**3GPP TSG RAN Meeting #105 RP-24xxxx**

**Melbourne, Australia, September 9-12, 2024**

**Agenda Item: 9.2.2**

**Source: Moderator (RAN1 Vice-Chair)**

**Title: Moderator's summary for offline discussion about Ambient IoT**

**Document for: Discussion and decision**

# Introduction

In RAN#105, 15 contributions propose a scope clarification for the release 19 study item on Ambient IoT. This document summarizes the proposals made in those contributions and provides proposals for discussion towards possible clarifications of the study item scope.

# Proposals submitted to RAN#105

Note from the moderator: proposals from contributions are provided for comments. In some cases, similar proposals from different contributions have been grouped together and the wording correspondingly adjusted for clarity. Some contributions provide generic observations on the progress of the study item (e.g. RP-241778) and additional considerations (e.g. in RP-241763 on energy harvesting testability) without concrete proposals, so no proposals are provided in this summary for such observations.

## DO-A traffic type

RP-241801 observes that there was no progress in WGs for DO-A (Device-originated autonomous) use case, and proposes not to pursue DO-A in Rel-19.

**Proposal [RP-241801]:**

* + **The study for Do-A is not pursued in R19, and the following part is removed from the SID.**
	+ **~~“From RAN#104, the study will assess whether the harmonized air interface design (per bullet ‘A’ above) can address the DO-A (Device-originated autonomous) use case, only to identify which part(s) of the harmonized air interface design (per bullet ‘A’ above) is/are not sufficient for the DO-A use case.”~~**
	+ **Note: Do-A traffic type can be studied in the future release**

Conclusion: no change to the SID regarding the study of Do-A.

## Out-of-coverage aspects

Agreement (RAN2#127): *Will support in-coverage and study cases for reader “temporarily” out of connection (e.g. RLF, HO). May consider extendibility to future “temporarily” out of coverage case with full NW control of resources (if possible).*

RP-241857 observes that the case for reader ‘temporarily’ out of coverage belongs to topology 4. RP-241857 argues that is not expected that there would be coverage holes for the intermediate UE in topology 2, and the study of the out-of-coverage case would require a lot of efforts.

RP-241944 observes that the scenario that UE reader is temporarily out of coverage is topology 4, which is not in the scope of study item, and that the SI scope not be extended considering the workload is already high in RAN. How to handle radio link failure, HO or inactive/idle mode intermediate UE (i.e., out-of-connection) is open to discuss in RAN2.

RP-242199 discusses out-of-coverage intermediate UE in topology 2 and proposes that it is not in scope of Rel-19 Ambient IoT, in line with RAN2 agreement.

**Proposal [RP-242199, RP-241944, RP-242199]:**

* + **Rel-19 Ambient IoT SI does not study the case for UE reader “temporarily” out of coverage.**
	+ **How to handle radio link failure, HO or inactive/idle mode intermediate UE (i.e., out-of-connection) can be studied in RAN2.**

Conclusion: no clarification needed on top of the RAN2 agreement.

## Ambient IoT device architectures

RP-242199 discusses the status of the RAN1 objective on Ambient IoT device architectures.

RP-241837 observes that the objective on device architectures needs to continue in RAN1.

**Proposal: For A-IoT device architectures:**

* + **[RP-242199] RAN1 to complete the “purposes of clocks” table by primarily offline work. RAN1 not to re-discuss “quantitative characterization of the device sustainable operation time”. Companies are trusted to make appropriate reports under the solution-directed agenda item, 9.4.2.2.**
	+ **[RP-242199] Alternatively:**
	+ **The remaining FFS cells in the “purposes of clocks table” are removed; and**
	+ **The objective is considered successfully completed, on schedule.**
	+ **[RP-241837] A-IoT device architectures agenda to continue in RAN1**

Conclusion: keep the A-IoT device architectures on the RAN1 agenda in 2024/Q4.

## CW waveform characteristics

### Status of CW agenda in RAN1

RP-242199 discuss the status of the RAN1 objective on characteristics of carrier-wave waveform.

RP-241837 observes that the objective on carrier-wave characteristics needs to continue in RAN1.

**Proposal**

* + **[RP-242199] The objective on carrier-waveform characteristics is considered complete in RAN1 for Rel-19 SI purposes.**
	+ **[RP-241837] carrier-wave characteristics agenda to continue in RAN1**

Conclusion: keep the CW waveform characteristics on the RAN1 agenda in 2024/Q4.

