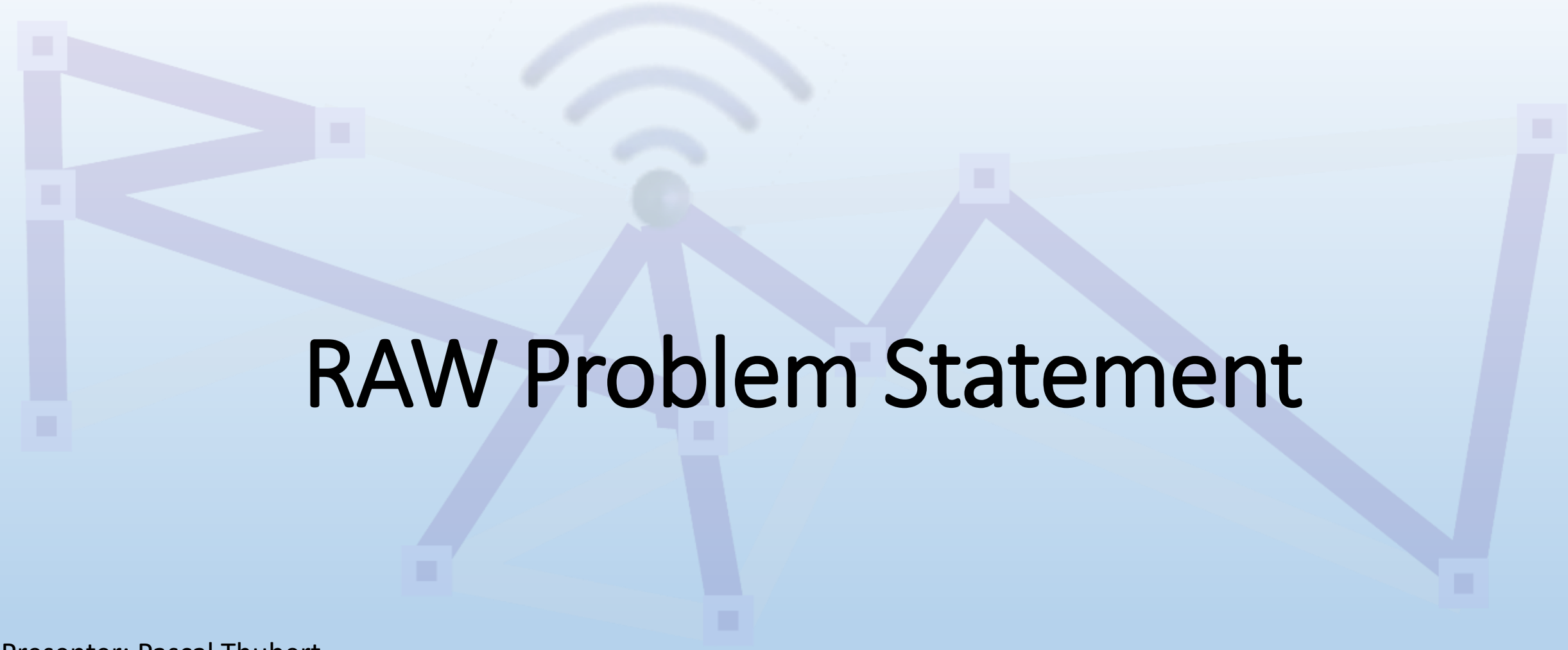

RAW Problem Statement

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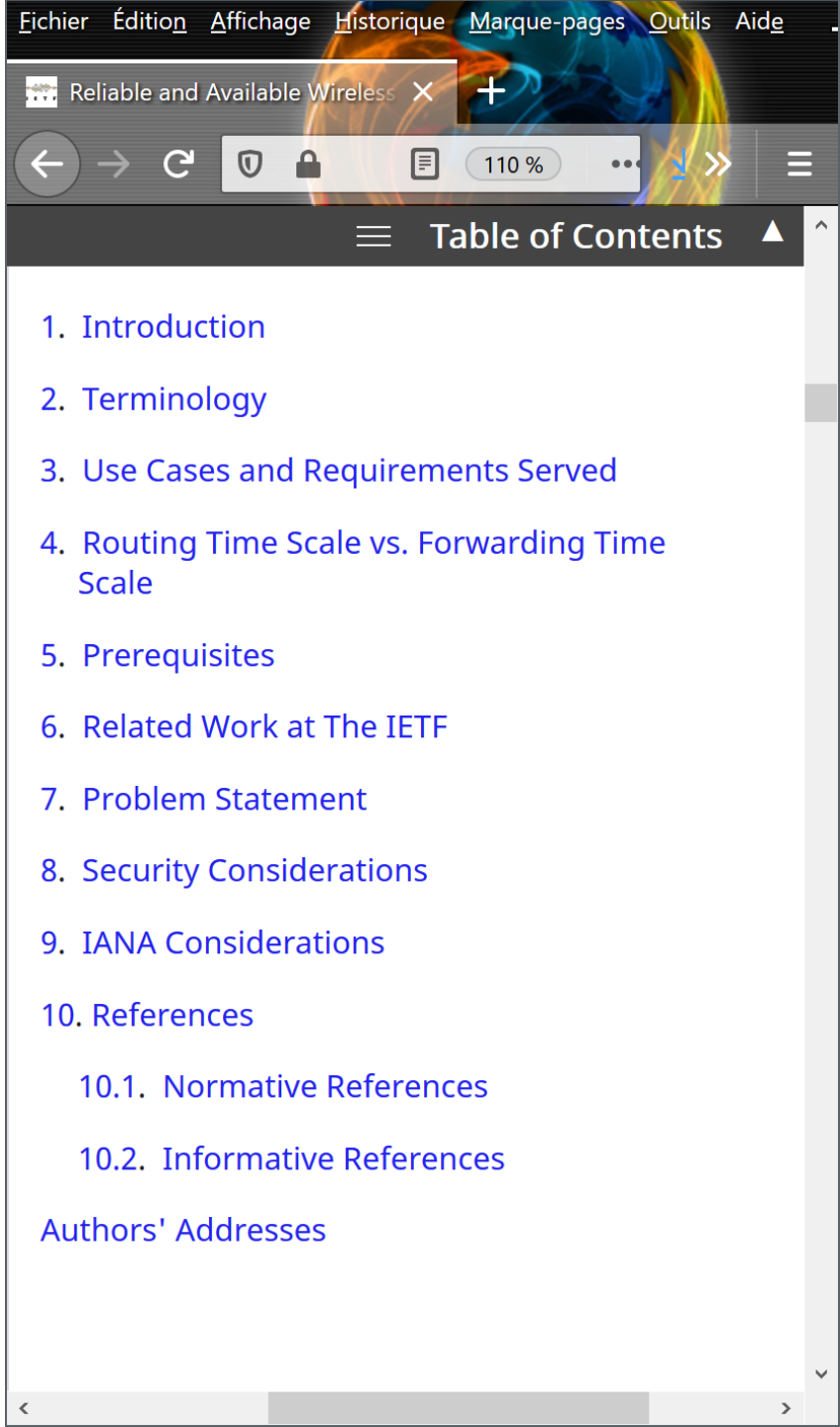
Authors: P. Thubert & G.Z. Papadopoulos

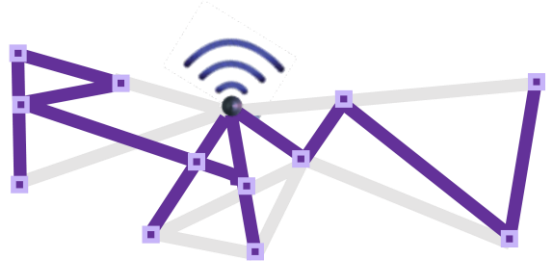
RAW - IETF 106 - Singapore

RAW Problem Statement draft status

- Current version is 04
- Added terminology
  - PAREO, Reliable, Available,
  - refs to DetNet and 6TiSCH archi.
- Renamed the gaps section to pb statement
  - Need expanding
- Added text
  - multihop homogeneous and non-homogeneous



