Views on Ambient IoT in Rel19

- December 4, 2023

A-IoT General Considerations

- A-IoT already has competition:
  - Direct competition - RFID
  - Less direct – Wi-Fi, Bluetooth, UWB, Wi-Sun, Zigbee, LoRaWAN
  - Future – IEEE (802.11 AMP)
- A-IoT needs to be differentiated on more than device cost especially against RFID. Key areas for differentiation:
  - Improved link budget / range
  - Simplified deployment (e.g. RFID requires lots of $$$ readers)
  - Improved access control (minimizing collisions)
  - Support for application-level security esp. 2-way auth.
- To ensure the TCO (total cost of ownership) is reduced, special care must be given at all levels of the 3GPP system design (RAN and Core Network) to minimize A-IoT recuring service costs whenever possible.

Rel 19 A-IoT

Open Item:

- Option 1 - Study Item (16 months)
- Option 2 - Study Item (12 months) -> check -> Work Item (6 months)

Discussion:

- A-IoT is a new RAT (Radio Access Technology) developed "from scratch" – very little re-use.
    - Requires a new Phy, MAC, RRC, RRM, PDCP, NAS, etc.
- A-IoT will likely use backscattering modulation, which is not previously standardized by 3GPP.
- Implementation requires a new core network and likely a new, lighter, more efficient security model to support low complexity authentication/encryption.
- Historically, new RATs, such as Sidelink, LTE-M, and NB-IOT, had full release studies before normative work. Despite having a full study phase, achieving completion of these new RATs within a single full release was still considered MTC (Miracle to Complete).

Proposal:

Given the amount of work, TU (time unit) allocation, and history, our view is strongly for Option 1 - study item only.

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Rel 19 A-IoT Scope Reduction

Open Item:

- Study device types A, B, and/or C?

Discussion:

- Type C will require a very different protocol than A&B. Type A&B will be able to utilize a similar protocol.
- The basic components (PA, LNA, RF Synth, digital baseband) required for type C are similar to a low power wide area (LPWA) device; so, cost delta is likely small.
- Type C closely competes with many strong incumbent technologies such as Wi-Fi, Bluetooth, Wi-SUN, Zigbee, UWB and LoRaWAN.
- Types A&B can provide the differentiation that is needed (e.g. link budget, access control).

Proposal:

- Study only device types A and B.
- For type B, study and define representative charging model(s) (e.g., RF - rural, sub-urban, urban) and energy storage (ES) leakage model(s). Protocol design shall consider devices with different ES capacities and charging rates.
- Device C can be re-considered in the future releases.

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Rel 19 A-IoT Scope Reduction

Open Item:

- Which scenarios (D1,D2,D4) and topologies (T1,T2,T3) to study?

Discussion:

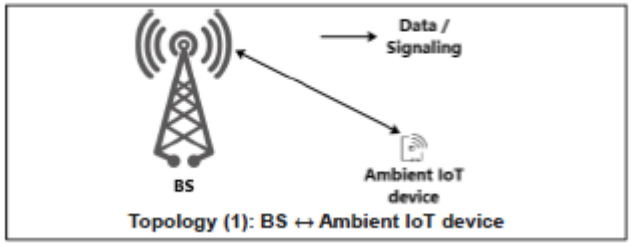
- The topologies outlined in TR do not offer clarification regarding the generation of the carrier wave or provide details on who controls it and how.
- The difference between scenarios (D1,D2, and D4) is only link budgets.
- T2 will require the intermediate node to be full duplex, which is complex, expensive and would likely preclude UE's to be intermediate nodes.
- T3 requires a single duplexing assisting node, which could be supported by future UEs likely without hardware changes/costs.
- Mono-static architectures require the BS to simultaneous generate a carrier wave and decode the resulting backscattered wave. Mono-static architectures often require specialized hardware not available on legacy BS.

