of TS38.101-4 covers Option 1a

Issue 2-2: MCS

Support Option 3. We propose to perform simulations for several MCSs under the agreed assumptions to choose one with feasible SNR test point. Ok to exclude MCS26 from the list.

Issue 2-3: Rank

Support Option 1.

Issue 2-4: Antenna configuration

Support Option 1.

Issue 2-5: Propagation channel model

Ok with any of three options.

Issue 2-6: SCS and Bandwidth

Support Option 1.

Issue 2-7: TDD pattern

Support Option 1.

Issue 2-8: PDSCH configuration

Support Option 1.

Issue 2-9: DMRS configuration

Support Option 1.

Issue 2-10: Tx EVM

Ok to follow feedback from the TE vendors.

Issue 2-11: Other PDSCH configurations

Ok with Option 1.

Issue 2-12: Whether to define SDR requirements

Support Option 1.

Issue 2-13: MCS index for SDR test (if introduced)

Support Option 2.

3.4 Summary for 1st round

3.4.1 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.

Issue 2-1: Whether to define new PDSCH requirements for 1024QAM

Summary of 1st round discussion:

- Proposals
  - Option 1: Yes (Ericsson, Apple, Intel, Huawei, Qualcomm)
    - Option 1a: Define tests for UE with 2 RX and 4 RX UE, with applicability rule that UE should be tested only for the largest number of supported RX (Qualcomm)

Tentative agreements:

- Define new PDSCH requirements for 1024 QAM by using the existing new applicability rule.

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-2: MCS

- Proposals
  - Option 1: MCS25 (Ericsson)
  - Option 2: Do not consider MCS26 (Apple)
  - Option 3: Select between MCS 23-26 based on the simulation results under agreed assumptions (Intel, Huawei)
  - Option 4: Use MAX_1024_QAM MCS Table and consider MCS=23 (Qualcomm)

Tentative agreements:

- Evaluate MCS23, 24, 25, and decide based on the simulation results in the next meeting.

Recommendation for 2nd round:

- No need for the 2nd round discussion

Issue 2-3: Rank

- Proposals
  - For PDSCH:
    - Option 1: Rank 1 (Ericsson, Intel, Qualcomm, Huawei, Apple)
    - Option 2: Rank 1/2 (Huawei)

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-4: Antenna configuration

- Proposals
  - Option 1: 2x2 / 2x4 ULA Low (Ericsson, Intel, Huawei, Apple, Qualcomm)

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-5: Propagation channel model

- Proposals
  - Option 1: TDLA30-10 (Ericsson, Apple, Intel, Qualcomm)

        - Option 1a: TDLA30-10 and further evaluate performance with different MIMO correlation if 4x4 is agreed (Apple)
    - Option 2: TDLD30-10 (Intel)
    - Option 3: TDLD30-5 (Huawei, Intel)

Tentative agreements:

- Choose either Option 1 (TDLA30-10) or Option 3 (TDLD30-5).

Recommendation for 2nd round:

- Further discuss Option 1 and option 3 in the 2nd round

Issue 2-6: SCS and Bandwidth

- Proposals
    - For FDD
        - Option 1: SCS=15kHz with 10MHz (Ericsson, Intel, Huawei)
    - For TDD
        - Option 1: SCS=30kHz with 40MHz (Ericsson, Intel, Huawei)

Tentative agreements:

- Option 1 for both FDD and TDD

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-7: TDD pattern

- Proposals
    - Option 1: 7D1S2U (Intel, Apple, Ericsson)
        - Option 1a: 7D1S2U, with S=6:4:4 for TDD 30kHz (Huawei, Qualcomm)

Tentative agreements:

- 7D1S2U, with S=6:4:4 for TDD 30kHz

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-8: PDSCH configuration

- Proposals
  - For FDD
    - Option 1: Type A mapping, Start symbol 2, Duration 12 (Intel, Huawei, Ericsson, Apple, Qualcomm)
  - For TDD
    - Option 1: Type A mapping, Start symbol 2 (Intel, Huawei, Ericsson, Apple, Qualcomm)

Tentative agreements:

- Option 1 for both FDD and TDD

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-9: DMRS configuration

- Proposals
  - Option 1: Type 1, Single symbol, additional DMRS: pos1 (Intel, Huawei, Ericsson, Apple, Qualcomm)

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-10: Tx EVM

- Proposals
  - Option 1: Assume Tx EVM 2.0% to derive the UE demodulation requirements with 1024QAM (Ericsson, Intel)
  - Option 2: 2.8% (Huawei)
  - Option 3: Use Tx EVM reference value based on the outcome of the ongoing BS RF EVM requirement discussion (TxEVM=2.5% or 2.8%) (Qualcomm)

Tentative agreements:

- Consider following options:
  - Option 1: 2.0%
  - Option 2: 2.5%
  - Option 3: 2.8%
- Also wait for the outcome of BS RF EVM requirement discussion.

