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Using RAW as Control Plane for Wireless Deterministic Networks: Challenges Ahead

Carlos J. Bernardos, Alain Mourad, **Milan Groshev**, Luis M. Contreras, Marc Mollà Roselló, Otilia Bularca, Valerio Frascolla, Peter Szilagyi, Sebastian Robitzsch

OUTLINE

- Introduction
- Use case: wireless for industrial applications
- IETF DetNet/RAW
- RAW Challenges Ahead
  1. Multi-domain extension
  2. RAW and MEC integration
  3. Mobility in RAW
- Conclusions

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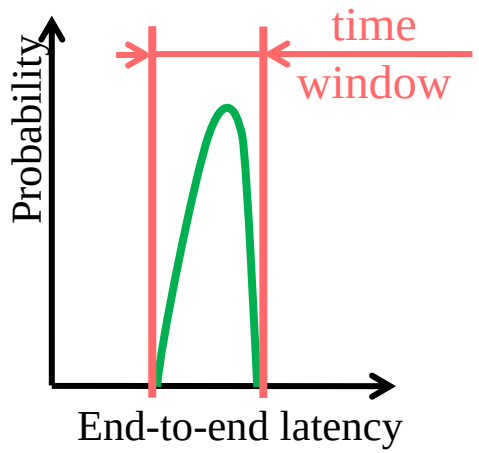
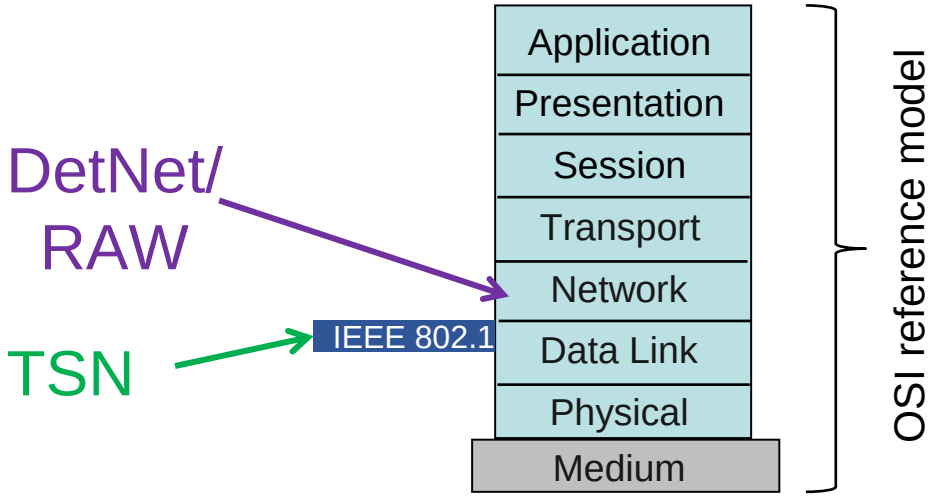
DETERMINISTIC COMMUNICATIONS

- The Right Packet at The Right Time
  - Deterministic data packet delivery
  - Packet delivery within a time window without loss or delay due to congestion or errors



- IEEE 802.1 Time-Sensitive Networking (TSN) at Layer 2 (bridging)
- IETF Deterministic Networking (DetNet) at Layer 3 (IP/MPLS routing)



IETF DetNet WG

The Deterministic Networking (DetNet) Working Group focuses on deterministic data paths that operate over Layer 2 bridged and Layer 3 routed segments, where such paths can **provide bounds on latency, loss, and packet delay variation (jitter), and high reliability**. The Working Group addresses **Layer 3 aspects in support of applications requiring deterministic networking**. The Working Group collaborates with IEEE802.1 Time-Sensitive Networking (TSN), which is responsible for Layer 2 operations, to define a **common architecture for both Layer 2 and Layer 3**. Example applications for deterministic networks include professional and home audio/video, multimedia in transportation, engine control systems, and other general industrial and vehicular applications being considered by the IEEE 802.1 TSN Task Group.

