(L4S XOR RFC3168) ECN Marking
for improved detection of Classic ECN AQMs?

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Exclusive ECN Marking – the Base Proposal

- **An L4S AQM node that marks ECT1 packets MUST NOT also mark ECT0 packets**

- Rationale: Would make the presence of an RFC3168 AQM more clear-cut

- Recap of Problem

  - L4S would outcompete Classic in an RFC3168 AQM

  - L4S sources are meant to detect an RFC3168 AQM

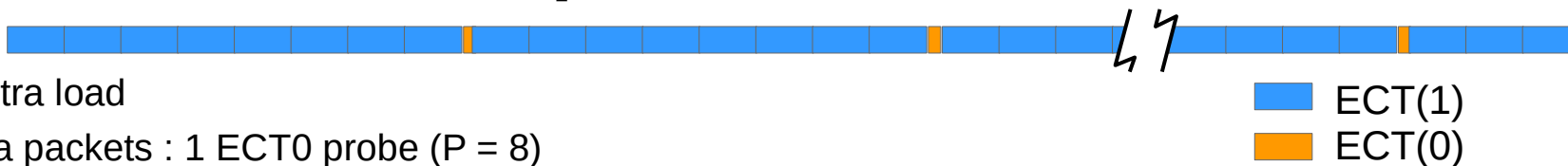 - Certainty that it's not L4S has proved challenging
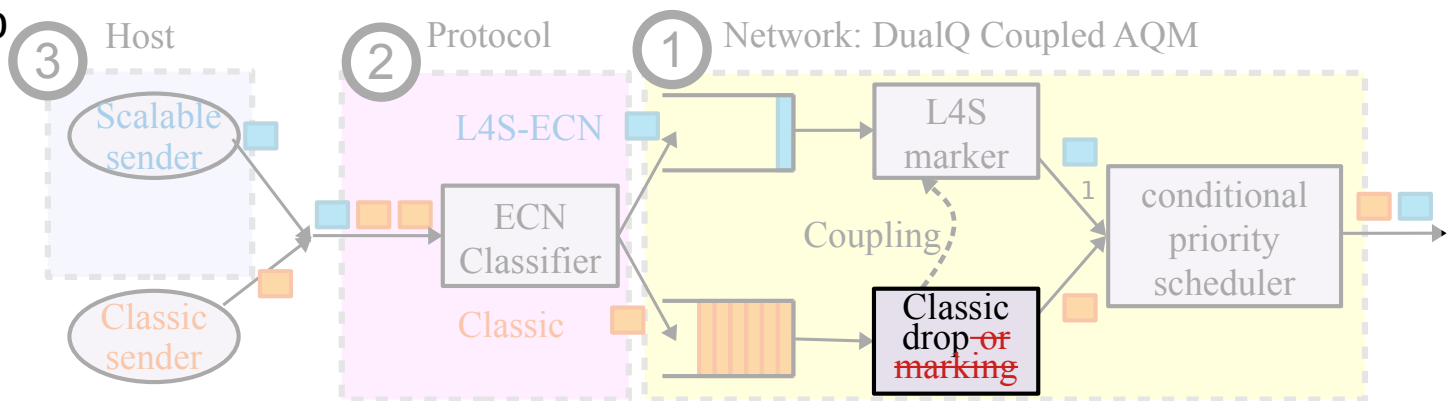
In-Band Active Detection Ex.#1 ECT0 probes

- L4S source

  ECT(1) / ECT(0) packet sequence diagram

  | ECT(1) |
  | ECT(0) |

  - minimise extra load
  - 8 ECT1 data packets : 1 ECT0 probe (P = 8)
  - data 1500B, probes 75B (r = 1500/75 = 20)

