Decentralized RRM for integrated WiFi and O-RAN to support time-sensitive flows

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Authors:

Name	Affiliations	Address	Phone	email
Jetmir Haxhibeqiri	IDLab, IMEC	Kapeldreef 75 3001 Leuven Belgium		jetmir.haxhibeqiri@imec.be
Adnan Shahid				adnan.shahid@imec.be

Abstract

- Multi-RAT serves as critical facilitator in Industry 4.0 scenarios.
- To support **cross-technology time-sensitive networking** we need to **integrate different RATs** at the radio level to benefit the most from decentralized knowledge-based optimization and configuration.
- This presentation shows how seamless integration at the radio level between **WiFi and cellular networks** utilizing **O-RAN** architecture ensures effective co-optimization across different domains while abstracting the RAN complexity using AI/ML-based control.

How TSN can be integrated with wireless technologies?

- **TSN currently only supported in wired networks (IEEE 802.1)**
  - Set of standards dealing with time synchronization (IEEE 802.1AS), scheduling (IEEE 802.1Qbv), management of TSN (IEEE 802.1 Qcc), frame replication and elimination (IEEE 802.1cb)
- **TSN integration with cellular 5G networks**
  - 5GS is perceived as logical TSN bridge between two wired TSN islands
  - Integration only at network level
    - Control plane integration by means of TSN application functions
    - Data plane integration
      - On the UE side by means of device-side TSN translator (DS-TT) function
      - On the network side by means of network-side TT (NW-TT) function
- **TSN integration with IEEE 802.11**
  - Accurate time synchronization (IEEE 802.1AS over WiFi, FTM)
  - Support for time-aware scheduling on lower layers (gated control + EDCA)
  - Network monitoring: in-band network monitoring on per-packet level, statistical monitoring.

IEEE 802.11 features used for TSN

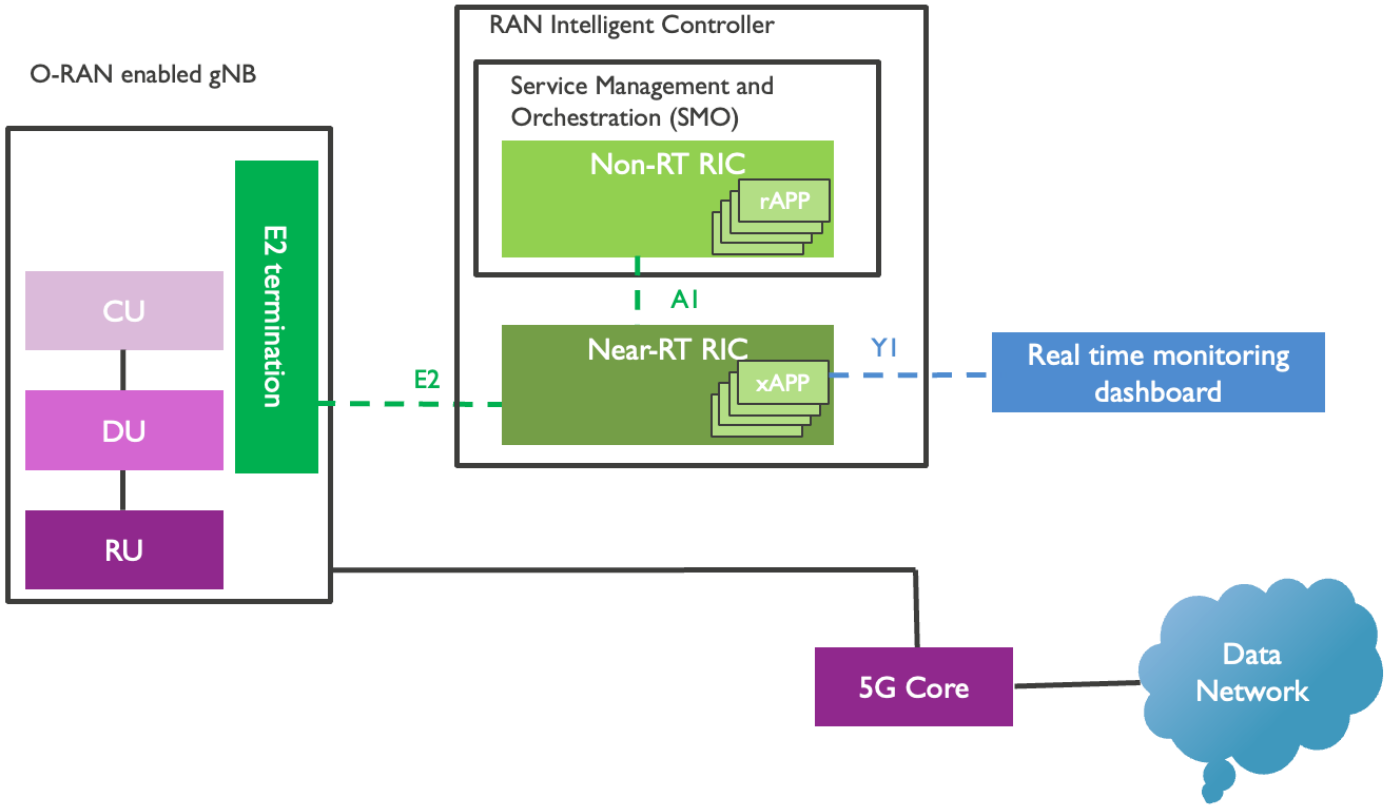
	C-SR	C-OFDMA	R-TWT	MLO	EDCA RT
Low latency	+	+	+	+	+
Low jitter		+	+	+	+
Deterministic timing		+	+		
High reliability	+	+		+	
Traffic isolation		+	+		
Bandwidth reservation		+	+		
Scalability	+	+		+	+

