Reliable and Available Wireless Architecture/Framework

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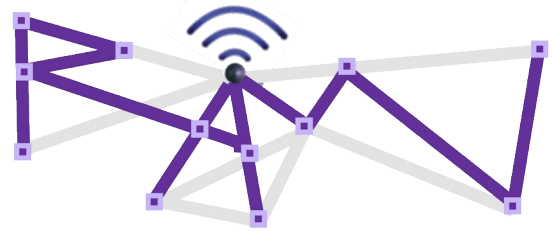
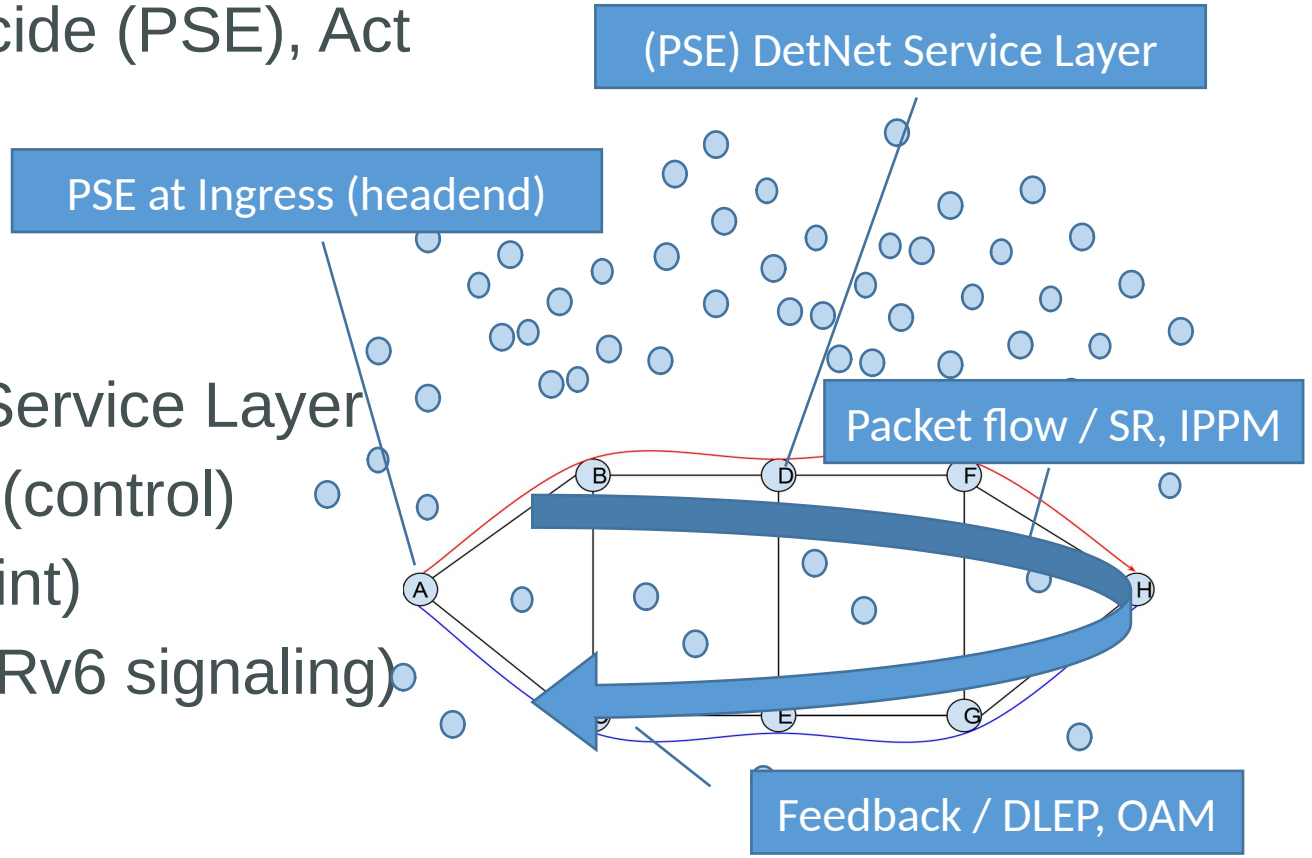
RAW - IETF 112 – Virtual

