[98e-11-Ambient-IoT] - Version 0.0.2

RAN1

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3GPP TSG RAN TSG Meeting #98-e RP-22xxxx

e-Meeting, December 12th – 16th, 2022

Agenda Item: 9.2.3

Source: Moderator (Huawei)

Title: Summary of email discussion [98e-11-Ambient-IoT]

Document for: Discussion and Decision

1 Introduction

This first meeting of the RAN Ambient IoT SI is scoped to discuss the TR 38.848 skeleton, and have initial discussions on (1) use cases, and deployment scenarios; and (2) device characteristics and categorization.

2 Topic 1 - TR skeleton

2.1 Initial round

A draft TR skeleton is available in RP-223073. It was distributed on the RAN reflector around 2 weeks before the meeting. No comments are made on it in any submitted paper.

Feedback Form 1: Question 1: Any objection to endorsing RP-223073 as v0.1.0 of TR 38.848?

1 – KT Corp. No objection
2 – Samsung Electronics Co. We are ok with endorse based on current SID but for chapter 5 of KPI. Based on SA1's requirements, we propose to include latency as the key target KPI for next update. From SA1's use case and also other companies Tdoc in this plenary, latency should be considered together with other KPIs in ambient IoT service.

3 – VODAFONE Group Plc

on objection

4 – MediaTek Inc.

The overall structure is ok - however as Samsung commented, other KPIs (as documented in the draft SA1 TR) may need to be considered.

5 – Spark NZ Ltd

No objection

6 – Huawei Tech.(UK) Co.. Ltd

No objection, and we note that Clause 5 of the TR, and the SID wording, already allows for additions.

7 – Futurewei Technologies

No objection.

8 – Apple France

No Objection

9 – vivo Communication Technology

OK

10 – NTT DOCOMO INC.

No objection

11 – Kyocera Corporation

We're fine with the TR skeleton proposed in RP-223073.

12 – Spreadtrum Communications

We suggest to improve chapter 4 structure a bit clearer:

1. Swap section 4.1 and 4.2 (it is a normal order)
2. Take section 4.2.1 (Device categorization) out as section 4.3 (as Device categorization is a different level with use case)

13 – Motorola Mobility España SA

[Lenovo] No objection

14 – CATT

OK

15 – Telstra Limited

We are ok with the proposed TR skeleton.

16 – China Mobile Com. Corporation

OK.

As TR rapporteur, we are open for adding additional KPIs if agreeable.

17 – Shenzhen Heytap

[OPPO]

Generally ok.

But don't see there is a need of "4.2.3 Further use cases/services". In SA1, there have already 30 use cases (28 use cases+2 traffic scenarios). Based on the input paper, not see the need for additional new use cases on top of SA1. In addition, as a new technology, the will be impact on other group for a new use case, suggest to propose the use case in SA1 to check the impact on all the downlink working groups(SA2/SA3/SA5 ...).

18 – LG Electronics Inc.

No objection

19 – China Telecommunications

No objection

20 – Nokia Denmark

Nokia is fine with the proposed skeleton for the TR.

21 – Sony Europe B.V.

No objection.

22 – ZTE Corporation

Also fine to endorse RP-223073 as v0.1.0 of TR 38.848.

We further suggest to clarify the relationship between the section 4.1 Deployment scenarios and 4.2 Use cases/services (maybe during the late discussion stage).

Moreover, according to our observation on the latest use cases from SA1 (diverse requirements), for chapter 5 of RAN design targets, we are fine with adding latency as suggested by Samsung and want to further suggest adding connection density, mobility and security.

23 – Intel Belgium SA/NV

We share Samsung's view to include latency as KPI

24 – Panasonic Holdings Corporation No objection
25 – Orange No objection
26 – TURKCELL No objection
27 – KPN N.V. No objection
28 – Ericsson LM Regarding clause 4, we think that subclauses 4.2.2 and 4.2.3 can be removed and only keep a single subclause 4.2 called 'Use cases/services' (or just 'Use cases'), since it does not seem correct to us to refer to the SA1 TR in the heading like this. Regarding clause 5 on 'RAN design targets', the SID notes that *"Other RAN design targets in relation to connection density, mobility, security, latency, reliability etc. may be discussed, if necessary for the relevant use cases"*. We would like to at least add a subclause on 'Service availability' or similar in the 'RAN design targets' clause to better capture that data communication may only be possible under certain conditions, i.e., when a smartphone or reader is located close to device for the passive solution track, and when the device is not energy-depleted for the active solution track (assuming energy harvesting). Regarding clause 6 on 'Comparison and assessment', we wonder whether this clause will also treat how the proposed device categories fit the targeted deployments and how well they meet the performance design targets. In that case, it should be clarified in the Editor's note. Otherwise, a new clause for this may be needed.
29 – Philips International B.V. In general, we are ok with the structure. For clause 5, we would suggest to add something about peak power.

2.2 Initial round summary

Companies are positive to endorsing the TR skeleton. There are a few suggested changes:

- To swap 4.1 and 4.2, i.e. make the order "Use cases", followed by "Deployment Scenarios".
    - Moderator response: I understand the skeleton chose this order since we are supposed to identify which deployment scenarios can go with which use cases. The order of 4.1 and 4.2 does not seem critical, so should be OK to swap them.

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- On section 4.2 -
  - Make 4.2.1 (Device categorization) into its own sub-clause in section 4, e.g. 4.3.
    - Moderator response: I understand this arrangement was suggested since device categorization is not a SI objective in its own right. But seeing how companies have discussed it in their papers, it seems fine to make it into clause 4.3.
  - Delete clause 4.2.2 (as well as clause 4.2.3)
    - Moderator response: It seems that RAN is not going for a process of including/excluding among the SA1 use cases, so we could remove this section.
  - Delete 4.2.3 (Further use cases/services), i.e. any agreed beyond SA1's list.
    - Moderator response: Indeed no such additions have been proposed, and the editor's note implies potential removal. So, we can delete 4.2.3 and, if discussion according to the rapporteur's workplan in RAN#99 results in agreement to such an addition, the clause can be re-instated.
  - Overall, this would leave only 4.2.x – Representative UCs. This could then become the whole content of section 4.2.
- Add additional RAN design targets to clause 5, e.g. latency, connection density, mobility, security.
  - Moderator response: The RAN#97e decision indicates no discussion on RAN design targets in this meeting. Since the TR skeleton already allows extension of clause 5 (thanks to '5.*z* - <RAN design target *z*>'), the moderator will not propose any alteration this time, and invites companies to freely discuss in subsequent meetings, when we will continuously update the TR as needed.

2.3 Intermediate round

Based on the moderator's responses to the first round, the following is proposed:

Proposal 1:

- Update the TR skeleton in RP-223073 as follows, and agree that update as v0.1.0 of TR 38.848:
  - Make clause 4.2.1 (Device categorization) into new clause 4.3, with consequent renumbering within 4.2.
  - Delete clauses 4.2.2, 4.2.3
  - Rename 4.2 to be "4.2 Representative use cases".
  - Reverse the order of the clauses for "deployment scenarios" and "use cases/services"
  - Delete clause 4.2.3.

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- Responses are only necessary if any remaining concern, otherwise we can agree as above.
- The overall revised skeleton (by the moderator) is in the draft folder at the following link: https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_98e/Inbox/Drafts/%5B98e-11-Ambient-IoT%5D/TR%20skeleton/Moderator_Draft_RP_22xxxx%20TR%2038.xxx%20skeleton%20v0.0.1.docx

Feedback Form 2: Is proposal 1 agreeable?

3 Topic 2 - Handling of SA1 use cases in RAN

3.1 Initial round

The draft TR skeleton in section 4.2.2 proposes to describe the SA1 use cases that have been included in the RAN SI. Moderator suggests this can be done later in the SI, by taking into account the agreements actually made in RAN and SA1.

Topic 2-1: Representative use cases

The SID notes that so-called 'representative use cases' (rUCs) can be developed, for groups of use cases (UCs) that have similar requirements. In the moderator's understanding, the purpose of this process is to reduce the total number of use cases to consider in the RAN SI, to a set which focus on the aspects among the SA1 UCs which come within the expertise of TSG RAN. Those rUCs will put RAN in a position to derive deployment scenarios, guide device categorization, and see the RAN design targets that are required across the SA1 set.

Most companies have taken one of three approaches to grouping the SA1 UCs:

(A) Group first by deployment environment described by SA1 in the UC

- FFS the deployment environments, e.g. indoor/outdoor, service area size

(B) Group first by functionality/application

- FFS the functionalities / applications to group by, e.g. inventory, sensor report, … etc.

(C) Group first by applicable industry

- FFS the industries to group by, e.g. agricultural, personal, etc

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One company suggests picking representative use cases based on the envelope of the SA1 potential requirements, such as the most demanding positioning target, or the highest/lowest data rate, etc. Moderator suggests such analysis is considered under the 'RAN design targets' objective.

Hence, in this first round, the moderator would like to understand companies views and preferences among the 3 grouping approaches listed above.

Feedback Form 3: Question 2 – What are companies' views and preferences on these first-level ways to group the SA1 UCs into representative use cases?

1 – VODAFONE Group Plc

similar to what analyses in RP-223072 [CMCC], the use case grouping can be based on (B) functionality/application

2 – MediaTek Inc.

A)

Not B), Not C)

The grouping should be representative of the use case characteristics (in terms of range, latency, data rate etc.) such that a use case does not end up listed in a group with characteristics different from those required by said use case, that could artificially inflate the need for a particular characteristic.

E.g. we note in RP-223072 that use case #23 end up listed in a group with a communication range up to 200m that this particular use case clearly does not require.

We think the communication trigger for a Tag to communicated is also an important criterion in the grouping - as the vast majority of use cases display a common MT trigger.

3 – Spark NZ Ltd

we agree with MediaTek and support group A

4 – Huawei Tech.(UK) Co.. Ltd

We think grouping (A) is good.

The purpose of representative use cases is to group the SA1 use cases such that they facilitate properties which are of interest to RAN for development of deployment scenarios (especially connectivity topologies), design targets, and functions. Whereas, to us, the purpose is not so much to serve as a secondary SA1 identifying business purposes, services, service requirements, etc.

In general, different applications or functionalities may share very similar deployments scenarios. For example, environment monitoring in electrical substation (wireless sensing) and asset tracking in airport

terminal/shipping port may both be supported by a local area network based on e.g. micro-cell BS, with similar requirements on communication range. Meanwhile, the same applications or functionalities may be fulfilled with distinct deployment scenarios and design targets. For example, personal belonging finding requires object tracking in both indoor and outdoor scenarios, which may be supported by different node types and connectivity topologies, with different requirements on communication range and positioning accuracy.

Consequently, as in RP-223397, we grouped the SA1 UCs first by approach (A) deployment environment, including indoor/outdoor and service area size (continuous coverage over a large area, small area by one or only a few nodes, personal applications).

While with approach (B)/(C), sensing, inventory, actuator are more about the traffic model. The use cases under same group may have very different requirements. For example, “sensor report” includes different applications of wide area (e.g. smart agriculture), small area (e.g. cow monitoring in stable) , and personal/home area (e.g. smart home).

5 – Samsung Electronics Co.

To have clear work in RAN, group A is best among other alternatives.

6 – Sierra Wireless. S.A.

Group A.

7 – KT Corp.

Group A

8 – Apple France

Group B is our first preference, but Group A is also fine for us

9 – Futurewei Technologies

Approach A for grouping is preferred. This is more relevant for RAN study.

10 – vivo Communication Technology

Option-(B) Group first by functionality/application is preferred.

the representative use case could be a group of use cases with similar functionalities and traffic characteristics. The use cases can be grouped as follows

- inventory and management of large number of objects
- data reporting from Ambient IoT device
- positioning
- Actuator

based on above groupping, we can further define different KPIs for different deployment scenarios, e.g., indoor/outdoor, and identify mandatory /optional functionalities for each group of use case, if needed.

11 – NTT DOCOMO INC.

Group A is preferred considering that representative use cases are used to identify the suitable deployment scenarios, formulate a set of RAN design targets, and identify assumptions on required functionality to be supported as stated in the SID

12 – Spreadtrum Communications

We do see benefit of A and B. So we suggest combining A&B. While we are also fine with only B for simplicity.

13 – Motorola Mobility España SA

[Lenovo] Support B – Grouping of use case according to functionality such as inventory tracking based on RFID technology, commercial positioning and wireless sensor network to transmit sensor data

14 – CATT

We support B grouping by functionality. There is no definite case for A grouping for the deployment environment, e.g., indoor/outdoor. Some Ambient-IoT could be deployed in different deployment environment.

