



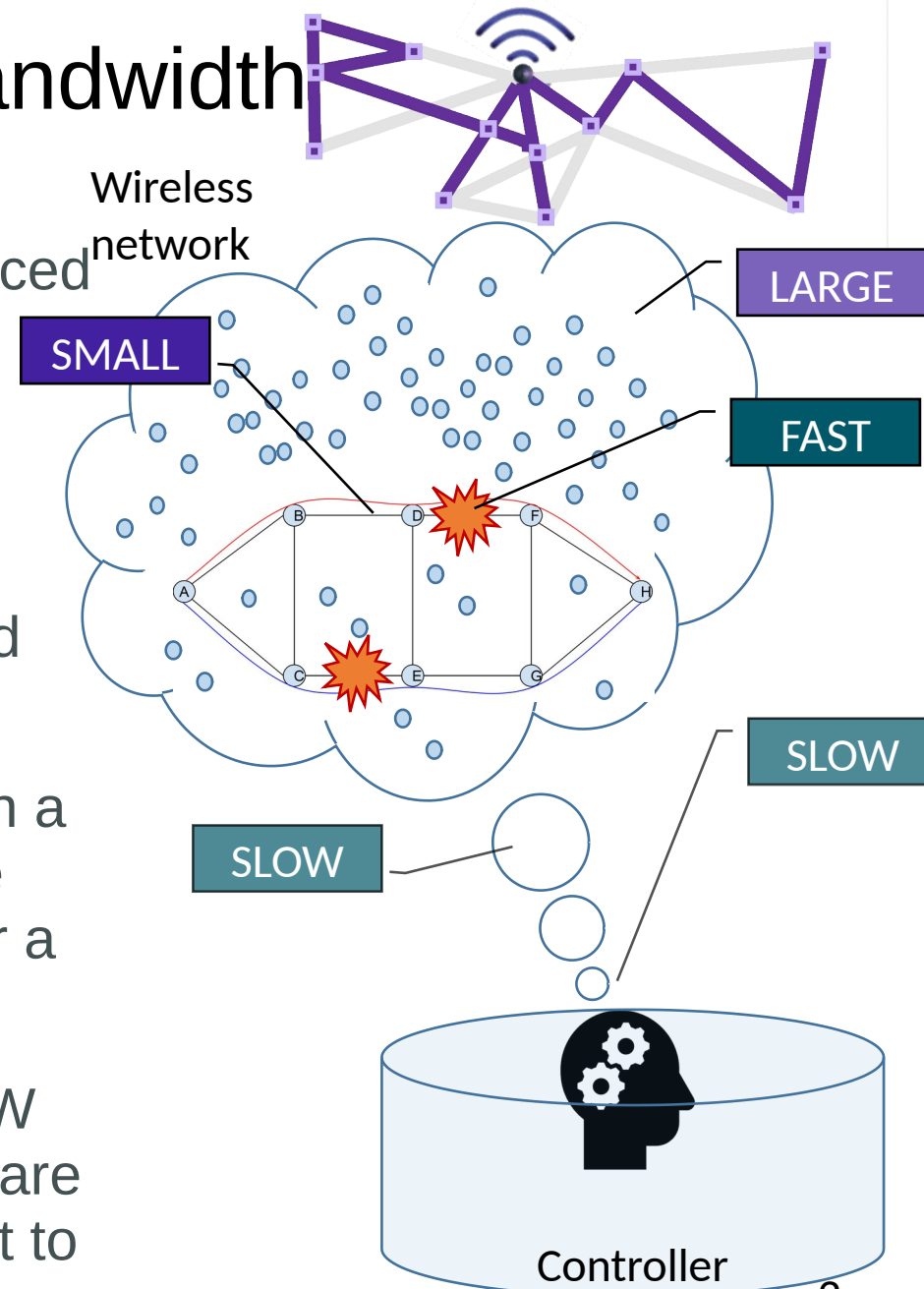
Reliable and Available Wireless Architecture

Presenter: Pascal Thubert

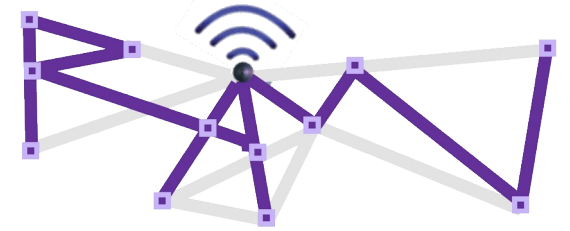
Authors: P. Thubert, G.Z. Papadopoulos, (+ contributors)

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.

