**3GPP TSG-RAN WG4 Meeting #116 R4-2511481**

**Bengaluru, India, August 25th – 29th, 2025**

**Agenda item:** 7.22.1

**Source:** Moderator (CMCC)

**Title:** Topic summary for [116][335] A-IoT\_demod

**Document for:** Information

# Introduction

This summary focuses on Demod performance requirements for Rel-19 Solutions for Ambient IoT, including agenda 7.22.8 Demodulation performance requirements for device 1 and 7.22.9 Demodulation performance requirements for Ambient-IoT BS.

# Topic #1: General

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2510389 | CMCC, Huawei, HiSilicon | Proposal 1: RAN4 to agree the latest Demodulation performance part work plan for “Solutions for Ambient IoT (Internet of Things) in NR” as presented in this contribution.  **RAN4#116**  Demodulation performance requirements for device 1   * Initial discussion on test scenarios * Initial discussion on simulation parameters   Demodulation performance requirements for Ambient-IoT BS   * Initial discussion on test scenarios * Initial discussion on simulation parameters   **RAN4#116-bis**  Demodulation performance requirements for device 1   * Discuss and agree on test scenarios * Discuss and agree on required simulation parameters * CR split   Demodulation performance requirements for Ambient-IoT BS   * Discuss and agree on test scenarios * Discuss and agree on required simulation parameters * CR split   **RAN4#117**  Demodulation performance requirements for device 1   * Companies provide simulation results for alignment * Discuss and agree on the demodulation performance requirements * Provide initial CRs   Demodulation performance requirements for Ambient-IoT BS   * Companies provide simulation results for alignment * Discuss and agree on the demodulation performance requirements * Provide initial CRs   **RAN4#118**  Demodulation performance requirements for device 1   * Finalization of the remaining issues and agree on CRs.   Demodulation performance requirements for Ambient-IoT BS   * Finalization of the remaining issues and agree on CRs. |

## Open issues summary

**Issue 1-1: Work plan**

* **Proposals**
  + Proposal 1: RAN4 to agree the latest Demodulation performance part work plan for “Solutions for Ambient IoT (Internet of Things) in NR (CMCC, Huawei, HiSilicon)
    - RAN4#116
      * Demodulation performance requirements for device 1
        + Initial discussion on test scenarios
        + Initial discussion on simulation parameters
      * Demodulation performance requirements for Ambient-IoT BS
        + Initial discussion on test scenarios
        + Initial discussion on simulation parameters
    - RAN4#116-bis
      * Demodulation performance requirements for device 1
        + Discuss and agree on test scenarios
        + Discuss and agree on required simulation parameters
        + CR split
      * Demodulation performance requirements for Ambient-IoT BS
        + Discuss and agree on test scenarios
        + Discuss and agree on required simulation parameters
        + CR split
    - RAN4#117
      * Demodulation performance requirements for device 1
        + Companies provide simulation results for alignment
        + Discuss and agree on the demodulation performance requirements
        + Provide initial CRs
      * Demodulation performance requirements for Ambient-IoT BS
        + Companies provide simulation results for alignment
        + Discuss and agree on the demodulation performance requirements
        + Provide initial CRs
    - RAN4#118
      * Demodulation performance requirements for device 1
        + Finalization of the remaining issues and agree on CRs.
      * Demodulation performance requirements for Ambient-IoT BS
        + Finalization of the remaining issues and agree on CRs.
* **Recommended WF**
  + Approve the work plan R4-2510389

**Issue 1-2: Deployment and topology**

* **Proposals**
  + Proposal 1: D1T1-B (Samsung)
* **Recommended WF**
  + D1T1-B

**Issue 1-3: Operation system**

* **Proposals**
  + Proposal 1: Consider the standalone operation when defining the PRDCH requirement, FFS on considering the in-band operation when defining the PRDCH requirement (Samsung)
* **Recommended WF**
  + Standalone
  + FFS In band