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https://datatracker.ietf.org/wg/detnet/about

IETF Reliable and Available Wireless (RAW) WG

- Dedicated WG established to **extend the DetNet concepts to provide high reliability and availability for an IP network utilizing scheduled wireless segments and other wireless media**. … https://datatracker.ietf.org/wg/raw/about
- RAW WG has achieved key milestones
- RAW WG is being folded to DetNet WG for wider community work

- RFC 9372 L-Band Digital Aeronautical Communications System (LDACS)
- RAW Use Cases – with RFC Editor
- RAW Technologies – wrapping up
- OAM Features for RAW – to be finalized in DetNet WG
- RAW Architecture – joint review by RAW and DetNet WGs
- RAW Framework – to be done after the architecture

ETSI Multi-access Edge Computing

The Multi-access Edge Computing (MEC) initiative is an Industry Specification Group (ISG) within ETSI. The purpose of the ISG is to create a **standardized, open environment which will allow the efficient and seamless integration of applications from vendors, service providers, and third-parties across multi-vendor Multi-access Edge Computing platforms**. The work of the MEC initiative aims to unite the telco and IT-cloud worlds, providing IT and cloud-computing capabilities within the RAN (Radio Access Network). The MEC ISG specifies the elements that are required to enable applications to be hosted in a multi-vendor multi-access edge computing environment.

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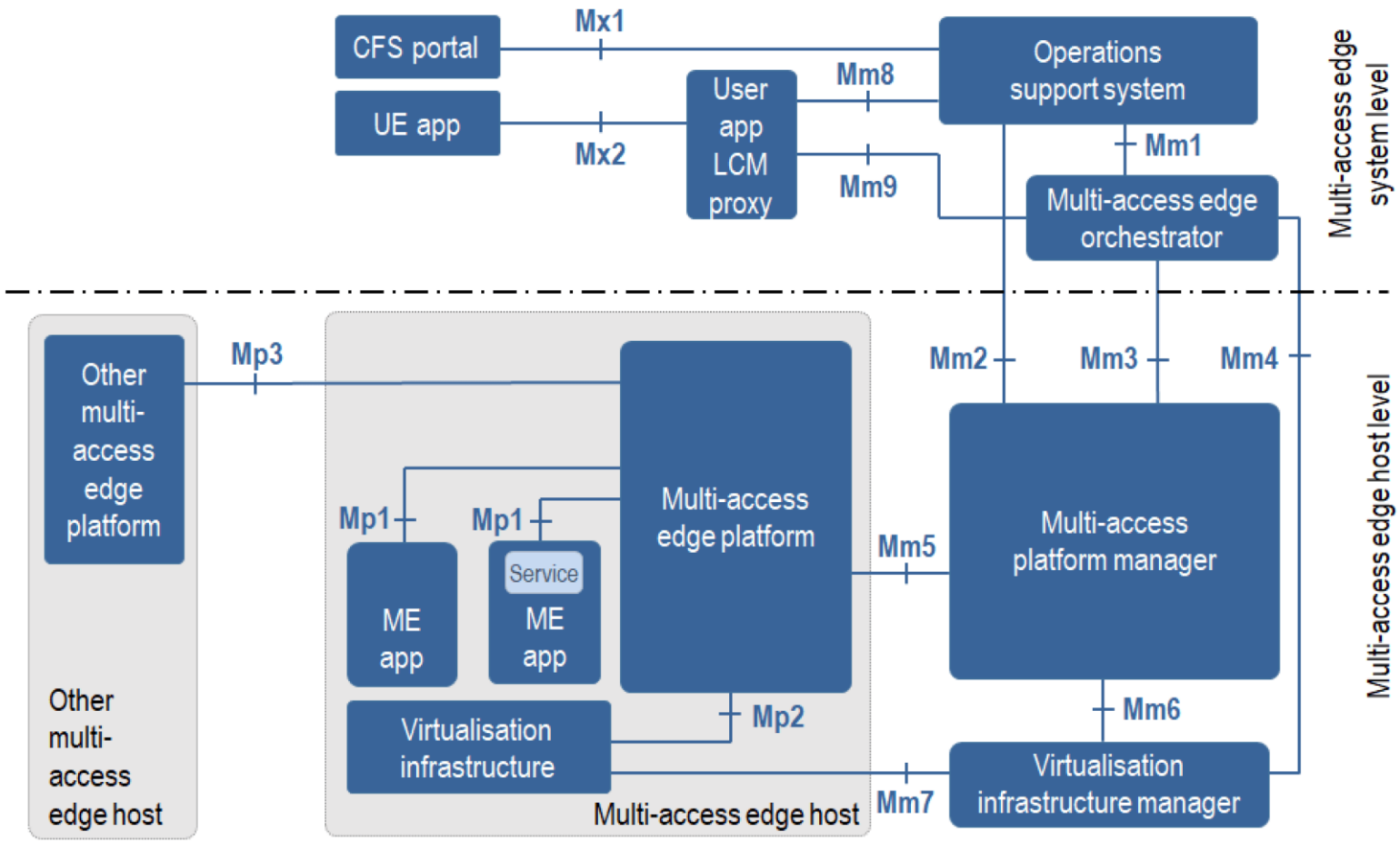
https://www.etsi.org/technologies/multi-access-edge-computing

