Reliable and Available Wireless Architecture

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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.
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.
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](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.

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

<table>
<thead>
<tr>
<th>Packet</th>
<th>Going Down The Stack</th>
</tr>
</thead>
<tbody>
<tr>
<td>(iOAM + iCTRL)</td>
<td>(L2 Triggers, DLEP)</td>
</tr>
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</table>

- Learn from packet tagging
- Forwarding decision
- Retag Packet and Forward
- Learn abstracted metrics about Links
- Enrich or Regenerate OAM packets
- Lower layers
- Frame sent over wireless
- Frame L2 Ack
- oOAM packet In
- In and out
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 ?