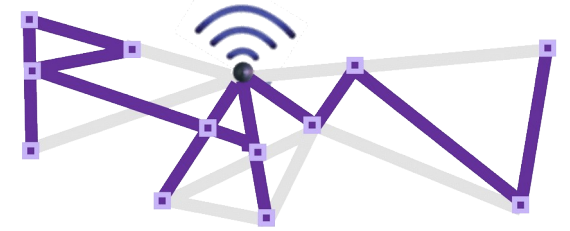


RAW Architecture / Framework Split



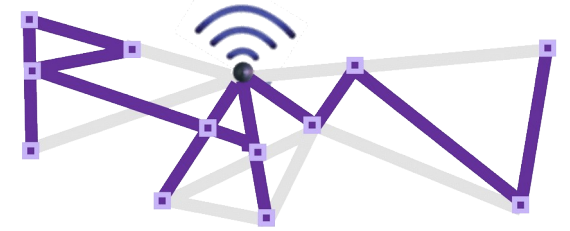
- **Architecture:** what we will do, the broad picture before the work
 - Terminology
 - Reliability and availability in the context of the IETF
 - Conceptual Model with OODA Loop,
 - Introducing the Path Selection Engine (PSE)
- **Framework:** How we did it, selected building blocks and their interaction
 - Use cases and requirements served
 - Scope of the work / applicability
 - Identifying Tracks, Paths, and Flows
 - Source Routing vs distributed PSE
 - OAM and metrics

Path and Complex Path (the experience)



- The general acceptance of a path is a linear sequence of nodes, as opposed to a multi-dimensional graph, defined by the experience of the packet that went from a node A to a node B (see the definition of "path" in section 1.1 of [RFC9049]).
- With DetNet and RAW, a packet may be duplicated, fragmented and network-coded, and the various byproducts may travel different paths that are not necessarily end-to-end between A and B; we refer to that experience as a complex path.
- The complex path does not fit the traditional description of a path; it is subject to change from a packet to the next.
- This is why we introduce below the term of a Track as the overall topology where the possible complex paths are all contained.

Track (the piping)

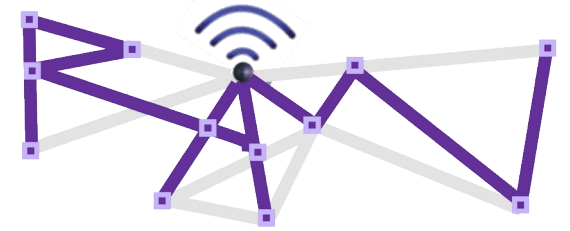


A networking graph that can be followed to transport packets with equivalent treatment; as opposed to the definition of a path above, a Track represents not an experience but a potential, is not necessarily a linear sequence, and is not necessarily fully traversed (flooded) by all packets of a flow. It may contain multiple paths that may overlap, fork and rejoin, for instance to enable the RAW PAREO operations

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

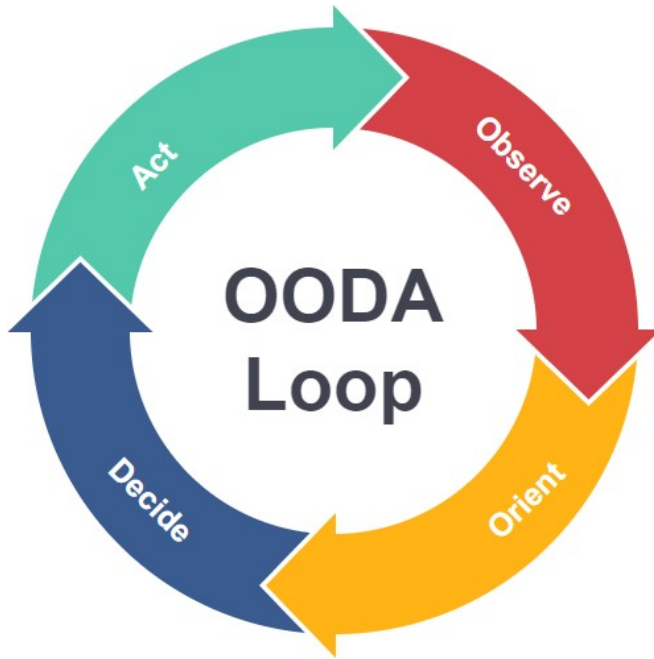
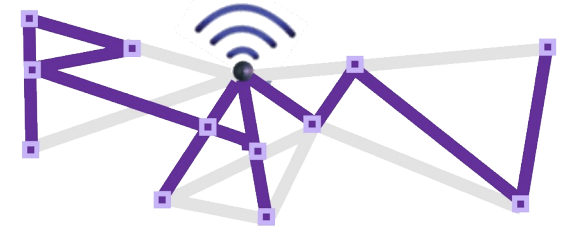
- A Track is a layer-3 abstraction built upon P2P IP links between routers. A router may form multiple P2P IP links over a single radio interface.
- A Track has one Ingress and one Egress nodes, which operate as DetNet Edge nodes.
- A Track is reversible, meaning that packets can be routed against the 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.

