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3GPP TSG RAN Meeting #101 **RP-231854**

Bangalore, India, September 11-15, 2023

Agenda Item: 8A.2.4

Source: Spreadtrum Communications

Title: Ambient IoT considerations in Rel-19

Document for: Discussion and decision

Justification and background (1/5)

- **Broad market prospects for "batteryless" IoT devices**
  - RFID technology has been widely used in commercial and industry scenarios, such as warehousing and logistics, smart retail, smart manufacturing, clothing management, smart medical care, air transportation, etc.

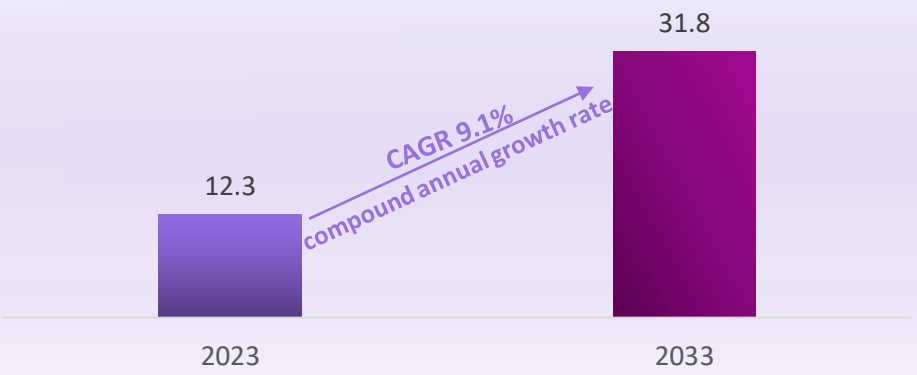
Warehouse Logistics

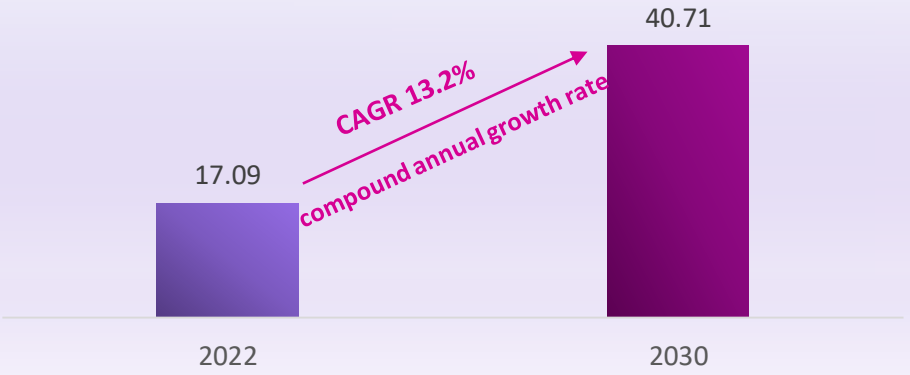
Smart medical

Smart retail

clothing management

  - Growing applications across various industrial verticals to boost the market growth: several forecasts show that the market will double in the next ten years.