The RAW Architecture

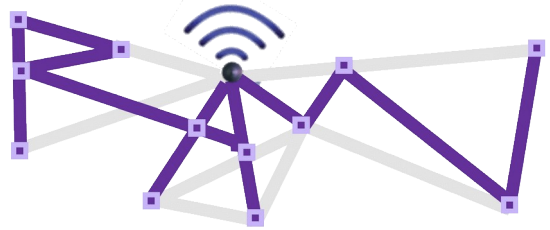


Redundant Radio Access

- OODA loop with 3 new steps:
  - Observe (OAM), Orient (PCE), Decide (PSE), Act (PAREO)
- PSE:
  - DetNet to signal Flow information
  - RAW-SRv6 to hint/control DetNet Service Layer
  - PSE operate at Track Ingress only (control)
  - PSE may be partially distributed (hint)
  - PSE may be fully distributed (No SRv6 signaling)
- DetNet Service Plane
  - Enrich DetNet (PAREO, timing, SR hint/control))



RAW Architecture/Framework draft status



- WG Doc -01 stable since last IETF

  Expecting updates from Lou

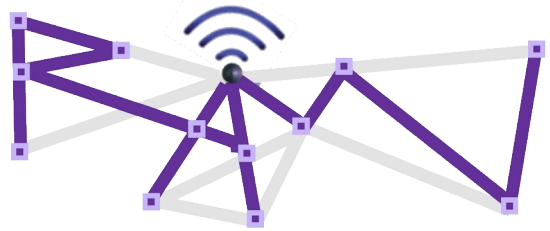
- What's missing:
  - Lou's points
  - New Sections ?

  Þ Yaakov's work / SRv6

  Þ DLEP (Lou?)

  Þ IPv6 encapsulations, use of HbH, DOH and SRH

New terms (1/4)



Flow (the water):

A collection of consecutive packets that must be placed on the same Track to receive an equivalent treatment from Ingress to Egress within the Track. Multiple flows may be transported along the same Track. The subTrack that is selected for the flow may change over time under the control of the PSE.

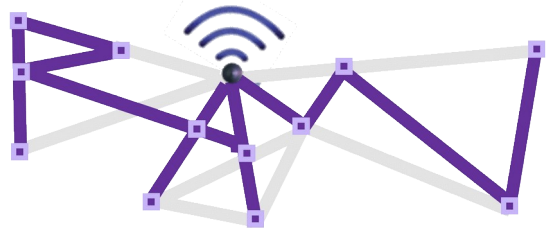
Track (the pipe):

A networking graph that can be used as a "path" to transport RAW packets with equivalent treatment; as opposed to the usual understanding of a path (see for instance the definition of "path" in section 1.1 of [RFC9049]), a Track may fork and rejoin to enable the PAREO operations.

In DetNet [RFC8655] terms, a Track has the following properties:

- A Track has one Ingress and one Egress nodes, which operate as DetNet Edge nodes.
- A Track is reversible, meaning that packets can be routed against the flow of data packets, e.g., to carry OAM measurements or control messages back to the Ingress.
- The vertices of the Track are DetNet Relay nodes that operate at the DetNet Service sublayer and provide the PAREO functions.
- The topological edges of the graph are serial sequences of DetNet Transit nodes that operate at the DetNet Forwarding sublayer.

New terms (2/4)



SubTrack:

A Track within a Track. The RAW PSE selects a subTrack on a per-packet or a per-collection of packets basis to provide the desired reliability for the transported flows.