# Topic #2: Device 1 Demodulation

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2509400 | Samsung | Connectivity topologies  Proposal 1: RAN4 focuses on D1T1-B scenario for specifying the A-IoT Device demodulation requirement  PRDC  Observation 1: There is no ACK/NACK feedback for R2D transmission, it is difficult to have the statistics for throughput. TE has no idea about whether the A-IoT device correctly decoded the PRDCH or not  Proposal 2: RAN4 should further discuss how to test the PRDCH demodulation requirement for Ambient-IoT devices.  R2D timing  Observation 2: RAN1 has designed the preamble-based R2D transmission with R-TAS signal to indicate the starting point of the PRDCH transmission, and designed postamble transmission to indicate the end of the PRDCH transmission  Proposal 3: RAN4 should further discuss whether to include the R2D preamble detection when defining demodulation requirement for PRDCH  In-band or standalone operation  Proposal 4: Consider the standalone operation when defining the PRDCH requirement, FFS on considering the in-band operation  Waveform & Nomology  Proposal 5: RAN4 to define PRDCH requirement with DFT-s-OFDM with OOK-4 waveform for 15KHz SCS.  Observation 3: The value of M will impact on the length of R2D chip duration, R2D postamble related operation, CP handling and minimum Btx,R2D # of PRBs  Proposal 6: RAN4 should discuss the proper value of M when defining PRDCH requirement, M as 24 can be considered as starting point.  Repetition  Proposal 7: No repetition when defining PRDCH requirement  Chanel coding and CRC  Observation 4: Both 6-bit CRC and 16-bit CRC can be supported for PRDCH transmission  Proposal 8: Consider the number of 16-bits CRC as starting point when defining PRDCH requirement.  R2D line coding  Proposal 9: RAN4 will follow the R2D line coding to define the corresponding PRDCH requirement.  Maximum TBS  Proposal 10: RAN4 should further discuss the number of TBS used for defining PRDCH demodulation requirement  Channel Bandwidth  Proposal 11: Considering the number of PRB as 3 for starting point when defining PRDCH requirement. FFS on other R2D transmission bandwidth configuration  Test metric  Proposal 12: RAN4 should further discuss the proper test metric for defining the A-IoT device demodulation requirement  Channel Model  Proposal 13: RAN4 should further discuss the proper channel used for defining the number of TBS used for defining PDRCH requirement  R2D multiplexing  Proposal 14: RAN4 focuses on single device to define PRDCH requirement. |
| R4-2510840 | Ericsson | Observation 1: Ambient IoT device demodulation requirements are conducted OTA.  Observation 2: 3GPP creates new specifications for Ambient IoT device and BS performance requirements.  Proposal 1: If RAN4 defines PRDCH demodulation requirements, the requirements should be defined only with FR1 FDD SCS=15kHz.  Proposal 2: If RAN4 defines PRDCH demodulation requirements, use TDLA30-10.  Proposal 3: Ambient IoT device demodulation requirements are set based on 1Tx/1Rx antenna configuration.  Proposal 4: Define PRDCH demodulation requirement at least for Message 0 reception.  Proposal 5: Discuss the feasibility of defining PRDCH demodulation requirement for Message 2 reception.  Proposal 6: Test metric of PRDCH demodulation requirement is the SNR to achieve [1] % of probability of miss-detection of the paging (Message 0). TE can count the number of Message 1 to derive the miss-detection probability.  Proposal 7: RAN4 should choose one or more M values used for PRDCH based on the simulation results.  Proposal 8: RAN4 should specify the Ambient IoT device demodulation requirements in “Ambient IoT device radio transmission and reception”, if RAN4 agree to define the Ambient IoT device demodulation requirements. |
| R4-2510882 | Huawei, HiSilicon | Proposal 1: Define the demodulation requirements for PRDCH, the demodulation requirements can be captured in clause 10 of TS 38.191.  Proposal 2: Define test metric of 10% BLER and not define false alarm requirements.  Proposal 3: RAN4 to reuse RF receiver test procedure (defined in [3]) for demodulation test as starting point with following changes or additions:   * Re-consider the signal power to make the received power at reasonable range used for demodulation test. FFS for signal power. * Define the R2D message type as upper layer Data Transfer message * TE to determine whether a PRDCH is decoded successfully by checking whether a response PDRCH is sent.   Proposal 4: RAN4 to consider following parameters as start point:   |  |  | | --- | --- | | Test parameter | Proposal | | Channel model | TDLA30-10, Low | | SCS | 15 kHz | | Antenna configuration | 2T1R | | Number of bits | 20 bits | | M (Number of chips per OFDM symbol) | 6 | | Number of PRB | 2 | |
| R4-2510950 | CMCC | Proposal 1: Introduce new PRDCH channel for Device 1 demodulation requirements.  Proposal 2: Use 2T1R and TDLA30-10 for initial simulation.  Proposal 3: Reuse the same FRC reference sensitivity simulation in RF session, and wait their conclusion.  Proposal 4: At least define SNR at 10% BLER requirement. |

## Open issues summary

**Issue 2-1: Whether to define PRDCH the demodulation requirement**

* **Proposals**
  + Proposal 1: Define PRDCH the demodulation requirement for Ambient-IoT. (HW, CMCC)
* **Recommended WF**
  + Check Issue 2-2 first