Recommendation for 2nd round:

- Further discuss whether to use the same or smaller value as the BS RF EVM requirement

Issue 2-11: Other PDSCH configurations

- Proposals
  - Option 1: Define new performance requirements for NR DL 1024QAM for FR1 based on the evaluations by using the following simulation assumptions: (Huawei)

Table 4:

Parameters	**Value**
SSB configuration	Periodicity 20 ms, Allocated in first slot within 20ms
TRS configuration	20 ms periodicity, 2 slots, Offset 10 ms
HARQ process number	4 for FDD 15kHz, 8 for TDD 30kHz
Transform precoding	CP-OFDM
Allocated RBs	Full BWP

PRB bundling	2
Precoding model	Random Precoding, per slot, WB granularity (codebook configuration Single panel Type 1)
Receiver type	MMSE-IRC
Test metric	70% of max TP

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-12: Whether to define SDR requirements

- Proposals
  - Option 1: Yes (Ericsson, Intel, Huawei, Qualcomm)

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 2-13: MCS index for SDR test (if introduced)

- Proposals
  - Option 1: Set MCS indexes for SDR test with 1024QAM based on Table 1 (Ericsson)

Table 1 MCS indexes for SDR test with 1024QAM.

Table 5:

Maximum number of PDSCH MIMO layers	**Maximum modulation format**	**Scaling factor**	**MCS (Upper bound)**	**MCS (Practical)**
1	10	1	[25]	[25]
1	10	0.8	[21]	
1	10	0.75	[19]	
1	10	0.4	[9]	
2	10	1	[25]	[25]
2	10	0.8	[21]	
2	10	0.75	[19]	
2	10	0.4	[9]	
4	10	1	[25]	[25]
4	10	0.8	[21]	
4	10	0.75	[21]	
4	10	0.4	[10]	
Note: The final MCS is set from MIN(Upper bound MCS, Practical MCS)				

- Option 2: RAN4 to adopt the values of MCS^{j}upperbound from Table 1 to be used to derive MCS for 1024QAM SDR requirements (Intel)

  Table 1. Look up table to derive MCS for 1024QAM

- Option 3: Perform simulation to find the maximum achievable MCS indexes for rank 1 and rank 2 separately (Huawei, Qualcomm)

Tentative agreements:

- Perform simulation to find the maximum achievable MCS indexes for rank 1 and rank 2 separately

v^j_{Layers}	Q^j_m	f^j	$MCS^j_{upperbound}$	$MCS^j_{practical}$	MCS^j_{req}
1	10	1	25	TBD	TBD
1	10	0.8	21		TBD
1	10	0.75	19		TBD
1	10	0.4	9		TBD
2	10	1	25	TBD	TBD
2	10	0.8	21		TBD
2	10	0.75	19		TBD
2	10	0.4	9		TBD

Figure 7:

- Use table 1 as starting assumption

  Table 1

v^j_{Layers}	Q^j_m	f^j	$MCS^j_{upperbound}$	$MCS^j_{practical}$	MCS^j_{req}
1	10	1	25	TBD	TBD
1	10	0.8	21		TBD
1	10	0.75	19		TBD
1	10	0.4	9		TBD
2	10	1	25	TBD	TBD
2	10	0.8	21		TBD
2	10	0.75	19		TBD
2	10	0.4	9		TBD

Figure 8:

Recommendation for 2nd round:

- No need for 2nd round discussion

3.5 Discussion in 2nd round

Issue 2-5: Propagation channel model

- Proposals
  - Option 1: TDLA30-10 (Ericsson, Apple, Intel, Qualcomm)
    - Option 1a: TDLA30-10 and further evaluate performance with different MIMO correlation if 4x4 is agreed (Apple)
  - Option 2: TDLD30-5 (Huawei, Intel)

Feedback Form 3: Propagation channel model

1 – Ericsson Japan K.K.

We prefer to reuse the same propagation channel model used for FR1 256QAM test. But we can discuss further in the next meeting based on the simulation results.