15 – Telstra Limited

We prefer option A)

16 – China Mobile Com. Corporation

We prefer Group B, which is also adopted in our contribution.

The use cases sharing same motivation and function mostly sharing similar requirement and deployment scenario. For example, inventory requires local deployment and battery-less devices. While, positioning/-tracking requires wide area deployment. Sensor perception requires the device has limited energy storage capability, which can guarantee the working power of senor.

Regarding to MTK's comments on use case #23, we observe in SA1 TR 22.840, the communication rage for smart livestock farming is 250m. So we classify it into category of sensor perception with communication range of 50 m (indoor), 200 m(outdoor).

To be honest, the most important thing is to work out the RAN design targets and RAN deployment architecture. The use case classification is just a way to narrow down the large number of SA1 use cases into limited number of operable use case categories, each of which share different requirements.

17 – Qualcomm Incorporated

Although normally Approach (B) "Group first by functionality/application" would be the natural first step when considering new verticals, given the fundamental impact the deployment environment has on our discussions, it makes sense to make Approach A be the first step for Ambient IoT. Then Approach B and after that Approach C can follow.

18 – LG Electronics Inc.

Basically, deployment environment as in (A) can be a starting point but it should be also considered whether/how this grouping can reflect other issues such as required functionality

19 – Shenzhen Heytap

[OPPO]

Group B shall be adopted as the first step.

Different function has different requirement of the system (both the tag and the gNB). For example, identification only need the transmission of the ID of the tag, but for sensors, higher power is needed to drive the sensor and the payload will be also larger. For positioning, it will involve positioning function of the tags and the gNB.

On top of group B, we can further derive the specific requirement for indoor and outdoor.

this is the most natural and clear way to categorize the use cases and derive the RAN requirements.

20 – Sony Europe B.V.

A and B are useful for RAN to consider.

- A will provide some guidance on RAN design targets (e.g. range).
- B will provide guidance on RAN functionality (e.g. whether both MO and MT need to be considered).

21 – Nokia Denmark

Nokia support (B) Group first by functionality/application.

This helps to define the technical requirements which is one of the key objectives for the RAN led SI.

22 – ZTE Corporation

We support option (B) Group first by functionality/application.

Option A) for grouping the SA1 use cases seems to be repeating the discussion for deployment scenario (and some service requirements are hidden).

So we think it's better to firstly make some summary on the application/use cases themselves and try to identify the service requirements, e.g., data rate, communication rage, mobility, security and positioning function/acturacy etc., which can further help to identify the possible impacts/requirements on the design of 3GPP network structure and functionalities.

We [RP-223264] use similar way to categorize the use cases captured in SA1 as that in RP-223072 [CMCC] as below:

- Category#1 of logistics and warehousing based on tag and with simple services

- Category#2 of device monitoring/supervision and control in Smart agriculture, livestock farming, Smart City etc.

- Category#3 of lost and found with ranging and positioning requirements.

For Category#1, it may be more suitable to use logistics and warehousing as the naming of such application type or use case category while the inventory can be the typical service of the ambient IoT devices in this category. Moreover, We have a bit different observation on the use cases which can belong to the Category#1. We observe that the Message size and also the range of service area, communication range vary a lot. Therefore, only 30 meters for communication range for such category as mentioned in RP-223072 may be not enough.

For Category#2, we are fine to separate it into the category of environment perception sensor and category of activator/controller as they may have very different traffic model.

23 – Panasonic Holdings Corporation

For RAN plenary level discussion, grouping by A can be started, although the grouping by B also necessary in the course of the discussion.

24 – Intel Belgium SA/NV

Option A is slightly preferred. The different functions/applications may have similar characteristics that are interested in RAN study which motivate Option A. Option A also fits better with the discussion on deployment scenarios in topic 2/3

25 – Orange

Group A is preferred.

26 – TURKCELL

We prefer to start with Option A. Then continue with B and C.

27 – Telia Company AB

A+B

28 – China Telecommunications

Group B is slightly preferred

29 – Ericsson LM

Approach B seems best to us, since we think this would increase the likelihood that a single technical solution/deployment scenario can address all the use cases in a given use case group.

30 – KPN N.V.

Option A is slightly preferred als grouping approach of the UCs.

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31 – Philips International B.V.

We prefer to group use cases by A) deployment environment, which will help derive deployment scenarios later. For example, use case 5.8 on finding remote lost item and use case 5.12 on Ambient IoT service for personal belongings finding in TR 22.840 can happen both indoor and outdoor.

3.2 Initial round summary

17 companies supported approach A: group first by deployment environment. The consideration is that representative use cases are intended to formulate clear work in RAN, including suitable deployment scenarios, RAN design target and assumption on required functionalities to be supported as stated in SID.

11 companies supported approach B: group first by functionality/application. The consideration is also mentioned as to identify KPIs and required functionalities for each group of use cases.

No company supported approach C. One company mentioned that communication trigger for a Tag to communicate is also an important criterion in the grouping.

3.3 Intermediate round

Since the proposals for Groupings A and B are relatively well-converged in their respective papers, and both have a lot of support, we could allow both to be represented in the TR. If companies prefer only one grouping, then we could group: first by deployment environment and second by functionality/application.

Question 2 - Which of these two approaches do companies prefer.

- Approach 1: Have Grouping A, and Grouping B in the TR.
- Approach 2: Group first by A, and second by B, i.e. for each group in A, a series of sub-groups from B.

NOTE: The moderator thinks we should choose Approach 1 if we can, as the combination work in Approach 2 may be too much for not a clear purpose. Hence if preferring Approach 2, please help explain how it can be done simply enough.

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Feedback Form 4: Question 2: which approach do you think is better?

4 Topic 3 - Deployment scenarios

The SID states that a deployment scenario has at least the following aspects:

- Indoor/outdoor environment
- Basestation characteristics, e.g. macro/micro/pico cells-based deployments
- Connectivity topologies, including which node(s) e.g. basestation, UE, relay, repeater, etc. can communicate with target devices
- TDD/FDD, and frequency bands in licensed or unlicensed spectrum
- Coexistence with UEs and infrastructure in frequency bands for existing 3GPP technologies
- Device originated and/or device terminated traffic assumption

The SID also tasks RAN to identify which deployment scenarios are applicable to a (r)UC.

4.1 Initial round

A number of companies have presented tabulated descriptions of a deployment scenario, which include similar points. In some cases, they also present a direct linkage to UCs or rUCs.

Hence, in order to describe a deployment scenario consistently with the aspects given in the SID, moderator suggests we can use a tabulated form as follows. In subsequent meetings, we can then populate the aspects and decide how many deployment scenarios to capture.

Moderator's note: the use cases column could be a merged single-cell in the TR. NWM cannot display this correctly.

Table 1: Table for Deployment Scenario X

Applicable representative use cases	**Characteristic**	**Value**
	Environment (of device)	
	Basestation characteristic	
	Connectivity topology	

rUC1, rUC2, …, …	Spectrum	
	Coexistence with existing 3GPP technologies	
	Traffic assumption	

FFS: whether/which rows can be indicated with more than one value, e.g. Environment = Indoor/Outdoor

FFS: Possible values for each characteristic row (see following questions)

Feedback Form 5: Question 3: Do companies think this overall table structure needs any major refinement (note that the possible values of each row are considered in subsequent questions)?

1 – VODAFONE Group Plc the proposed tabular form for capturing deployment scenarios is ok.
2 – MediaTek Inc. Tabular format is ok. Base station characteristic may not necessarily be applicable though (e.g. for tags communicating directly with a reader device) - or alternatively ”base station” should be defined.
3 – Spark NZ Ltd we agree that the tabular structure form as suggested by the moderator for the deployment scenarios is a good way to proceed.
4 – Sierra Wireless. S.A. Tabular structure looks good.
5 – Apple France Proposed tabular structure is fine from our perspective and provides good starting point.
6 – Futurewei Technologies The overall table structure looks fine.
7 – vivo Communication Technology Looks good in general.

For clarification, since the title of the table is ”Table for deployment scenario X”, is the intention that there will be different tables for each deployment scenario, e.g. indoor , outdoor, etc?

8 – Qualcomm Incorporated

We have a few comments.

The first column could include information categorized based on approach (A) and partially approach (B).

A new row “UE characteristics” would be necessary to capture UE related characteristics, e.g., full duplex capability requirement, etc.

We wonder how to capture Ambient IoT device related aspects in the deployment scenario. Currently, we don’t see any row related to Ambient IoT device capability. Ideally, it should be also the part of deployment scenarios. We suggest to discuss deployment scenario and device categorization in parallel, and later we capture Ambient IoT device related aspects in deployment scenarios.

9 – NTT DOCOMO INC.

OK with the table structure

10 – Kyocera Corporation

We’re fine with the table, in general. Although it’s not a strong opinion so far, we wonder if the device categorization will be added at the end (i.e., the categorization is fixed).

11 – Spreadtrum Communications

Table structure is OK for us.

12 – Motorola Mobility España SA

[Lenovo] Similar to Basestation characteristic in the table to implement the reader functionality, the UE characteristic can also be added as the reader functionality can also be integrated in UE.

13 – CATT

Use cases by SA1 are only references. RAN should take SA1 use cases as bases and develop the use cases based on Ambient IoT technologies. Tabulate format is too restricted.

14 – Telstra Limited

We are ok with the proposed table structure

15 – China Mobile Com. Corporation

We are ok with the table structure for deployment scenario.

16 – LG Electronics Inc.

Ok with the proposed tabular form.

17 – Shenzhen Heytap

[OPPO]

OK with this form.

18 – Sony Europe B.V.

We are basically OK with the table format. We would like more clarity on the details of the table structure though. Is the intention that each r_UC is defined in terms of the same set of characteristics:

- r_UC1 has rows for {environment, base station characteristic, topology, spectrum, coexistence, traffic}
- r_UC2 has rows for {environment, base station characteristic, topology, spectrum, coexistence, traffic}
- etc

19 – Nokia Denmark

We agree with the comment from Qualcomm.

20 – ZTE Corporation

We are fine to use Tabular structure to describe each Deployment Scenario.

Moreover, per our observations on the use cases from SA1, we think “with or without CN connection” is another important factor which should be taken into account in the deployment scenario from the beginning of the discussion. So it’s suggested to add a new line “CN connection” in this table.

For the header of last column, we think it’s more suitable to use “description” instead of “value”.

21 – Panasonic Holdings Corporation

OK with the proposed table.

22 – Orange

we are fine

23 – Huawei Tech.(UK) Co.. Ltd

OK for us.

To MediaTek: The basestation characteristic in case there is no basestation could be {none}, or we could add a NOTE: Basestation characteristic applies only to deployments containing basestations. The former option seems more elegant!

CATT: Maybe your comment is in the wrong section. This table does not define use cases, but deployment scenarios, which are RAN's work in the SID.

Sony; We understood from the moderator's explanation above the table that in fact the rUC listing would be just once for the whole table in a merged cell, but NWM cannot display merged cells.

24 – TURKCELL

We agree with Qualcomm's suggestions.

25 – Intel Belgium SA/NV

OK to define representative use case in the tabulated way. We share the views from QC and Lenovo that UE character should also mentioned. One example could be the communication range of A-IoT device which is different from cell coverage assuming the signal of A-IoT device can be relayed by an intermediate node.

26 – Telia Company AB

Agree and support Qualcomm proposals.

27 – Ericsson LM

We are fine with the overall table structure, but we would like to add a characteristic about 'Possibility to reuse existing NW deployment' in the middle column (unless it is made clear that it is included in one of the other characteristics).

28 – KPN N.V.

The tabular form is fine, and we agree with Ericsson comments. It is not beneficial to get a new technology that cannot be integrated with existing infrastructure. E.g. not new / separate frequency licenses and separate base stations.

29 – Philips International B.V.

We are okay with the table except the "base station characteristic" row, because it could implicitly deprioritize the deployment scenarios via UE, relay, repeater, etc. as stated in SID. We prefer to remove "base station characteristic" row, since it can be covered by connection topology. We also agree with Intel's input. Furthermore, we agree with Qualcomm to add UE characteristics

4.2 Initial round summary

The tabular format seems agreeable. There are some detailed comments and questions:

- What to do with "basestation characteristic" when there is no basestation (MediaTek, Philips).
    - Moderator response: Suggest adding "if any" to this row.
- If there is an intention to have different tables for e.g. indoor, outdoor, etc. (vivo)

- Moderator response: See the first FFS under the table. It seems likely to be more convenient to allow multiple values per row in most cases, but it may create some complications in ensuring all value are compatible across rows. Suggest case-by-case is best.