ETSI Multi-access Edge Computing



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RAW use cases

- Different use cases considered in draft-ietf-raw-use-cases:
  - Aeronautical Communications
  - Amusement Parks
  - Wireless for Industrial Applications
  - Pro Audio and Video
  - Wireless gaming
  - Unmanned Aerial Vehicles and Vehicle-to-Vehicle platooning and control
  - Edge Robotics control
  - Instrumented emergency medical vehicles

Wireless for Industrial Applications

Ethernet backbone

IEEE 802.15.4

IEEE 802.11

3GPP 5G

Wireless for Industrial Applications: Specifics

- Heterogeneous technologies
- Multiple simultaneous links
- Variable link conditions (even with low mobility)
- Different needs/traffic types, e.g.:
  - Control loops: reliability is key
  - Monitoring and diagnostics: should not be mixed with previous

Wireless for Industrial Applications: Requirements for RAW

- Solutions should support heterogeneous traffic
  - Capable of transporting both regular (multiplexed) flows and flows requiring predictable behavior

- Solutions should be able to work over multiple wireless access technologies
  - E.g., segment such as Time Slotted Channel Hopping (TSCH) [IEEE 802.15.4] and a backbone segment such as Ethernet

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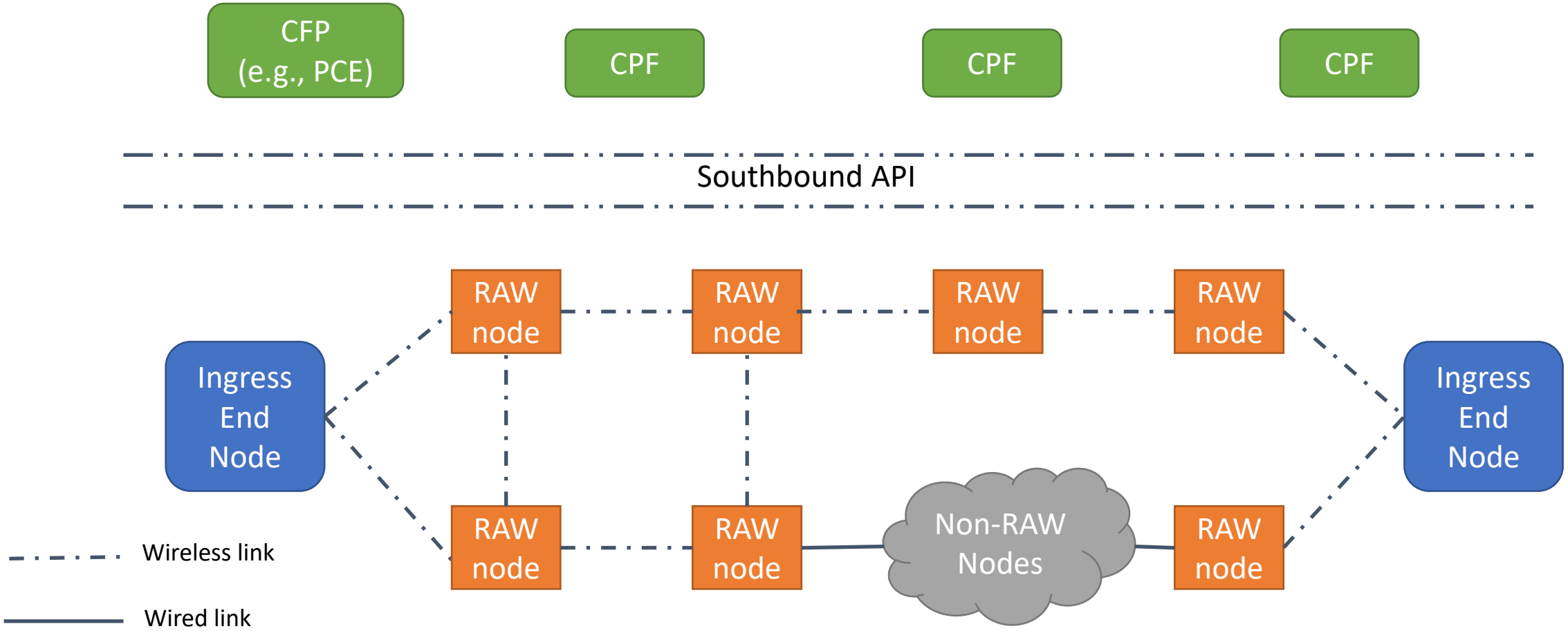
RAW architecture: conceptual model