Terms

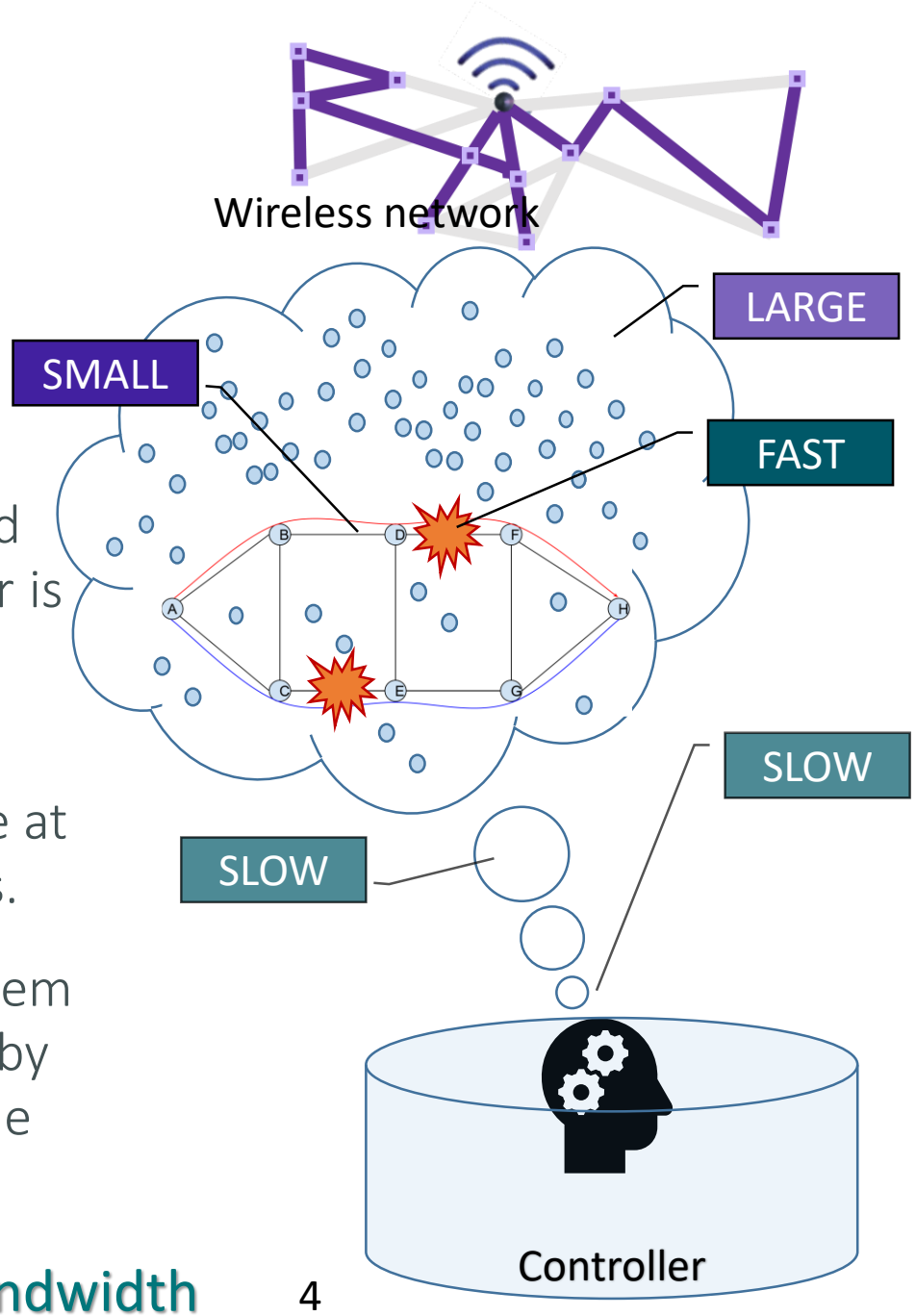


- **Reliability**: Reliability is a measure of the probability that an item will perform its intended function for a specified interval under stated conditions. For RAW, the service that is expected is delivery within a bounded latency and a failure is when the packet is either lost or delivered too late. RAW expresses reliability in terms of Mean Time Between Failure (MTBF) and Maximum Consecutive Failures (MCF).
- **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 (H)ARQ, Replication, Elimination, and Ordering

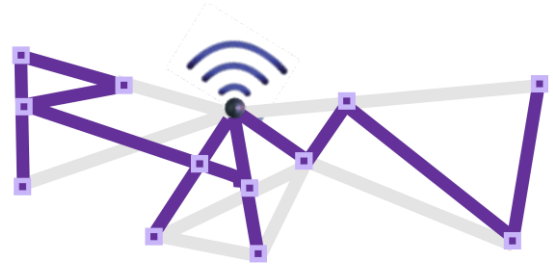
=> Includes wireless specific techniques such as Overhearing and Constructive Interference

The RAW Problem

- 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.