Segment:

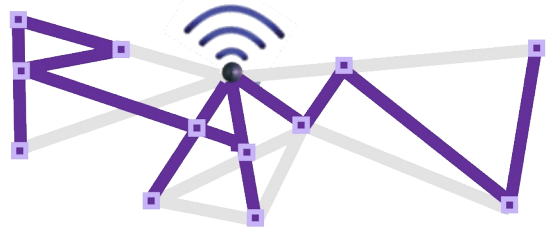
A serial path formed by a topological edge of a Track.
East-West Segments are oriented from Ingress (East) to Egress (West).
North/South Segments can be bidirectional;
to avoid loops, measures must be taken to ensure that a given packet flows either Northwards or Southwards along a bidirectional Segment, but never bounces back.

Structurally not a DODAG though the packet experiences one

Flapping:

In the context of RAW, a link flaps when the reliability of the wireless connectivity drops abruptly for a short period of time, typically of a subsecond to seconds duration.

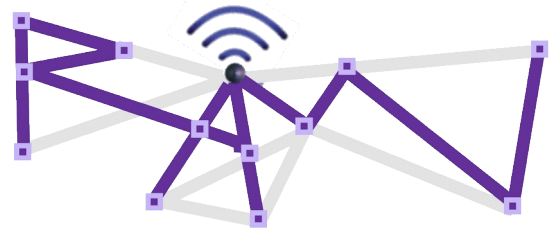
Questions ?



Content from IETF 108

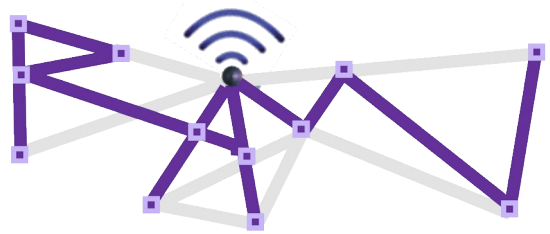
- Back up slides

RAW interactions with other IETF WGs



- DetNet: RAW is mostly a focused Subset
  - Radio specialists, different interests
  - Unstable links (bandwidth, flapping), not ‘deterministic’
  - OAM is a common interest – cross participation
- MANET: Non-Congruent domains
  - Non-Mobile & not Ad-Hoc (antagonistic to DetNet)
  - Centralized routing
  - DLEP a relevant tool but need multihop view (OAM)
- CCAMP: May need work from CCAMP for data models
- IPPM can be leveraged for in-band OAM, direct export,
- and BIER for path selection & control