Flow (the water)



- A collection of consecutive IP packets defined by the upper layers and signaled by the same 5 or 6-tuple.
- Packets of the same flow must be placed on the same Track to receive an equivalent treatment 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.

OODA Loop



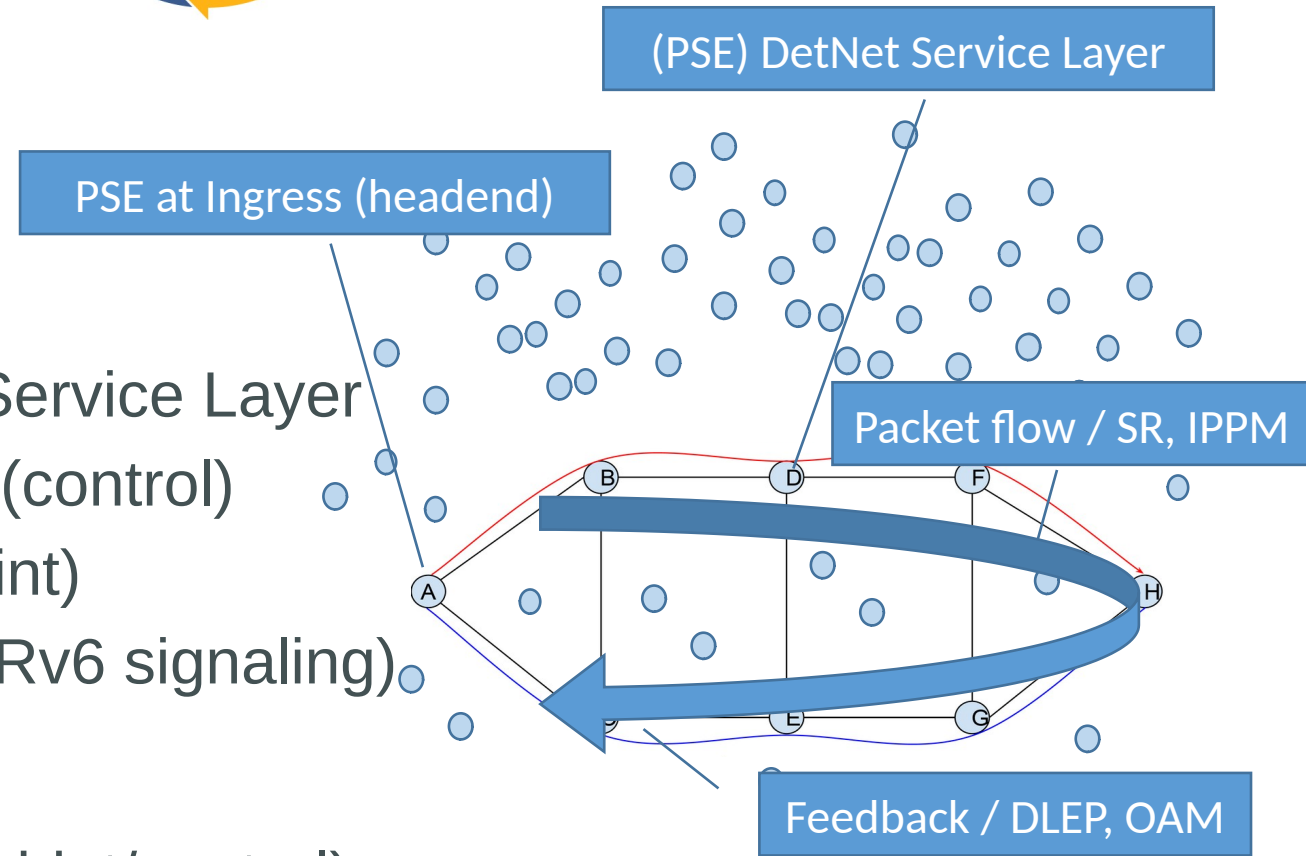
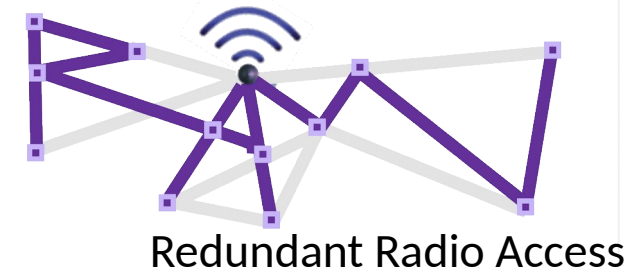
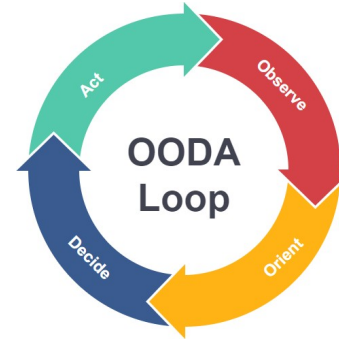
The OODA Loop Enables Continuous Adaptation to Continuously Changing Situations:

- **Observation:** the collection of data by means of the senses
- **Orientation** the analysis and synthesis of data to form one's current mental perspective
- **Decision** the determination of a course of action based on one's current mental perspective
- **Action** the physical playing-out of decisions

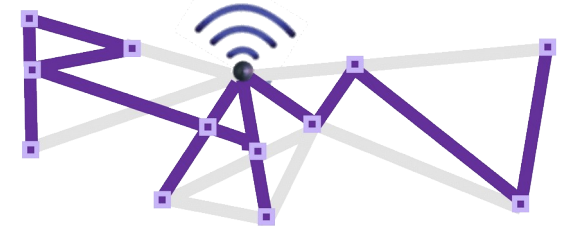
Source: <https://imarcai.com/ooda-loop-new>

The Conceptual Model

- 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 within (and vs.) DetNet

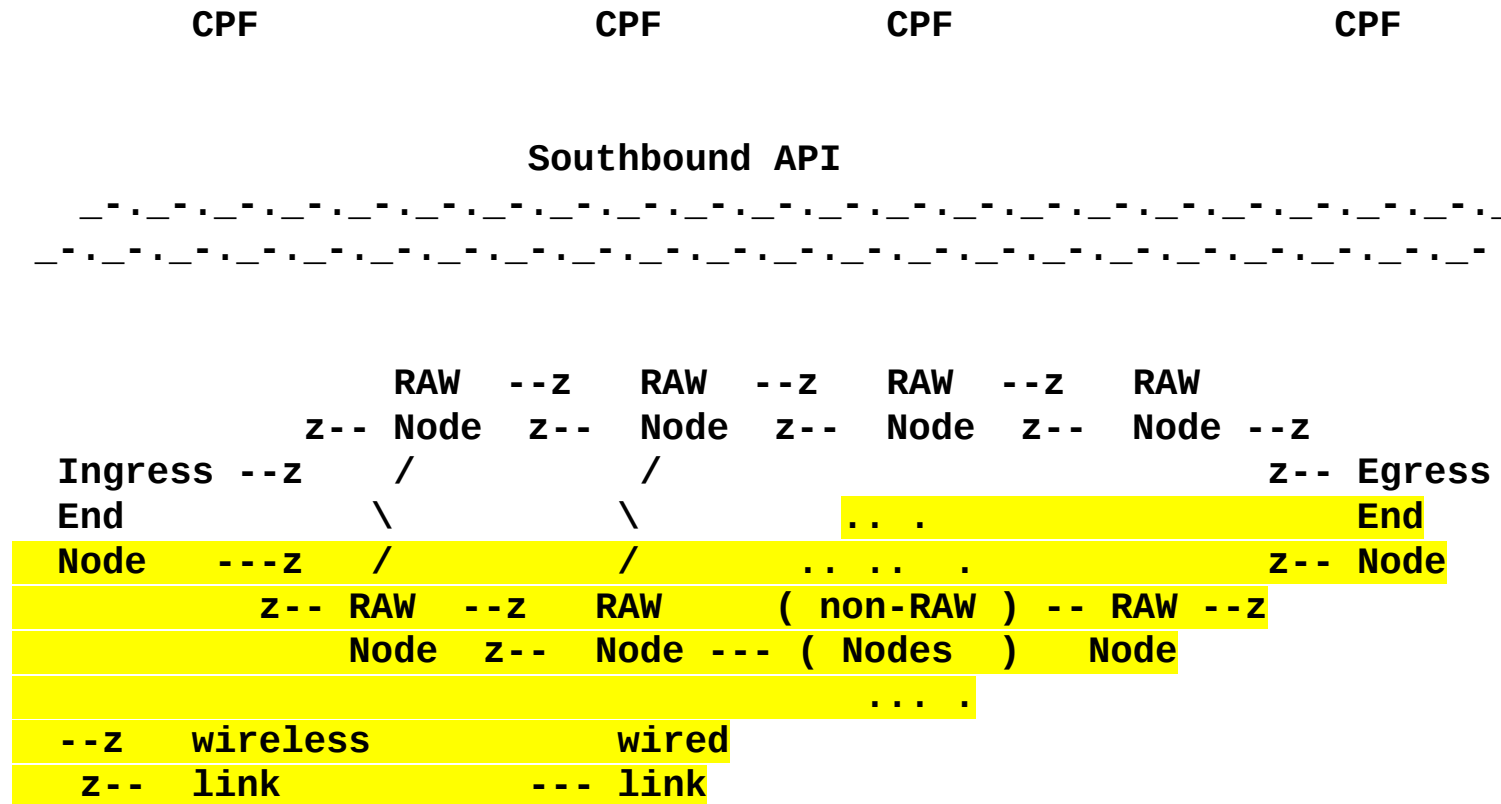


RAW operates at the DetNet Service Layer in the Network Plane

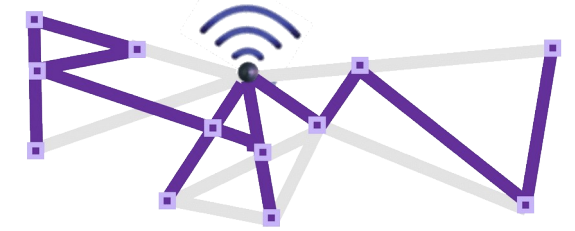
Controller Plane Functions compute complex Tracks

RAW observes a selection of L2 Links (the others are “infinite”)

