Passive IoT for 5G-Advanced

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Example use cases for Passive IoT

Automated asset management

Automated real-time inventory and tracking of objects with **small size, ultra-low cost, and batteryless tags**

- Manufacturing
- Logistics and warehousing

Current practice: Barcode on paper for inventory and tracking

Printer

Printed barcode on various parcels

Barcode

Handheld LOS scanning (labor intensive)

Slow one-by-one scanning (time consuming)

Passive IoT tag

Automatic remote reading

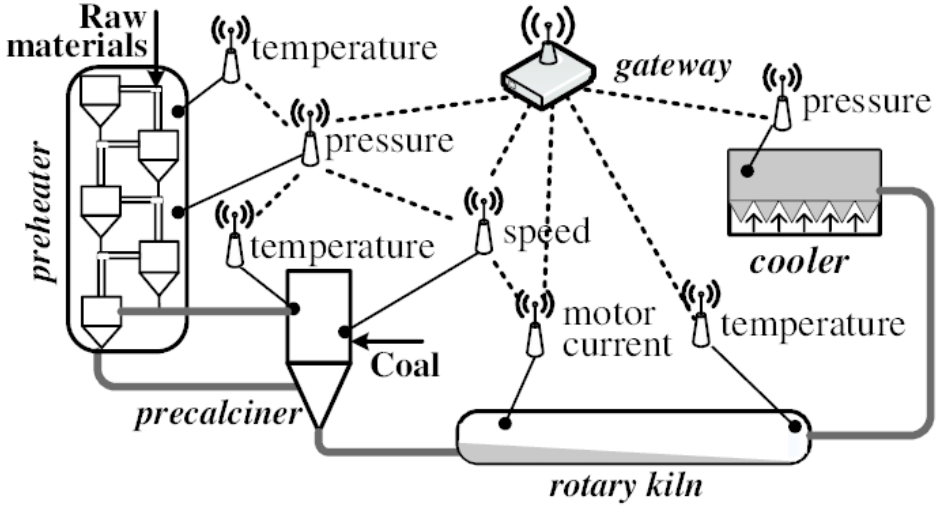
Hundred times faster reading

Industrial sensor network

Environment and status monitoring by wireless sensor network with **sensors no need of replacing battery during lifetime**

- Manufacturing
- Logistics

An industrial wireless sensor network in a cement factory



Battery-operated

Cost for batteries and replacement

Device size impacted by battery

Infrequent transmissions for battery life

Environmental issue (Lithium, lead, etc.)

Energy-harvesting

Self-sustainability

Miniaturized device

No limits on transmission period

Eco-friendly (Ambient energy)

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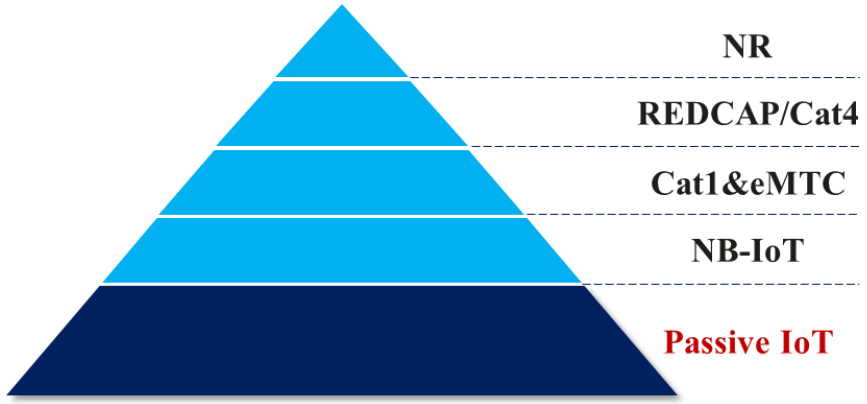
Use cases and requirements for Passive IoT

