Reliable and Available Wireless Architecture/Framework

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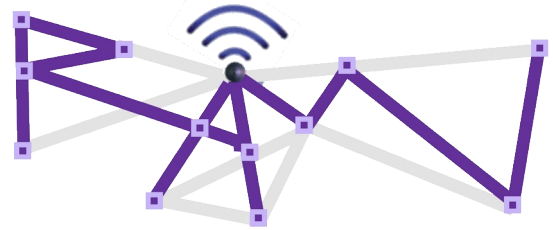
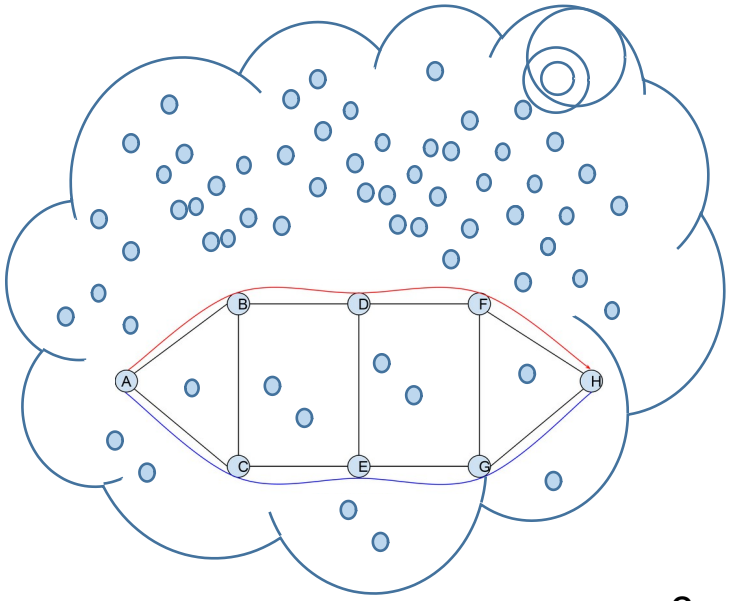
Requirements served

- Two basic use cases, Radio Access Protection with diverse Wireless Access (e.g., 4/5G vs. Wi-Fi 6/7) , and end-to-end Track Protection in a Wireless Mesh Network.
- Due to uncontrolled interferences, including the self-induced multipath fading, objects in the Fresnel zone, etc… Deterministic Networking can only be approached on a wireless link.
- It takes diverse radio links and radio technologies to provide RAW properties. From above, Layer-3 can decide how and when to use those diverse radio links based on cost and current PDR.
- The radio conditions may change -way- faster than a centralized routing can adapt and reprogram, in particular when the controller is distant, and connectivity is slow and limited.

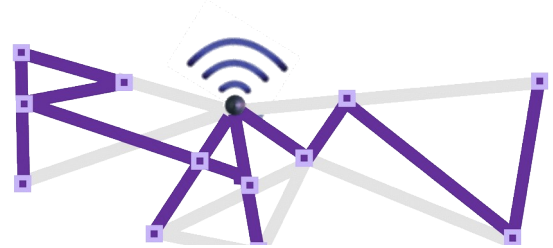


Redundant Radio Access

Wireless Mesh Network



RAW Architecture/Framework draft status



- Current version is 05
- Updated structure
  - Problem
  - Framework
  - Architecture
- What's missing:
  - Section ?
  - Co author?

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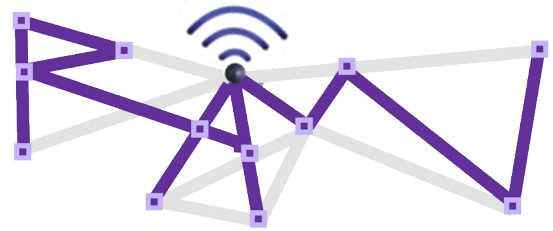
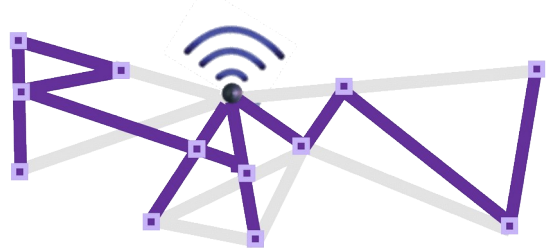
RAW interactions with other IETF WGs