- How to use the grouping approaches for rUCs (Qualcomm)
  - Moderator response: It should be ok to capture more than one set of rUCs in that column, if we agree to more than one grouping method.

- Add row "UE characteristics", and capture device related aspects later in the deployment scenarios (Qualcomm, Kyocera, Lenovo)
  - Moderator response: Let's have discussion in the intermediate round on this point. It is not immediately obvious from the SID that a deployment scenario is conditioned on the devices that are present.

- Add with/without CN connection (ZTE)
  - Moderator response: It's possible. Let's have a check in the intermediate round.

- Change "Value" to "description" (ZTE)
  - Moderator response: Seems fine.

- Mapping of rUC to rows (Sony)
  - Moderator response: Just an NWM layout issue. It would be one merged table cell for the rUC list, is the intention.

4.3 Intermediate round

Moderator requests companies input on whether device characteristic should be added to the deployment scenario. According to Qualcomm's comment, it seems we could continue the parallel discussions for the time being, e.g. into RAN#99, and in this meeting have an FFS under this table on if/how to capture devices in deployment scenarios.

Question 3-1: What are you views on including device characteristic in this table, and is it suitable for this meeting to add it as another FFS under the table?

FFS: Whether, and if so how, device characteristic is added to the table.

Feedback Form 6: Question 3-1: What are you views on including device characteristic in this table, and is it suitable for this meeting to add it as another FFS under the table?

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On including core network, moderator's notes it is mentioned as potentially included in deployment scenarios in the SID, while not prioritized for RAN effort. Moderator can see two ways to handle this – either as a row in this table, or under "required functionalities" in the third objective

Question 3-2: Where, and if, companies would like to mention with/without CN as a deployment characteristic.

Option 1: As a deployment scenario characteristic

Option 2: As a "required functionality" under the 3rd objective in the SID.

Feedback Form 7: Question 3-2: Where, and if, companies would like to mention with/without CN as a deployment characteristic: option 1 or option2?

For information, the table would consequently appear as below, where [..] simply indicate the decisions to be made above.

Table 2: Deployment Scenario X

Applicable representative use cases	**Characteristic**	**~~Value~~ Description**
	Environment (of device)	
	Basestation characteristic *(if any)*	
	Connectivity topology	
rUC1, rUC2, …, …	**Spectrum**	
	Coexistence with existing 3GPP technologies	
	Traffic assumption	
	[With or without CN connectivity]	

FFS: whether/which rows can be indicated with more than one value, e.g. Environment = Indoor/Outdoor

FFS: Possible values for each characteristic row (see following questions)

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[FFS: Whether device characteristic is added to the table.]

5 Topic 4 - Deployment scenario characteristics

Moderator would like to understand what potential values we need to capture for the deployment scenarios aspects listed in the SID. It is suggested to take this discussion in parallel with the separate discussion on how to represent a deployment in Question 3.

Companies in some aspects state their views on prioritization among options. Moderator suggests at this stage of the SI, we can collect a general set of inputs, and prioritization can be discussed when writing recommendations and conclusions later in the SI.

5.1 Topic 4-1: Environment

5.1.1 Initial round

Topic 4-1: Environment

The SID tells us that deployment scenarios have an "indoor/outdoor environment". Companies do not appear to have any different view in their papers. Moderator understands the SID is referring to the environment of the device in this aspect, whereas the location of the basestation or other reading node is taken in the next row of the table, "Basestation characteristic".

Feedback Form 8: Question 4-1: Is it agreeable that 'Environment (of device)' can be indoor or outdoor?

1 – Samsung Electronics Co. We support both indoor and outdoor based on SA1's use cases.
2 – VODAFONE Group Plc there are some use cases which is supported in indoor and outdoor scenarios. Hence, not only the indoor or outdoor scenarios but also indoor and outdoor scenarios should be considered.
3 – MediaTek Inc. Indoor and/or outdoor should be possible.
4 – Spark NZ Ltd The use cases should be based on SA1 use cases and include both indoor and outdoor deployments

5 – Huawei Tech.(UK) Co.. Ltd

Yes, agreeable. An ambient IoT device could be placed in either indoor or outdoor environment, according to use cases identified in SA1.

To Vodafone, et al., on the possibility of a use case existing indoor and outdoor – (i) we understand the suggestion is addressed by the first FFS under the table (and its specific example); or (ii) there could be one deployment scenario table for each of indoor, and outdoor, both of which the rUC is linked.

In addition, we would recommend RAN also consider service area size to describe the environment of ambient IoT device. It affects what deployment scenario a representative use case(s) applies to.

6 – Sierra Wireless. S.A.

Agreeable

7 – Apple France

We agree with both indoor and outdoor environment

8 – Futurewei Technologies

Agree to consider both indoor and outdoor environment

9 – vivo Communication Technology

OK

10 – NTT DOCOMO INC.

Agree

11 – Kyocera Corporation

We support both indoor and outdoor deployments.

12 – Spreadtrum Communications

Yes, agreeable.

13 – Motorola Mobility España SA

[Lenovo] Both indoor and outdoor use cases needs to be supported

14 – CATT

Indoor and outdoor includes all scenarios. It is OK but not a good categorization.

15 – Telstra Limited

Both indoor and outdoor scenarios need to be included.

16 – China Mobile Com. Corporation

Agree indoor and/or outdoor should be considered.

17 – Qualcomm Incorporated

We are ok to assume that it could be either indoor or outdoor. To make it clearer, it would be good to explicitly replace “Environment” with “Environment for devices”.

18 – LG Electronics Inc.

Yes

19 – Shenzhen Heytap

[OPPO]

Indoor and/or outdoor shall be considerred.

But in SA1 use cases, there may be more complicated use cases. For example, use case 15, smart laundry, the device may work **within the washing machine**.

In use cases 5.24, smart manhole cover monitoring, outdoor but may be **underground**.

Such detail shall also be considerred since it has significant on the requirement of the system.

20 – Sony Europe B.V.

Yes. Device can be either indoor or outdoor. From a deployment perspective, some devices can be indoor and some outdoor within the same deployment.

21 – Nokia Denmark

Yes, both needs to be considered.

22 – ZTE Corporation

We have sympathy with Vodafone’s comments. We understand the main point to clarify is that we can’t restrict a certain deployment to serve only indoor or only outdoor devices. For example we think the case where an outdoor deployment can also server the indoor devices needs to be considered.

For the service area size suggested by Huawei, we think it’s the detail under the indoor or outdoor environment. So it can be discussed later, together with some other relevant factors, e.g., mobility, connection density.

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23 – Panasonic Holdings Corporation We support FL view..
24 – NEC Corporation Agreeable. We think Ambient IoT environment should support both from RAN's perspective based on SA1's use cases.
25 – Orange There are 3 types of use cases from the device location perspective: full indoor, full outdoor and a mix of indoor and outdoor (for devices in mobility). All 3 cases should be considered.
26 – TURKCELL We support both indoor and outdoor deployments.
27 – Intel Belgium SA/NV We are supportive to the proposal
28 – Telia Company AB Both indoor and outdoor to be considered.
29 – Ericsson LM Agree.
30 – China Telecommunications It is OK.
31 – KPN N.V. Indoor and outdoor deployments are to be considered.
32 – Philips International B.V. We support both indoor and outdoor scenarios: quite a few number of use cases in TR 22.840 cover both indoor and outdoor scenarios. We think that additional details may be added, such as service area as suggested by Huawei or additional characteristics such as underground as suggested by Oppo.

5.1.2 Initial round summary

All companies agree to indoor and outdoor.

- VDF suggests to add the option "indoor and outdoor". MediaTek, CMCC, OPPO, ZTE, Orange, Sony

also mentions as well.

  - Moderator response: This was anticipated the first FFS below deployment scenario table in Topic 3. Seems we can agree, for this row, to have the joint option also. Note that other rows can be discussed separately.

- Huawei recommend to consider service area size in addition. ZTE think it can be discussed as details of indoor and outdoor later. OPPO also mention some specific details such inside a washing machine, or under a manhole cover.

  - Moderator response: Whilst service area size may affect what is a suitable deployment, the moderator wonders whether we can take the finer SA1 details at WG level, by finding a way to express them under 'design targets' (e.g. coverage). It seems less desirable to replicate the fine granularity of the SA1 use cases into RAN in full.

- Qualcomm suggest it would be good to explicitly replace 'Environment' with 'Environment for devices'

  - Moderator response: OK.

- ZTE think need to consider the case where an outdoor deployment can also serve the indoor devices

  - Moderator response: This O2I can captured in the existing table by correctly populating the right-hand column.

5.1.3 Intermediate round

According to the initial round summary:

Proposal 4-1: Agree that:

- 'Environment of device' can be 'indoor', 'outdoor', 'indoor or outdoor'.

  - FFS: Whether to further describe the size of the served area.

Feedback Form 9: Is Proposal 4-1 agreeable?

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5.2 Topic 4-2: Basestation characteristic

Topic 4-2: Basestation characteristic

Companies express various views on which types of basestation are applicable to which UCs, etc., but in total it seems that macro, micro, and pico-cellular deployments are going to be considered within the SI. Moderator understands that reference to these dimensions of deployments refers mainly to inter-site distance of ambient IoT basestation nodes, and can be reflected in more detail when considering 'RAN design targets' on communication range.

Moderator suggests it is not necessary to include, for example, a restraint that macro is for outdoor, since such obvious inter-relationships will be evident when the deployment scenarios are constructed in the tables from Question 3.

Feedback Form 10: Question 4-2: For basestation deployments, is it agreeable that 'basestation characteristic' can be: macro-cell based deployment, micro-cell based deployment, or pico-cell based deployment?

1 – Samsung Electronics Co. We are ok to include pico and micro considering link budget of ambient IoT, but not sure whether macro cell is really workable for direction connection. We think basestation deployment should be considered together with topology. For example, direction gNB for pico and micro, and relay based for macro.
2 – VODAFONE Group Plc agree on the support of macro-cell, micro-cell and pico-cell deployment scenario
3 – MediaTek Inc. Dependent on topology and max range. We're not convinced macro cell is relevant.
4 – Huawei Tech.(UK) Co.. Ltd Yes, agreeable. We suggest it is too early to rule a particular deployment out, before assessing demand and feasibility, especially since there are a variety of connectivity topologies proposed which could play into the views. These terminologies are in-line with RAN4 specification and can be used as candidate values of 'Basestation characteristic' in our view.
5 – Sierra Wireless. S.A. Agree - and should include macro, at least for now.

6 – Apple France

We support both micro-cell and pico-cell based deployment, but not sure if macro-cell based deployment should be included.

7 – Futurewei Technologies

We are fine to include all 3 options at the beginning of study. For macro-cell, it is most relevant when FDD spectrum is used. However, the ISD for macro-cell may have to be relatively small in order to connect with Ambient IoT devices.

8 – vivo Communication Technology

OK

9 – NTT DOCOMO INC.

Agree. All BS characteristics should be included for now. Appropriate one(s) can be discussed together with topology later.

10 – Kyocera Corporation

We're fine to include all of macro-cell, micro-cell and pico-cell deployments. We have similar view as Samsung that these base station characteristics are related to the topology options.

11 – Spreadtrum Communications

Yes, agreeable. And we also share the observation and potential refinement by Samsung.

12 – Motorola Mobility España SA

[Lenovo] Consider basestation characteristic for deployment together with the connectivity topology as Samsung suggested

13 – CATT

Macro, micro, and pico base stations are categorized based on Tx power. We should also include the mobile base station with IAB backhaul.

14 – Telstra Limited

We agree with Huawei, its too early to rule out particulalr deployment architectures, therefore agree on the support of macro-cell, micro-cell and pico-cell deployment scenarios

15 – China Mobile Com. Corporation

Agree. At this stage, we support to study all these macro-cell, micro-cell and pico-cell deployments.

16 – Qualcomm Incorporated

We agree with the given choices of base stations deployments for initial consideration, although once the target device types are narrowed down, some of the base station deployment cases may become irrelevant.

17 – LG Electronics Inc.

Yes

18 – Shenzhen Heytap

[OPPO]

We are ok to include Macro at this early stage, but not sure whether it is feasible.

Based on the requirement in SA1, the required maximum communication distance is 250m.

19 – Sony Europe B.V.

