3GPP TSG-RAN Meeting # 102
Edinburgh, UK, December 11 – 15, 2023

RP-233268
Agenda Item 9.1.1.4

Rel-19 Ambient IoT: Device Types and Topologies

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Proposal

- Per the inception of this work: "[Ambient IoT] intends to provide a clear differentiation, i.e. addressing use cases and scenarios that cannot otherwise be fulfilled based on existing 3GPP LPWA IoT technology."
- Device C w/ Topology 1 is the combination that is clearly the most at risk of addressing use cases and scenarios that can *already* be fulfilled based on existing 3GPP LPWA IoT technology, namely NB-IoT / Cat M
  - The added value for this combination remains unclear at this stage, even considering a device complexity *target* orders of magnitude lower than NB-IoT and LTE MTC (noting that "a detailed analysis of designs which meet the device complexity requirement is considered to require WG-level technical expertise")
- Topologies and Deployment scenarios
  - Topology 3 is fully dependent on Topologies 1 and 2
  - Topology 2 allows deploying A-IoT in a wide range of scenarios, and in "any" network
- **Observation 1:** A clear differentiation vs. existing 3GPP LPWA can be obtained with Device Types A, B combined with Topologies 1 <u>and</u> 2
- **Proposal 1:** to restrict the scope of the study to
  - Device Types: (A and) B – B is of clearly higher priority than A
  - Topologies: 1 <u>and</u> 2
- **Observation 2:** with Device Types A and B in mind
  - Topology 1 is well suited for "homogeneous" deployment scenario 1 (indoor), much less so for "heterogeneous" deployment scenario 2 (i.e. BS outdoor Device indoor)
    - For scenario 4 (outdoor), topology 1 relies on Device C
  - Topology 2 is well suited for all deployment scenarios, and in particular for "heterogeneous" deployment scenario 2.
- **Proposal 2** – to further restrict the scope of the study to
  - Topology 1 with deployment scenario 1 only
  - Topology 2 with deployment scenarios 1, 2 and 4
- **Proposal 3** – to align the above in both RAN and SA
- **It is expected these proposals will keep the work manageable esp. if addressed from the ground up around the constraints imposed by Devices A and B**

Proposal vs. RP-232745 baseline

- Potential objectives:
  - Devices A and B only
  - ~~Consider all Devices A, B and C in the SI?~~
  - Topology 1 with Deployment scenario 1 only
  - Topology 2 with Deployment scenarios 1, 2 and 4
  - ~~Down-selection among:~~
    - ~~Deployment scenario 1 with Topology 1~~
    - ~~Deployment scenario 2 with Topology 1~~
    - ~~Deployment scenario 2 with Topology 2~~
    - ~~Deployment scenario 4 with Topology 1~~
    - ~~Deployment scenario 4 with Topology 3~~
  - FR1 licensed spectrum, focusing on FDD only
    - Downselection Spectrum in-band to NR, in guard-band to LTE/NR, and in standalone band(s)

- Evaluations and remaining feasibility assessments
  - Device architecture and characteristics
  - Evaluation methodology and assumptions
  - Design target evaluations
  - Coexistence evaluations
- Physical layer study on:
  - Waveform and multiple access
  - Frame structure and numerology
  - Modulation and channel coding
  - Physical layer signals/channels
  - Physical layer procedures including initial access and mobility, scheduling, (H)ARQ, power control, etc
- Higher layers study on:
  - Compact protocol stack and lightweight signaling procedure, including mobility aspects
    - Control plane functionalities, including CN connectivity
    - User plane functionalities
  - Security aspects (*Note: This does not necessarily mean security has RAN impact)
- RAN3 aspects for study:
  - Enabling necessary CN-RAN signalling
  - RAN architecture aspects, if any
- RAN4 aspects for study:
  - Feasibility study of BS/UE/device architectures
  - Link budget study
  - Coexistence analysis
  - RRM

Background

RP-232745 – Ambient IoT SI – Potential Objectives

- References: RWS-230488, RP-231540, RP-232614
- Potential objectives:
  - Consider all Devices A, B and C in the SI?
  - Down-selection among:
    - Deployment scenario 1 with Topology 1
    - Deployment scenario 2 with Topology 1
    - Deployment scenario 2 with Topology 2
    - Deployment scenario 4 with Topology 1
    - Deployment scenario 4 with Topology 3
  - FR1 licensed spectrum, focusing on FDD only
    - Downselection Spectrum in-band to NR, in guard-band to LTE/NR, and in standalone band(s)