- 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

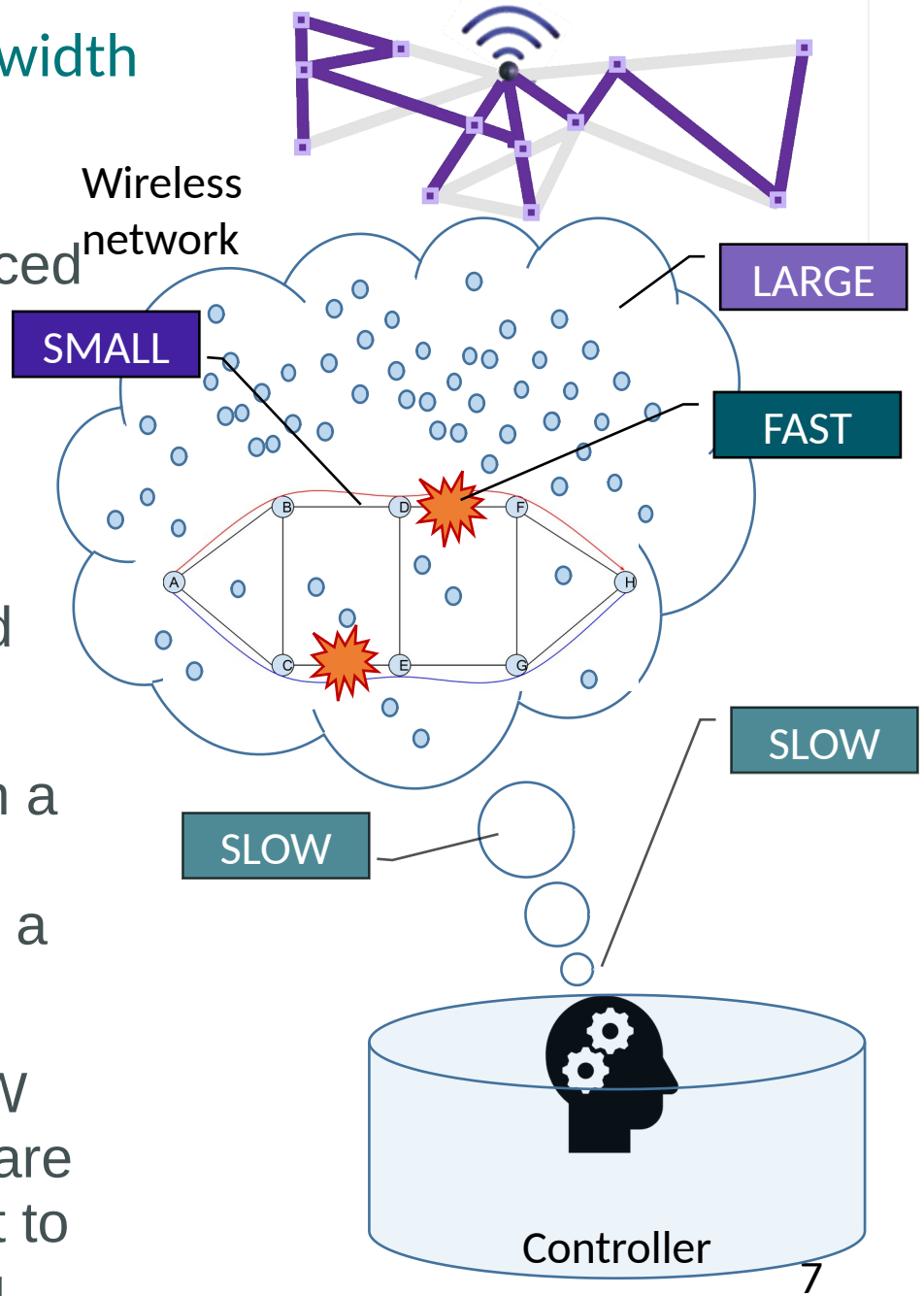


- **Reliability**: Reliability is a measure of the probability that an item will perform its intended function for a specified interval under stated conditions. For RAW, the service that is expected is delivery within a bounded latency and a failure is when the packet is either lost or delivered too 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