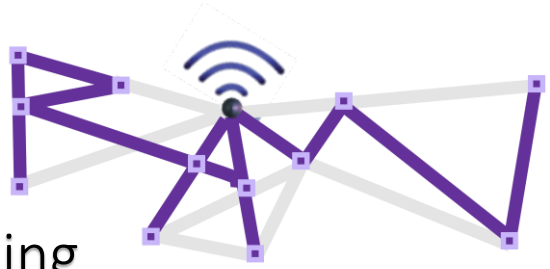
Routing vs. Forwarding



- **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

Achieving RAW



Wireless can be made Reliable and Available through TDM and Scheduling

Scheduling provides similar benefits as wired

⇒ High delivery ratio through path redundancy and collision elimination

⇒ High ratio of critical flows

⇒ Bounded maximum latency (and jitter)

Centrally scheduled operations bring additional benefits in wireless

⇒ Medium usage optimization (no IFS, backoff, etc… + multichannel operation)

⇒ Energy savings (wake up on scheduled transmission)

Diversity,
Diversity,
Diversity!

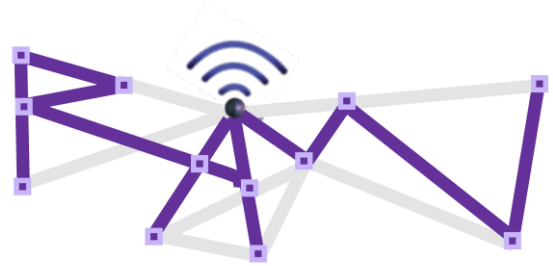
But **how that is effectively achieved is different** in wireless

⇒ All transmissions on shared media are scheduled for collision exclusion with RAW traffic

⇒ Maximal use of all forms of diversity to combat all sources of packet loss

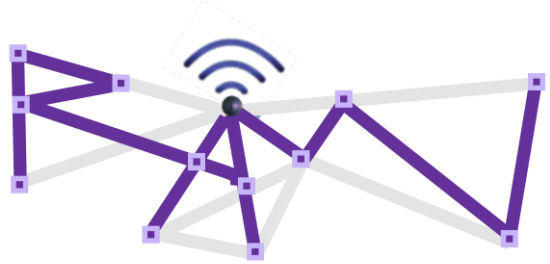
⇒ More than PREOF: PAREO functions include HARQ, overhearing and constructive interference

Differentiators between RAW and other WGs



- DetNet: Mostly a focused Subset though
  - Radio specialists, different interests
  - Unstable links (bandwidth, flapping), not ‘deterministic’
  - Focus on forwarding optimizations over multipath NECM
- 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

What do we need to do?



Select Appropriate Radios and Effective Use Cases

- ⇒ Req: Capability to schedule resources
- ⇒ Opt: Diversity capabilities (frequency, beam, …)

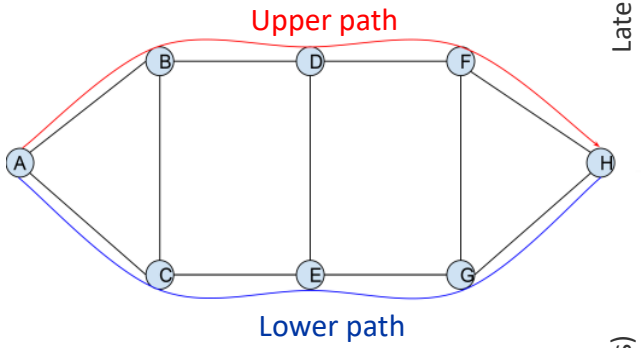
Adapt per-packet activity of a RAW flow along a diverse path