We first need to agree on the network topology and role definitions of different devices/nodes, before making any decision on the base-station deployment. For example, if a tag talks to a reader (intermediate node) and the reader talk to the basestation, the basestation characteristic might not be that important.

20 – Nokia Denmark

Yes, all needs to be considered.

21 – Wiliot Ltd.

We support all 3 options including making macro base station connectivity to Ambient IoT possible, as it is needed on some use cases.

22 – ZTE Corporation

Agree with Vodafone and some other companies that all macro-cell, micro-cell and pico-cell deployment scenario should be considered.

We see many use cases that have requirement on the certain large coverage/mobility for the Ambient IoT devices.

23 – Panasonic Holdings Corporation

We support FL view.

24 – NEC Corporation

Agree. Macro-cell based deployment needs to be included in the study.

25 – Orange

yes all 3 cases (macro, micro & pico) should be considered

26 – TURKCELL

We support all three cases.

27 – Intel Belgium SA/NV We support the categorize base station as macro, micro and pico, which can provide additional differentiation to the division of indoor/outdoor
28 – Telia Company AB All 3 cases to be considered.
29 – China Telecommunications Fine with FL view. Macro-cell can be supported at least for this stage
30 – Ericsson LM Yes, all three cases need to be considered.
31 – KPN N.V. All the 3 cell types need to be considered
32 – Philips International B.V. Similar to our answer to Topic 3, we prefer to remove this characteristic and have it covered by 4-4 Connectivity topology. It is more appropriate to discuss base station characteristics in different connectivity topology options.

5.2.1 Initial round summary

The vast majority of companies are OK with the proposal that basestation characteristic can be macro-cell based deployment, micro-cell based deployment, or pico-cell based deployment. Some companies express concerns on macro-cell with feasibility or relationship to topology, etc. Moderator think these can be addressed in later study when discuss topology or feasibility, and can have further conclusion or recommendation in the end of the study.

CATT mention mobile IAB. Moderator is not sure if that is any different than a typical cell size from the proposed list, since an IAB node is a logical entity and relay function.

3 companies ask about a case where there is no basestation involved. The SID tells us to include this characteristic, so the case in question can be represented by having the description “None” for this row.

A few companies suggest to consider BS characteristic together with topology. Since the deployment scenarios table in Topic 3 does that naturally, the moderator assumes that companies will find suitable expressions and restrictions for how to populate the table.

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5.2.2 Intermediate round

Based on the summary of the initial round, the moderator thinks we can continue with the existing proposal slightly refined:

Proposal 4-2: Agree that 'basestation characteristic' can be: macro-cell based deployment, micro-cell based deployment, pico-cell base deployment, or none.

- *FFS: If/how it is necessary to reflect mobile IAB basestation.*

Feedback Form 11: Is Proposal 4-2 agreeable?

5.3 Topic 4-3: Coexistence with UEs and infrastructure

Topic 4-3: Coexistence with UEs and infrastructure

The SID includes a deployment characteristic of whether ambient IoT deployment coexists with existing UEs and infrastructure. Moderator suggests the following handling of those points.

(a) In-band, guard-band, standalone

Coexistence with UEs can be addressed in noting that a number of companies propose Ambient IoT should take an assumption that it can be deployed in-band, guard-band, or standalone from NR. This should be reasonable since in-band and guard-band allow re-use of existing spectrum assets, while the potential for new bands in the future should not be precluded at this stage.

For this meeting, moderator suggests agreeing that all three deployment modes are considered, and that further study is needed to determine the possible relationships with deployment scenarios.

Feedback Form 12: Question 4-3a: Is it agreeable that the study considers Ambient IoT deployment in-band to NR, in guard-band of NR, and standalone from NR, and FFS: relationship to deployment scenarios?

1 – VODAFONE Group Plc

agree

2 – MediaTek Inc.

These different scenarios likely open the door to a wide range of band support which will inevitably lead to prohibitive complexity for ultra simple devices (which we do see remain the primary target for this work). Global operation and very limited #bands need to be targeted to keep complexity low and potential for economies of scale high. It might be ok to consider deployments as indicated above, so long as there is NO implicit requirement all these options must be supported.

In our view the study need to be driven from the constraints of the device itself and what these impose on the system as opposed to try and make the existing system fit into the device.

3 – Spark NZ Ltd

we support MediaTek

4 – Huawei Tech.(UK) Co.. Ltd

Yes, agree with moderator's proposal. We don't see the need to preclude any of the 3 potential ways for the study.

On MediaTek's point, we would suggest returning to the question of inclusion when writing conclusions/recommendations in the TR, or in onward SID drafting, etc. Whereas this RAN-stage SI can provide broadly useful input to that process.

5 – Sierra Wireless. S.A.

agree with FL's proposal.

6 – Apple France

We are fine with moderator's proposal

7 – Futurewei Technologies

We are ok to include these 3 options at the beginning of study. However, to our understanding, the fundamental technical study of these 3 options is largely common with unique aspects of each that can be dealt with much later

8 – vivo Communication Technology

OK

9 – NTT DOCOMO INC.

Agree

10 – Kyocera Corporation

We're fine with all deployments, i.e., in-band, guard-band and standalone.

11 – Spreadtrum Communications

Yes, agreeable.

12 – Motorola Mobility España SA

[Lenovo] Agree, in addition consider frequency deployment, UHF band is the popular frequency band for RFID deployment in this license exempt/unlicensed Frequency and C-band for indoor factory

13 – CATT

We are OK with the lists of operation frequency. We should prioritize the inband operation.

14 – China Mobile Com. Corporation

Agree with moderator's proposal.

15 – Telstra Limited

Ok with the moderators proposal, all three deployment modes should be considered at this stage

16 – Qualcomm Incorporated

We are open to study these options, although once the device type is narrowed down, some of the options may become irrelevant due to lack of appropriate filtering capability.

17 – LG Electronics Inc.

Yes, with clarifying "standalone from NR to standalone band from NR"

18 – Shenzhen Heytap

[OPPO]

We can consider all these 3 modes but prefer to put high priority to standalone and in-band mode.

19 – Sony Europe B.V.

OK

20 – Nokia Denmark

We are ok to study all the scenarios, assuming we can narrow down the scope.

21 – Wiliot Ltd.

We support in-band or standalone as the best scope.

22 – Panasonic Holdings Corporation We support FL view.
23 – ZTE Corporation As we have no any conclusion on the UE complexity, we are fine with moderator's proposal and see nothing to be precluded.
24 – NEC Corporation Agree. From coexistence's perspective, we think all of moderator proposed deployment should not be precluded for the flexibility of operation. On the other hand, we agree with MediaTek that there could be very limited #bands need from operation band's perspective.
25 – Orange we agree
26 – TURKCELL We agree.
27 – Intel Belgium SA/NV We are fine to the proposal
28 – Ericsson LM It is fine to study all three deployment cases, but we prefer to prioritize in-band deployment.
29 – China Telecommunications We agree
30 – KPN N.V. Our preference is to give priority to the in-band deployment.
31 – Philips International B.V. We agree.

(b) Co-deployment with existing 3GPP deployment

The papers which address coexistence with existing infrastructure take the assumption that it is a potential way to serve certain use cases, such as in a warehouse where an existing 3GPP small cell deployment can be present, onto which an Ambient IoT deployment is added.

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For basestation deployments, to allow "coexistence with existing 3GPP technologies" could be described as:

- *Deployed on the same sites as an existing 3GPP deployment corresponding to the basestation type*
- *Deployed without an assumption of an existing 3GPP deployment.*

Feedback Form 13: Question 4-3b: For basestation deployments, is it agreeable to allow "coexistence with existing 3GPP technologies" to be described as above?

1 – VODAFONE Group Plc agree
2 – Spark NZ Ltd agree
3 – Huawei Tech.(UK) Co.. Ltd Yes.
4 – Samsung Electronics Co. Yes
5 – Apple France Yes, it is agreeable
6 – Futurewei Technologies It is agreeable.
7 – vivo Communication Technology OK
8 – NTT DOCOMO INC. Agree
9 – Kyocera Corporation We're wondering if the "existing 3GPP deployment" includes the legacy 3GPP system such as LTE. We also wonder if there is any difference between the second bullet "*Deployed without an assumption of an existing 3GPP deployment*" and the standalone deployment.

10 – Spreadtrum Communications

Yes.

11 – Motorola Mobility España SA

[Lenovo] Agree

12 – CATT

Agree

13 – Telstra Limited

Agree

14 – China Mobile Com. Corporation

Agree

15 – Qualcomm Incorporated

We agree

16 – LG Electronics Inc.

Yes

17 – Shenzhen Heytap

[OPPO]

Agree

18 – Sony Europe B.V.

The coexistence issue is presumably about whether ambient IoT devices can operate within the coverage area of an existing 3GPP deployment. Hence, the issue is not about whether deployment can be about deployment of nodes on the same site. We also don't see a coexistence issue if there is no existing 3GPP deployment (what thing would the Ambient IoT device need to coexist with if there were no existing 3GPP deployment?).

19 – Nokia Denmark

Yes, we agree

20 – ZTE Corporation

Agree.

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21 – Panasonic Holdings Corporation We support FL view.
22 – Orange we agree
23 – TURKCELL We agree.
24 – Intel Belgium SA/NV We are fine to the proposal
25 – Ericsson LM Yes, and it would be good to also capture assumptions on whether new NW hardware deployment is required or not.
26 – KPN N.V. Agree. And integrateing with the existing infrastructure is desirable.
27 – Philips International B.V. We agree

5.3.1 Initial round summary

Topic 4-3a: Coexistence with UEs.

The proposal has support from the vast majority of companies, and a few companies mention their preferences for prioritization. Qualcomm and MediaTek raise the point of what the device might, or would, support in practice. For these type of points, the moderator suggests further discussion under e.g. required functionalities and/or when writing recommendations and conclusions for the TR.

Lenovo mention UHF bands, which seems adequately addressed by “standalone from NR”. Details of frequency bands may be more conveniently discussed under “spectrum”.

LG ask to clarify “standalone **band** from NR” ,which seems fine.

Topic 4-3b: Co-deployment with existing 3GPP deployment

All companies agreed to the first round suggestion, with a couple of additional questions.

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- Kyocera: Ask (1) if the "existing 3GPP deployment" includes the legacy 3GPP system such as LTE. And (2) if there is any difference between the second bullet "Deployed without an assumption of an existing 3GPP deployment" and the standalone deployment.
    - Moderator response: It just refers to whether there is existing infrastructure sites, agnostic to what legacy/existing RAT is on those sites, or what bands those existing sites are using.
- Sony: Moderator responds that if there is no existing 3GPP deployment, that is the second bullet of the proposal. It refers to e.g. whether Ambient IoT is convenient to deploy on the same sites as existing network (first bullet), vs. when there is no existing infrastructure (second bullet).

5.3.2 Intermediate round

Topic 4-3a: Coexistence with UEs.

Based on the initial round summary, the moderator thinks we can agree with the existing proposal, and take questions of prioritization at a later stage.

Proposal 4-3a: Agree that the study considers Ambient IoT deployment in-band to NR, in guardband of NR, and standalone band from NR, and FFS: relationship to deployment scenarios.

Note: Prioritization among them can be discussed in later meetings.

Feedback Form 14: Is Proposal 4-3a agreeable?

Topic 4-3b: Co-deployment with existing 3GPP deployment

Based on the initial round summary, the moderator thinks we can agree with the existing proposal.

Proposal 4-3b: Agree that for basestation deployments (when present), "Coexistence with existing 3GPP technologies" can be:

- *Deployed on the same sites as an existing 3GPP deployment corresponding to the basestation type*
- *Deployed without an assumption of an existing 3GPP deployment*

Feedback Form 15: Is Proposal 4-3b agreeable?

5.4 Topic 4-4: Connectivity topology

Topic 4-4: Connectivity topology

A large number of connectivity topologies are discussed in papers. They fall essentially into two families, according to whether air-interface transmission to, and reception from, the Ambient IoT device are at the same or different node(s). Some companies term these respectively mono-static or bi-/multi-static, of which in the latter case most companies consider bi-static. There are additional considerations of whether there is a node which only supplies RF energy for backscattering at the Ambient IoT device, what functions an assisting node plays in the bi-/multi-static topologies (e.g. data and/or energy), and whether transmission to and reception from the Ambient IoT device are at the same or different nodes.

The moderator believes that the following set of 4 generalized connectivity topologies covers all the proposals that companies have made, by carefully considering the NOTEs attached to each.