2 – Qualcomm Technologies Int

We also prefer option 1 but we can discuss Option 2 if the results show it helps in the definition the requirement

Issue 2-10: Tx EVM

- Proposals
  - Option 1: Assume Tx EVM 2.0% to derive the UE demodulation requirements with 1024QAM (Ericsson, Intel)
  - Option 2: 2.8% (Huawei)
  - Option 3: Use Tx EVM reference value based on the outcome of the ongoing BS RF EVM requirement discussion (TxEVM=2.5% or 2.8%) (Qualcomm)

1st round tentative agreements:

- Consider following options:
  - Option 1: 2.0%
  - Option 2: 2.5%
  - Option 3: 2.8%
- Also wait for the outcome of BS RF EVM requirement discussion.

2nd round discussion on whether to use the same or smaller value as the BS RF EVM requirement.

- Consider following options:
  - Option 1: Same as the BS RF EVM requirement
  - Option 2: Smaller than the BS RF EVM requirement

Feedback Form 4: Whether to use the same or smaller value as the BS RF EVM requirement

1 – Ericsson Japan K.K.

We prefer to assume the same Tx EVM assumption as LTE 1024QAM PDSCH demodulation requirements, so we prefer Option 1. On the other hand, we also need to consider the input from R&S: 'We propose to follow the BS agreement and to not further tighten the requirement.'

Since BS Tx EVM requirements for 1024QAM should be agreed in this meeting, we propose to wait for the BS RF decision and decide in the next meeting. We also propose to evaluate the PDSCH performance with the combination of MCS, channel and EVM options to check the achievable SNRs.

It is also great if TE vendors give inputs.

2 – Qualcomm Technologies Int

Based on the input received, it is our view that relying the outcome of the BS RF discussion would reduce the risk of feasibility issues and match with expectation of BS performance in the field, so we don't see a strong motivation to tighten the assumed Tx EVM for this test case.

Support Option 1: Same as the BS RF EVM requirement

3.6 Summary of 2nd round

Recommendation of WF **R4-2120699**:

Table 6:

Issue	Title	Recommendation of WF **R4-2120699**
3-5	**Propagation channel model**	Leave following two options for further selection based on the initial simulation results in the next meeting. – Option 1: TDLA30-10 – Option 2: TDLD30-5
3-10	**Tx EVM**	The assumed Tx EVM should be same or less than the BS Tx EVM requirement Consider following options: – Option 1: 2.0% – Option 2: 2.5% – Option 3: 2.8% Take the conclusion from BS Tx EVM discussion into consideration and then further decide.

4 Topic #3: CQI requirements

4.1 Companies' contributions summary

T-doc number	Company	Proposals / Observations
R4-2118690	Ericsson	**Proposal 1: RAN4 defines CQI definition tests with new CQI table with 1024QAM entries.** **Proposal 2: For 1024QAM CQI reporting test, RAN4 reuses the test setup and test metrics for 256QAM CQI reporting tests.** **Proposal 3: RAN4 sets one SNR test point to verify the UE reports CQI index 14 or 15 in the CQI table with 1024 entries.** **Proposal 4: RAN4 sets one more SNR test (e.g., 8/9dB) to verify the UE reports the proper CQI index when the new CQI table is configured.**

Figure 9:

R4-2119025	Huawei	**Proposal 1: Define new performance requirements for NR DL 1024QAM for FR1 based on the evaluations by using the following simulation assumptions:**

Parameters	Value
Channel bandwidth	10MHz for FDD 15kHz, 40MHz for TDD 30kHz
Tx EVM	2.8%
FRC	Rank 1/2, CQI 14/15
Propagation condition	AWGN
Antenna configuration	2x2 ULA low, 2x4 ULA low
SSB configuration	Periodicity 20 ms, Allocated in first slot within 20ms
PDSCH configuration	Type A, Start symbol 2, Duration 12
DMRS configuration	Type 1, 1 additional DMRS, Single symbol
TRS configuration	20 ms periodicity, 2 slots, offset 10 ms
TDD UL-DL pattern	7D1S2U with S=6:4:4 for TDD 30kHz
HARQ process number	4 for FDD 15kHz, 8 for TDD 30kHz
Allocated RBs	Full BWP
PRB bundling size	2
Receiver type	MMSE-IRC
Test metric	70% of max TP
ReportConfigType	Periodic
CSI-Report periodicity and offset	5/0
CQI-table	Table 4
reportQuantity	cri-RI-PMI-CQI
cqi-FormatIndicator	Wideband
pmi-FormatIndicator	Wideband
CQI/RI/PMI delay	8
Maximum number of HARQ transmission	1
Other parameters	Same as the common test parameters in TS38.101-4