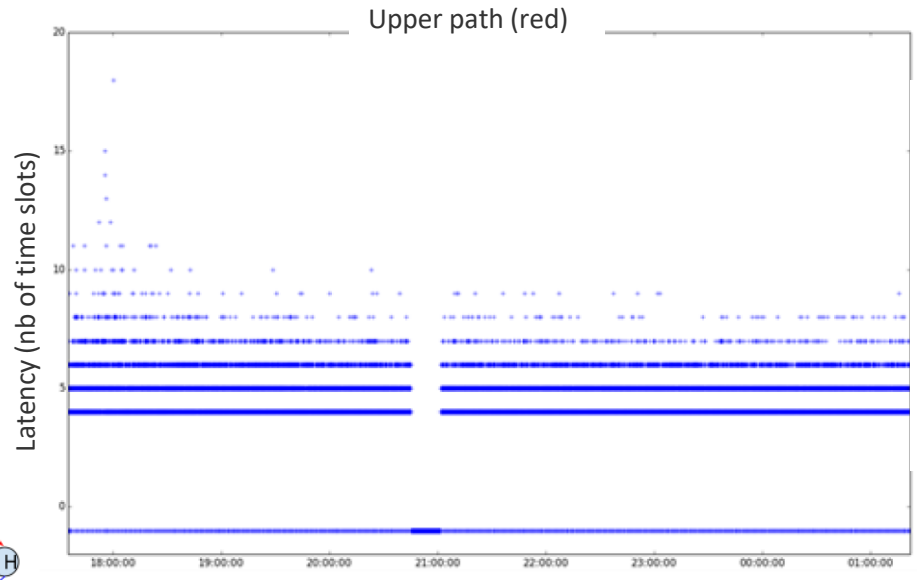
- ⇒ Determine Specific Data Models to match radio properties (for CCAMP and IPPM?)
- ⇒ Signal forwarding properties in packets (e.g., BIER-TE)
- ⇒ Source routed and Distributed forwarding decision (use of PAREO functions)
- ⇒ In-band control of resource Usage to optimize energy and bandwidth

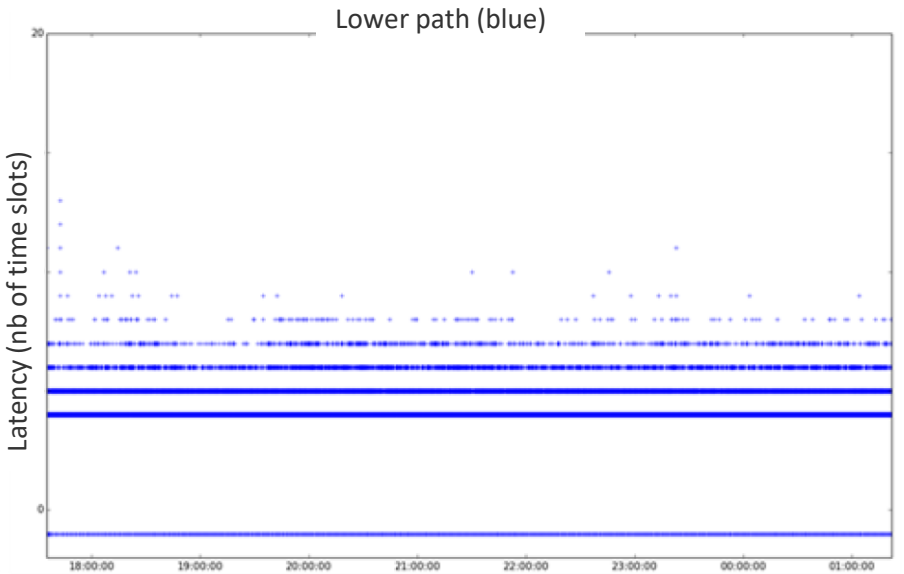
Enable OAM (in and out-of-band)

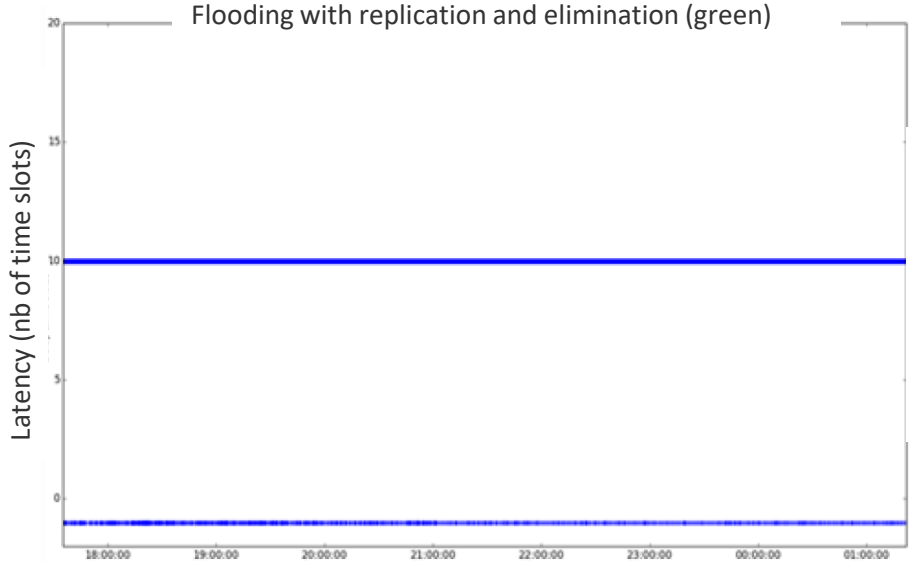
- ⇒ Forward packets or generated placebo packets to measure LQI
- ⇒ In-band forward and out-of-band backward gathering of metrics across NECM