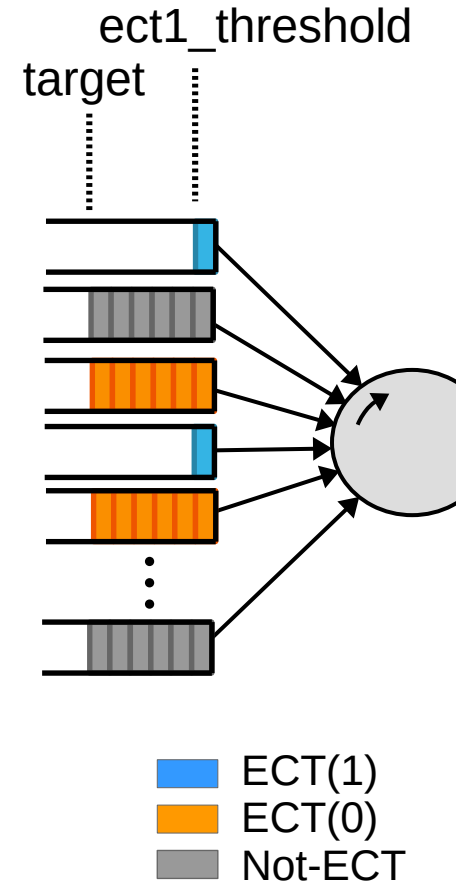| ECT0		ECT1		
drop	**mark**	**drop**	**mark**	**Inferred bottleneck type**
>0	0	>0	0	Tail drop or non-ECN AQM
	>0		>0	Classic ECN AQM (FQ or FIFO)
>0	0		>0	L4S AQM

- How long to decide no ECT0 have been marked?
  - after N ECT1 packets marked, where N = r * P * 5 (say)
  - and at least one ECT0 drop

FQ-Exclusive ECN Marking

per-flow-queue

ect1_threshold

target

- An L4S AQM ~~node~~ that marks ECT1 packets MUST NOT also mark ECT0 packets

- if ECT1 seen 'recently', disable marking ECT0
  - just in that flow-queue
  - 'recently' either requires a timer, or for the life of the queue

- Not essential to disable ECT0 marking
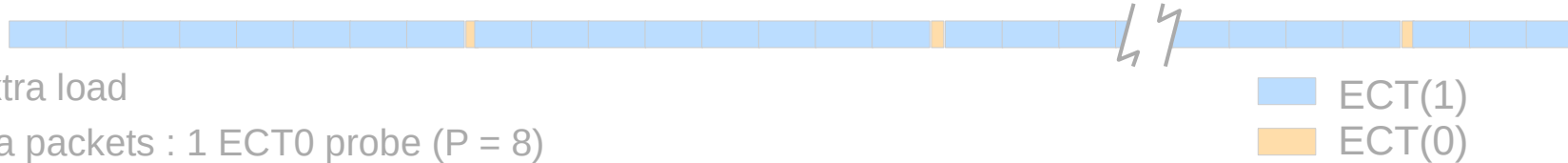 - An L4S source ought to keep queue below ECT0 target anyway

ECT(1)
ECT(0)
Not-ECT

In-Band Active Detection Ex.#1
ECT0 probes – problems

- L4S source

  - minimise extra load

  - 8 ECT1 data packets : 1 ECT0 probe (P = 8)

  - data 1500B, probes 75B (r = 1500/75 = 20)

ECT0		ECT1		
drop	mark	drop	mark	Inferred bottleneck type
>0	0	>0	0	Tail drop or non-ECN AQM
	>0		>0	Classic ECN AQM (FQ or FIFO)
>0	0		>0	L4S AQM

- How long to decide no ECT0 have been marked?

  - after N ECT1 packets marked, where N = r * P * 5 (say)

  - and at least one ECT0 drop

<div>

	ECT(1)
	ECT(0)

</div>

- If ECT0 marked, proves RFC3168

  - but no ECT0 marked, doesn't disprove

- Other reasons for no ECT0 markings

  - variable congestion didn't coincide with probes

  - size-based marking, e.g. DOCSIS PIE

  - didn't test for long enough

- Challenges

  - delayed ACKs – which packet was marked?

    - if TCP, seqno = snd_next – 1

 - 800 marks is too long for in-band detection

Exclusive ECN marking
What does it give us?

- Ideal would be an in-band passive test
    - But exclusive ECN marking is inherently for active testing

- In-band active test (ECT0 probes) have to minimize extra load
    - Then, too slow to catch unfairness in time

- Can use exclusive ECN marking for a fast out-of-band test ($\rightarrow$ spare slide)
    - but once we've resorted to out-of-band, no longer constrained to minimize extra load
    - then, we already have good tests **without** exclusive ECN marking...

<u>Out-of-Band test without exclusive marking</u>
parallel L4S (L) & Classic (C) test flows
can distinguish everything

Rate	RTT	Inferred AQM
L > C	L = C	Classic ECN AQM (FIFO)
L = C	L = C	Classic ECN AQM (FQ)
L = C	L < C	FQ Classic+L4S AQM
L ≈ C	L < C	DualQ Coupled AQM

Exclusive ECN marking
Summary
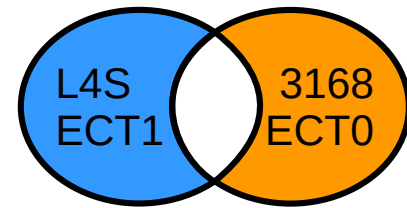
Cons

- Rapid in-band detection strategy not possible (yet?)