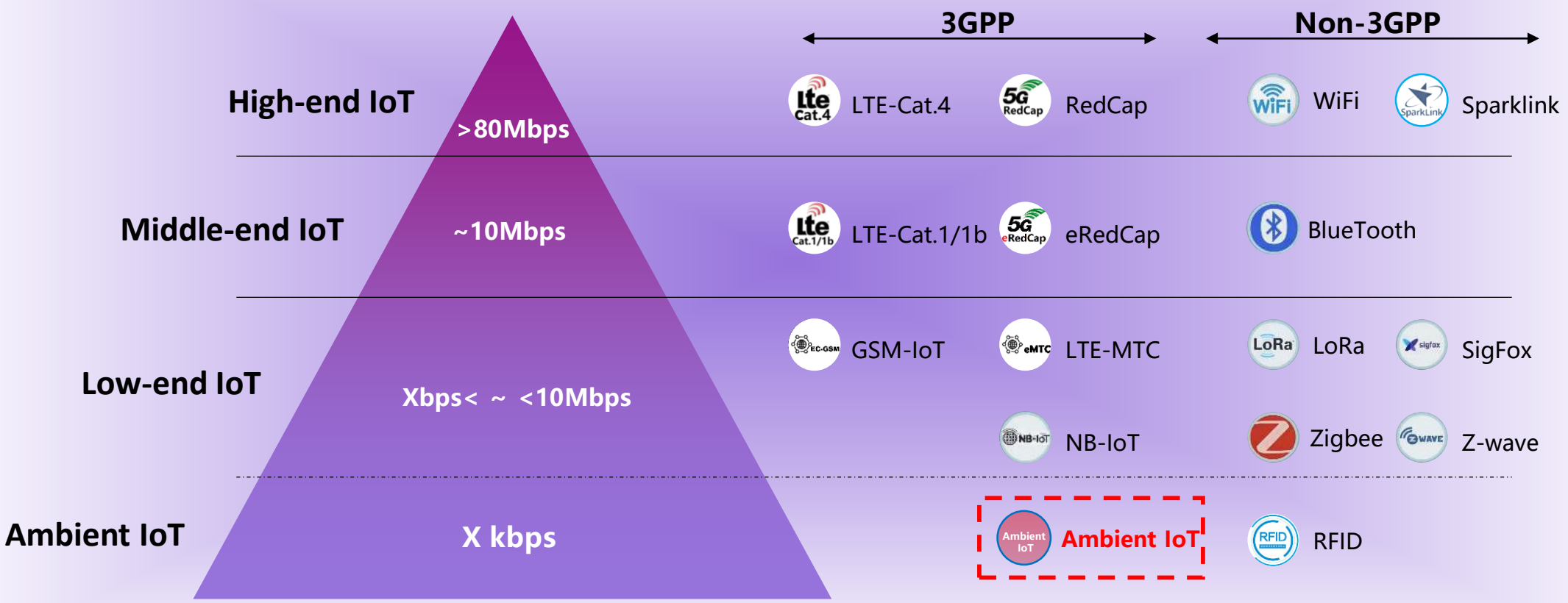




Source 1: https://www.persistencemarketresearch.com/market-research/rfid-tags-market.asp; Source2: https://www.marketresearchfuture.com/reports/radio-frequency-identification-market-3189

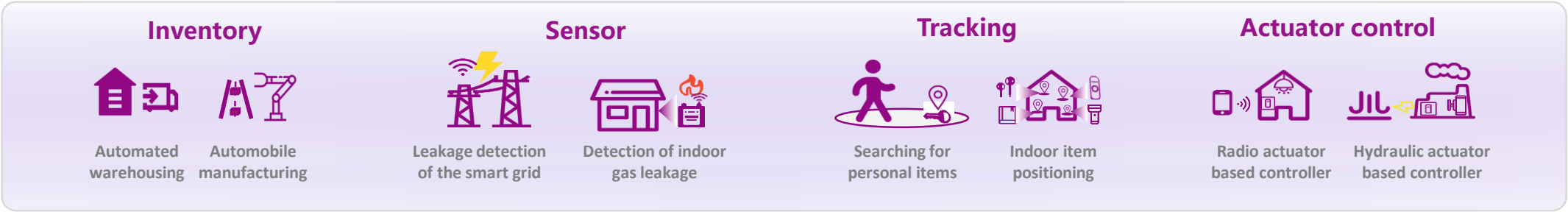
Justification and background (2/5)

- A-IoT's position in IoT world
  - Energy harvest, extremely low complexity/cost (than NB-IoT).