Requirements on passive IoT devices

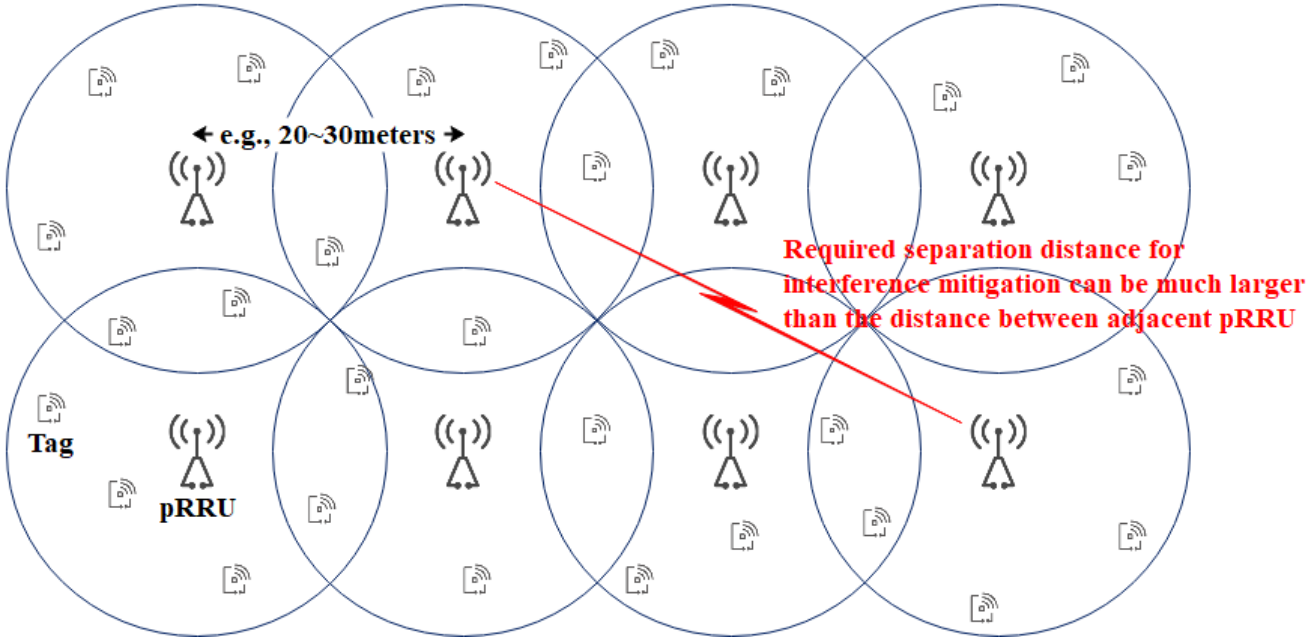
- Cost without significant increase compared with barcode (0.01$ level)
- Power consumption comparable to MEMS sensor (microwatts level), without batteries
- Coverage and networking match the deployed indoor 5G network

Device cost and power consumption

	UE power	UE cost
LPWAN	>10mW	>1$
Passive IoT	1~100uW	0.01~0.1$



Coverage and networking



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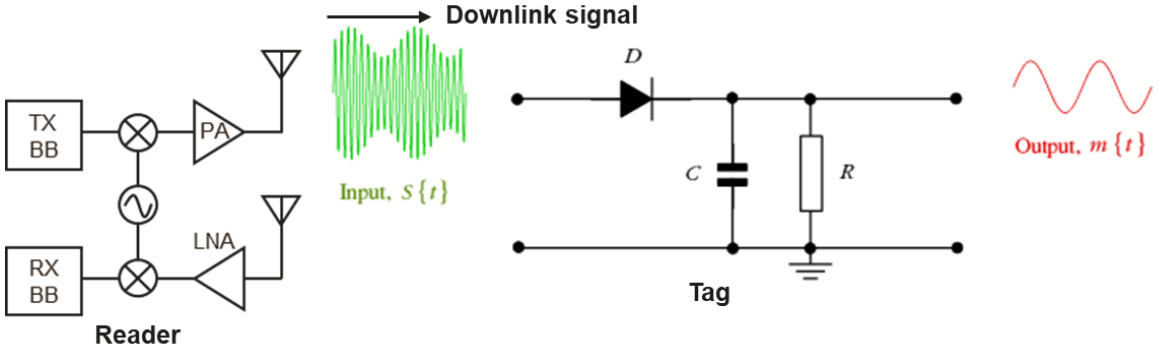
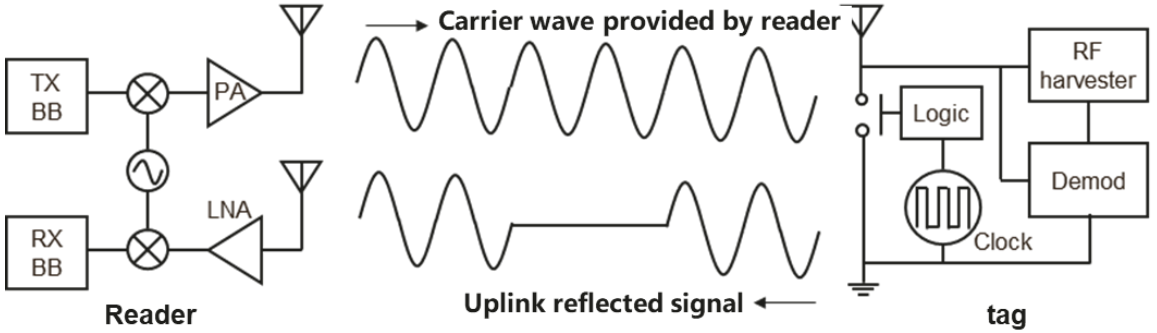
Potential technical approaches for Passive IoT

- **Envelope detection for downlink**
  - Non-coherent demodulation for receiving downlink data without the need of mixing received RF signal with locally generated carrier waves
    - RF chains with high power consumption can be saved, which comprises oscillators, mixers and digital-to-analog converters
    - Power consumption can be as low as 1uW for envelope detection with on-off keying (OOK)



- **Backscatter modulation for uplink**
  - Signal source sends carrier wave to a backscatter tag
  - Tag modulates and reflects received carrier wave to transmit uplink data
    - Power consumption of a backscatter transmitter can be as low as 1uW
    - The RF frontend of tag is reduced to a single transistor switch, which minimizes manufacturing costs as well



Envelope detection and backscatter modulation achieve microwatts-level power consumption enabling batteryless devices

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Thank you.

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