CFP: Control Plane Function
PCE: Path Computation Element



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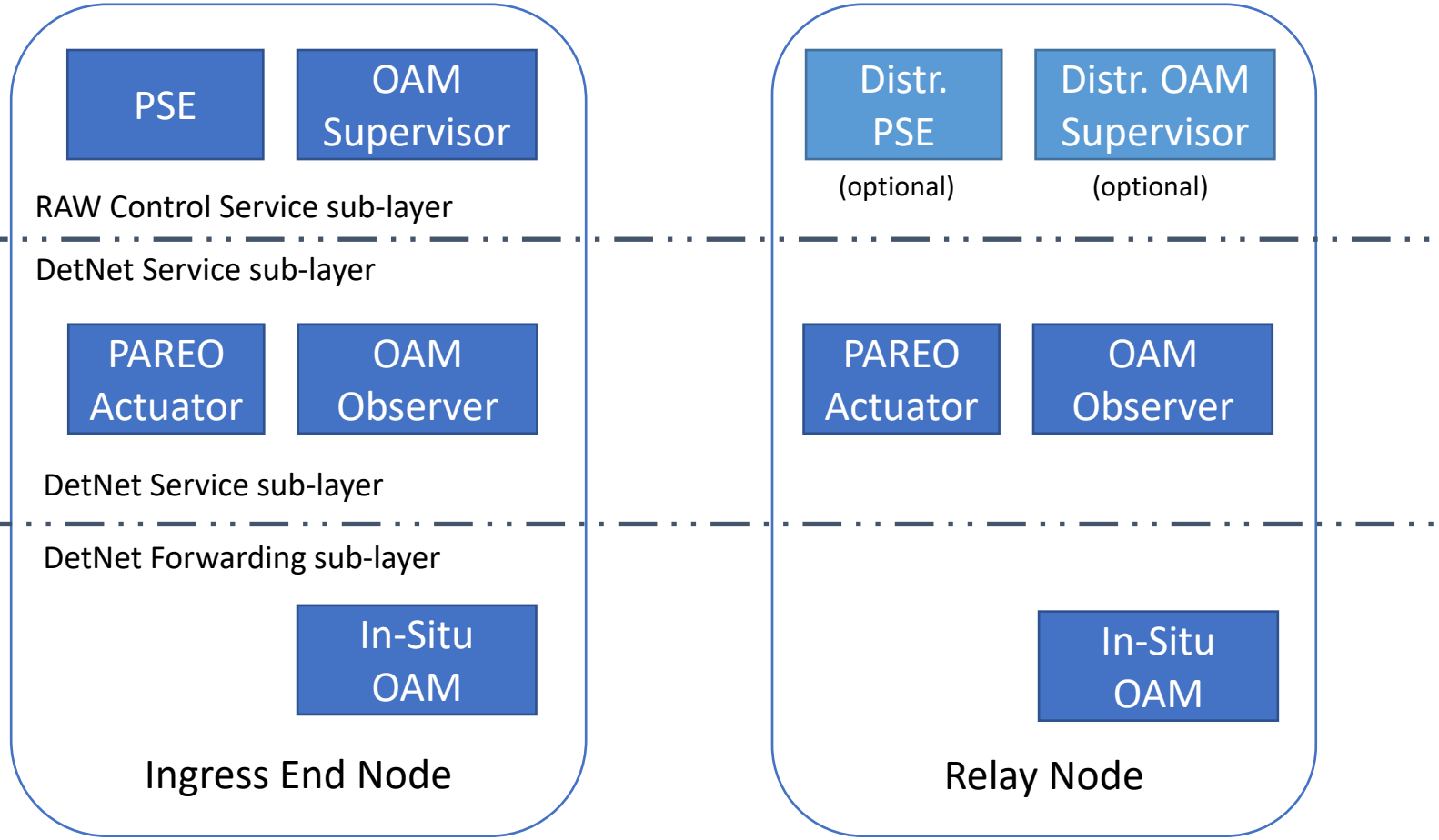
RAW architecture: RAW and DetNet



PSE: Path Selection Engine
OAM: Operations, Administration and Maintenance
PAREO: Packet (hybrid) ARQ, Replication, Elimination and Ordering