Figure 10:

4.2 Open Issues Summary

Issue 3-1: Whether to define new CQI definition tests for 1024QAM

- Proposals
  - Option 1: Yes, with new CQI table with 1024QAM entries (Ericsson, Apple, Huawei)

- Recommended WF
  - *Agree on defining new CQI definition requirements for CQI table with 1024QAM entries.*

Issue 3-2: Test setup

- Proposals
  - Option 1: Reuse the existing CQI reporting tests (Ericsson)
  - Option 2: Use the following simulation assumptions: (Huawei)

Table 7:

Parameters	**Value**
Channel bandwidth	10MHz for FDD 15kHz, 40MHz for TDD 30kHz
Tx EVM	2.8%
FRC	Rank 1/2, CQI 14/15
Propagation condition	AWGN
Antenna configuration	2x2 ULA low, 2x4 ULA low
SSB configuration	Periodicity 20 ms, Allocated in first slot within 20ms
PDSCH configuration	Type A, Start symbol 2, Duration 12
DMRS configuration	Type 1, 1 additional DMRS, Single symbol
TRS configuration	20 ms periodicity, 2 slots, offset 10 ms
TDD UL-DL pattern	7D1S2U with S=6:4:4 for TDD 30kHz
HARQ process number	4 for FDD 15kHz, 8 for TDD 30kHz

Allocated RBs	Full BWP
PRB bundling size	2
Receiver type	MMSE-IRC
Test metric	70% of max TP
ReportConfigType	Periodic
CSI-Report periodicity and offset	5/0
CQI-table	Table 4
reportQuantity	cri-RI-PMI-CQI
cqi-FormatIndicator	Wideband
pmi-FormatIndicator	Wideband
CQI/RI/PMI delay	8
Maximum number of HARQ transmission	1
Other parameters	Same as the common test parameters in TS38.101-4

- Recommended WF
  - *Discuss further*

Issue 3-3: Rank for CQI definition test

- Proposals
  - Option 1: 1 and 2 (Huawei)
  - Option 2: 1 or 2 (Apple)
  - Option 3: 2 (Ericsson)
- Recommended WF
  - *Discuss further*

Issue 3-4: Tx EVM

- Proposals

- Option 1: 2.8% (Huawei)

undefined

- Recommended WF
  - *Discuss further*

Issue 3-5: Test metric

- Proposals
  - Option 1: Reuse the existing CQI definition tests (Ericsson)

- Recommended WF
  - *Discuss further*

Issue 3-6: Test points

- Proposals
  - Option 1: 1 (SNR corresponding to CQI index 14/15) (Huawei)
  - Option 2: 2 (Lower SNR point in addition to SNR corresponding to CQI index 14/15) (Ericsson)

undefined

- Recommended WF
  - *Discuss further*

4.3 Companies' views collection for 1st round

4.3.1 Open issues

Feedback Form 5: Open issues for CQI requirements

1 – Apple GmbH

Issue 3-2: Test setup

Option 1- Re-use parameters from existing CQI reporting test in AWGN to the extent possible

Issue 3-3: Rank for CQI definition test

Option 2. Based on simulation results decided on either rank 1 or rank 2.

Issue 3-4: Tx EVM

Same as PDSCH demod, once that is finalized.

Issue 3-5: Test metric

Option 1.

Issue 3-6: Test points

Option 1. Introducing requirements for 1 SNR pair at 1024QAM CQI is sufficient.

2 – Ericsson Japan K.K.

Issue 3-1: Whether to define new CQI definition tests for 1024QAM

We are ok with Option 1.

Issue 3-2: Test setup

We think both options are basically same instead of Tx EVM.

Issue 3-3: Rank for CQI definition test

We prefer to reuse the existing CQI reporting test. (Option 2)

Issue 3-4: Tx EVM

It should be aligned with PDSCH demodulation requirements.

Issue 3-5: Test metric

We are ok with Option 1.

Issue 3-6: Test points

Option 2, but we are open to specify only one test point corresponding to CQI14/15.

3 – HiSilicon Technologies Co. Ltd

Issue 3-1: Whether to define new CQI definition tests for 1024QAM

Option 1.

Issue 3-2: Test setup

The difference between Option 1 and Option 2 is EVM and rank. We prefer to discuss them in Issue 3-3 and Issue 3-4 and reuse the existing CQI reporting configuration for other parameters.

Issue 3-3: Rank for CQI definition test

Option 2. It should be decided based on simulation results.