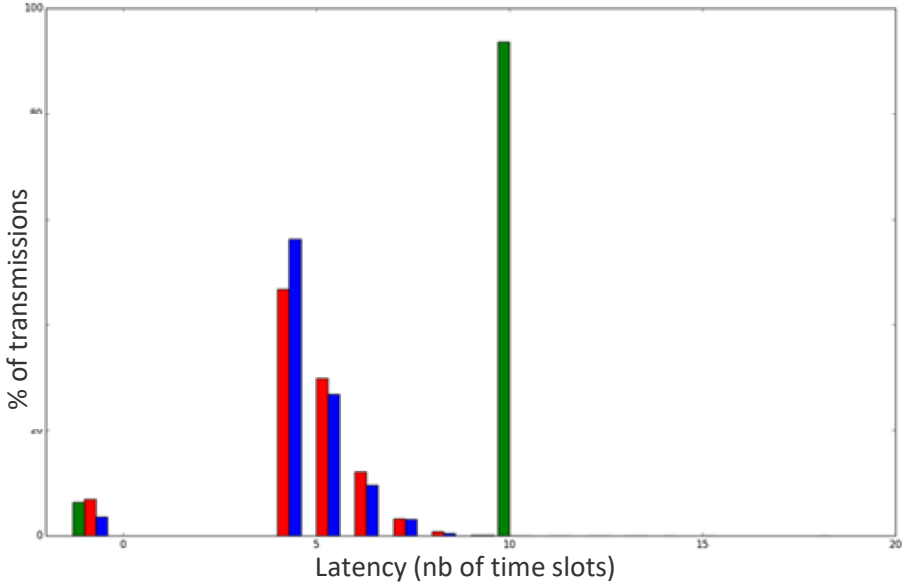
Replication and Elimination vs. Serial Path