- Useful out-of-band, but we already have good out-of-band tests without it

- Only useful if near-universal compliance

Pros

- Seems promising, but not a silver bullet

- Can be withdrawn later (but can't be introduced later)

Tech report: https://arxiv.org/pdf/1911.00710.pdf#subsection.5.3

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Q&A

spare slides

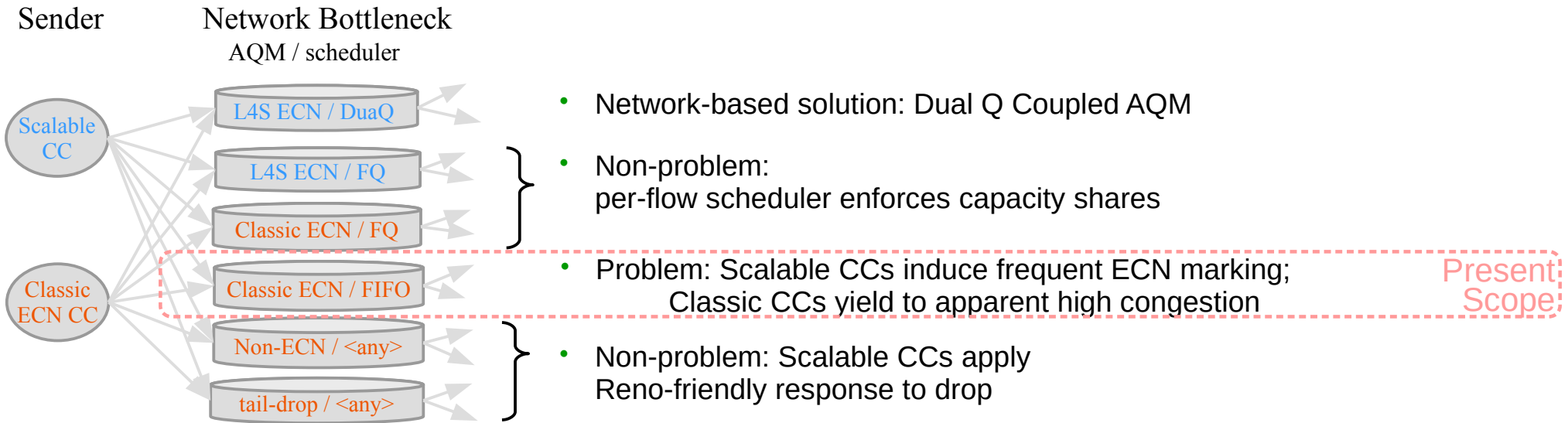# Problem: Coexistence between L4S and Classic flows in a FIFO RFC3168 ECN AQM
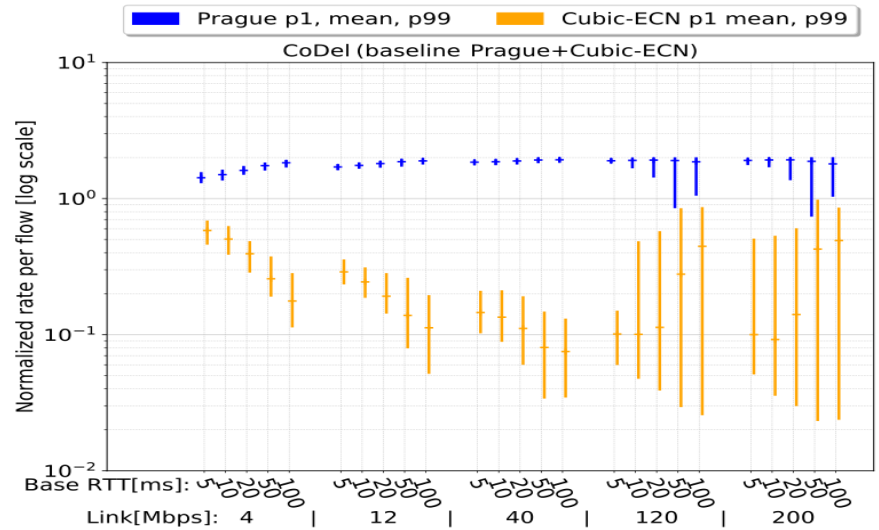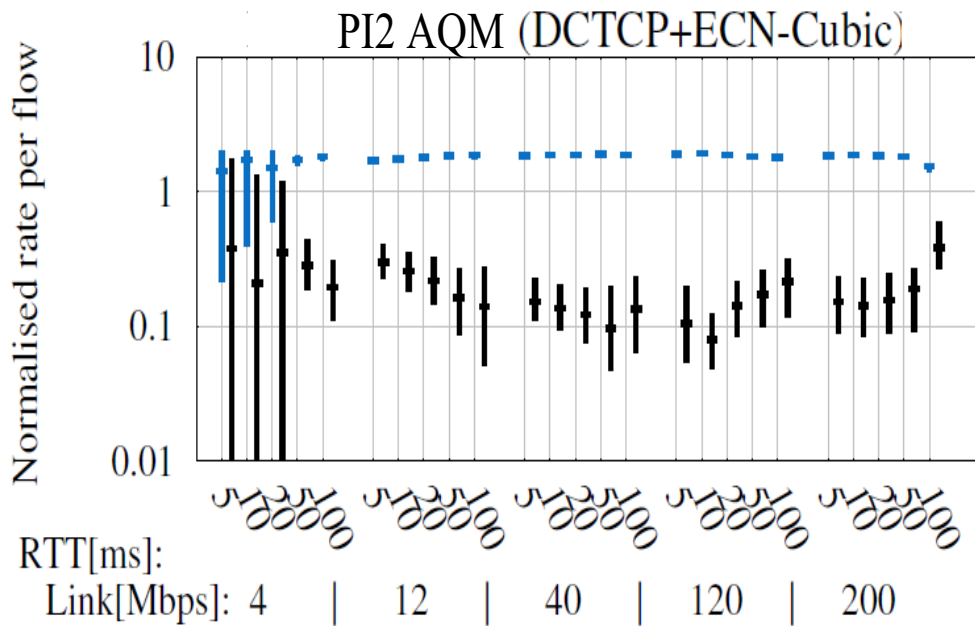
- Normalized rate per flow
  = flow rate after convergence / (capacity / no. of flows)
- 1 v 1 long-running flows
- Default config. for all CCs and AQMs

