Towards Emergency Networks Security with Per-Flow Queue Rate Management

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The PPDR-TC project: Public Protection and Disaster Relief - Transformation Center

PPDR-TC goals

- Effective Public Protection & Disaster Relief (PPDR) communications
- Preparation of the next generation of PPDR systems

The Consortium:

EXUS

ICCS

THALES

rinicom generation wireless

teletel TELECOMS TECHNOLOGY

ÆGIS spectrum engineering

iTTi e-technologies & business

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TELE CENTRAS

Talk overview

Problem

what

to support PPDR communications

- QoS guarantees
- attack prevention

why

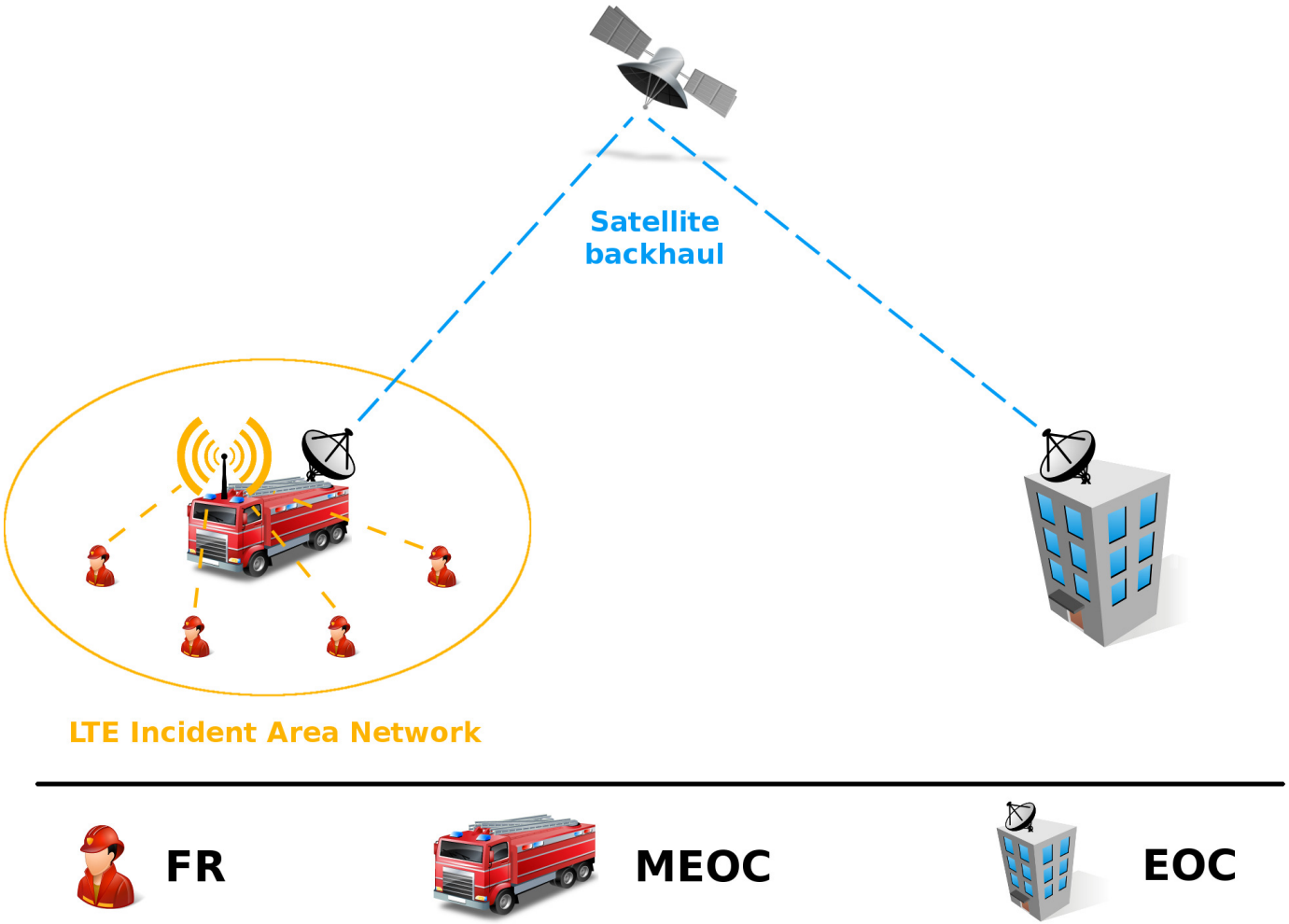
resources are precious after a disaster

- satellite tech are often the only one solution (TCP problems)
- malicious users make things more challenging