Multi-RAT integration

- Wireless-wired TSN in industrial use cases might use different technologies
  - IEEE 802.1, IEEE 802.1, 5G campus networks etc.
- To support end-to-end TSN tighter integration between different technologies is needed.
- All the current solutions integrate at network level
  - 5G wired TSN integration
  - No IEEE 802.11 and 5G integration
  - No IEEE 802.11 and wired TSN integration
- Need for integration closer to the radio

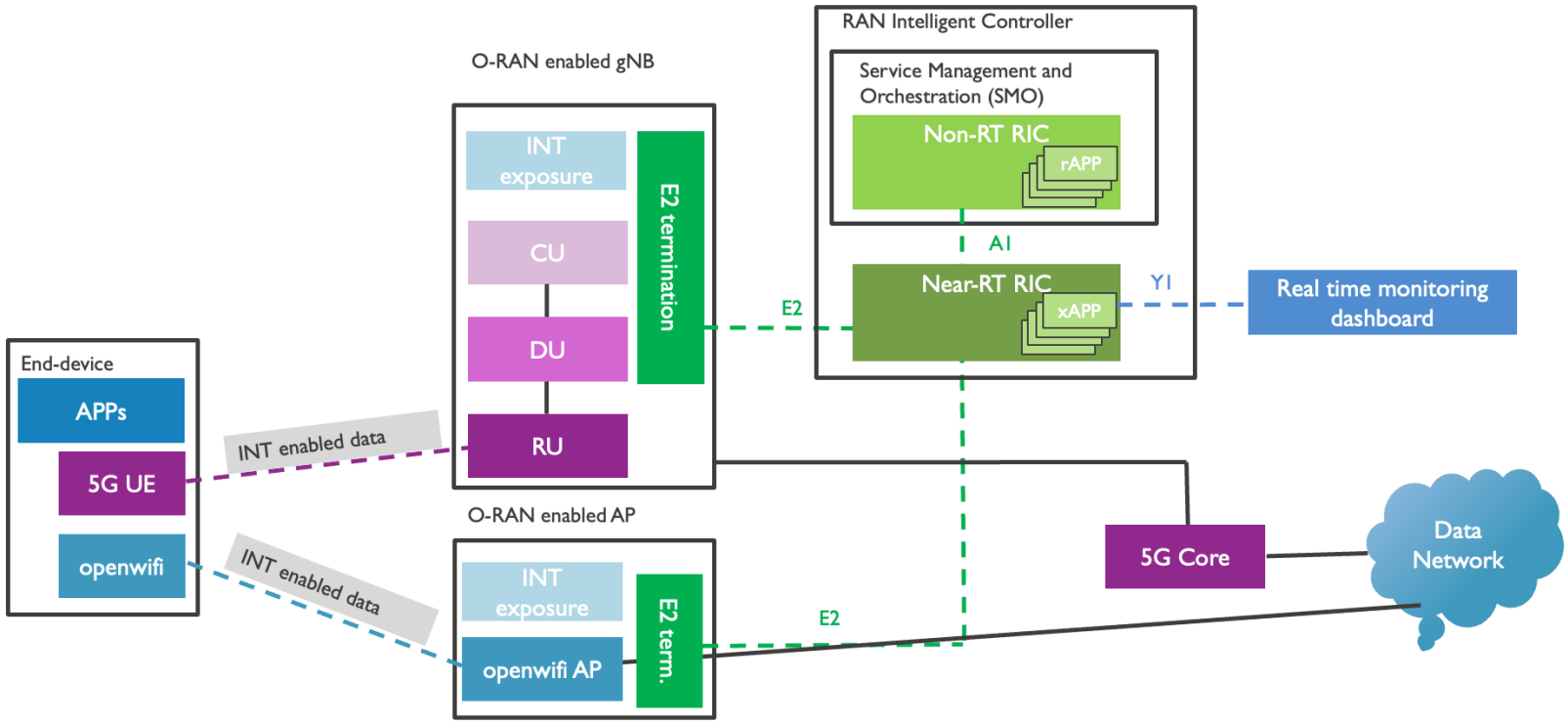
Multi-RAT integration