### CW control

RP-242053 argues that there is no consensus on whether/how to study control aspects in RAN1 so far, and that it is unclear how to handle the interference as defined in SID without a study on specific control aspects (e.g. at least for scenarios D2T2-A1/A2).

RP-241837 also asks for study of intermediate UE control and scheduling aspects.

RP-242146 discusses the scope of carrier wave control in case where the CW is not provided by the reader.

**Proposal**

* + **[RP-242053] Identify scenario(s) for which control of the CW waveform characteristics is necessary, and study how to control the CW waveform characteristics e.g. when CW is transmitted or not transmitted, transmission power, frequency resources.**
	+ **[RP-242146] RAN should guide RAN1 to reach a common understanding of the definition of the CW outside the topology. Whether a CW node outside the topology is a 3GPP node or a non-3GPP node? In the case of a non-3GPP CW node, RAN should guide RAN1 to clarify how to control such a node.**
	+ **[RP-241837] study intermediate UE control and scheduling aspects**

The moderator reminds of the endorsed proposal 3v2 in RP-240854 at RAN#103.

*Proposal 3v2 (endorsed at RAN#103 in RP-240854)*

* Regarding the objective in the SID: *Study necessary characteristics of carrier-wave waveform for a carrier wave provided externally to the Ambient IoT device, including for interference handling at Ambient IoT UL receiver, and at NR basestation.*
	+ This objective allows studying CW waveform characteristics which would need control of the CW node(s), e.g. waveform characteristics that impact interference such as when CW is transmitted or not transmitted, power, bandwidth, spectrum, etc.
* No SID revision is necessary

Conclusion: as already clarified at RAN#103, the above objective does not include studying how to control the characteristics of the CW waveform in topology 1 or topology 2 or outside the topology.

### CW interference cancellation at reader

RP-241763 asks that RAN4 performs the feasibility study of CW IC and captures the outcome in the TR.

Note the RAN4 agreements in WF R4-2414305:

*Issue 2-6: CW for D1T1*

*Agreement in RAN4#111:*

* *To further investigate output power, emission requirements for CW node*
	+ *FFS for other requirements.*

*Agreement in RAN4#112:*

* *FFS on methods and feasible values for CW cancellation*

*Issue 4-4: CW for D2T2*

*Agreement in RAN4#111:*

* *To further investigate output power, emission requirements for CW node*
	+ *FFS for other requirements.*

*Agreement in RAN4#112:*

* *FFS on methods and feasible values for CW cancellation*

**Proposals [RP-241763]**

* + **RAN4 should study the methods and feasibility of CW interference cancellation.**
	+ **Capture the outcome of CW IC capability study in TR.**

Conclusion: RAN guidance to RAN4:

* + RAN confirms that RAN4 studies and documents the methods and feasible values of CW interference cancellation according to their agreements.

## Proximity determination

The Ambient IoT study item includes this objective:

* Study the feasibility and required functionalities for proximity determination (coordination with SA3 is required for privacy aspects).

*Agreement [RAN1#117]*

*Study the following schemes for proximity determination:*

* *Option 1: If reader receives D2R transmission from the device in response to R2D transmission, then device is determined as near*
	+ *FFS: Details on reception criteria (e.g. either successful or not) at reader and device*
* *Option 2: Device is determined to be near the reader based on measurements at the reader side*
	+ *FFS: Details on measurement methods*
* *FFS: Whether/how transmit power of R2D and/or D2R is considered for proximity determination*

*Conclusion [RAN1#118]*

*Proximity determination is concluded to be feasible with either of the two solutions below. Potential specification impact or not will not be determined in the Rel-19 study item.*

*Solution 1*

*For proximity determination, if reader successfully receives D2R transmission from the device in response to R2D transmission*

* *then the device is determined as near to the reader based on measurements at the reader side*

*Solution 2*

*For proximity determination, if reader successfully receives D2R transmission from the device in response to R2D transmission then the device is determined as near to the reader*

RP-241773 asks RAN#105 to define the purpose for the “feasibility and required functionalities for proximity determination”, noting that the RAN1 conclusion applies only for the mono-static configurations.