**Issue 2-2: R2D message type, Test method and procedure**

* **Proposals**
  + Proposal 1: Use Message 0 as R2D demodulation message, then TE count the number of Message 1 to derive the miss-detection probability (Ericsson)
  + Proposal 2: (HW)
    - Re-consider the signal power to make the received power at reasonable range used for demodulation test. FFS for signal power.
    - Define the R2D message type as R2D Upper Layer Data Transfer message
    - TE to determine whether a PRDCH is decoded successfully by checking whether a response PDRCH is sent. The BLER could be derived with following equation:
* **Recommended WF**
  + TBD

**Issue 2-3: Multiplexing**

* **Proposals**
  + Proposal 1: focuses on single device to define PRDCH requirement (Samsung)
* **Recommended WF**
  + Single device

**Issue 2-4: Antenna configuration**

* **Proposals**
  + Proposal 1: 1T1R (Ericsson)
  + Proposal 1: 2T1R (HW, CMCC)
* **Recommended WF**
  + TBD

**Issue 2-5: Numerology**

* **Proposals**
  + Proposal 1: 15kHz SCS (Samsung, Ericsson, HW)
* **Recommended WF**
  + 15kHz SCS

**Issue 2-6: Preamble**

* **Proposals**
  + Proposal 1: Include the R2D preamble detection when defining demodulation requirement for PRDCH (Samsung)
* **Recommended WF**
  + TBD

**Issue 2-7: CRC**

* **Proposals**
  + Proposal 1: Consider the number of 16-bits CRC as starting point when defining PRDCH requirement (Samsung)
* **Recommended WF**
  + To be discussed

**Issue 2-8: R2D line coding**

* **Proposals**
  + Proposal 1: RAN4 will follow the R2D line coding to define the corresponding PRDCH requirement (Samsung)
* **Recommended WF**
  + R2D line coding

**Issue 2-9: Waveform**

* **Proposals**
  + Proposal 1: DFT-s-OFDM with OOK-4 waveform (Samsung)
* **Recommended WF**
  + DFT-s-OFDM with OOK-4

**Issue 2-10: M-chips for OOK**

Background: M can configured as {2, 4, 12, 24} based on RAN1 conclusion

* **Proposals**
  + Proposal 1: M=24 (Samsung)
  + Proposal 2: Choose one or more M values used for PRDCH based on the simulation results (Ericsson)
  + Proposal 3: M=6 (HW)
* **Recommended WF**
  + To be discussed

**Issue 2-11: Repetition**

* **Proposals**
  + Proposal 1: No repetition (Samsung)
* **Recommended WF**
  + To be discussed

**Issue 2-12: TBS**

* **Proposals**
  + Proposal 1: further discuss the number of TBS used for defining PRDCH demodulation requirement (Samsung)
  + Proposal 2: 20bis (HW)
* **Recommended WF**
  + To be discussed

**Issue 2-13: Channel bandwidth**

* **Proposals**
  + Proposal 1: 3 PRB as the starting point, FFS on other R2D transmission bandwidth configuration (Samsung)
  + Proposal 2: 2 PRB(HW)
* **Recommended WF**
  + To be discussed

**Issue 2-14: Channel model**

* **Proposals**
  + Proposal 1: TDLA30-10 (Ericsson, CMCC)
  + Proposal 2: TDLA30-10 low (HW)
* **Recommended WF**
  + TDLA30-10 low correlation if needed

**Issue 2-15: Test metric**

* **Proposals**
  + Proposal 1: [1] % MDR (Ericsson)
  + Proposal 2: 10% BLER and not define false alarm requirements (HW)
  + Proposal 3: At least define SNR at 10% BLER requirement (CMCC)
* **Recommended WF**
  + To be discussed

**Issue 2-16: Specification structure**

* **Proposals**
  + Proposal 1: RAN4 should specify the Ambient IoT device demodulation requirements in “Ambient IoT device radio transmission and reception”(Ericsson)
  + Proposal 2: The demodulation requirements can be captured in clause 10 of TS 38.191 (HW)
* **Recommended WF**
  + To be discussed