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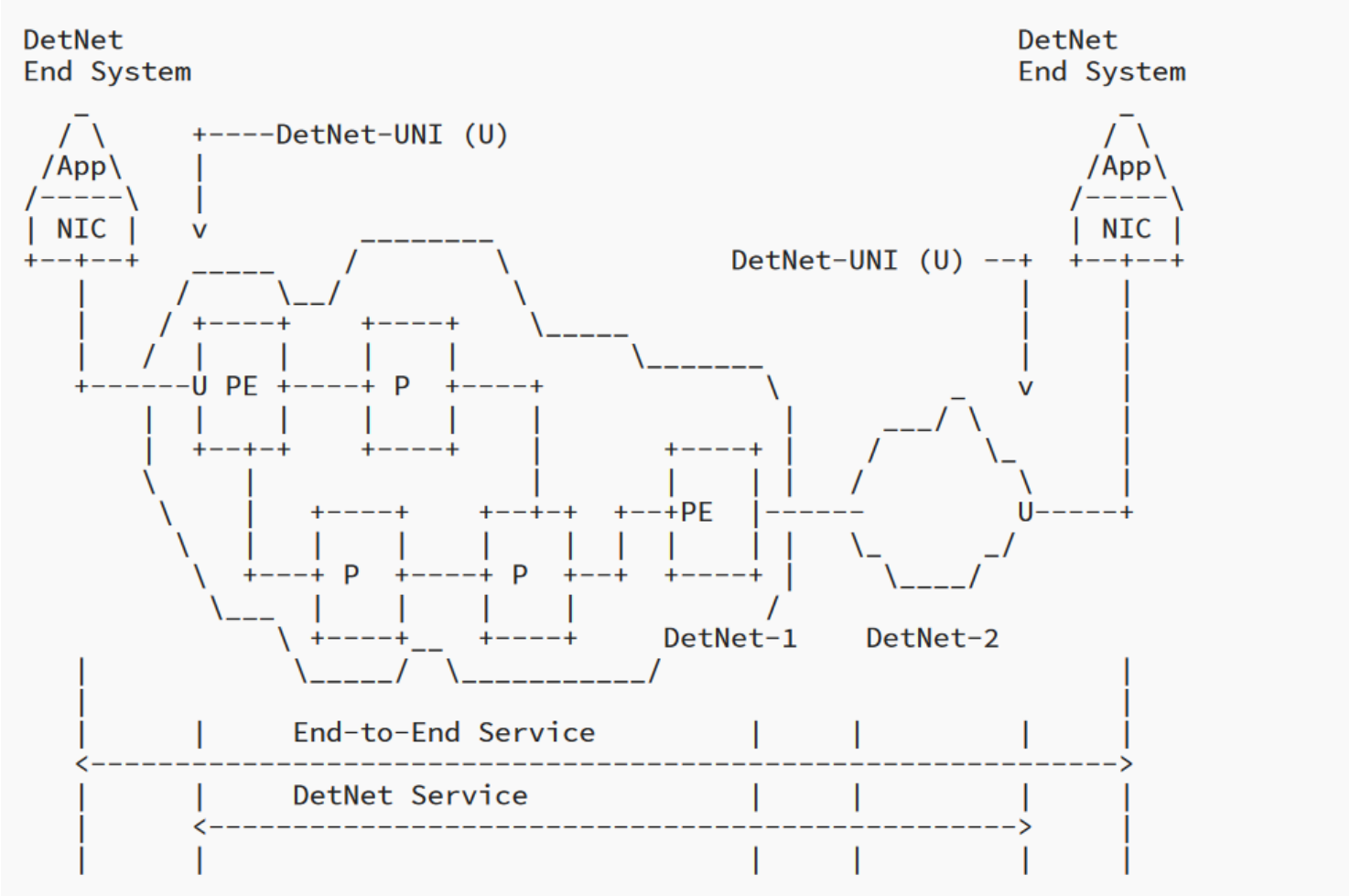