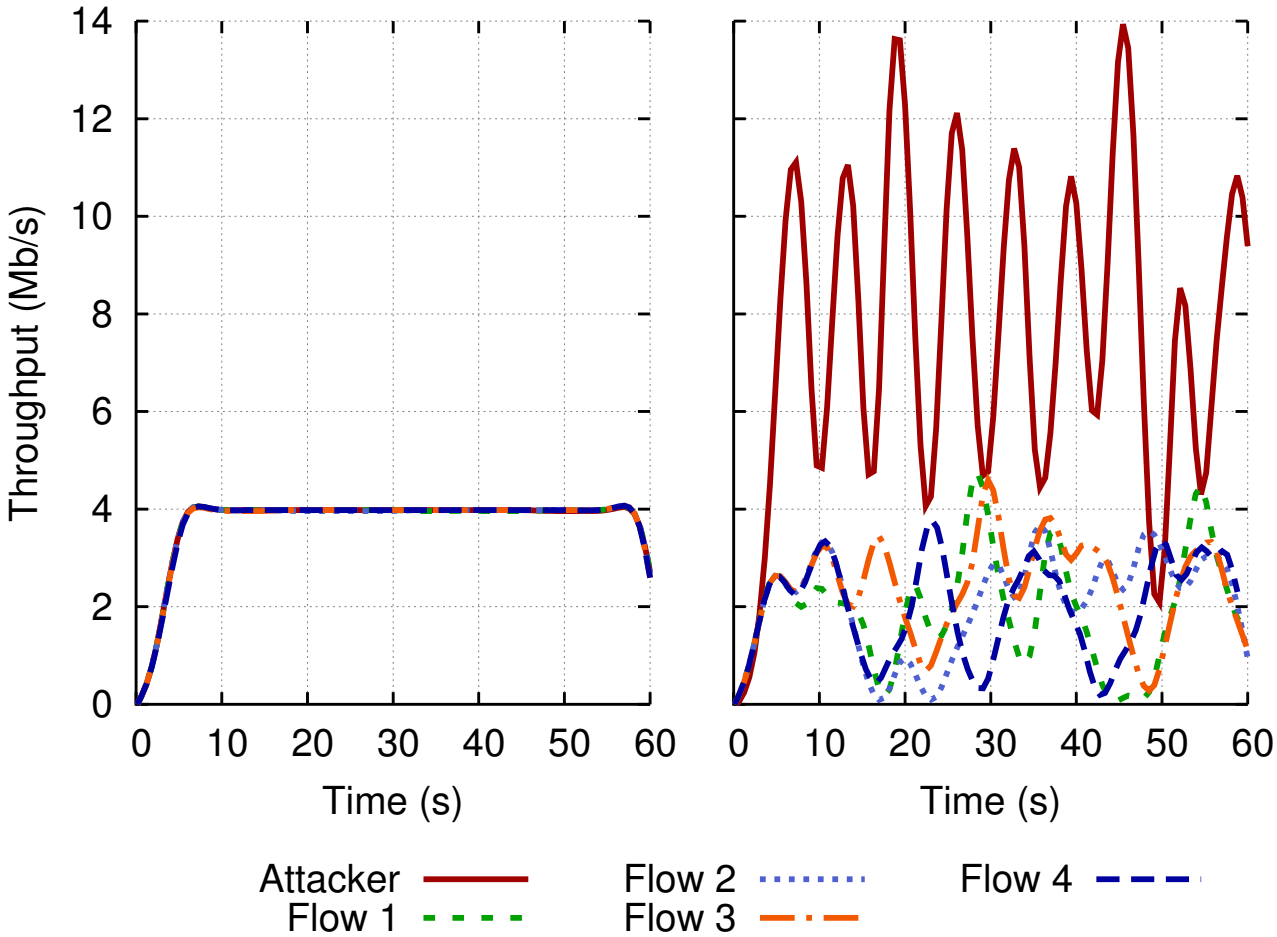
where

cooperative network layer: buffer management

Problem: simple PPDR scenario



Effect of an attack over