- Evaluations and remaining feasibility assessments
  - Device architecture and characteristics
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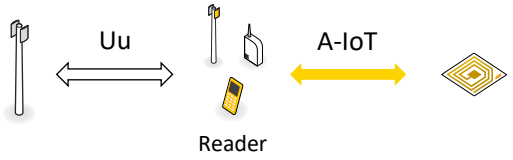
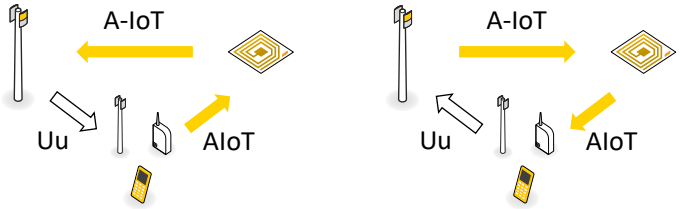
Background
Topologies and Devices

Topologies	
1) BS ↔ Ambient IoT device	
2) BS ↔ intermediate node * ↔ Ambient IoT device	
3) BS ↔ assisting node * ↔ Ambient IoT device ↔ BS	
4) UE ↔ Ambient IoT device	

NOTE; In Topology 2, the use of licensed spectrum for A-IoT requires network control of resources between the Reader and the A-IoT device

NOTE: Topology 4 is no longer considered (it is a subset of Topology 2)

Device	Energy storage	Signal Gen.	Signal Amp.	Power Cons.
A	None	No. Backscattering	No	[≤ 1 μW] or [≤ 10 μW]
B	Yes	No. Backscattering	Possible (w/ stored energy)	A << B < C or A ≤ B < C
C	Yes	Yes	Yes	C ≤ 1mW to C ≤ 10mW

NOTE:

- Device Complexity: A < B < C
- UL/DL Data Rates: min ≥ 0.1kbps; max ≥ 5kbps
- Max message size: 1000bits (based on max app layer packet size)

Background
Deployment scenarios

Deployment 1 – Indoor (Device, BS)		
Use Cases	**Characteristics**	**Description**
Inventory Sensor Positioning Command	Device environment	Indoor
	Device characteristics	A, B, C
	BS characteristics (if any)	micro- / pico-cell
	Topology	1, 2, 3
	Spectrum	Licensed (FDD, TDD) Unlicensed
	Coexistence with 3GPP tech	Co-site or New site
	Traffic assumption	DT, DO

Deployment 2 – Indoor (Device) Outdoor (BS) / **Deployment 4** – Outdoor (Device, BS)		
Use Cases	**Characteristics**	**Description**
Inventory Sensor Positioning Command	Device environment	**Depl.2:** Indoor **Depl.4:** Outdoor
	Device characteristics	A: Topology 2 B: Topology 2, 3 C: Topology 1, 2, 3
	BS characteristics (if any)	macro- / micro-cell
	Topology	1, 2, 3 Intermediate/assisting node: indoor or outdoor
	Spectrum	Licensed (FDD, TDD) Unlicensed
	Coexistence with 3GPP tech	Co-site or New site
	Traffic assumption	DT, DO

DT: Device-terminated (DT)
DO: Device-originated (DO)
DO-A: Device-originated – autonomous
DO-DTT: Device-originated – device-terminated triggered

Background
Deployment scenarios

Depl. 3 – Indoor (Device, UE-reader) / **Depl. 5** – Outdoor (Device, UE-reader)		
Use Cases	**Characteristics**	**Description**
Inventory Sensor Positioning Command	Device environment	**Depl.3:** Indoor **Depl.5:** Outdoor
	Device characteristics	A, B, C
	BS characteristics (if any)	N/A
	Topology	4
	Spectrum	Licensed (FDD, TDD) Unlicensed
	Coexistence with 3GPP tech	N/A
	Traffic assumption	DT, DO

Deployments 3 and 5 are no longer considered given Topology 4 is no longer considered

Thank you!