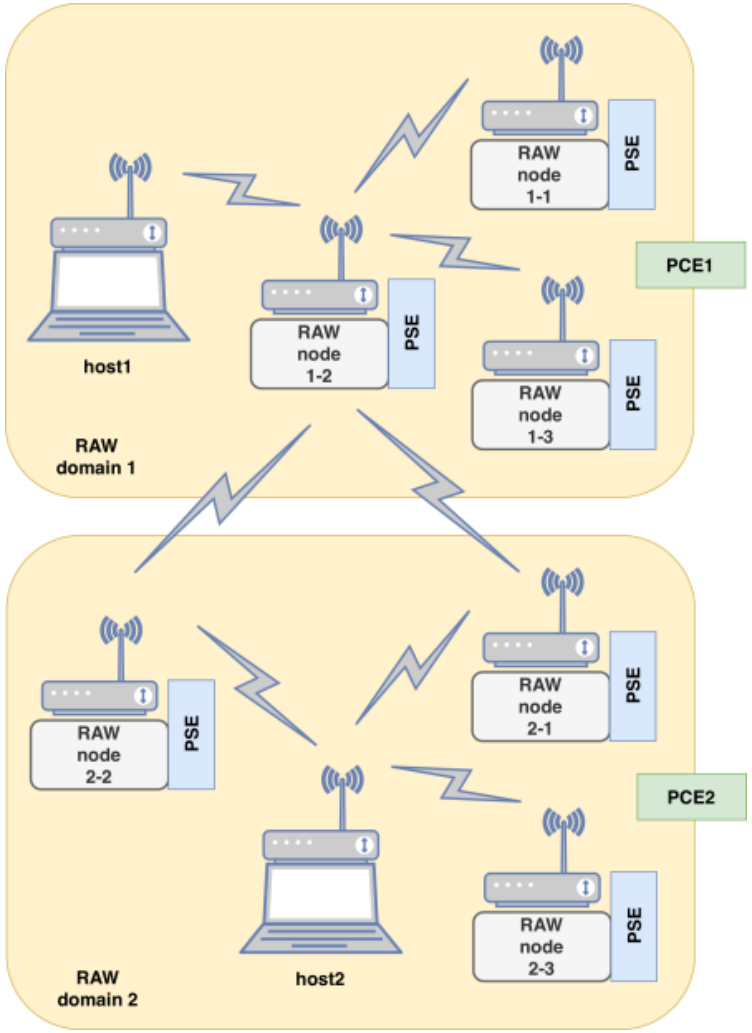
DetNet Service Reference Model (Multidomain)