cooperative environment



State of the Art

typical solution

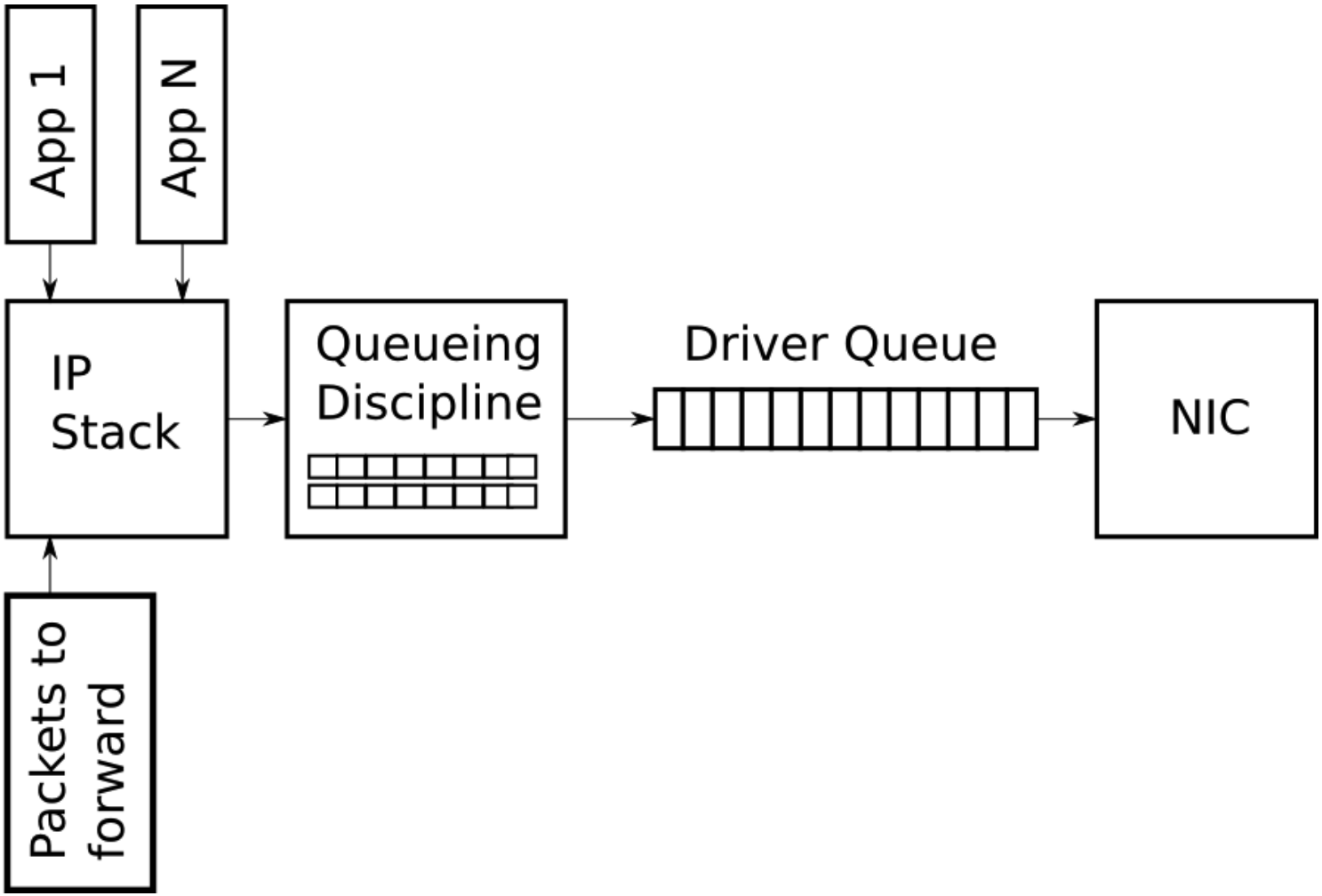
Network layer techniques: AQM or Packet Scheduler