Topology (1) BS <-> Ambient IoT device

NOTE 1: Includes the possibility of BS Rx and BS Tx in different BSs

NOTE 2: The Ambient IoT device may be provided with energy from another node(s)

Topology (2) BS <-> intermediate node <-> Ambient IoT device

NOTE 1: Intermediate node can be relay, IAB, UE, etc. which is capable of ambient IoT

NOTE 2: The Ambient IoT device may be provided with energy from another node(s)

Topology (3) BS <-> assisting UE <-> Ambient IoT device <-> BS

NOTE 1: The link from assisting UE to the Ambient IoT device can provide energy for the device's transmission

NOTE 2: Assisting UE can be either bidirectional or unidirectional operation to others

Topology (4) UE <-> Ambient IoT device <-> {BS or none}

NOTE 1: The links may be bidirectional or unidirectional operation

Feedback Form 16: Question 4-4: Is it agreeable to capture the above connectivity topologies in TR 38.848, and for use in the deployment scenario tables?

1 – Samsung Electronics Co.

In general, we are ok with current fomulation, one comment is that whether this topology is assumed only one BS for energy transmission and data transmissio and reception. Maybe better to include to have one or multiple BSs or Assiting UEs for transmission energy signal or data TX/RX.

2 – VODAFONE Group Plc

agreed to capture all four topologies. Additionally, it is also possible to have a scenario with combination of 2 topologies (eg. Topology(1) and topology (2)).

3 – MediaTek Inc.

Please clarify topology (4).

Topology (5) that in our view is essential, is missing i.e.: {BS or none} <> UE <> Ambient IoT device

Note the communication end points will need to be clarified.

We strongly question why the ”energy provision” should be considered at all in the study - that and how the Ambient IoT device harvests (if at all) energy is *irrelevant* to the study. See topology 1 note 2, topology 2 note 2, topology 3 note 1 - these notes are inappropriate and go beyond the scope of the study. As per the SID, the energy source and storage are mere device categorization characteristics.

4 – Spark NZ Ltd

all four topologies should be captured

5 – Huawei Tech.(UK) Co.. Ltd

We think it makes sense to summarize the topologies which have been proposed in papers in a generalized way. Our understanding:

(1), for the case ambient IoT device is directly connected to gNB(s).

(2), for the relay case, ambient IoT device is connect to gNB via relay-type node, there is no direct link between gNB and ambient IoT device.

(3), different to relay case, ambient IoT device is connect to gNB via assisting UE where both gNB and assisting UE have direct connection to ambient IoT device.

(4), for the case ambient IoT device is directly connected to UE, possibly with control from gNB.

The above 4 connectivity topologies could cover all possibilities, thus we think it should be agreeable as high-level description of connectivity topologies in our view.

To address points from a few companies (may followup more later):

@Vodafone: That combinational topology is not raised in any paper. It seems to suggest a kind of dual-connectivity for an extremely simple Ambient IoT device. Could you clarify the intention and use for this combined topology? Perhaps it is best to take an FFS on such things, or wait to see if a company motivates such combinations in their next papers?

@Samsung: It seems the optional-plural node**(s)** covers your case for energy. For data TX, it seems surprising if an ambient IoT node of such minimal complexity is able to perform data combination from multiple TRPs. Is this really intended? We think it might be captured by repeated application of Topology 1 to a given deployment implementation

@MediaTek: Your topology (5) with {BS} is precisely topology (2), according to the NOTE 1 including a UE, and topology (5) with {none} is Topology 4 with {none}.

6 – Samsung Electronics Co.

@Huawei, we do not see the possbility to combine date from mTRP for Ambient IoT device, but MTRP can combine data from Ambient IoT to improve the reliability. In addition, plural node(s) works for us. Thanks.

7 – Sierra Wireless. S.A.

Topology 1 and 2 are clear.

For topology 3 - What is the meaning of a ”assisting UE” and how is it different than a Relay? If gNB has a bi-directional direct link to Ambient-IOT device, why does it need an assisting UE? Perhaps you can add a note.

8 – Apple France

Topology 1, 2 and 3 are fine. For topology 4, based on the clarification from Huawei, we would suggest to further separate this into topology 4 and topology 5, where topology 4 can be direct connection of ambient-IoT device to the UE without BS control (UE<->Ambient-IoT Device) and topology 5 can be direct connection of ambient-IoT device to the UE with BS control (UE<->Ambient-IoT Device <-> BS). In our view, this clear distinction do not leave any room for confusion.

9 – Futurewei Technologies

We are ok to be inclusive at the RAN level study. In future WG level work, the aspects related to using UE via sidelink, relay/IAB, or repeater does not provide additional insight in terms of feasible study and fundamental technique study while risks spending a lot of time and distracting the group from the basics. Focusing on base-station only (topology (1)) is a better approach

10 – vivo Communication Technology

For the four topologies, we have the following comments

1, We would like to further distinguish the two types of links as the following, which could make the discussion more easier

- 1) The existing Uu link (enhancement not precluded)

- 2) The new link from/to ambient IoT devices (e.g., gNB/UE/realy <-> Ambient IoT device)

2, According to above 1, the Topology 2) can be espressed as

BS <-(Uu)-> intermediate node <-> Ambient IoT device

3. For topology 3, it seems cover multiple topologies in our understanding. We would prefer to further categorize it for better clarity.

- Topology 3-1: BS<-(Uu)-> assisting UE ->Ambient IoT device ->BS. In this case, BS is used to configure/schedule assisting UE to transmit signal (control command and/or carrier wave) to Ambient-IoT device, based on which the abmbient-IoT device to modulate and transmit signal to the BS, e.g. based on backscattering of the carrier wave from assisting UE.
- Topology 3-2: BS->Ambient IoT device-> assisting UE<-(Uu)->BS. In this case, BS transmit control signaling/carrier wave to Ambient-IoT device, based on which the Ambient-IoT device to modulate and transmit signal to the assisting UE, e.g. based on backscattering of the carrier wave from BS.
- Note that the Uu link in above topologies can be deleted for simplicity, or seperately discussed.

4. For topology 4, we do not quite understand this connection. could moderator or proponents clarify?

11 – NTT DOCOMO INC.

Agree

12 – Kyocera Corporation

We support all the topology options. We assume the arrows include both the data transmission and the energy transmission. We wonder if Topology (3) can only have the "->" direction, and if Topology (3) is a subset of Topology (4).

13 – Spreadtrum Communications

We are fine to capture all the above connectivity topologies

14 – Motorola Mobility España SA

[Lenovo] assisting node in the connectivity topology is low priority. In the RAN level study, the motivation is to define the scope for RAN1 SID. Also it is not necessary as how the device harvest energy should be left to implementation as done in SA1

15 – CATT

We believe that first two topologies are sufficient.

16 – Telstra Limited

We are ok to capture all four topologies but if needed, would prioritise topologies 1 & 2

17 – Qualcomm Incorporated

We are generally ok with having multiple topologies. We have a few comments for selected topologies.

For topology (2), is the "UE" in NOTE1 "assisting UE"? It would be good to clarify the difference of "UE" and "assisting UE".

For topology (3), we see there are two base stations, one at the starting point and the other one in the end. It is better to clarify if they are the same BS or different BS.

For topology (4), Recommend replacing "{BS or none}" to "{BS or UE or none}" to capture UE<->A-IoT<->UE topology.

18 – LG Electronics Inc.

Topology (1) and (2) should be sufficient and Topology (3) would be acceptible. However, it needs clarification on topology (4). In topology (4), does it mean that the UE does not have any connection with BS? But we think that the UE would have a connection with the BS to be controlled, if so, topology (4) is same as topology (2).

19 – China Mobile Com. Corporation

At this stage, we are open to capture all the topologies for study.

It seems companies are asking for further clarification on the descriptions. So we think capture some figures (may be just for example) would be helpful for the readers to comprehend the whole picture. The figures in our contribution RP-223072 can be a candidate.

For topology 3, I think it refers to topology 2-1&2-2 in RP-223072, to increase the link budget of DL or UL with the help of assisting UE. So the two gNB can be the same.

Regarding to company's concerns on whether "energy provision" should be considered, we think energy provision need to be captured in the deployment scenario, as the energy provision is one of the key element to analysis the link budget for DL/UL.

20 – Shenzhen Heytap

[OPPO]

1) 1st comment

Topology (4) UE <-> Ambient IoT device <-> {BS or none}

This topology 4 is not clear. If a UE can connect with the device, why there is a need to let also the gNB to connect the device.

Suggest to change Topology 4 as:

UE<->Ambient IoT devie.

2) Generally fine with other 3 toplogies.

21 – Nokia Denmark

We are generally fine with the proposed topologies. We would include multiple reading & illumination nodes (UE, BS, etc). What is the difference between UE, assisting UE, and intermediate node?

22 – ZTE Corporation

We cannot clearly understand Mediatek's comment, why energy is irrelevant to the study? We understand the simplest/typical case is that the battery–less device can make use/backscatter the energy carried by the DL radio transmission to generate the UL radio transmission.

For Vodafone's comments, we understand the main intention is that a BS needs to support both Topology (1) and Topology (2), we think it generally make sense.

Back to the Topologies, we have the following comments:

1. We have the general understanding that in all the four Topologies, "<->" mainly indicates the communication end points. So we need to make some clarification on energy provision in the Notes (there is already something in some Topologies but also something missed in other Topologies). So firstly, a clarification is needed to Note 2 in Topology 1 and 2 to clarify gNB/intermediate node can also provide energy for the device. Secondly, we think another nodes can also provide energy in Topology 3 and Topology 4.

2. We suggest to add repeater in the Topology 2 as it's benefit for extending the coverage in this scenario. Please note smart repeater is already specified in RAN and easier to be deployed, e.g., than NW-side relay.

3. We cannot understand why there is "UE" in the Note 1 of Topology (2). If it's a typo, we suggest to remove it.

4. We cannot understand why we have such restriction that there is no direct link between gNB and ambient IoT device in Topology (2)? We think similar as Topology (3), it's also possible to have the "asymmetric links" in Topology (2), e.g., ambient IoT device is connect to gNB via intermediate node where both gNB and intermediate node have direct connection to ambient IoT device. So we suggest to add "" in the end of Topology (2)

5. For Topology (4), if the control is from gNB, we think possibility is same as that in Topology (3). So in order to avoid overlapping between Topologies, we suggest to remove "<-> {BS or none}" from Topology (4)

Based on the above comments, we give the following suggestions:

Topology (1) BS <-> Ambient IoT device

NOTE 1: Includes the possibility of BS Rx and BS Tx in different BSs

NOTE 2: The Ambient IoT device may be provided with energy from **BS(s) or** another node(s)

Topology (2) BS <-> intermediate node <-> Ambient IoT device <-> BS

NOTE 1: Intermediate node can be **repeater**, relay, IAB, ~~**UE,**~~ etc. which is capable of ambient IoT

NOTE 2: The Ambient IoT device may be provided with energy from **intermediate node(s) or** another node(s)

Topology (3) BS <-> assisting UE <-> Ambient IoT device <-> BS

NOTE 1: The link from assisting UE to the Ambient IoT device can provide energy for the device's transmission

NOTE 2: Assisting UE can be either bidirectional or unidirectional operation to others

NOTE 3: The Ambient IoT device may be provided with energy from another node(s)

Topology (4) UE <-> Ambient IoT device ~~**<-> {BS or none}**~~

NOTE 1: The links may be bidirectional or unidirectional operation

NOTE 2: The Ambient IoT device may be provided with energy from UE(s) and another node(s)

23 – Sony Europe B.V.

We are open to study different topologies. The 4 examples provided in the text of topic 4-4 could form the basis (and we can refine these) but we are open to study more topologies if found necessary.

24 – Panasonic Holdings Corporation

We support FL view.

25 – NEC Corporation

We think the motivation of Topology (3) BS <-> assisting UE <-> Ambient IoT device <-> BS is to extend the coverage. The assisting UE should be a ambient IoT aware UE. However, we think assisting UE can be applied as a relay node to communication with Ambient IoT device and relay the information to BS. So the motivation for the link Ambient IoT device <-> BS in Topology (3) is not strong compared with other three Topologies. We think Topology (3) could be FFS and others are agreeable.

26 – Orange

we support all 4 topologies and think these capture all the cases to be covered

27 – TURKCELL

We support all topology options.

28 – Intel Belgium SA/NV

Our understanding on the proposal is to identify the possible topologies for A-IoT. On the other hand, it is preferred to prioritize certain typical topologies.