# Topic #3: Ambient-IoT BS demodulation

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2509399 | Samsung | Proposal 1: RAN4 focuses on D1T1-B scenario for specifying the A-IoT BS demodulation requirement  Proposal 2: RAN4 focuses on the standalone for specifying the A-IoT BS demodulation requirement.  Proposal 3: RAN4 to define PDRCH the demodulation requirement for Ambient-IoT  Observation 1: RAN1 has designed the preamble-based D2R transmission with D-TAS signal to indicate the starting point of the PDRCH transmission, and designed postamble transmission to indicate the end of the PDRCH transmission  Proposal 4: RAN4 should further discuss whether to include the preamble detection when defining demodulation requirement for PDRCH  Proposal 5: No Random-access requirement will be defined for Ambient-IoT.  Proposal 6: RAN4 should cover both BPSK and OOK modulation scheme when defining PDRCH requirement  Proposal 7: RAN4 will follow the RAN1 agreement related with waveform when defining PDRCH requirement  Proposal 8: RAN4 will follow the RAN1 agreement related with channel coding and FEC when defining PDRCH requirement  Proposal 9: RAN4 can consider the block-level repetition as 2 when defining PDRCH requirement  Proposal 10: RAN4 should further discuss the number of TBS used for defining PDRCH requirements  Observation 2: SFO not only affects the D2R transmission bandwidth, but also scale the small frequency shift value  Proposal 11: RAN4 should further discuss how to select the proper CBW when defining PDRCH requirements.  Proposal 12: RAN4 should further the proper test metric for defining the A-IoT BS PDRCH demodulation requirement  Proposal 13: RAN4 should further discussion the number of TBS used for defining PDRCH requirement |
| R4-2510841 | Ericsson | Observation 1: 3GPP creates new specifications for Ambient IoT device and BS performance requirements.  Proposal 1: If RAN4 defines PDRCH demodulation requirements, RAN4 should define PDRCH demodulation requirements only with FR1 FDD SCS=15kHz.  Proposal 2: If RAN4 defines PDRCH demodulation requirements, use TDLA30-10.  Proposal 3: Ambient IoT BS demodulation requirements are set based on 1Tx/1Rx antenna configuration.  Proposal 4: For BS demodulation performance, RAN4 should consider defining PDRCH demodulation requirements at least with Message 3 reception.  Proposal 5: Test metric of PDRCH demodulation requirement is the SNR to achieve [1] % of PDRCH block error probability (BLER).  Proposal 6: Consider applying block repetition, convolutional coding, and mid-amble insertion to PDRCH demodulation requirements.  Proposal 7: RAN4 should specify the Ambient IoT BS demodulation requirements in “Ambient IoT Base Station (BS) and Carrier-Wave (CW) node radio transmission and reception” and “Ambient IoT Base Station (BS) and Carrier-Wave (CW) node conformance testing” if RAN4 agreed to define the Ambient IoT BS demodulation requirements. |
| R4-2510883 | Huawei, HiSilicon | Proposal 1: Define the demodulation requirements for PDRCH, the demodulation requirements can be captured in clause 10 of TS 38.191.  Proposal 2: RAN4 to postpone the channel bandwidth and (Tb, Tc, R) discussion until related core part is stable.  Proposal 3: RAN4 to consider channel coding with 1/3 Convolutional Code for PDRCH requirements  Proposal 4: RAN4 to consider OOK for PDRCH requirements.  Proposal 5: RAN4 to set 10% SFO and assume coherence detection at reader side for simulation alignment.  Proposal 6: RAN4 to consider 1.92MHz device sampling rate.  Proposal 7: RAN4 to consider Amble length 31.  Proposal 8: RAN4 to consider following parameters as starting point:   |  |  | | --- | --- | | Test parameter | Proposal | | Channel model | TDLA30-10, Low | | SCS | 15 kHz | | Antenna configuration | 1T2R | | SFO | 10% | | Device sampling rate | 1.92 MHz | | Number of bits | FFS | |  | None | |  | FFS | |  | 32bits m-sequence | |  | FFS | | Channel coding indication | 1/3 Convolutional Code | |
| R4-2510915 | CMCC | Proposal 1: Introduce new PDRCH channel for A-IOT BS demodulation requirements.  Proposal 2: Consider both BPSK and OOK for simulation.  Proposal 3: Unmodulated single tone shall be configured for OOK signal.  Proposal 4: Consider 105 ppm SFO for simulation  Proposal 5: Configure 31 bit Preamble and 31 bit Midamble.  Proposal 6: Assume coherent receiver for Reader  Proposal 7: At least define SNR at 10% BLER requirement.  Proposal 8: Use 15kHz SCS, 1T2R and TDLA30-10 for initial simulation. |

## Open issues summary

**Issue 3-1: Whether to define PDRCH the demodulation requirement**

* **Proposals**
  + Proposal 1: Define PDRCH the demodulation requirement for Ambient-IoT. (Samsung, HW, CMCC)
* **Recommended WF**
  + Define PDRCH the demodulation requirement

**Issue 3-2: Whether to define Random-access demodulation requirement**

* **Proposals**
  + Proposal 1: No Random-access requirement will be defined for Ambient-IoT. (Samsung)
* **Recommended WF**
  + Directly discuss Issue 3-3