Issue 3-4: Tx EVM

We prefer to discuss Tx EVM issue in Issue 2-10 and align the value in CQI reporting case with PDSCH demodulation case.

Issue 3-5: Test metric

Option 1.

Issue 3-6: Test points

Option 1. We think one requirement is sufficient to verify the correct implementation of the new table 4.

4 – Qualcomm Technologies Int

Issue 3-1: Whether to define new CQI definition tests for 1024QAM

We agree with recommended WF;

Issue 3-2: Test setup

Agree with Option 1;

Issue 3-3: Rank for CQI definition test

In line with PDSCH testing, we support defining CQI testing with 1 Layer only;

Issue 3-4: Tx EVM

Should be aligned with the outcome of Issue 2-10;

Issue 3-5: Test metric

Support Option 1;

Issue 3-6

We are ok with option 1;

4.4 Summary for 1st round

4.4.1 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.

Issue 3-1: Whether to define new CQI definition tests for 1024QAM

- Proposals
  - Option 1: Yes, with new CQI table with 1024QAM entries (Ericsson, Apple, Intel, Huawei, Qualcomm)

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 3-2: Test setup

- Proposals

- Option 1: Reuse the existing CQI reporting tests (Ericsson)
- Option 2: Use the following simulation assumptions: (Huawei)

Table 8:

Parameters	**Value**
Channel bandwidth	10MHz for FDD 15kHz, 40MHz for TDD 30kHz
Tx EVM	2.8%
FRC	Rank 1/2, CQI 14/15
Propagation condition	AWGN
Antenna configuration	2x2 ULA low, 2x4 ULA low
SSB configuration	Periodicity 20 ms, Allocated in first slot within 20ms
PDSCH configuration	Type A, Start symbol 2, Duration 12
DMRS configuration	Type 1, 1 additional DMRS, Single symbol
TRS configuration	20 ms periodicity, 2 slots, offset 10 ms
TDD UL-DL pattern	7D1S2U with S=6:4:4 for TDD 30kHz
HARQ process number	4 for FDD 15kHz, 8 for TDD 30kHz
Allocated RBs	Full BWP
PRB bundling size	2
Receiver type	MMSE-IRC
Test metric	70% of max TP
ReportConfigType	Periodic
CSI-Report periodicity and offset	5/0
CQI-table	Table 4
reportQuantity	cri-RI-PMI-CQI
cqi-FormatIndicator	Wideband
pmi-FormatIndicator	Wideband
CQI/RI/PMI delay	8
Maximum number of HARQ transmission	1
Other parameters	Same as the common test parameters in TS38.101-4

Tentative agreements:

- Reuse the existing CQI reporting tests
- Rank and EVM are based on the outcome of issue 3-3 and 3-4

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 3-3: Rank for CQI definition test

- Proposals
  - Option 1: 1 and 2 (Huawei)
  - Option 2: 1 or 2 (Apple, Ericsson, Huawei)
  - Option 3: 2 (Ericsson)
  - Option 4: 1 (Qualcomm)

Tentative agreements:

- Option 2 and make decision on 1 or 2 based on the simulation in the next meeting

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 3-4: Tx EVM

- Proposals
  - Option 1: 2.8% (Huawei)

Tentative agreements:

- Aligned with PDSCH demodulation requirements.

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 3-5: Test metric

- Proposals
  - Option 1: Reuse the existing CQI definition tests (Ericsson, Apple, Intel, Huawei, Qualcomm)

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

Issue 3-6: Test points

- Proposals
  - Option 1: 1 (SNR corresponding to CQI index 14/15) (Huawei, Apple, Qualcomm, [Ericsson])
  - Option 2: 2 (Lower SNR point in addition to SNR corresponding to CQI index 14/15) (Ericsson)

Tentative agreements:

- Option 1

Recommendation for 2nd round:

- No need for 2nd round discussion

4.5 Discussion in 2nd round

Moderator: no need for 2nd round based on the outcome of 1st round discussion

5 Recommendations for Tdocs

5.1 1st round

New Tdoc:

Table 9:

Tdoc	Title	Source	Comments
R4-2120699	Way forward for NR DL1024QAM demodulation and CQI reporting requirements	Ericsson	Including the simulation assumption

5.2 2nd round

Table 10:

Tdoc	Title	Source	Comment
R4-2120699	Way forward for NR DL1024QAM demodulation and CQI reporting requirements	Ericsson	Agreeable

6 Annex

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

Feedback Form 6: Contact information

1 – Qualcomm Technologies Int Qualcomm, Pierpaolo Vallese (pvallese@qti.qualcomm.com
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