- For Topology (1) note 1, we are not convinced for ‘BS Rx and BS Tx in different BSs’ since it is not supported in the existing NR operations.

- For Topology (2), prefer to add ‘repeater’ in Note 2.

- For Topology (3), does it mean the uplink or downlink transmission of A-IoT device are to/from different nodes (UE or BS)?

- For Topology (4), what is the assumption for uplink, downlink and energy source?

29 – Intel Belgium SA/NV

Some further comments

- To clarify our question to Topology (3), the dual arrow is confusing. Does it limited to following two flows, or more interpretations are allowed?

Topology (3-1) BS -> assisting UE -> Ambient IoT device -> BS

Topology (3-2) BS <- assisting UE <- Ambient IoT device <- BS

- Note 2 in topology 1/2 is not included in Topology 3/4. Does it mean energy source must be one of listed UE or BS doing Tx/Rx transmission to/from the A-IoT device? If not, better to capture Note 2 in Topology 3/4 too.

30 – Ericsson LM

It would be good to clarify the meaning of the arrows and consider distinguishing between unidirectional and bidirectional arrows if needed. If larger changes can be considered, we think that the following topologies would be clearer.

Topology (1) BS <-> Ambient IoT device

NOTE 1: Bidirectional case, i.e., BS Rx and BS Tx in the same BS.

NOTE 2: Applicable both to active Tx/Rx and passive Tx/Rx.

NOTE 3: BS can possibly be an IAB node or NW-based relay.

Topology (2) BS -> Ambient IoT device -> BS

NOTE 1: BS Rx and BS Tx in different BSs.

NOTE 2: Applicable only to passive Tx/Rx.

NOTE 3: BS can possibly be any NW node, e.g., IAB node, NW-based relay, separate charge carrier wave transmitter, or separate reader.

Topology (3) UE -> Ambient IoT device -> BS

NOTE 1: UE Tx (charge carrier wave) and BS Rx reader.

NOTE 2: Applicable only to passive Tx/Rx.

NOTE 3: UE can possibly be a UE, assistance UE, or UE-based relay.

NOTE 4: BS can possibly be any NW node, e.g., IAB node, NW-based relay, or separate reader.

Topology (4) BS -> Ambient IoT device -> UE

NOTE 1: BS Tx (charge carrier wave) and UE Rx reader.

NOTE 2: Applicable only to passive Tx/Rx.

NOTE 3: UE can possibly be a UE, assistance UE, or UE-based relay.

NOTE 4: BS can possibly be any NW node, e.g., IAB node, NW-based relay, or separate charge carrier wave transmitter.

Topology (5) UE <-> Ambient IoT device

NOTE 1: Bidirectional case, i.e., UE Rx and UE Tx in the same UE.

NOTE 2: Applicable both to active Tx/Rx and passive Tx/Rx.

NOTE 3: UE can possibly be a UE, assistance UE, or UE-based relay.

31 – Huawei Tech.(UK) Co.. Ltd

Couple of follow-ups:

@Qualcomm: On the topology of your suggested UE<->Ambient IoT<->UE. What is the difference to UE<->Ambient IoT, and what is the second UE used for? Does it mean the ambient IoT device needs to maintain dual -connectivity to multiple UEs? We cannot see this topology in a submitted paper.

@Samsung: Thanks for the reply.

@Sierra; At least in our understanding, UE assistant case is different to relay case. For relay case, the relay node is usually used for coverage extension of a base station, ambient IoT device is connected to relay node and relay node forwarding data between BS and ambient IoT device. For UE assistant case, ambient IoT device is connected to BS, the assisting UE works to improve the link budget of the weaker one between 'ambient IoT device receiving from BS' and 'ambient IoT device transmitting to BS'. Perhaps some refinement of these topologies can be considered.

32 – KPN N.V.

We support all the 4 topologies.

33 – Philips International B.V.

In addition to the four topologies above, we propose to study the following topologies:

- the topology as discussed in Qualcomm's paper RP-222918 Figure 3 (e.g. BS <-> Ambient IoT device <-> UE). It is not clear if this is covered by these four topologies above.

- Similarly, an Ambient IoT device could be in direct coverage of the BS to receive information, but then use an intermediate node to communicate back to the BS, e.g. BS -> Ambient IoT device -> intermediate node -> BS.

5.4.1 Initial round summary

Based on the inputs, moderator understands most of companies could live with all of the 4 connectivity topologies for the study at least as a starting point. Some companies give detail comments on these topologies in general or specific to each. Moderator gives response as follows:

Comments in general:

- There are some comments to clarify including the multiple BSs or assisting UE in these topologies from Samsung and Nokia. And Samsung further clarifies in the reply they do not see the possibility to combine date from mTRP for Ambient IoT device, but mTRP can combine data from Ambient IoT to improve the reliability. Moderator think it is possible but seems up to basestation implementation. For the multiple illumination nodes moderator also think it seems up to implementation.
- Some comments to discuss whether need to consider energy provision in topology. MediaTek believe it should be discussed in device categorization. Lenovo think it is up to implementation. CMCC and ZTE explicitly support to discuss associated with topology. The reason moderator wrote energy providing in NOTE under topology candidates is just from contributions where companies propose it in their topology. ZTE also comment to add more energy providing node on top of existing wording.
    - In general, the situation is that energy may provided either by a node which is not the ambient IoT device, or may be from storage in the device. Moderator suggests making this a general note to all the topologies and removing it from the per-topology level.

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- Vivo suggest to distinguish Uu link and Ambient IoT link with different arrows. <- Uu -> and <- ->
    - Moderator: It seems that this could be usefully discussed as a next-level detail once we have the high level topologies settled, so I leave the change for now, whilst not precluding clarification.
- MediaTek and ZTE mentions whether need to claim communication end points for each topology. Moderator's understanding for (1), (2), (3) the end point is BS, and (4) is either UE or BS depend on the direction of the link from Qualcomm's paper.
- CMCC suggest to add figure for each topology.
    - Moderator may ask the rapporteur or TR editor to help with this once they are stable!
- Combination of topology can be FFS as Huawei replied to VDF.
- Some companies ask about a difference between topology 2 and 3 when the intermediate node is a UE. This is mentioned by at least Samsung, and Intel. Moderator offers the explanation that a relay node is typically for coverage extension of a BS, with the ambient IoT device connected to the relay, and (due to coverage) not connected to the BS. Whereas with an assisting UE node, it works to improve the link budget of the weaker between 'ambient IoT device receiving from BS' and 'ambient IoT device transmitting to BS' (see e.g. CMCC's reply). Thus, moderator retains 'UE' in NOTE 1 of topology 2 at this time.

Comments specific to Topology (1):

- (No specific comments).

Specific to Topology (2):

- ZTE suggest to add 'repeater'. Moderator notes the "etc", but can explicitly add it, though scope does not change. If ZTE consider there is link between gNB and ambient IoT UE, it would be in topology 3.
- Some companies ask why UE could be the intermediate node in topology 2. And what is the difference to assisting UE in topology 3. Moderator wrote it by reading contributions from Samsung and Intel. Moderator suggest interested companies to further discuss and clarify on this issue.

Specific to Topology (3):

- Vivo suggest to split (3) to 3-1 and 3-2, moderator suggests this should be next step after agree the high-level type, if companies raise this point.

Specific to Topology (4):

- There are some comments on the meaning of {BS or none}, and Qualcomm suggest to make it {BS or UE or none}, and another suggestion is to remove the whole "{BS or none}". Moderator notes that adding UE at each end is not a topology raised in any paper, and that these suggestions partially overlap.

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- Moderator will clarify this topology by splitting the version with a third node (either BS or UE) into a new topology 5, and making topology 4 only UE<->device.

5.4.2 Intermediate round

Based on the initial round summary, the topologies are revised as follows.

Topology (1) BS <-> Ambient IoT device

NOTE 1: Includes the possibility of BS Rx and BS Tx in different BSs

~~**NOTE 2: The Ambient IoT device may be provided with energy from another node(s)**~~

Topology (2) BS <-> intermediate node <-> Ambient IoT device

NOTE 1: Intermediate node can be relay, IAB, UE, **repeater,** etc. which is capable of ambient IoT

~~**NOTE 2: The Ambient IoT device may be provided with energy from another node(s)**~~

Topology (3) BS <-> assisting UE <-> Ambient IoT device <-> BS

~~**NOTE 1: The link from assisting UE to the Ambient IoT device can provide energy for the device's transmission**~~

NOTE 2: Assisting UE can be either bidirectional or unidirectional operation to others

FFS: If the two BS can be different, or are always the same BS

Topology (4) UE <-> Ambient IoT device ~~**<-> {BS or UE}**~~

NOTE 1: The links may be bidirectional or unidirectional operation

Topology (5) UE <-> Ambient IoT device <-> {BS or UE}

NOTE 1: The links may be bidirectional or unidirectional operation

NOTE for all topologies: The Ambient IoT device may be provided with energy from another node(s) either inside or outside the topology

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FFS: Whether to consider combination of different topologies in the study.

FFS: BS, UE, or assisting UE could be multiple BSs, UEs or assisting UEs, respectively.

Feedback Form 17: Question 4-4: Can we agree to the above list of topologies?

5.5 Topic 4-5: Spectrum

Topic 4-5: Spectrum

Papers discuss in general terms that licensed and unlicensed spectrum should be included in the study, with a few comments on the applicability of unlicensed, and/or on priority between licensed and unlicensed. No company raises a concern on including FDD and TDD bands in the study.

For the first meeting(s), Moderator suggests we decide what is included in the study. Issues of prioritization can be addressed when writing conclusions and recommendations towards potential future SI/WIs.

Feedback Form 18: Question 4-5: Is it agreeable that 'Spectrum' in a deployment scenario is: licensed FDD, licensed TDD, or unlicensed?

1 – Samsung Electronics Co.

We think interference management is one of the reasons why the ambient IoT is operated in the 3GPP ecosystem. Considering the difference between interference management in licensed and unlicensed spectrums, it is difficult to consider both from a work load perspective. We propose to proceed with SID in preference to licensed spectrum first. Regarding FDD and TDD, it is ok to include both as the deployment scenarios.

2 – Wiliot Ltd.

It is possible to include unlicensed spectrum in the study in interference insensitive usages such as energy signals.

3 – VODAFONE Group Plc

all three scenarios ; licensed FDD, licensed TDD and unlicensed can be considered

4 – MediaTek Inc.

All three.

5 – Spark NZ Ltd

interference management will be easier with licensed bands and we could prioritize to start with this.

6 – Sierra Wireless. S.A.

All three with equal priority.

7 – Apple France

We agree with all three

8 – Futurewei Technologies

It is ok to be more inclusive during RAN level study. For future WG level work, though unlicensed spectrum for ambient IoT has its additional aspects, those are secondary and can be addressed later. In addition, the transmission power of the unlicensed spectrum is quite limited which could further reduce the range of ambient IoT. Focusing on licensed spectrum is preferred.

9 – vivo Communication Technology

OK

10 – NTT DOCOMO INC.

Agree

11 – Kyocera Corporation

We support all spectrum options, i.e., licensed FDD/TDD and unlicensed spectrums. Though, we assume the prioritization among these spectrums will be discussed in the future, if needed, e.g., when the follow-up SID/WID is formed.

12 – Spreadtrum Communications

We are fine to consider these three deployment scenarios

13 – Motorola Mobility España SA

[Lenovo] consider All

14 – CATT

Ok on all.

15 – Telstra Limited

Only need to capture licensed spectrum for both FDD and TDD

16 – Qualcomm Incorporated

All three cases could be considered.

17 – LG Electronics Inc.

Yes

18 – Shenzhen Heytap

[OPPO]

All 3 cases can be considerred. Licensed band will be usually the 1st step in 3GPP

19 – Huawei Tech.(UK) Co.. Ltd

We can agree with the proposal.

For unlicensed, like others, we also think interference is the primary limitation, and this is only likely to be sufficiently suppressed indoors. Although the tabular structure would be able to capture that restriction implicitly TR purposes, we are open to further discussion on how/if to include unlicensed for indoors.

20 – China Mobile Com. Corporation

We support only licensed FDD and licensed TDD. But, we have serious problem with unlicensed.

Because the unlicensed spectrum has the limitation of transmission power, more serious intra-freq interference, which impact on the transmission range of ambient IoT. And the restriction of LBT will make the design more complex, since it is difficult to support LBT on the battery-less tag.

So we don’t support to capture unlicensed.

21 – Sony Europe B.V.