O-RAN strategy

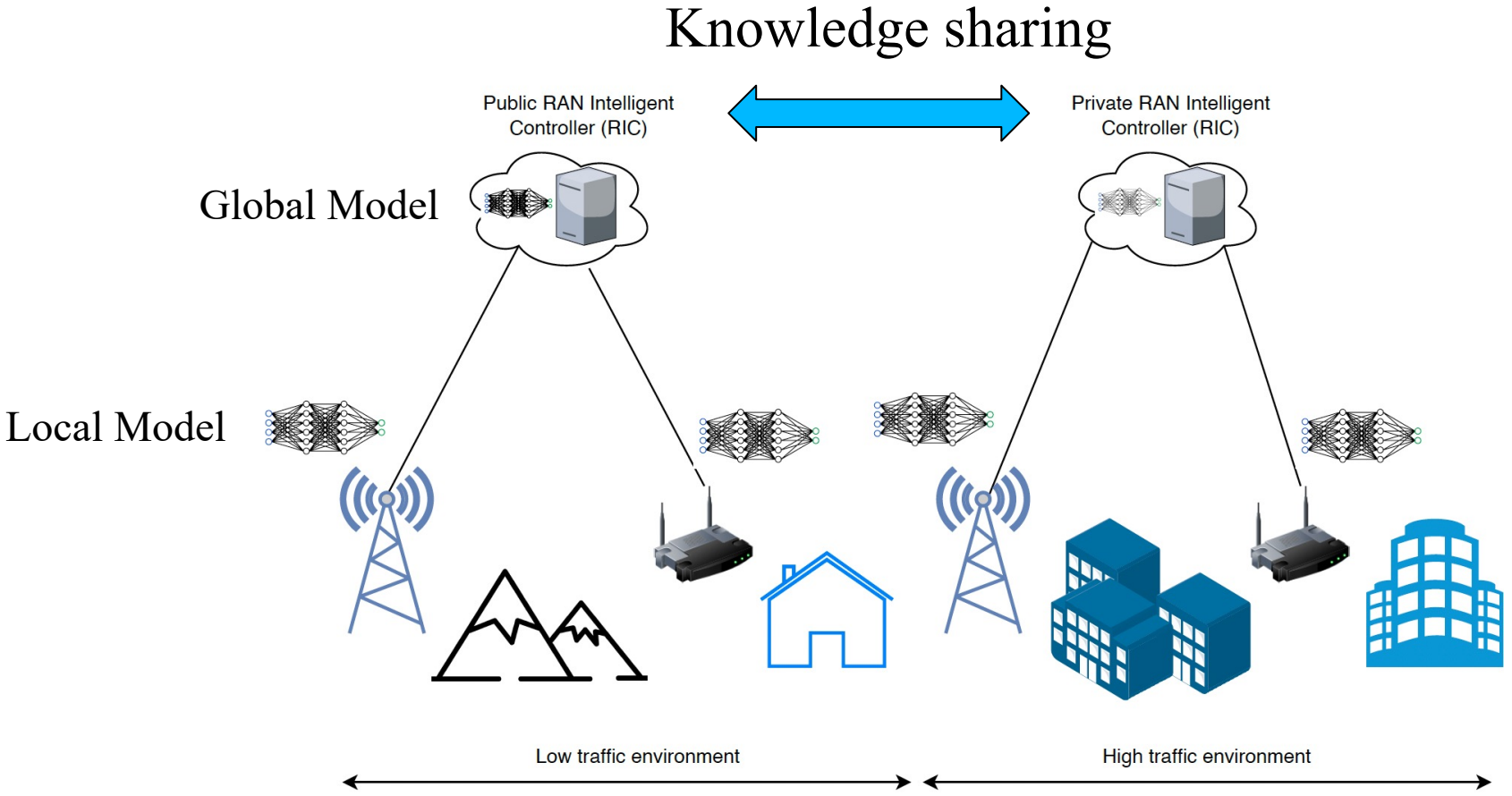


Multi-RAT integration

IEEE 802.11 AP integration with O-RAN



Decentralized RRM for integrated WiFi and cellular network



Summary

The use case is crucial for realizing the integration of WiFi and cellular networks to support time-sensitive flows. Additionally, decentralized AI/ML using Federated Learning has a clear advantage in knowledge sharing from one environment to another.

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