**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.
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## 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

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2509400 | Samsung | Connectivity topologiesProposal 1: RAN4 focuses on D1T1-B scenario for specifying the A-IoT Device demodulation requirement PRDCObservation 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 notProposal 2: RAN4 should further discuss how to test the PRDCH demodulation requirement for Ambient-IoT devices.R2D timingObservation 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 operationProposal 4: Consider the standalone operation when defining the PRDCH requirement, FFS on considering the in-band operationWaveform & NomologyProposal 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 PRBsProposal 6: RAN4 should discuss the proper value of M when defining PRDCH requirement, M as 24 can be considered as starting point.RepetitionProposal 7: No repetition when defining PRDCH requirementChanel coding and CRCObservation 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 codingProposal 9: RAN4 will follow the R2D line coding to define the corresponding PRDCH requirement.Maximum TBSProposal 10: RAN4 should further discuss the number of TBS used for defining PRDCH demodulation requirement Channel BandwidthProposal 11: Considering the number of PRB as 3 for starting point when defining PRDCH requirement. FFS on other R2D transmission bandwidth configurationTest metricProposal 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 multiplexingProposal 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.

$$BLER=\frac{Number of responsed PDRCHs}{Number of transmitted PRDCHs }$$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:
		- $BLER=\frac{Number of responsed PDRCHs}{Number of transmitted PRDCHs }$
* **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

|  |  |  |
| --- | --- | --- |
| **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-IoTObservation 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 requirementProposal 7: RAN4 will follow the RAN1 agreement related with waveform when defining PDRCH requirementProposal 8: RAN4 will follow the RAN1 agreement related with channel coding and FEC when defining PDRCH requirementProposal 9: RAN4 can consider the block-level repetition as 2 when defining PDRCH requirementProposal 10: RAN4 should further discuss the number of TBS used for defining PDRCH requirementsObservation 2: SFO not only affects the D2R transmission bandwidth, but also scale the small frequency shift valueProposal 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 requirementsProposal 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 |
| $$R\_{block}$$ | None |
| $$I\_{bit}$$ | FFS |
| $$L\_{amble}$$ | 32bits m-sequence |
| $$I\_{add}$$ | 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 simulationProposal 5: Configure 31 bit Preamble and 31 bit Midamble.Proposal 6: Assume coherent receiver for ReaderProposal 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