RAW observes the L3 end-to-end operation



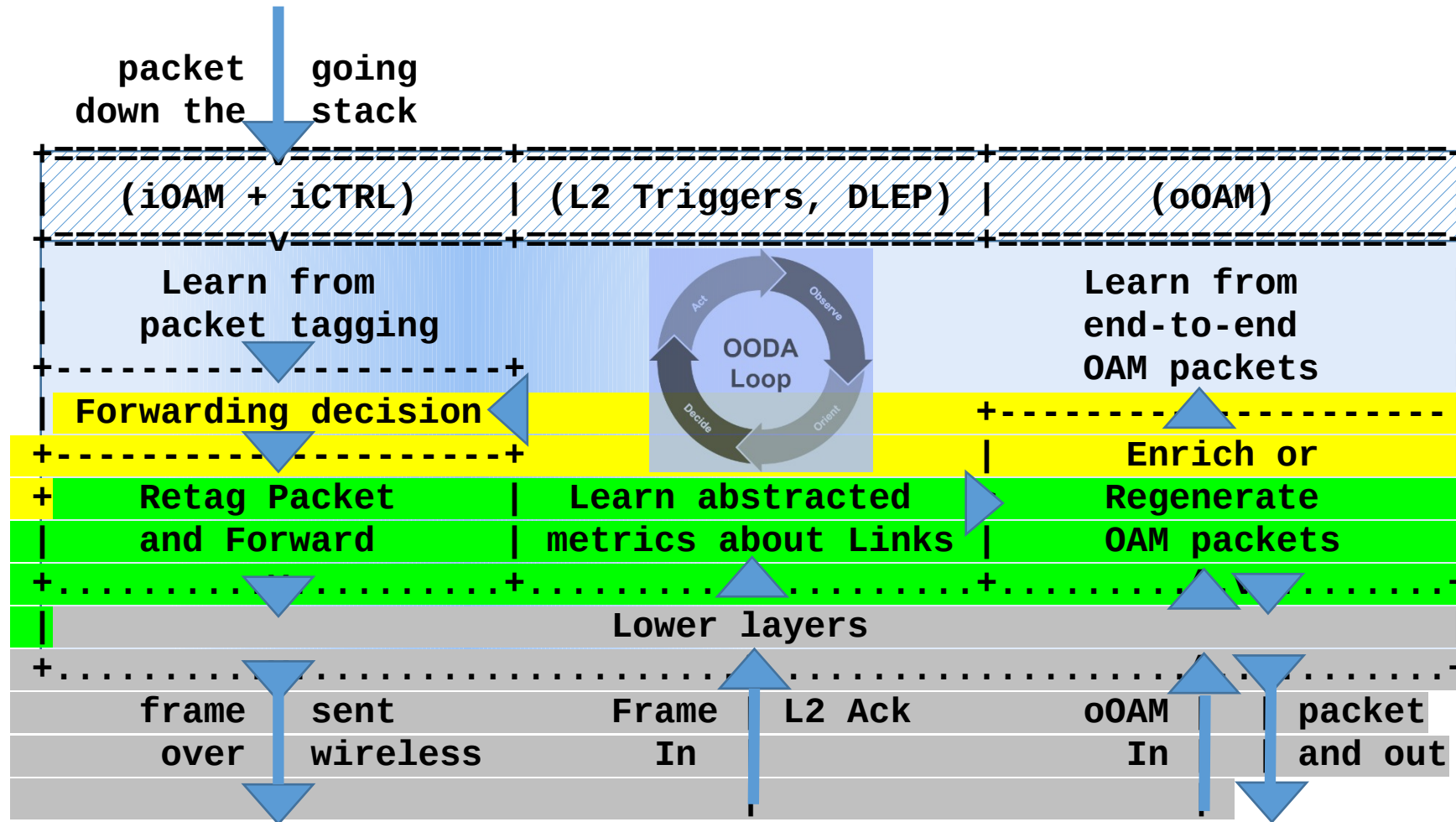
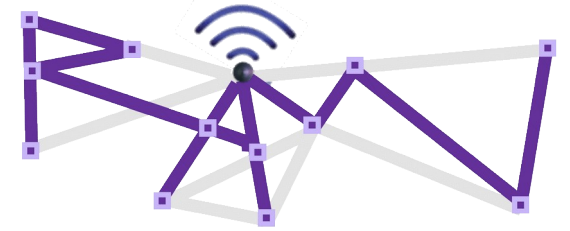
RAW Architecture: the PSE



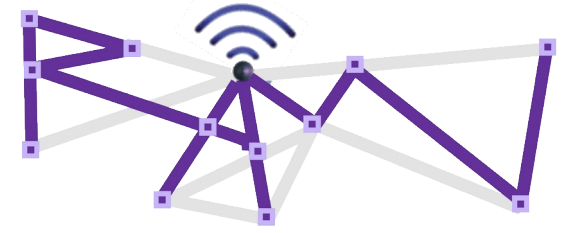
- **RAW** defines the path selection engine (PSE) that performs rapid local adjustments of the forwarding tables to avoid excessive use of the resource diversity that the PCE proposes
- Exploiting richer forwarding capabilities with PARFO and scheduled transmissions

	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

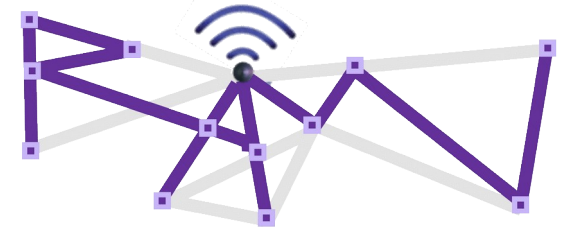
The PSE "Stack"



Status



- 02: split architecture / framework after IETF 112
- 03: Fabrice's review
 - Clarification and reformulations (e.g., short range radios)
 - Forward references between sections 1 and 4
 - Promiscuous vs. multicast
- 04: Dave's pre-WGLC review
 - Why @ L3 ? (technology diversity, increased spatial and spectrum diversity)
 - Positioning vs. DetNet (add DetNet Service Sublayer services)
 - Scope, clarify that multiple wireless access(es) is in scope
- **Editor's view: Ready for WGLC**



Questions ?