Terms

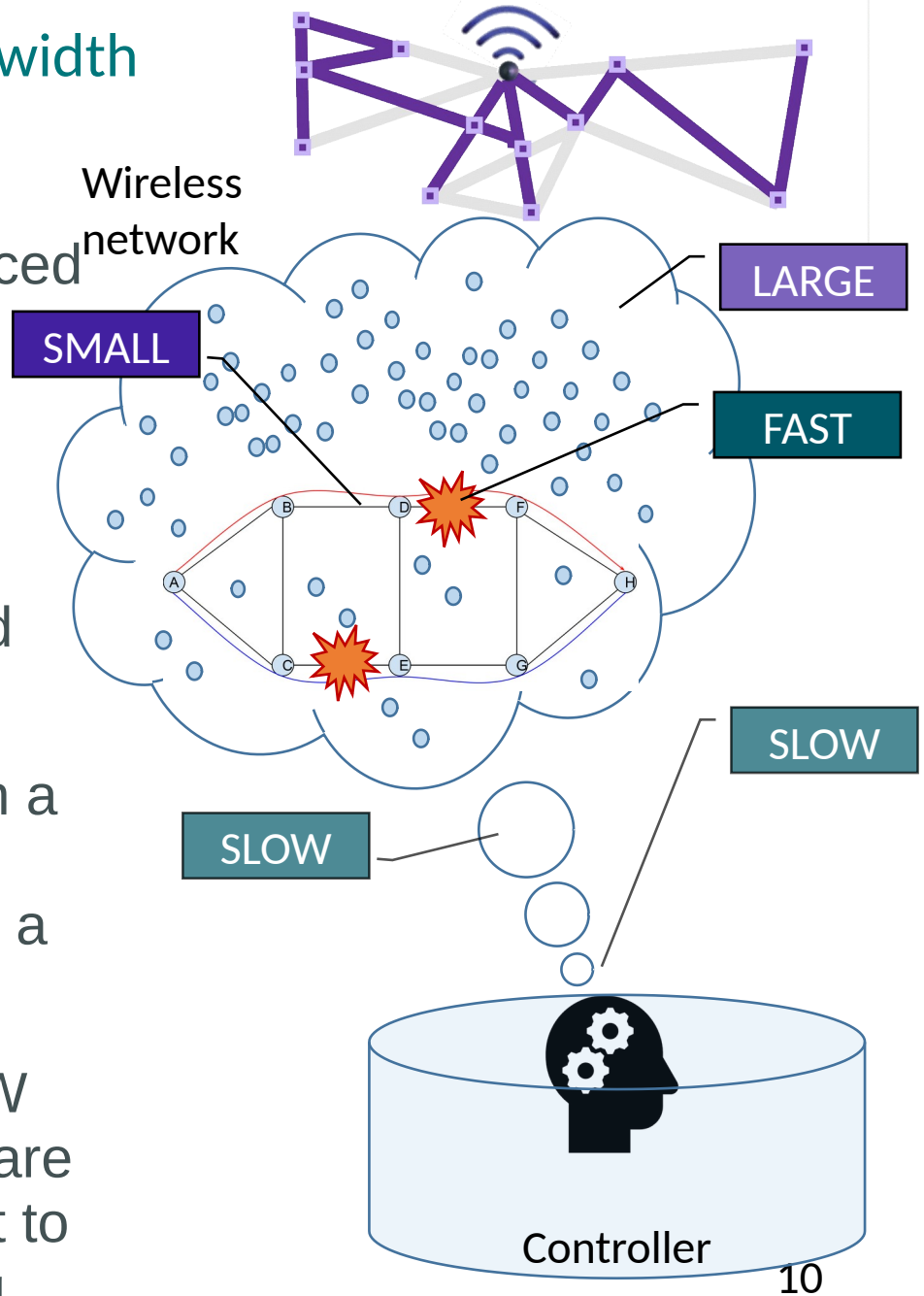


- **Reliability**: Reliability is a measure of the probability that an item will perform its intended function for a specified interval under stated conditions. For RAW, the service that is expected is delivery within a bounded latency and a failure is when the packet is either lost or delivered too late. RAW expresses reliability in terms of Mean Time Between Failure (MTBF) and Maximum Consecutive Failures (MCF). More in [NASA].
- **Availability**: Availability is a measure of the relative amount of time where a path operates in stated condition, in other words (uptime)/(uptime+downtime). Because a serial wireless path may not be good enough to provide the required availability, and even 2 parallel paths may not be over a longer period of time, the RAW availability implies a path that is a lot more complex than what DetNet typically envisages (a Track)
- **PAREO:** Packet (hybrid) ARQ, Replication, Elimination and Ordering. PAREO is a superset Of DetNet's PREOF that includes radio-specific techniques such as short range broadcast, MUMIMO, constructive interference and overhearing, which can be leveraged separately or combined to increase the reliability