**Proposal [RP-241773]**

* + **Define proximity for all essential links for a successful Ambient IoT communication session (R2D, CW to Ambient IoT, D2R) for both mono-static configuration as well as multi-static configurations to enable efficient configuration and reconfigurations of these essential links and nodes.**

## Latency for inventory of multiple devices

RP-242098 discusses the latency for inventory for multiple devices, and observes that commercial RFID readers available in the market provides the inventory speed in their data sheet, as the number of RFID tags inventoried per second. RP-242098 observes that RAN/RAN1 did not define a target for the inventory completion time for multiple devices.

**Proposal [RP-242098]**

* + **RAN should provide guidance to RAN1 to select a target value for the inventory completion time for multiple devices based on companies evaluation results.**

The moderator reminds of the RAN1#118 agreement:

*Agreement (RAN1#118)*

*The following performance metric is considered for evaluation purpose only,*

* *Inventory completion time for multiple A-IoT devices*
	+ *For inventory-only use case, the  ‘Inventory completion time for multiple A-IoT devices’ is defined as the time a reader successfully completed the inventory process for at least 99% of all A-IoT devices within the coverage of the reader, assuming device density of 1.5 devices per m2.*

*Note: RAN1 will not define a target for the inventory completion time*

## Design for device 2

Two documents discuss differentiated design for device-2b, with interpretations of the SI target to “study a harmonized framework with minimized differences (where necessary)”.

RP-242098 observes that some companies think that the harmonized design means unified solution for all device types and hence the unified solution optimally designed considering only device type-1. It also observes that the SID allows differences to be studied for different device types.

RP-241763 argues that the harmonized framework should be designed to support/enable device 2 specific capabilities/features, quoting 1) the higher IF frequency synchronization for Device 2a/b and asking for study of reference/sync signal that enables device 2 internal clock calibration/synchronization, 2) the possibility to optimize D2R link for device 2b with differences in waveform/modulation, (line) coding and resource allocation compared to device 1, and 3) image suppression for Device 2a with larger frequency which takes different amount of D2R resources than device 1.

RP-241837 also asks for study of frequency synchronization for device 2b.

**Proposal**

* + **[RP-241763] Study a harmonized framework supporting device 2 with necessary designs including, e.g.,**
	+ **Signal enabling frequency synchronization based on clock calibration**
	+ **Waveform/modulation/(line) coding/resource allocation same or different from that for device 1**
	+ **[RP-242098]**
	+ **Harmonized design should be interpreted as a baseline design feature for Ambient IoT devices while some features can be removed, added depending on the device capabilities.**
	+ **RAN should provide guidance to RAN1/RAN2 to allow studying differentiated D2R solutions considering device type 2b in the remainder of study as the present thinking of harmonized design as unified solution for all device types favors device type-1 operation while it is not optimal for device type 2b operation.**
	+ **[RP-241837] Study frequency synchronization for device 2b.**

# Conclusions

# References

1. RP-241763 Views on the scope of Rel-19 Ambient IoT SI Qualcomm Incorporated
2. RP-241773 Rel-19 study on Ambient IoT Nokia
3. RP-241778 Discussion on progress in ambient IoT study Samsung
4. RP-241784 Presentation of Specification/Report to TSG: TR 38.769, Version 1.0.0 Huawei
5. RP-241801 Views on R19 Ambient IoT Study Item Spreadtrum Communications
6. RP-241837 Discussion on A-IoT study progress in RAN1 OPPO
7. RP-241857 Views on Rel-19 Ambient IoT Beijing Xiaomi Mobile Software
8. RP-241858 Views on Rel-19 Ambient IoT Beijing Xiaomi Mobile Software
9. RP-241943 Status report for Study on solutions for Ambient IoT (Internet of Things) in NR CMCC
10. RP-241944 Views on the scenarios for Ambient IoT in NR CMCC, Huawei, ZTE, China Telecom, China Unicom, xiaomi, CATT
11. RP-242053 Rel-19 Ambient-IoT: Control of CW emission MediaTek Inc.
12. RP-242098 Clarification on the scope of Rel-19 Ambient IoT SI Lenovo
13. RP-242116 Views on Release 19 Study on Ambient IoT Indian Institute of Tech (M), IIT Kanpur
14. RP-242146 Views on Release 19 Ambient IoT Study IIT Kanpur, CEWiT, Indian Institute of Tech (M)
15. RP-242199 Rel-19 Ambient IoT clarifications Huawei, HiSilicon
16. RP- 240854 Moderator's summary on R19 Ambient IoT Moderator (Huawei), RAN#103