Justification and background (3/5)

- A-IoT is being studied by SA1 Rel-19
  - **Motivation**: Study the requirements for ultra-low complexity, very small device size/form factor (e.g. thickness of mm), longer life cycle (maintenance free), etc.
  - More than 30 use cases are divided into four categories: inventory, sensor, tracking and actuator control



  - Functional and performance requirements (Refer to S1-232664 and S1-232651)

The functional requirement

- Communication;
- Positioning/location;
- Management;
- Collected information and network capability exposure;
- Charging;
- Security and privacy

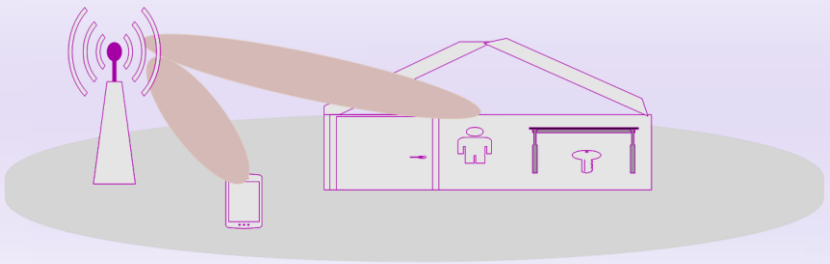
Performance requirements for inventory

Scenarios	Max. allowed end-to-end latency	User-experienced data rate	Message Size	Device density	Communication Range (Note 1)	Service area dimension	Device speed	Positioning Accuracy
inventory or asset management	Typically, seconds level	<2 kbit/s	96/256 bits	<1,5 Million/km²	30~50 m indoor, 200 m~400 m outdoor	1-10 km²	3~10 km/h	3 m indoor, cell-level outdoor

Justification and background (4/5)

- A-IoT is being studied by RAN
  - Deployment Scenarios

Outdoor Deployment of Base Stations

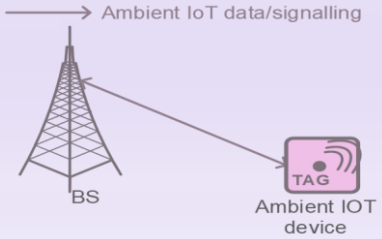


Indoor Deployment of Base Stations

  - Connect Topologies

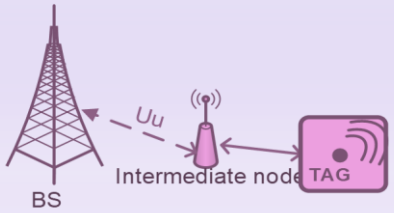
Topology 1:

BS ↔ Ambient IoT device



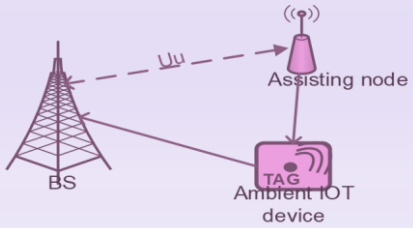
Topology 2:

BS ↔ intermediate node ↔ Ambient IoT device



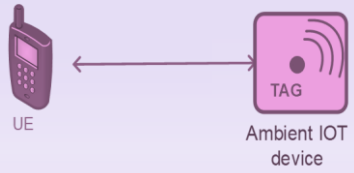
Topology 3:

BS ↔ assisting node ↔ Ambient IoT device ↔ BS



Topology 4:

UE ↔ Ambient IoT device



Justification and background (5/5)

- A-IoT is being studied by RAN
  - **Device types defined in RAN**
    - Device A: No energy storage, no independent signal generation/amplification
    - Device B: Has energy storage, no independent signal generation
    - Device C: Has energy storage, has independent signal generation, i.e. active RF component for transmission
  - **General design targets**
    - Device power consumption
      - Device A ≤ 10 uw;
      - Device A ≪ Device B < Device C, or Device A ≤ Device B < Device C
      - Device C ≤ 1 mW to ≤ 10 mW
    - Device complexity
      - Device A: Comparable to UHF RFID ISO18000-6C (EPC C1G2)
      - Device A < Device B < Device C
      - Device C: Orders-of-magnitude lower than NB-IoT
    - Data rate
      - Maximum data rate >= 5 kbps
      - Minimum data rate >= 0.1 kbps
      - Note: at least for uplink

RAN1 aspects for Ambient IoT in Rel-19 (1/1)