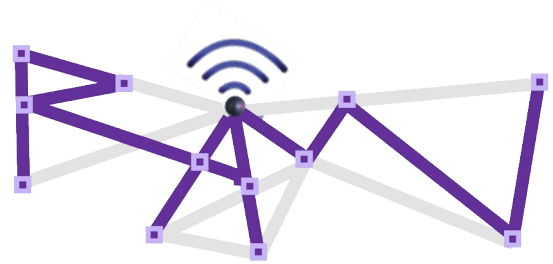
The Gap

Reliability & Availability vs. Energy & Bandwidth

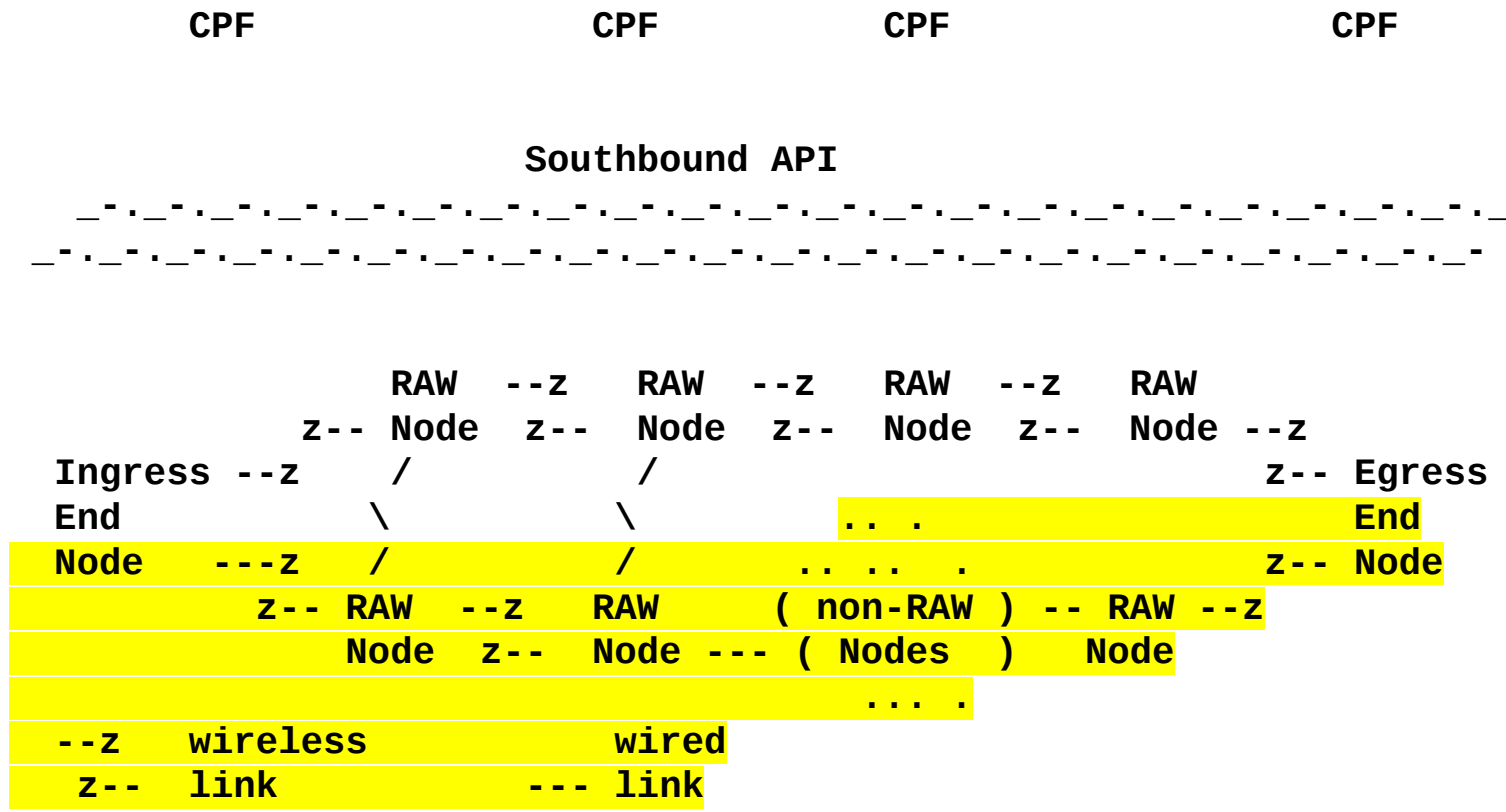
- Due to uncontrolled interferences, including the self-induced multipath fading, deterministic networking can only be approached on wireless links.
- The radio conditions may change -way- faster than a centralized PCE can adapt and reprogram, in particular when the controller is distant and connectivity is slow and limited.
- RAW separates the path computation time scale at which a complex path is recomputed from the path selection time scale at which the forwarding decision is taken for one or a few packets.
- RAW operates at the path selection time scale. The RAW problem is to decide, within the redundant solutions that are proposed by the PCE, which will be used for each packet to provide a Reliable and Available service while minimizing the waste of resources.