**Issue 3-3: D2R message type**

* **Proposals**
  + Proposal 1: consider defining PDRCH demodulation requirements at least with Message 3 reception (Ericsson)
* **Recommended WF**
  + TBD

**Issue 3-4: Preamble/Midamble**

* **Proposals**
  + Proposal 1: Further discuss whether to include the preamble detection when defining demodulation requirement for PDRCH (Samsung)
  + Proposal 2: Consider applying mid-amble insertion (Ericsson)
  + Proposal 3: Amble length 31bit (HW)
  + Proposal 4: Configure 31 bit Preamble and 31 bit Midamble (CMCC)
* **Recommended WF**
  + Configure 31 bit Preamble and 31 bit Midamble

**Issue 3-5: Reader detection assumption**

* **Proposals**
  + Proposal 1: coherence detection (HW, CMCC)
* **Recommended WF**
  + coherence detection

**Issue 3-6: Antenna configuration**

* **Proposals**
  + Proposal 1: 1T1R (Ericsson)
  + Proposal 1: 1T2R (HW, CMCC)
* **Recommended WF**
  + TBD

**Issue 3-7: Numerology**

* **Proposals**
  + Proposal 1: 15kHz SCS ( Ericsson, HW, CMCC)
* **Recommended WF**
  + 15kHz SCS

**Issue 3-8: Modulation**

* **Proposals**
  + Proposal 1:both BPSK and OOK modulation scheme (Samsung, CMCC)
  + Proposal 2: OOK modulation (HW)
* **Recommended WF**
  + OOK modulation

**Issue 3-9: Waveform**

* **Proposals**
  + Proposal 1: follow the RAN1 agreement related with waveform (Samsung)
  + Proposal 2: backscattering a carrier wave (CW) (Ericsson)
  + Proposal 3: Unmodulated single tone (CW) (CMCC)
* **Recommended WF**
  + CW for OOK

**Issue 3-10: Channel coding and FEC**

* **Proposals**
  + Proposal 1: follow the RAN1 agreement related with channel coding and FEC (Samsung)
  + Proposal 2: Consider applying convolutional coding (Ericsson)
  + Proposal 3: channel coding with 1/3 Convolutional Coding (HW)
* **Recommended WF**
  + Channel coding with 1/3 Convolutional Coding

**Issue 3-11: Repetition**

* **Proposals**
  + Proposal 1: consider the block-level repetition as 2 (Samsung)
  + Proposal 2: Consider applying block repetition (Ericsson)
* **Recommended WF**
  + TBD

**Issue 3-12: SFO assumption**

* **Proposals**
  + Proposal 1: 10% SFO (HW, CMCC)
* **Recommended WF**
  + 10% SFO

**Issue 3-13: Device sampling rate**

* **Proposals**
  + Proposal 1: 1.92MHz device sampling rate (HW)
* **Recommended WF**
  + 1.92MHz device sampling rate

**Issue 3-14: TBS**

* **Proposals**
  + Proposal 1: further discuss the number of TBS (Samsung)
* **Recommended WF**
  + TBD

**Issue 3-15: CBW**

* **Proposals**
  + Proposal 1: further discuss how to select the proper CBW (Samsung)
  + Proposal 2: postpone the channel bandwidth and (Tb, Tc, R) discussion until related core part is stable (HW)
* **Recommended WF**
  + TBD

**Issue 3-16: Channel model**

* **Proposals**
  + Proposal 1: use the AWGN and TDL-A channel as starting point (Samsung)
  + Proposal 2: TDL-A30-10 (Ericsson, CMCC)
  + Proposal 3: TDL-A30-10 low (HW)
* **Recommended WF**
  + TDLA30-10 low correlation if needed

**Issue 3-17: Test metric**

* **Proposals**
  + Proposal 1: further discuss the proper test metric (Samsung)
  + Proposal 2: [1] % of PDRCH BLER (Ericsson)
  + Proposal 3: At least define SNR at 10% BLER requirement (CMCC)
* **Recommended WF**
  + To be discussed

**Issue 3-18: Specification structure**

* **Proposals**
  + Proposal 1: Specify the Ambient IoT BS demodulation requirements in “Ambient IoT Base Station (BS) and Carrier-Wave (CW) node radio transmission and reception” and “Ambient IoT Base Station (BS) and Carrier-Wave (CW) node conformance testing” if RAN4 agreed to define the Ambient IoT BS demodulation requirements. (Ericsson)
  + Proposal 2: The demodulation requirements can be captured in clause 10 of TS 38.191 (HW)
* **Recommended WF**
  + To be discussed