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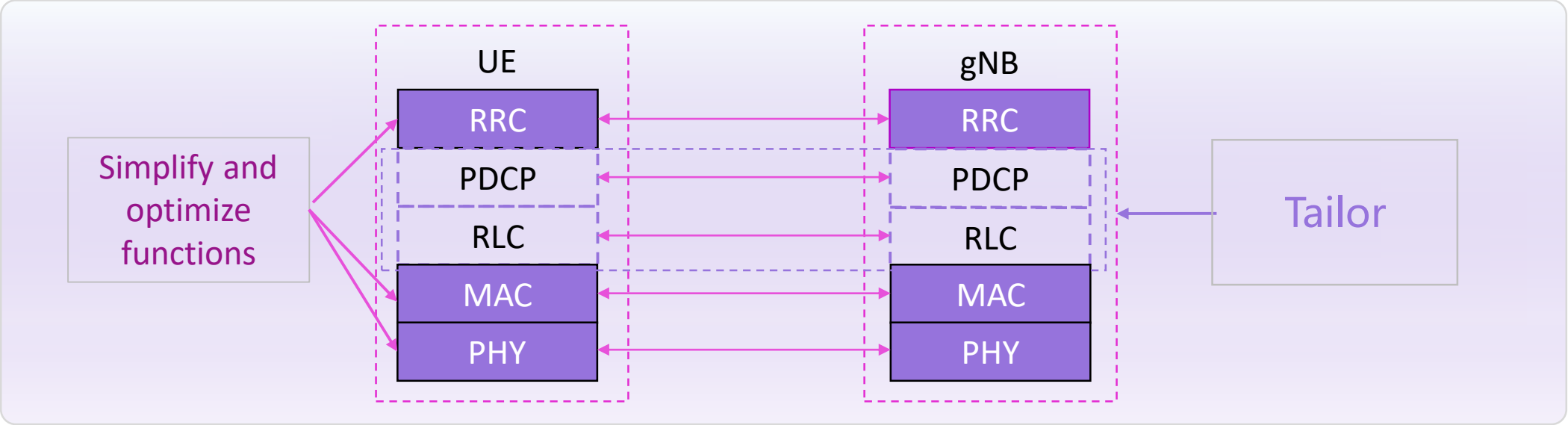
- **Frame structure**
  - Match new power consumption and traffic characteristic requirements.
- **Waveform & Coding & Modulation & Physical channel**
  - Meet the requirements of low power consumption and low complexity e.g., ASK/FSK-based waveform, Manchester encoding, etc.
- **Initial access**
  - Select appropriate multiple access schemes on the premise of low power consumption and low complexity, as well as more connections requirement.
- **Positioning**
  - Design positioning methodologies to meet indoor and outdoor positioning requirements.

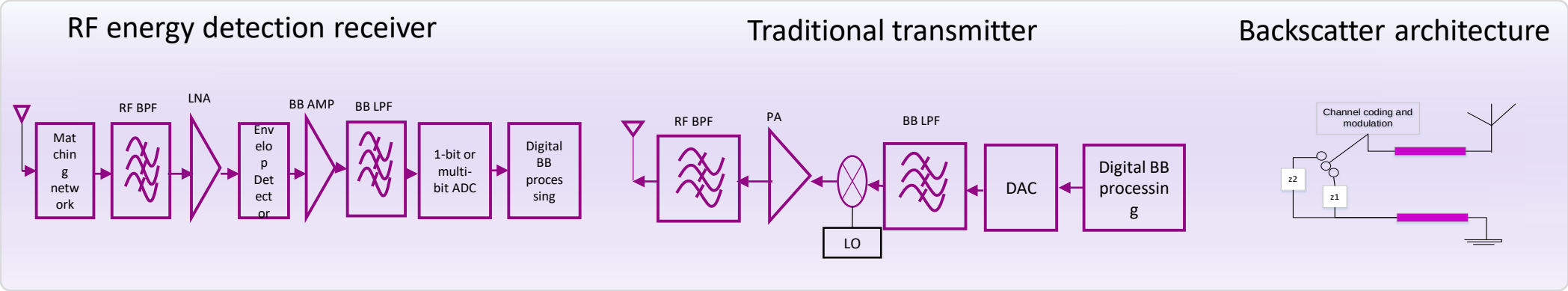
RAN2 aspects for Ambient IoT (1/1)

- **Light protocol stack design**
  - Design a light protocol stack(e.g., light PHY/RRC/MAC) based on new traffic characteristics.
    - Note: NB-IoT protocol stack can be used as a starting point.
- **Simplified signaling procedure design**
  - Design the basic set of signaling procedures such as paging, mobility management, positioning, etc.
- **Security**
  - Simplify security mechanisms without reducing security requirements.