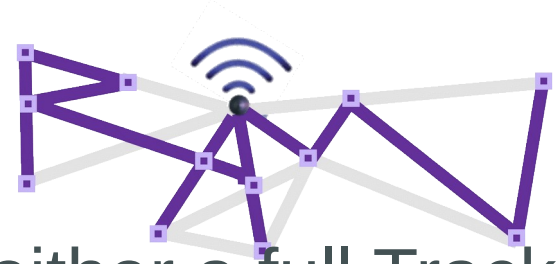
RAW within (and vs.) DetNet



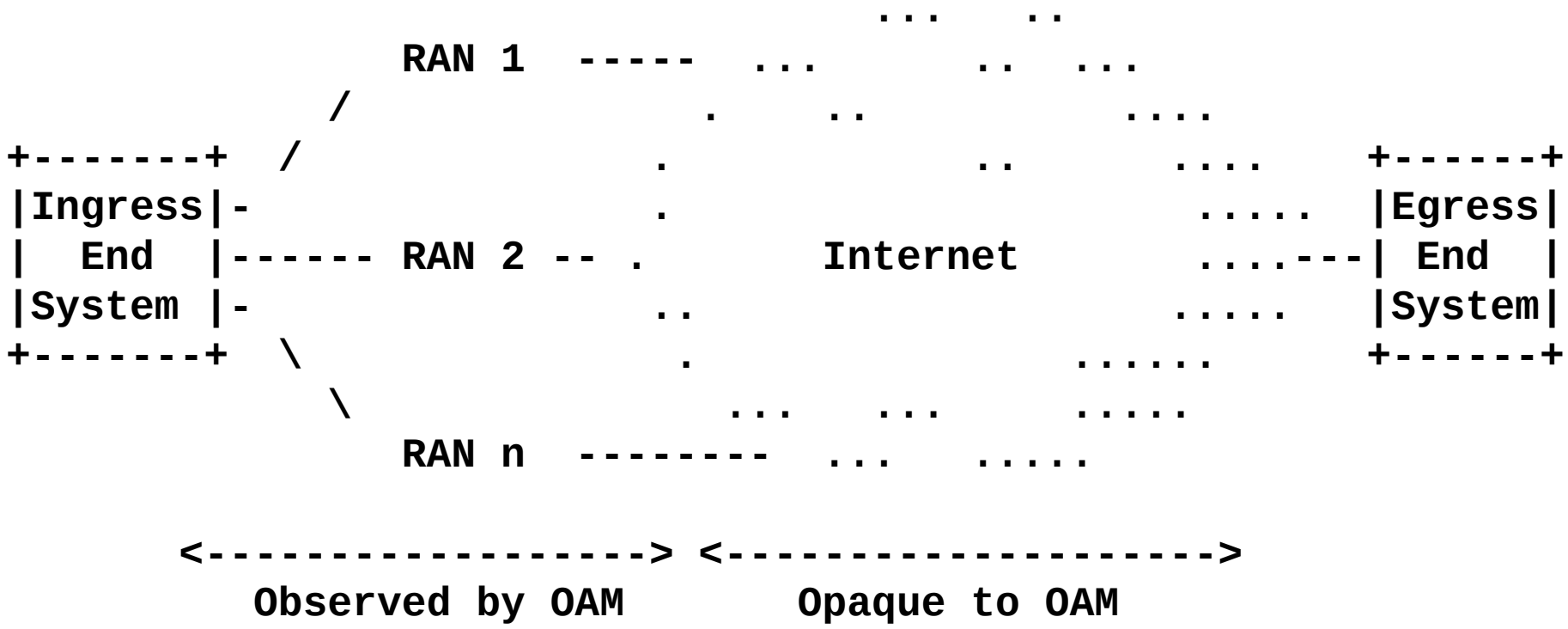
- RAW operates at the DetNet Service Layer in the Network Plane
- Controller Plane Functions compute complex Tracks
- RAW Nodes provide a PSE function
- RAW observes a selection of L2 Links (the others are “infinite”)
- RAW observes the L3 end-to-end operation