Scenario showing multiple RAW domains

- PSE of one domain can not act on the other domains (e.g., no multi-domain OAM solutions yet)
- Running uncoordinatedly RAW solutions in each domain is not an effective solution.
- PSEs need to have global E2E information as well as be capable of running OAM mechanism to monitor the quality of the selected multi-domain paths.



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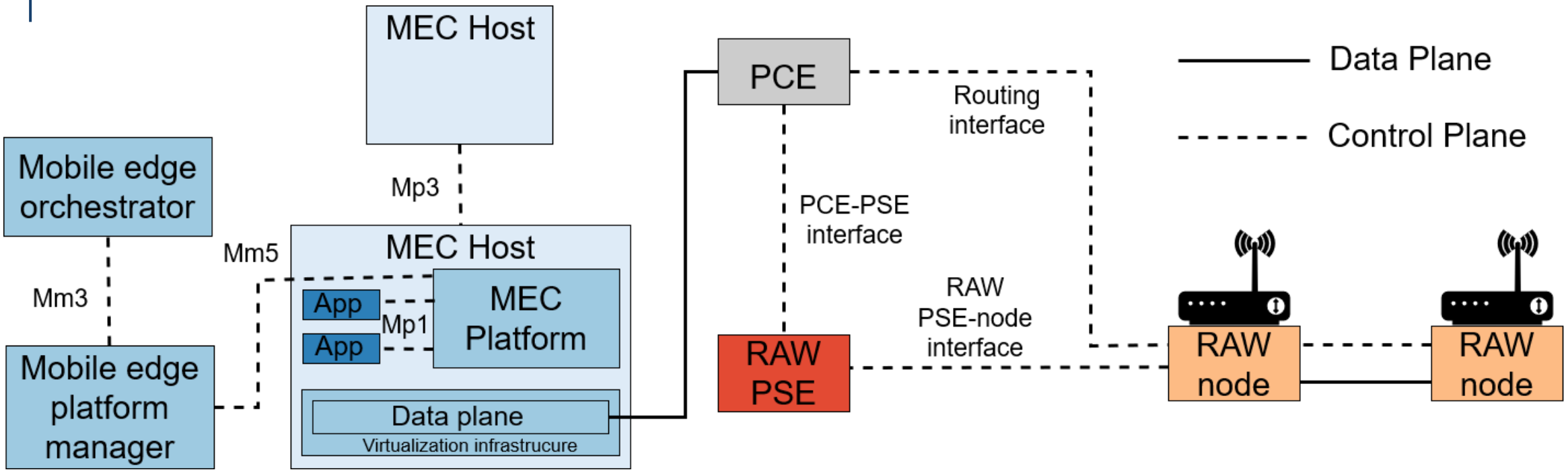
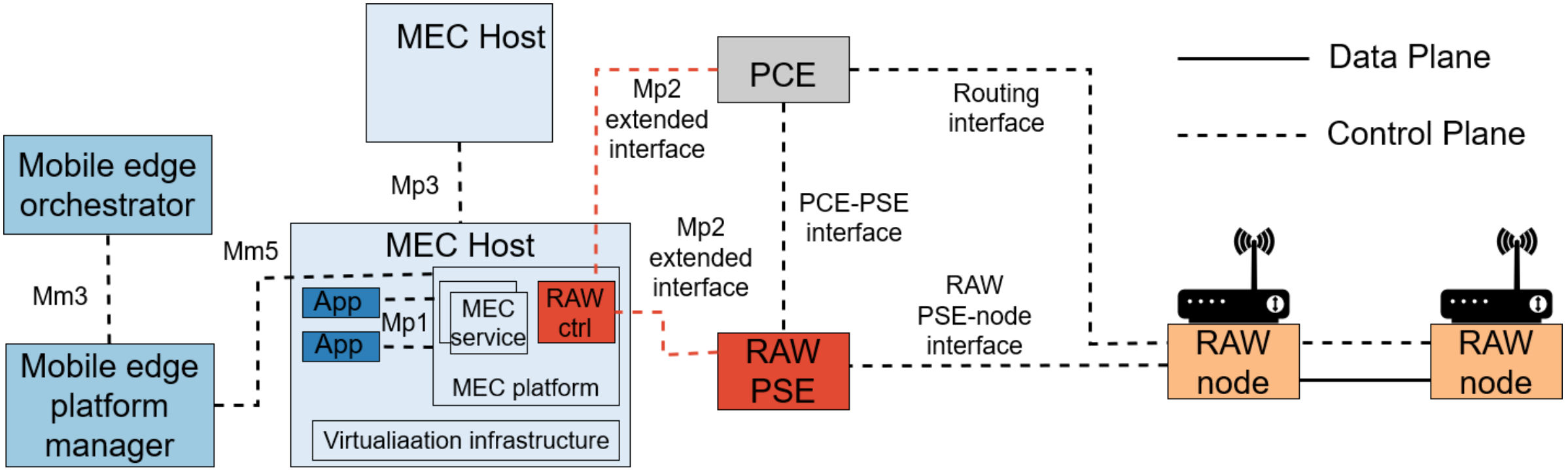
RAW in Multi-Access Edge Deployments