- Scheduling is useless with same traffic type
- In satellite environment, TCP congestion is the critical point

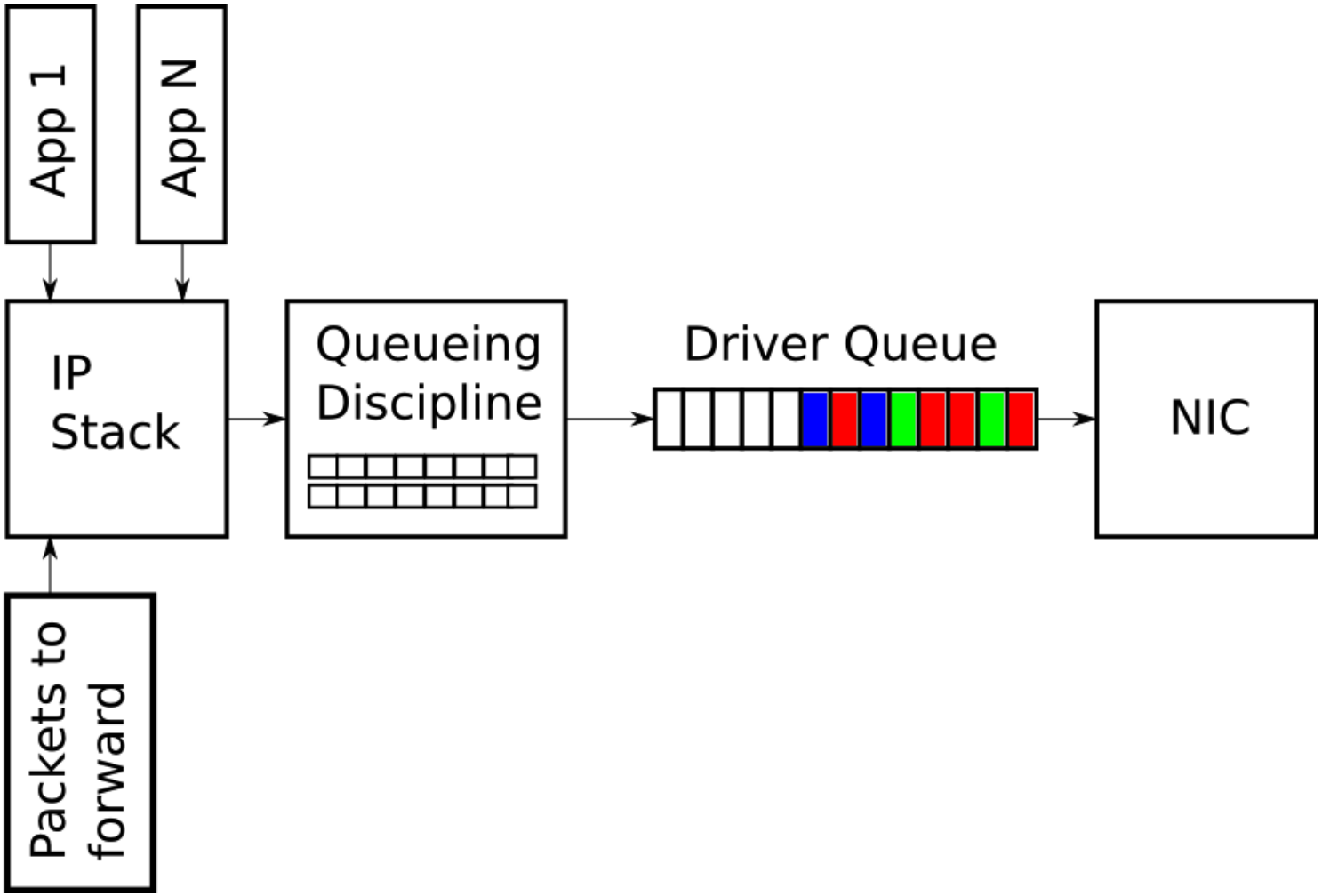
weaknesses

- difficult to bound the bandwidth
  - packets in the queue $\longrightarrow$ IP level
  - bandwidth (congestion control) $\longrightarrow$ TCP level
- how to move from packets burst to bandwidth?
- flooding attack cannot be managed by packet schedulers

AQM classical schema



AQM classical schema



Proposed solution: Queue Rate Management (QRM)

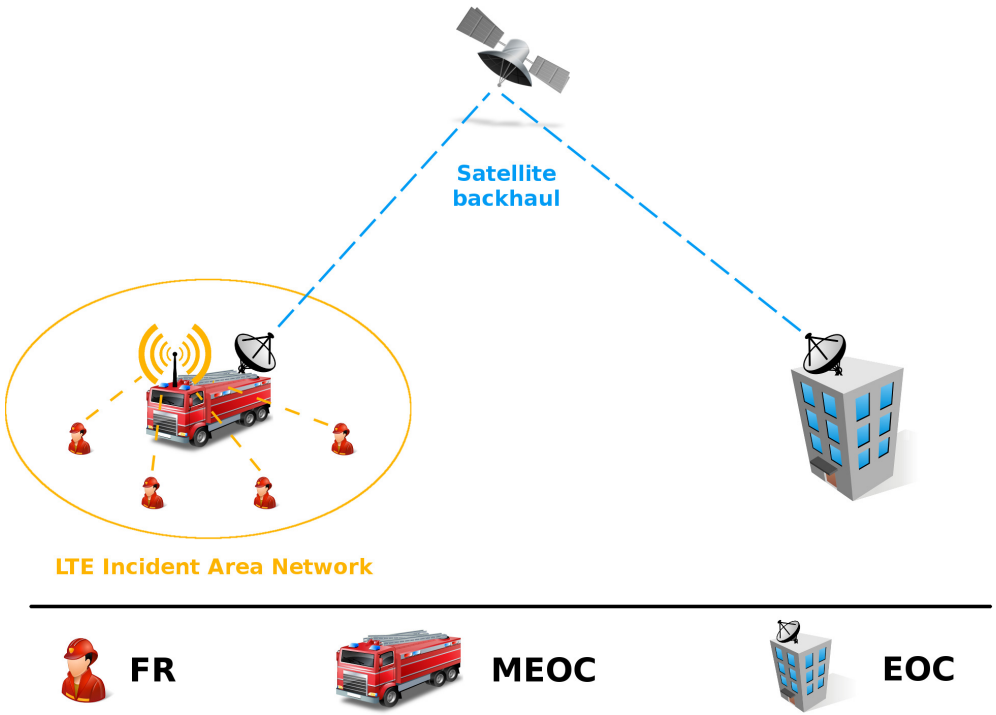
- simple AQM placed at networking layer
- born for cooperative networks (node-rate given)
  - RCP-AC, XPLIT, ECN, CCML (Satellite, Data Centers, etc)
  - malicious node could exceed it
  - QRM node-rate hypothesis not strong
- it traces packets to get the flow RTT and calculate the actual flow rate

QRM benefits

1. gives control about length and bandwidth in a single queue manager
2. deterministic drop policy
3. consume O(n) memory like standard AQM
4. time complexity of O(n), simulations show a $\Theta(1)$ behavior (we already have an O(1) version)
5. max queue length is bounded at BDP value (**Theorem**)