The Full Coexistence Scope

- Across all combinations of congestion control, AQM & scheduler

Sender   Network Bottleneck
AQM / scheduler

- L4S ECN / DuaQ
- L4S ECN / FQ
- Classic ECN / FQ
- Classic ECN / FIFO
- Non-ECN / <any>
- tail-drop / <any>

Scalable CC

Classic ECN CC

- Network-based solution: Dual Q Coupled AQM

- Non-problem:
  per-flow scheduler enforces capacity shares

- Problem: Scalable CCs induce frequent ECN marking;
  Classic CCs yield to apparent high congestion

Present Scope

- Non-problem: Scalable CCs apply
  Reno-friendly response to drop

- Classic ECN: RFC3168 Explicit Congestion Notification
- CC: Congestion Control
- Scalable CC: 1/p response to congestion (p)
- Classic CC: Reno-Friendly CC

- AQM: Active Queue Management
- FIFO: First-In First-Out
- FQ: Per-Flow Queuing
- L4S: Low Latency Low Loss Scalable throughput

Exclusive ECN marking
Implications if adopted by WG

- Would need to update:
  - 3 main L4S drafts
  - Linux DualPI2 code & other implementations
  - (Low Latency DOCSIS already doesn't support ECT0 marking, for hardware backward compatibility)

- Not onerous

Out-of-Band Active Detection Ex.#2
Late onset ECT1 samples

- L4S source

  ■ ECT(1)
  ■ ECT(0)

  - ECT0 until CE mark
  - then 1 ECT1 : 20 ECT0 (all full-sized data packets)

All ECT0 drop	mark	95% ECT0 drop	mark	5% ECT1 drop	mark	Implied bottleneck type
>0	0	>0	0	>0	0	Tail drop or non-ECN AQM
	>0		>0		>0	RFC3168 ECN AQM (FQ or FIFO)
	>0		>0		most	FQ Classic+L4S AQM (non-exclusive)
	>0	>0	0		>0	FQ Classic+L4S AQM (exclusive)
>0	0	>0	0		>0	DualQ L4S AQM (exclusive)