In the MEC reference architecture the Virtualisation infrastructure in the MEC host includes a **data plane that executes the traffic rules** received by the MEC platform, and routes the traffic among applications, services, DNS server/proxy, 3GPP network, **local networks and external networks**

RAW and MEC integration



The Mp2 reference point between the MEC platform and the data plane of the Virtualisation infrastructure is used to instruct the data plane on how to route traffic among applications, networks, services, etc. **This reference point is not further specified.**

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Mobility in RAW Scenarios

Exiting challenges

- As opposed to static scenarios, where possible “tracks” do not change due to mobility, mobility scenarios pose additional complexity
- Current solutions DetNet and RAW solutions are limited to static scenarios
- Control plane solutions need to cope with mobility by proactively preparing the network for change of point of attachment of the mobile node. And the impact that this has in terms of new tracks used for the traffic.

Way forward

- Inter-PSE coordination will be needed
- Mechanisms that will allow for a terminal to signal an imminent handover and convey its QoS requirements
- The signaling messages among RAW nodes (PSEs) need to be specified to prepare and coordinate an imminent handover.

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CONCLUSIONS

Running uncoordinatedly RAW solutions in each domain is not an effective solution.

- PSEs need to have global E2E information as well as be capable of running OAM mechanism to monitor the quality of the selected multi-domain paths.

ETSI MEC extension for direct interaction between the MEC platform and the RAW network are needed.

- Extending the MEC platform with a RAW control functionality to instruct the RAW PSE, based on the requirements from the MEC application, as well as to take decisions at the MEC side based on the information about the RAW network.

Solutions to solve the node mobility problem in both single and multi-domain RAW networks is needed.

PREDICT-6G

Thank you!

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