OK

22 – Nokia Denmark

Yes, we would like to include all spectrum scenarios in the RAN study with potential down selection.

23 – ZTE Corporation

We also think licensed FDD, licensed TDD and unlicensed (e.g., to also consider the bands used by legacy RFID) can be considered in all the deployment scenarios.

24 – Panasonic Holdings Corporation

We support FL view.

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25 – NEC Corporation Yes, it is agreeable.
26 – Orange Licensed FDD and TDD should be the priority scenarios
27 – TURKCELL We support all three options.
28 – Intel Belgium SA/NV We are fine to the proposal
29 – Ericsson LM Yes, and if there is a need to prioritize, we prefer to prioritize licensed bands. Here, it could also be clarified whether the bands are assumed (in the study) to be the same as the ones currently specified for NR.
30 – KPN N.V. Licensed FDD and TDD are our preference

5.5.1 Initial round summary

Companies views appear to be:

- Yes to all: VDF, MediaTek, Sierra, Apple, Futurewei, vivo, DCM, Kyocera, Spreadtrum, Lenovo, CATT, Qualcomm, LG, OPPO, Huawei/HiSilicon, Sony, Nokia, ZTE, Panasonic, NEC, TURKCELL, Intel, Ericsson,
- Concerns with unlicensed: Samsung, Huawei/HiSilicon (outdoor), Spark, Telstra, CMCC, Orange, KPN
- Support unlicensed: Wiliot

5.5.2 Intermediate round

Clearly licensed FDD and licensed TDD are agreeable. The concerns on unlicensed raise again the question of prioritization. However, a large number of companies specifically indicate they can accept all 3 at this stage. Moderator's general view is to take that later, when we write recommendations and conclusions, and work for now on the general understanding that down-selection / prioritization may occur in general across the SI. Given that additional to prioritization, companies also raise particular concerns on unlicensed, e.g. transmit power limitation, interference outdoors, the moderator can suggest to having a note about further discussions.

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Proposal 4-5: Agree that spectrum in a deployment scenario is: licensed FDD, licensed TDD, unlicensed.

- Note: Further discuss if the study should apply any limitations to the cases for which unlicensed spectrum is studied.

Feedback Form 19: Is Proposal 4-5 agreeable?

5.6 Topic 4-6: Traffic assumption

Topic 4-6: Traffic assumption

The SID gives traffic types of device-originated and/or device-terminated. Companies address both types across the submitted papers. Some submissions further look at the purpose of the traffic, e.g. to distinguish a device-terminated reporting trigger (wherein some give examples such as inventory or data report) from a device-terminated command message (wherein some give examples such as for control).

Some papers also discuss traffic pattern and payload size.

Since the SID already tells us that 'Traffic assumption' types for the deployment scenarios are at least DO and DT, Moderator's suggestion is to see if companies are ready to agree a further level of detail relating to the traffic purpose, since this can be inferred from SA1 UCs, as is seen in companies' papers.

For traffic patterns, payload sizes, and other further detail levels, Moderator encourages companies to look into these aspects for further discussion in the next meeting, whether under further study of (r)UCs, deployment scenarios, or RAN design targets.

Q4-6: For "Traffic assumption" of a deployment scenario, additional to "device-originated" and "device-terminated", what are companies view on also having:

- *Device-terminated command (for which the TR can state e.g. of positioning, actuation, etc.)*
- *Device-terminated reporting trigger (for which the TR can state e.g. of inventory, sensor report, etc.)*

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Feedback Form 20: Q4-6: For "Traffic assumption" of a deployment scenario, additional to "device-originated" and "device-terminated", what are companies view on also having Device-Terminated command and Device-Terminated reporting trigger, as described above?

1 – VODAFONE Group Plc

agree to have device-terminated command and device-terminated reporting trigger.

2 – MediaTek Inc.

We're not sure the distinction is needed at this stage. However we do agree that "device-terminated communication trigger" is a primary characteristic - whatever the communication that will next be made by the device.

3 – Huawei Tech.(UK) Co.. Ltd

It seems useful to have this clarification to help the TR set out the differences within the single terminology. There is a further case we'd like to capture:

- *Device-originated autonomous report (for which the TR can state e.g. of wireless sensor for environment monitoring, etc.)*

4 – Sierra Wireless. S.A.

We do not understand why we need this MT command vs Reporting Trigger distinction.

5 – Apple France

We would be fine to have the distinction of device-terminated command and device-terminated reporting trigger

6 – Futurewei Technologies

We are fine with the proposal

7 – vivo Communication Technology

Fine in general.

However, we would like to ask a question for clarificaiton. If sensor report is considered as "device-terminated report trigger", what would then be the representative use case for "device-originated" traffic? would be good to hear companies understanding on this.

8 – NTT DOCOMO INC.

We are open to differentiate these traffic types for clarification

9 – Kyocera Corporation

We're ok to include these assumptions.

10 – Spreadtrum Communications

We understand that both device-Terminated command and Device-Terminated reporting trigger are belong to the category details, so they can be included in the traffic category of device terminated.

In addition, device originated traffic can be transferred to device terminated traffic according to SA1 study, for example, sensor service can be categorized as device terminated traffic.

11 – Motorola Mobility España SA

[Lenovo] device originated for wireless sensor network and device terminated for inventory tracking for logistics

12 – CATT

Both active and passive devices could support device terminated. However, only active devices could support device originated. We need to define the device type and use cases first before defining device originated/terminated.

13 – Qualcomm Incorporated

We want to clarify that the traffic characterization such as "device-originated", "device-terminated-command" or "device-terminated-reporting-trigger" are all application layer characterization. Note that they may not necessarily be in line with physical layer signaling flow. For example, it is still possible that (semi)-passive device can send "device-originated" application message based on lower layer trigger signal from gNB. The lower layer trigger signal could be occasional polling signal to trigger/allow Ambient IoT devices to transmit its own message. The "device-originated" traffic could be also, of course, used to refer the traffic generated by active device (w/o trigger signal).

We think the traffic characterization should not implicate certain device type (i.e. passive or active).

14 – LG Electronics Inc.

Considering that Device-Terminated command can trigger Device-Terminated reporting, we are not sure to differentiate between Device-Terminated command and Device-Terminated reporting trigger.

15 – Shenzhen Heytap

[OPPO]

Not sure whether we need to have such detailed type.

And it may not be able to have an accurate categrozation. For example, for a function, it may include only one or include both.

16 – Sony Europe B.V.

Do not support. "Device terminated" is general terminology and includes the two extra bullets.

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17 – China Mobile Com. Corporation

It's too early to go into details. For now, we can simply use MO/MT for general.

18 – Nokia Denmark

We support the comment from Qualcomm.

19 – ZTE Corporation

We are generally fine with the following types suggested by the Rapp:

- *Device-originated autonomous report (for which the TR can state e.g. of wireless sensor for environment monitoring, etc.)*
- *Device-terminated command (for which the TR can state e.g. of ~~positioning,~~ actuation, etc.)*
- *Device-terminated reporting trigger (for which the TR can state e.g. of inventory, sensor report, etc.)*

Why we remove the positioning is that we are uncertain whether positioning belongs to Device-terminated command type since we are not clear yet how to perform positioning for such Ambient-IoT devices.

And we think one difference between Device-terminated command and Device-terminated reporting trigger is that UL application traffic may be not expected in Device-terminated command.

20 – Panasonic Holdings Corporation

We support FL view.

21 – TURKCELL

We support Qualcomm's view.

22 – Intel Belgium SA/NV

We prefer to first clarify if it is the case that a DT device always need to acknowledge the received DT indication. The acknowledge may be a physical layer signal or a high layer message

If it is supported that there is no acknowledge in either PHY or high layer, the categorization of device-terminated command or device-terminated reporting would be fine. However, positioning may not be a proper example for device-terminated command since A-IoT device may transmit/backscatter a signal after receiving an indication for positioning.

23 – Ericsson LM

We would prefer to see the more generic 'DT data' and 'DO data' (cf. NR Small Data Transmission), since according to several SA1 use cases, transmission of DL data payload must be supported.

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5.6.1 Initial round summary

Based on the inputs, moderator understands a lot companies are fine to have Device-Terminated command and Device-Terminated reporting trigger as additional descriptions of DT traffic assumption. While some companies don't think it is necessary to discuss such detail at this stage and would keep only DT and DO at high level. A few companies think DO can be implemented as DT (by polling) or has certain relation to DT trigger, one company ask to clarify the relation between DO and the DT triggered sensor report. Two companies ask to remove positioning in moderator's example. 2 companies think the application layer concept DT command, DT reporting trigger and DO may not necessarily be in-line with physical layer signaling flow which means application layer concept may be different to physical concept.

Moderator thinks it seems premature to discuss detail of DT at this moment, thus to propose remains DT and DO for now, and encourage companies to further look in next meeting.

5.6.2 Intermediate round

The SID at least tells us at DT and DO are valid within the SI. Given the divergent views on the basis of the discussion, moderator suggests taking an FFS for the next meeting. Moderator includes some level of detail as a reminder to companies of the discussion.

Conclusion 4-6: The moderator records the following for this meeting:

- FFS whether the TR will describe different types of device-terminated traffic, e.g. Device-Terminated command and Device-Terminated reporting trigger, and whether to describe relationships between device-originated and device-terminated traffic, etc.

Feedback Form 21: Is conclusion 4-6 agreeable?

5.7 Topic 4-7: With or without core network

Topic 4-7: With or without core network

Moderator suggests that with or without a CN connection is discussed under 'assumed functionality' in the next two RAN meetings.

6 Topic 5 - Devices

6.1 Topic 5-1 - Characteristics

Topic 5-1 - Characteristics

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At least the following characteristics have been widely identified for characterizing and categorizing Ambient IoT devices:

- Energy storage (with or without)
- Generation of RF signal for transmission (by backscattering or by active transmission)
- Device function (Tx only, Rx & Tx)

Feedback Form 22: Question 5-1: Is it agreeable to capture in the TR that at least the above characteristics are studied for Ambient IoT?

1 – VODAFONE Group Plc agree to consider all three device characteristics
2 – MediaTek Inc. So long as energy provision is NOT considered, the above is ok and in line with the SID.
3 – Spark NZ Ltd we should capture all device characteristics
4 – Huawei Tech.(UK) Co.. Ltd First two are OK, but we not sure about the "Tx only, Rx&Tx". Seems it is from RP-222929, could the proponent clarify how the "Tx only" device is supposed to work? For example, how can the device understand when to conduct uplink signal reflection/transmission without Rx capability in the device? It seems to lead to the loss raised by Vodafone: - *"The radio system should support the ability to address individual tags"* - *"Rather than "reflecting" every received radio signal, tags should be able to only react (reflect/transmit) when they receive something addressed to them (or their group).*" We also are not sure there is any SA1 use case calling for this operation. We would suggest to delete "Device function".
5 – Apple France We agree with categorization based on energy storage capability. For generation of RF signal for transmission, we are also fine. However, for Tx only, we have similar question as Huawei
6 – Futurewei Technologies We are fine with the first 2 bullets. On the third one, we have the same concern as Apple and Huawei.

7 – Qualcomm Incorporated

We agree to consider all three characteristics. Of course, some down-selection is expected and some of the sub-types, or combination of sub-types, are not expected to be pursued.

8 – vivo Communication Technology

Agree with these characteristics should be studied.

other characteristics can also be considered. for example, the energy source for energy storage can be different, e.g., RF energy vs Non-RF energy. typically, the latter has higher energy conversion efficiency, and can sustain higher device power consumption/design targets.

9 – NTT DOCOMO INC.

We are not sure whether ”Device function” is necessary or not since it is unclear what is the difference from ”Generation of RF signal for transmission”. If it is included, clarification is necessary on which combinations are feasible.

10 – Kyocera Corporation

We’re fine with the three characteristics as the moderator suggested. We just wonder what is intended in “Rx” in the third bullet, i.e., it only means the data reception or also includes the energy reception.

11 – Spreadtrum Communications

We are fine with the first two characteristics.

For the last characteristic, we share the similar views as HW, and prefer to delete it.

In addition, we suggest to add a new bullet:

- Inherent characteristics, e.g., device size, form factor, buffer, etc. (Note: To reflect the possible impacts to the complexity of A-IoT)

12 – Motorola Mobility España SA

[Lenovo] – agree

however, how to energize the ambient IoT device using RF is out of scope

13 – CATT

We are OK to study all type of devices. However, we need to define the target maximum power consumption for different categories of devices.

14 – Telstra Limited

We are ok to study all three device characteristics at this early stage

15 – LG Electronics Inc.