Proposal:

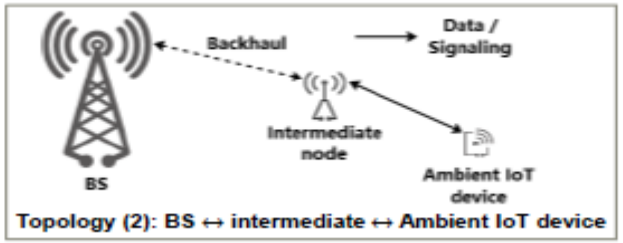
- Rel 19 A-IOT study includes:
  - Carrier wave generation and control.
  - Define a single maximum coupling loss target in RAN PL considering only D1 and D4 scenarios.
  - Only topology T1 avoiding mono-static architectures.
- Consider T3 (uplink) Topology in future releases

D1: Indoor to Indoor
D2: Outdoor to Indoor
D4: Outdoor to Outdoor

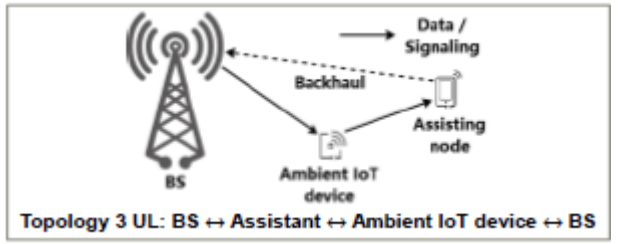
T1:



T2:



T3:



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Rel 19 A-IoT Scope Reduction

Open Item:

- RANPL in TR 38.848 defined 8 representative use cases (rUCs) based on SA1's 30+ use cases. Additional focus on use cases will reduce SID scope and workload.

Discussion:

- All use cases represent large market opportunities.
- Due to range limitations, device type A is more applicable to indoor scenarios.
- Positioning can often be added in subsequent releases.
- The async sensor use case with low latency constraints will require async device originated (DO) traffic support which is difficult using backscattering.

Proposal:

- Do not include:
  - Positioning use case – can be considered in a subsequent release.
  - Async device originated (DO) traffic – this can be added with type C.
- Focus on indoor but outdoor with limited range could also be considered since it adds no additional workload.
- Study traffic types:
  - DT (Device Terminated)
  - DO-DTT(Device originated by device terminated trigger)

TR 38.848 Representative Use Cases	
rUC1: Indoor inventory	rUC5: Outdoor inventory
rUC2: Indoor sensors	rUC6: Outdoor sensors
rUC3: Indoor positioning	rUC7: Outdoor positioning
rUC4: Indoor command	rUC8: Outdoor command

Proposed Study Use Cases	
rUC1: Indoor inventory	rUC5: Outdoor inventory
rUC2: Indoor sensors	rUC6: Outdoor sensors
~~rUC3: Indoor positioning~~	~~rUC7: Outdoor positioning~~
rUC4: Indoor command	rUC8: Outdoor command

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Rel 19 A-IoT Scope Reduction

Open Item:

- Spectrum FDD or TDD or unlicensed

Discussion:

- Legacy TDD U/D patterns are not compatible with backscattering.
- Unlicensed spectrum will result in lowest cost but have complex regulations (LBT, duty cycle, max TX time,…). IEEE is already focusing on a solutions for unlicensed bands.
- For FDD:
  - FDD will have best link budget and lowest device power consumption.
  - The carrier wave for backscattering could be sent in the UL or DL portion of spectrum. If DL is used, frequency shifting is required by the device which increases complexity and power.
  - The backscattered wave should be sent in the UL portion of spectrum.
  - It is unclear whether DL data will be sent in the UL or DL portion of spectrum.

Proposal:

Study only FDD spectrum where:

- The backscattered modulated carrier wave is sent by the device in the UL band.
- Study if UL or DL band is used to send the carrier wave
- Study if UL or DL band is used for DL data.

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Rel 19 A-IoT Scope Reduction

Open Item:

- Study In-band NR, Guard-band NR and/or Standalone?

Discussion:

- Capacity and thus spectrum requirements for A-IoT should be modest given the limited traffic volumes.
- Focus should be on lowest spectrum and deployment costs.
- In-band – A-IOT traffic would need to be treated as a lower priority traffic to NR traffic, which may require complex scheduling.
- Guard-band – TX power and thus range maybe limited.
- Standalone – deployments may use small slices of spectrum not suitable for NR deployments. Standalone deployments are very similar to Guard-band deployments and thus would not require additional RAN workload.
- Flexibility of deployment options will lead to higher market penetration.

Proposal:

Study all three deployments - In-band NR, Guard-band NR and/or Standalone. The In-band scenario will be the most work to study.

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