RAN4 aspects for Ambient IoT (1/1)

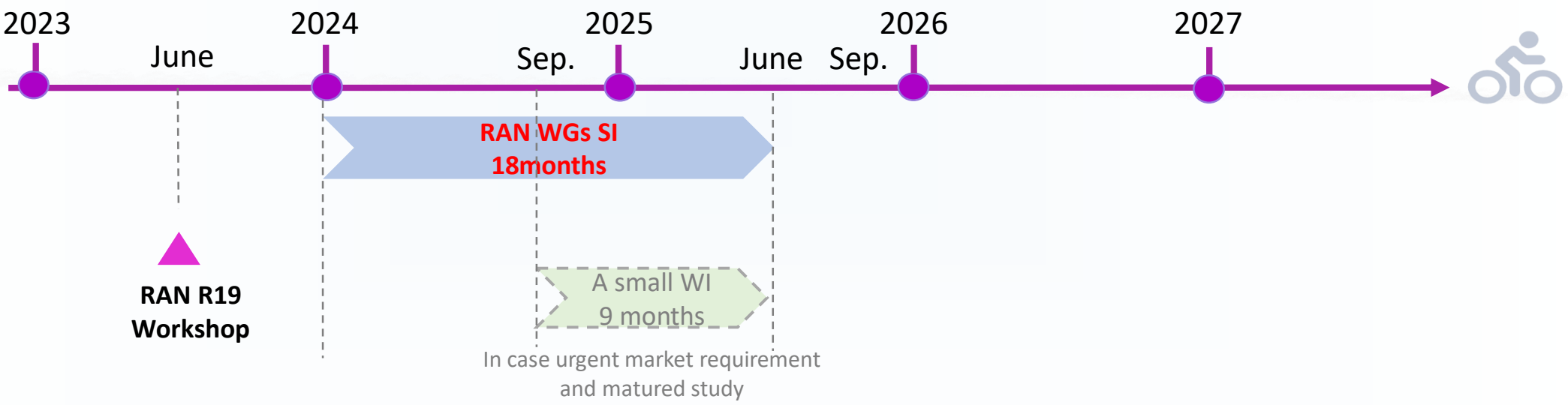
- **Study Receiver Architecture**
  - LP-WUR can be reference for Device A and B
  - The current NR receiver can be reference for Device C
- **Study Transmitter Architecture**
  - Study the backscattering transmission architecture for Device A/B
  - For Device C, the current NR transmitter can be reference
    - However, open to study a new low-power transmitter architecture, for example, ASK/FSK, etc.
- **Analysis of radio frequency requirement**
  - E.g., the spurious requirements for backscattering transmission, etc.



Simplification of transmitter architecture may lead to degradation of RF performance.

Proposal for Rel. 19 A-IoT (1/1)

- **A-IoT should be studied in R19 for the whole 18 months.**
  - If some scenarios together with the relevant design is clearly matured after 9 months study, a small WI can be considered at the middle of R19, e.g. 10th -18th month of R19.



Initial objectives for Rel. 19 A-IoT (1/1)

- Objectives for Rel. 19 A-IoT
  - Identify KPIs with evaluation methodology [RAN1]
    - Cost/complexity, e.g. Evaluation methodologies
    - Coverage e.g. Link budget; Requirements
    - Power consumption, e.g. Power model
  - Study L1/L2 designs and procedures [RAN1, RAN2]
  - Study the coexistence between A-IoT devices and legacy devices [RAN1]
  - Study A-IoT device transceiver architectures [RAN4, RAN1]

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