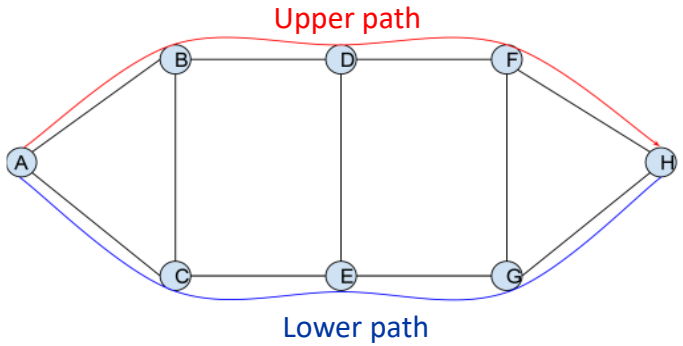


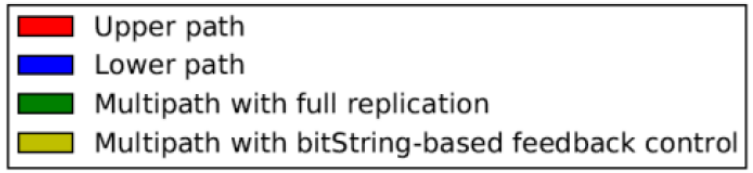


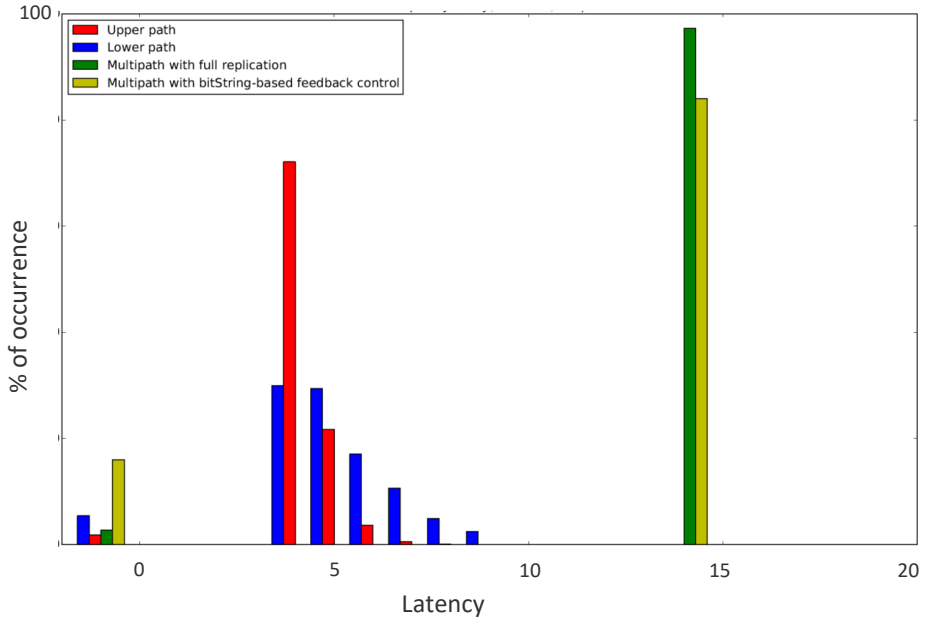


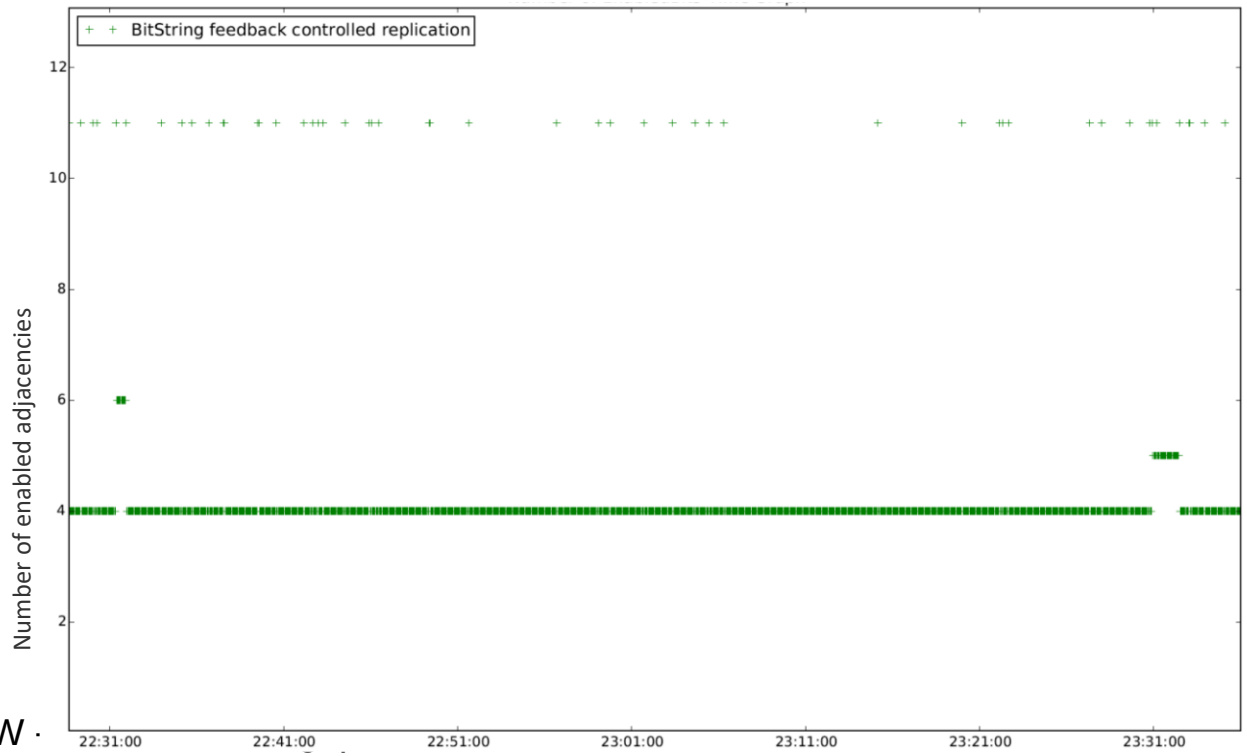


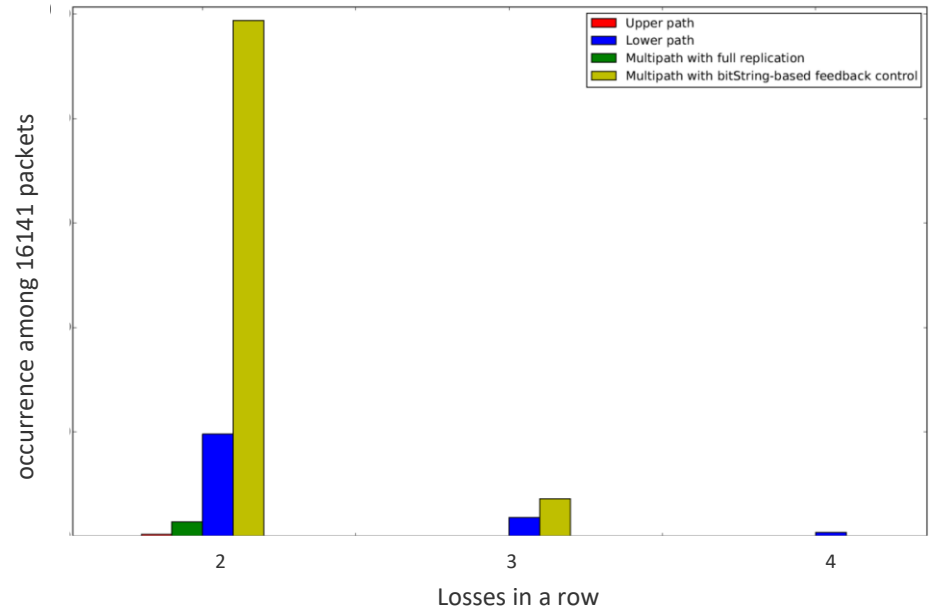
Energy Saving





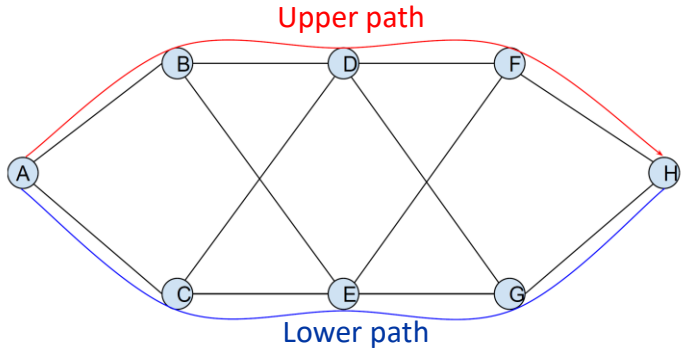


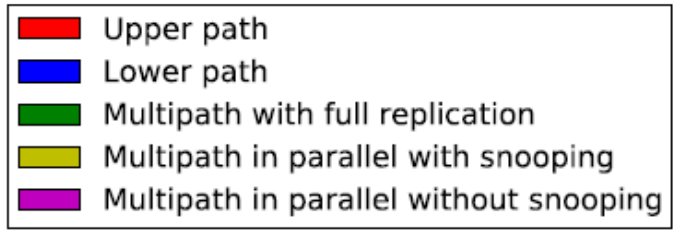




RAW ·

Optimizing use of Track





Multipath with full replication:

0	1	2	3	4	5	6	7	8	9	10	11
A --> B	A --> C	B --> E	B --> D	C --> E	C --> D	D --> G	D --> F	E --> G	E --> F	F --> H	G --> H

Multipath in parallel with snooping:

0	1	2	3	4	5	6	7	8	9	10	11
A --> B,C	A --> C,B	B --> E,D	C --> E,D	D --> G,F	E --> G,F	F --> H	G --> H				

Multipath in parallel without snooping:

0	1	2	3	4	5	6	7	8	9	10	11
A --> B	A --> C	B --> D	C --> E	D --> F	E --> G	F --> H	G --> H