Ok with these characteristics for now.

16 – Shenzhen Heytap

[OPPO]

OK.

For the 3rd bullet, in SA1 there is use cases may need Tx only device, e.g., Use case on pressure powered switch or Use case on smart bridge health monitoring using Ambient IoT

We need to evaluate whether we can support this type of device in future RAN study.

17 – Sony Europe B.V.

OK. These characteristics, however, need to be taken into account when defining device categorization in 5.2

18 – China Mobile Com. Corporation

Agree to capture first two bullets, i.e., energy storage and generation of RF signal.

However, we have concerns on the device or communication function. From our perspective, it can be concluded from SA1's requirements that all Ambient IoT devices should be capable of both RX and TX.

The requirement of introducing A TX only device should be clarified, is it like a beacon?

19 – Nokia Denmark

We are ok with the proposed three scenarios.

20 – ZTE Corporation

We are also generally fine with the first two bullets. But we think "RF" is too specific and can be removed from the second bullet.

Same comments for the third bullet as Huawei.

21 – Panasonic Holdings Corporation

We support FL view.

22 – TURKCELL

We agree with the categorization. We share the concern of other companies with Tx only.

23 – Orange

We support all 3 cases. For devices, Rx + Tx cases but also Tx only should be considered, with backscattering triggered without a specific receiver.

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24 – Intel Belgium SA/NV We are OK to study on the three characteristics
25 – Telia Company AB We are fine with the proposal.
26 – Ericsson LM Agree.
27 – China Telecommunications Agree.
28 – KPN N.V. We want AmbientIoT with power harvesting and we are not a fan of passive IoT with backscatter technology.

6.1.1 Initial round summary

All companies agreed to capture the first two bullet (energy storage, Generation of RF signal for transmission), while 8 companies asked for clarification or suggest to delete the third bullet (device function: Tx only, Rx&Tx). In addition, some other aspects were mentioned during the discussion, they are:

- On energy source for energy storage: there are different opinions of RF energy only, RF&non-RF energy, and out of scope.
- Add a new bullet: inherent characteristics, e.g. device size, form factor etc.
- Define target maximum power consumption for deferent categories of devices.

6.1.2 Intermediate round

Since all companies agree to (a) energy storage and (b) generation of RF signal for transmission, we can use those in Topic 5-2, and include them in the TR. Other can be added later, if agreed to.

On device function, it seems more controversial, and appropriately captured by the FFS in the categorization methods discussed next.

On maximum power consumption target (CATT), this might be a design requirement rather than a device characteristic (i.e. whatever is the device, it must not exceed a given power). However, we can add an FFS to the device categorizations below.

On “inherent characteristics” (Spreadtrum), the moderator sees that this is being discussed a lot in SA1 (e.g. what size device does a cattle farmer need, to be worn by the animals), and the general nature of that discussion seems non-radio, and hence better left out of RAN and in SA1.

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Topic 5-1b: Energy harvesting sources

On whether to have RF only, RF & non-RF, or consider it as out of scope to the SI, moderator thinks it is not immediate from the SID that it is entirely out of scope, since the justification section discusses such sources, and the device categorization text refers to "energy sources". On the other hand, clearly RAN should not start its own investigations into how to harvest energy. Is it sufficient to satisfy all companies if we just have a listing of all the sources reported by companies from literature, without any attempt to evaluate them or look at implementations, etc?

Question 5-1b: Can we agree to capture the following statements in an Annex of the TR.

- *"Companies have reported the following energy sources for energy harvesting in literature: RF, solar/light, piezoelectric (kinetic/vibration), electromagnetic, electrostatic, heat/thermal, thermoelectric, magnetic, wind/water, acoustic"*

Feedback Form 23: Question 5-1b: Can we agree to capture the above statements in an Annex of the TR?

6.2 Topic 5-2 - Categorization

Topic 5-2 - Categorization

Papers have primarily categorized devices using some of these characteristics, in one of three ways:

Method 1: Combination of energy storage and device transmission method

- Passive device A: No energy storage, backscattering transmission
- Passive device B: Energy storage from harvesting ambient sources, backscattering transmission
- Active device: Energy storage from harvesting ambient sources, active RF components for transmission.

FFS: Whether to include device function

Method 2: Consider only energy storage capability

- Device A: No energy storage
- Device B: Limited energy storage from energy harvesting
    - Device B1: Backscattering transmission only

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- Device B2: Active RF components for transmission

FFS: Whether to include device function

Method 3: Categorize only by device transmission method

- Device A: Backscattering transmission only
- Device B: Active RF components for transmission

FFS: Whether to include device function

Feedback Form 24: Question 5-2: Moderator invites views on which of/among the above methods to pursue for device categorization, as well as the content of a respective method.

1 – Samsung Electronics Co. We support method 3, whether to have energy storage for backscatter type is up to implementation and unclear in some implementations. Since transmission schemes might be impect on protocol design, device function can be considered a given method 3.
2 – VODAFONE Group Plc we support method 1 for device categorization
3 – MediaTek Inc. Method 3.
4 – MediaTek Inc. As explained earlier - that a device harvests energy is fine (when ”plugged” to a power source, it harvests the energy of said source... which in itself is nothing new) but is not relevant to the discussion. Energy storage could be considered, but we should make abstraction of the energy source. Some storage capacity, power consumption targets should be defined, against which traffic models can be tested.
5 – Spark NZ Ltd support method 1
6 – Huawei Tech.(UK) Co.. Ltd As in RP-223400, we categorized the devices by method 1: Combination of energy storage and device transmission method. - Device Category #1A corresponding to devices with only passive RF components, and without energy storage capability

- Device Category #1B corresponding to devices with only passive RF components, and with energy storage capability
- Device Category #2 corresponding to devices including active RF components, and with energy storage capability

This is because we think passive RF or RF active components for transmission and reception is the main factor which will make difference. We prefer to categorize the device by transmission method in the first place, then introduce sub-category by energy storage when needed. In this sense, both Method 1 and 3 are fine to us.

7 – Apple France

We support method 1

8 – Futurewei Technologies

We support method 1. As of energy source for harvesting, RAN should only consider RF signal.

9 – vivo Communication Technology

Method 1 seems close to our understanding.

For passive device B in method 1, it may be further categorized in to sub-types, e.g.,

- energy source only relies on RF energy from reader

- energy source from ambient(e.g., solar, vibra)

different energy source may sustain different device power consumption, and leading to different design KPIs.

10 – NTT DOCOMO INC.

At least categorization by device transmission method is necessary since it would have much impact on the air interface and coverage. In that sense, we are fine with either Method 1 or 3

11 – Kyocera Corporation

We think Method 1 is a reasonable categorization. We think it's obvious that the backscattering transmission can be done by both no energy storage and limited energy storage devices, while the active transmission can be done only by energy storage-capable devices. So, these should be depicted in the device categorization.

12 – Spreadtrum Communications

Method 1 is preferred.

13 – Motorola Mobility España SA

[Lenovo] method 1 is preferred

please rewrite as passive, semi-passive and active

14 – CATT

Method 1

15 – Telstra Limited

We support Method 1

16 – Qualcomm Incorporated

As a first step, we think that the two fundamental characteristics: signal generation method and energy storage should be treated as two independent dimensions, and we should develop good understanding of them and agree on a common terminology. Then as a second step, we could have a 'matrix' where we decide which combination of per dimension sub-types are supported or not supported.

For example, for signal generation, we could have:

- S1 (passive) has no independent signal generation or signal amplification capability
- S2 (semi-passive) has no independent signal generation capability but has active components with which to amplify reflected signals
- S3 (active) has independent signal generation capability, including producing oscillator frequency

And for energy storage, we could have

- P1 (no storage) has no energy storage
- P2 (very limited energy storage) expressed in a range of capacitance or range of mAh (or mA x ms) with agreed reference voltage
- P3 (medium energy storage) a higher range of capacitance or range of mAh
- ...

We could also have, as another dimension, Tx-only and Rx+Tx device types, as was discussed before.

As mentioned, it should be discussed as a second step (but as soon as possible) which Sx-Py combinations should be pursued and which shouldn't be.

17 – LG Electronics Inc.

Method 1 is preferred.

18 – Shenzhen Heytap

[OPPO]

Method 1 is most close to our preferrence.

But we think it is too premature at current stage to preclude other possibility thus it need an FFS: other device type is not precluded.

19 – Sony Europe B.V.

Do not support.

The categorisation only consider whether energy storage is required for transmission and does not include the case where energy storage is required to power a device that includes a low-power low-complexity receiver that requires an energy storage device.

Method 1should split active device into “active device A” and “active device B”:

- active device A: Energy storage from harvesting ambient sources, active RF components for transmission
- active device B: Energy storage from harvesting ambient sources, active RF components for reception and transmission

Method 2:

- device B1: presumably the energy storage is also used to maintain device state (memory) between a command phase (reception) and a transmit phase (backscaterring communication)
- device B2: active RF components can also be used for reception

Method 3: We think that this does not give the full picture as the method of reception is also significant

20 – China Mobile Com. Corporation

We prefer Method 1. It looks clear.

21 – Nokia Denmark

Method 1 seems to cover nicely.

22 – ZTE Corporation

We support Method 1 for device categorization.

23 – Intel Belgium SA/NV

We are OK with either Methed 1 or 2. For backscatter transmission, it is helpful to use separate categories since the operation with or without energy storage may be quite different

24 – Panasonic Holdings Corporation

We are fine either of method 1 or method 3. To distinguish backscattering or not is one important facor.

25 – NEC Corporation

Method 3 firstly. If much difference of backscattering transmission between no energy storage and energy storage device can be observed, then method 1 could be considered.

26 – TURKCELL We prefer Method 1.
27 – Ericsson LM Method 1 or 2 is fine. Regarding the FFS on device function, it seems reasonable to include whether the device supports downlink reception (of data or commands) or not, which to our understanding is not feasible for a device without any form of energy storage.
28 – China Telecommunications We prefer Method 1.
29 – KPN N.V. method 1

6.2.1 Initial round summary

23 companies supported method 1. 6 companies supported method 3. 2 company supported method 2. And there are some other suggestions raised during the discussion, including "to consider different methods for reception", "further discussion on different types of signal generation and energy storage", "energy source for harvesting, only RF signal or RF+Ambient", "rewrite as passive, semi-passive and active", "other device type is not precluded" and "including whether the device supports downlink reception or not". Qualcomm suggest different levels of energy storage, and the creation of energy-storage vs. signal-generation pairs. Sony suggest sub-dividing active devices according to whether active for Tx only (and presumably passive for Rx), or active for Tx and Rx.

6.2.2 Intermediate round

Topic 5-2a: Energy storage characteristic

On the Qualcomm suggestion for energy storage capacity, we can have discussion in this round on what/if to capture in this regard, although it seems clear we should have a closed-ended list. If we capture a few levels/capacities as Qualcomm suggests, this may be a useful way to highlight what the proponents of Method 2 are prioritizing.

Question 5-2a: Can we agree to categorize energy storage capacities as follows:

- *Storage 1: No storage at all.*
- *Storage 2: Up to that of an ordinary capacitor*
- *Storage 3: Up to that of a supercapacitor*

FFS: In RAN#99 if and what approximate maximum values to indicate for storage 2 and storage 3.

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Feedback Form 25: Can we agree to categorize energy storage capacities as in Question 5-2a?

Topic 5-2b: Device categorization

Based on initial round inputs, and the addition of energy storage capacity above, Moderator proposes to agree to Method 1 for categorization, wherein the angle of Method 2 is captured separately by the proposal 5-2a above. An FFS is added on potentially including target maximum power consumption per category of device, as suggested by CATT under the characteristics discussion.

On re-naming of device types, moderator suggests we should choose basically neutral names and use the long-form words to characterize. Thus, no change is proposed.

Proposal 1: The following devices are considered in the SI:

- *Passive device A: No energy storage, backscattering transmission*
- *Passive device B: Energy storage from harvesting ambient sources, backscattering transmission*
- *Active device: Energy storage from harvesting ambient sources, active RF components for transmission.*

FFS: Whether to include device function

FFS: Whether to include a target maximum power consumption for each device

Feedback Form 26: Question: Can we agree to the above proposal on devices?

7 Topic 6 - Design targets

A number of papers discuss design targets for devices, and/or the ambient IoT system in general. Such inputs are welcomed, while the related objective of the SI is not for discussion this meeting, according to RAN#97e decision. Moderator encourages further offline discussions in preparation for RAN#99.

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