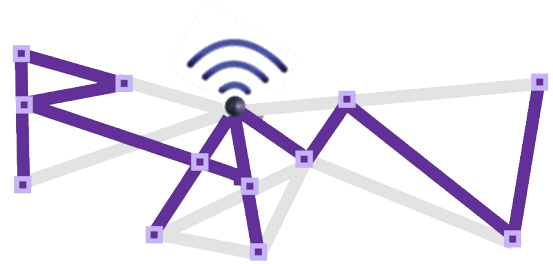
The Gap

Reliability & Availability vs. Energy & Bandwidth

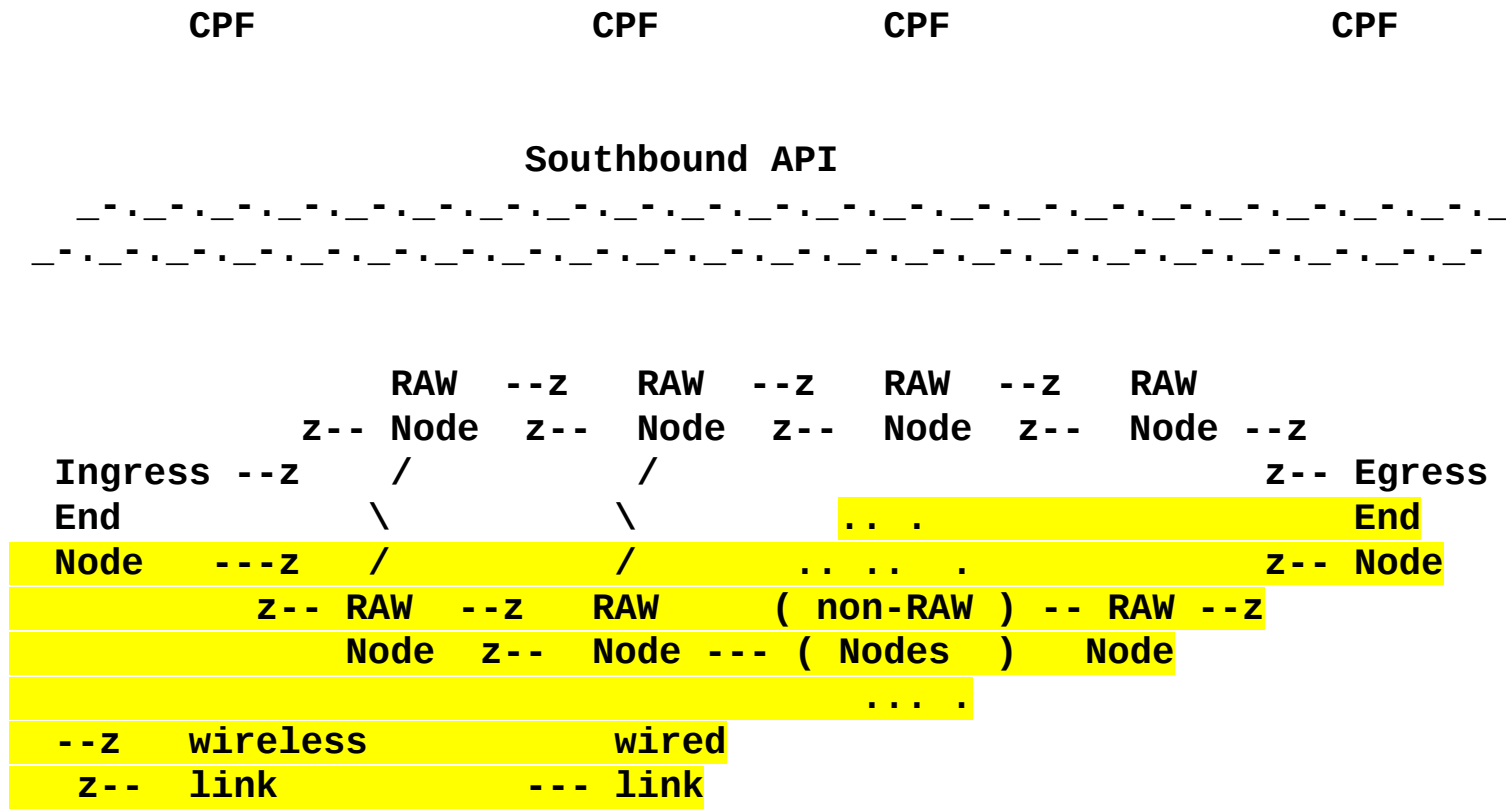
- Due to uncontrolled interferences, including the self-induced multipath fading, deterministic networking can only be approached on wireless links.
- The radio conditions may change -way- faster than a centralized PCE can adapt and reprogram, in particular when the controller is distant and connectivity 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.