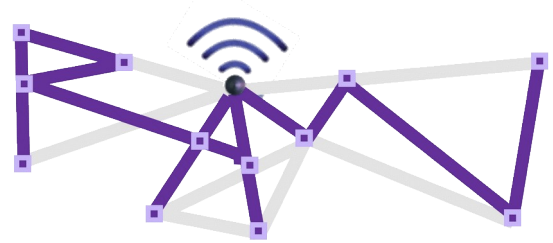
RAW Architecture: RAW i/oOAM



RAW OAM operation in the Network Plane observes either a full Track or subTracks that are being used at this time. In the case of Radio Access Protection, the Track is Loose and only the first hop is observed:



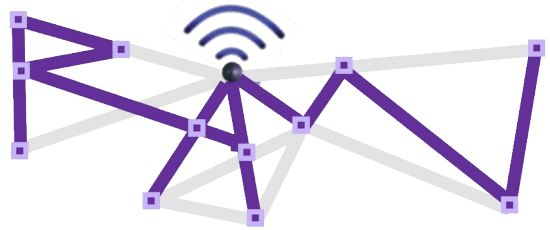
RAW Architecture: the PSE

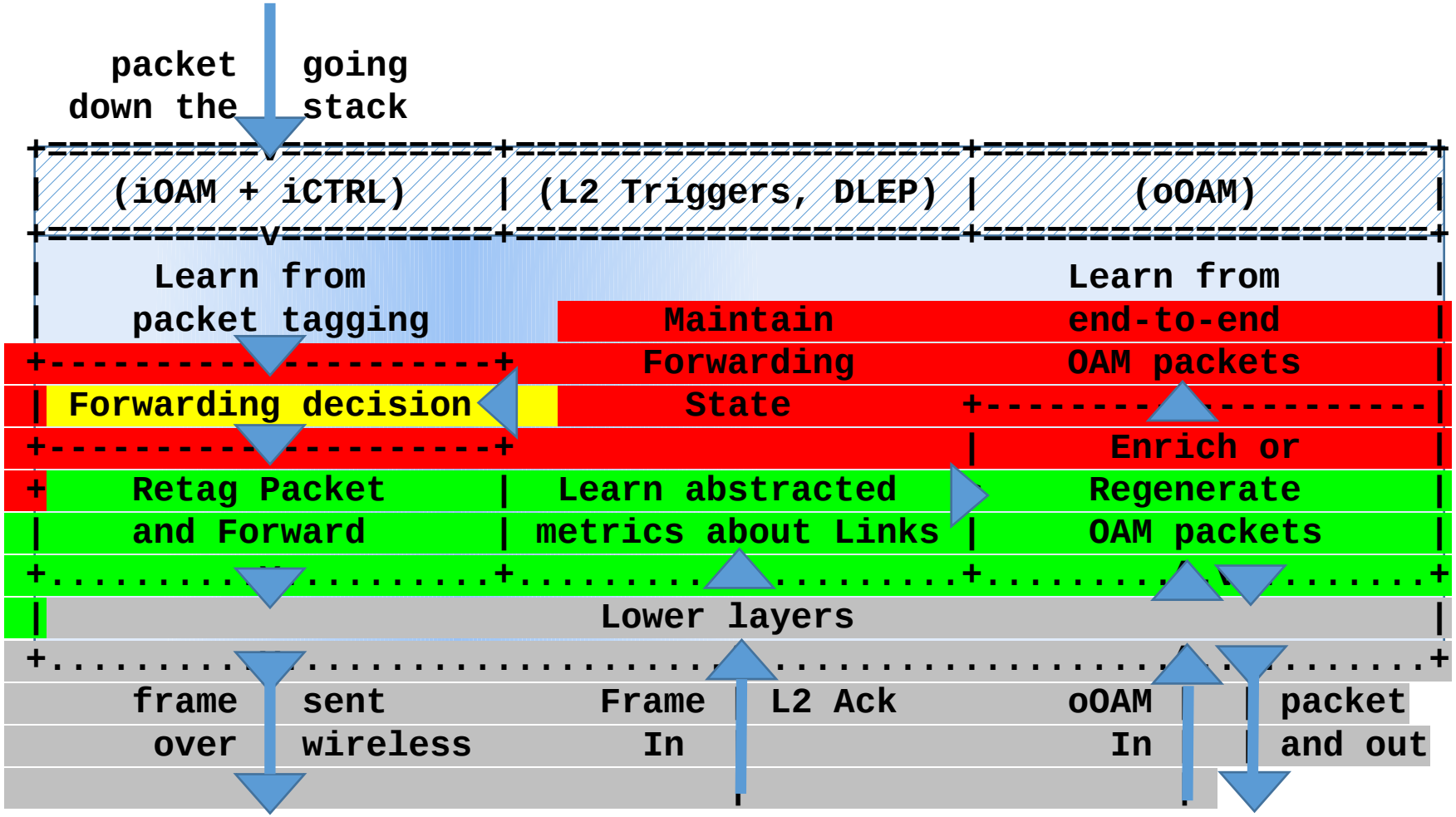


- **RAW** defines path selection engine (PSE) that performs rapid local adjustments of the forwarding tables to avoid excessive use of the resource diversity that the PCE proposes
- Exploiting richer forwarding capabilities with PAREO and scheduled transmissions

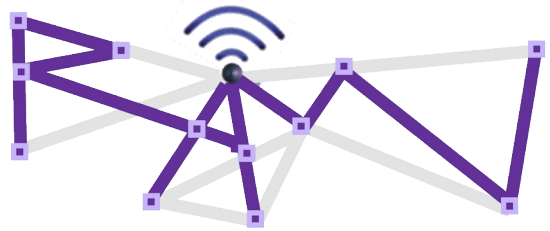
	PCE (not in scope)	PSE (in scope)
Operation	Centralized	Source-Routed or Distributed
Communication	Slow, expensive	Fast, local
Time Scale	Long (hours, days)	Short (sub-second)
Network size	Large, many Tracks to compute	Small, within one Track
Metrics	Averaged, Statistical, Shade of grey	Instant values / boolean state

RAW Architecture: The PSE “Stack”





What do we need to do?



- Select Appropriate Radios and Effective Use Cases
  - Þ Req: Capability to schedule resources
  - Þ Opt: Diversity capabilities (frequency, beam, …)

- Adapt per-packet activity of a RAW flow along a diverse path
  - Þ Determine Specific Data Models to match radio properties (for CCAMP and IPPM?)
  - Þ Signal forwarding properties in packets (e.g., BIER-TE)
  - Þ Source routed and Distributed forwarding decision (use of PAREO functions)
  - Þ In-band control of resource Usage to optimize energy and bandwidth
- Enable i/oOAM (in and out-of-band)
  - Þ Forward packets or generated placebo packets to measure LQI
  - Þ In-band forward and out-of-band backward gathering of metrics across NECM