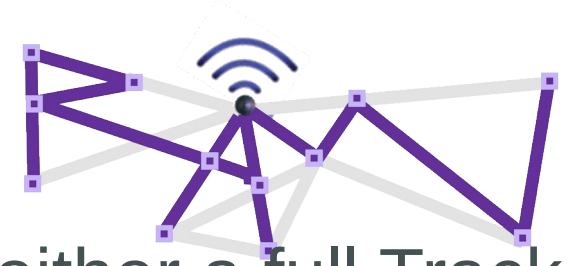
RAW within (and vs.) DetNet



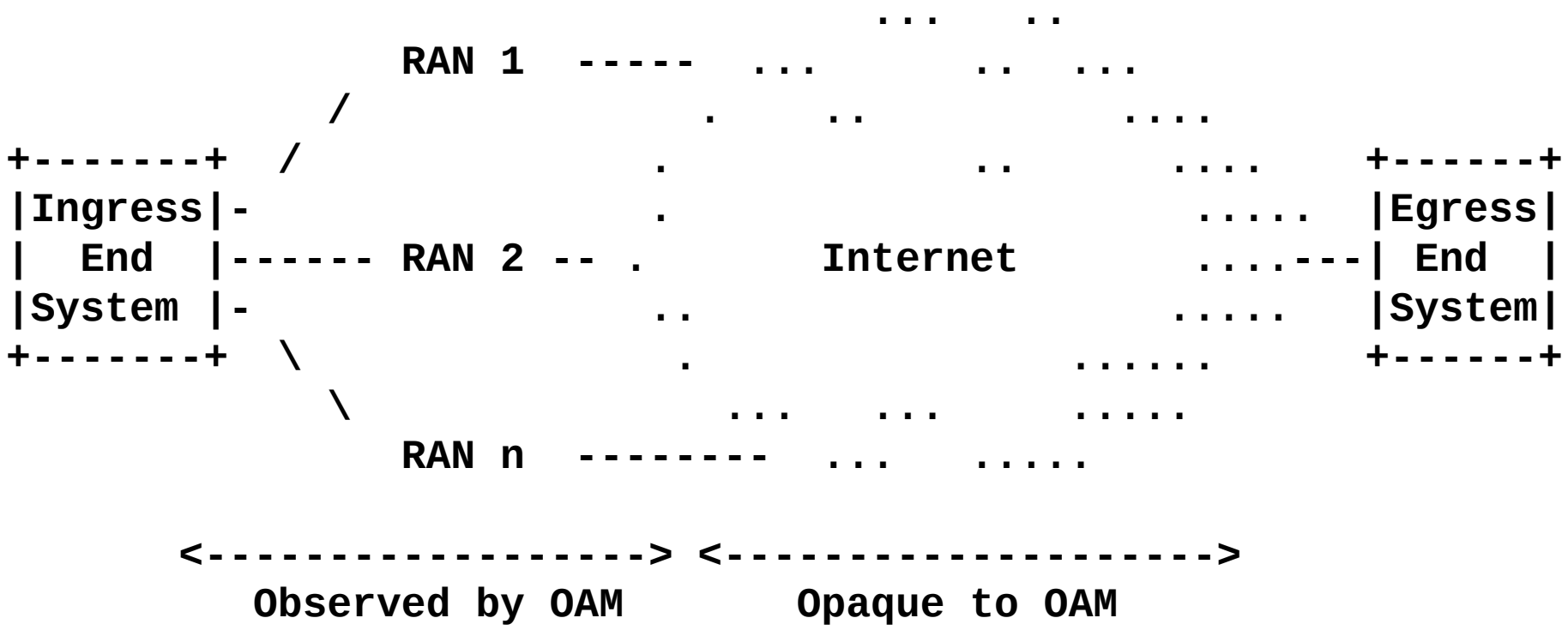
- RAW operates at the DetNet Service Layer in the Network Plane
- Controller Plane Functions compute complex Tracks
- RAW Nodes provide a PSE function
- RAW observes a selection of L2 Links (the others are “infinite”)
- RAW observes the L3 end-to-end operation



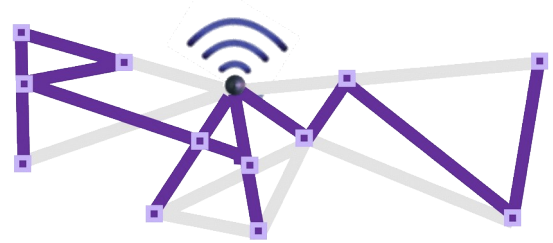
RAW Architecture: RAW i/oOAM



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:



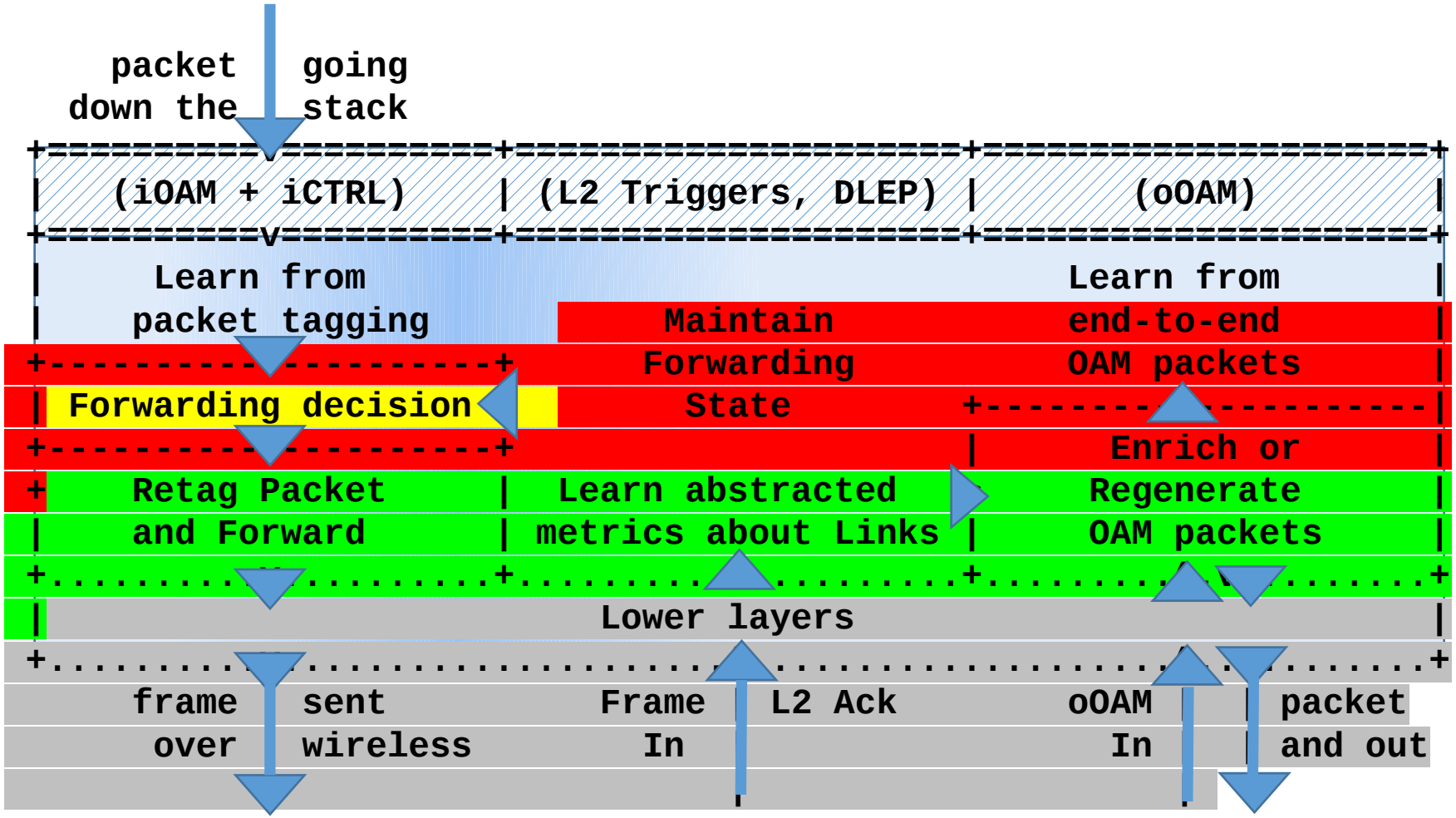
RAW Architecture: the PSE



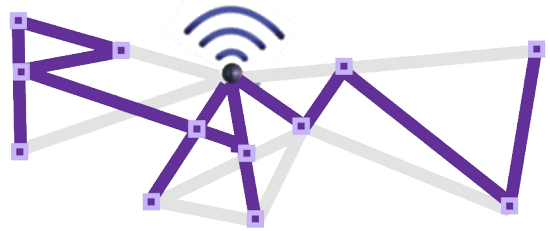
- **RAW** defines path selection engine (PSE) that performs rapid local adjustments of the forwarding tables to avoid excessive use of the resource diversity that the PCE proposes
- Exploiting richer forwarding capabilities with PAREO and scheduled transmissions

	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