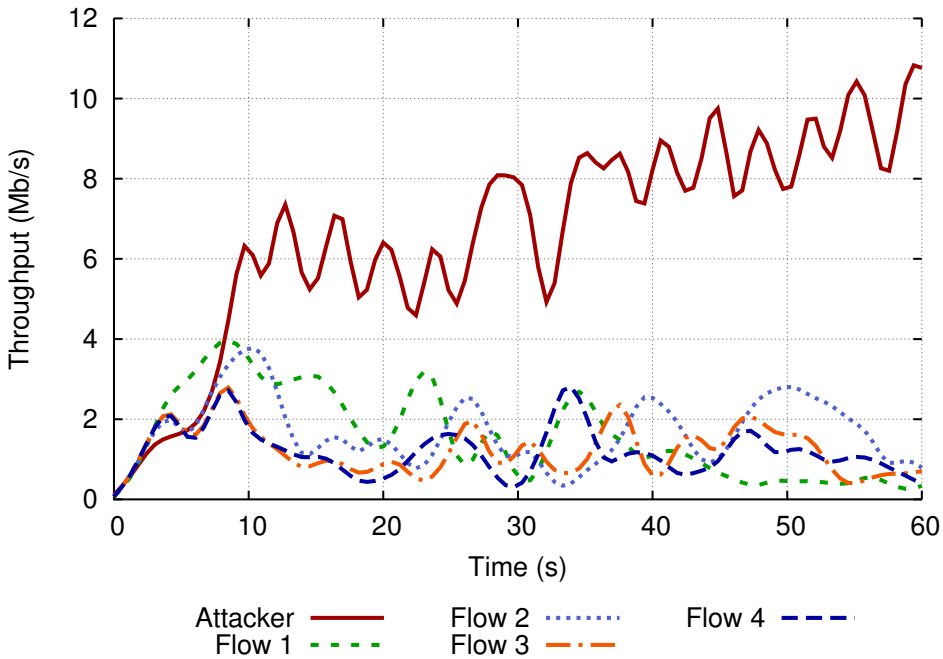
PPDR case study

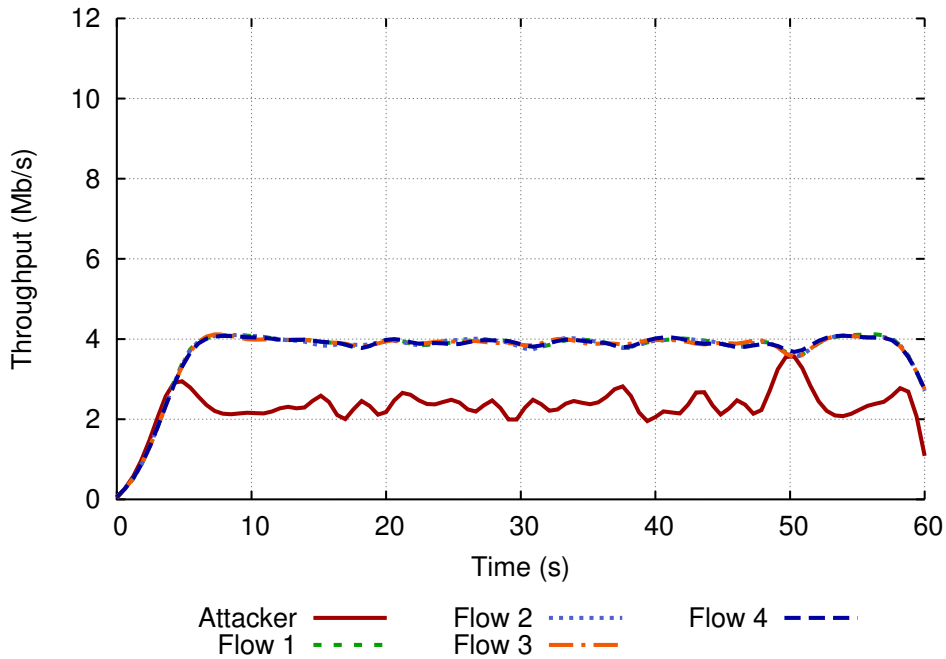
- LTE BandWidth: 20Mbit/s
- Satellite bandwidth 20Mbit/s
- Satellite delay 350ms
- Queue BDP size of 1.8MB
- $[2, 32]$ FRs involved:
- $[1, 16]$ Malicious users



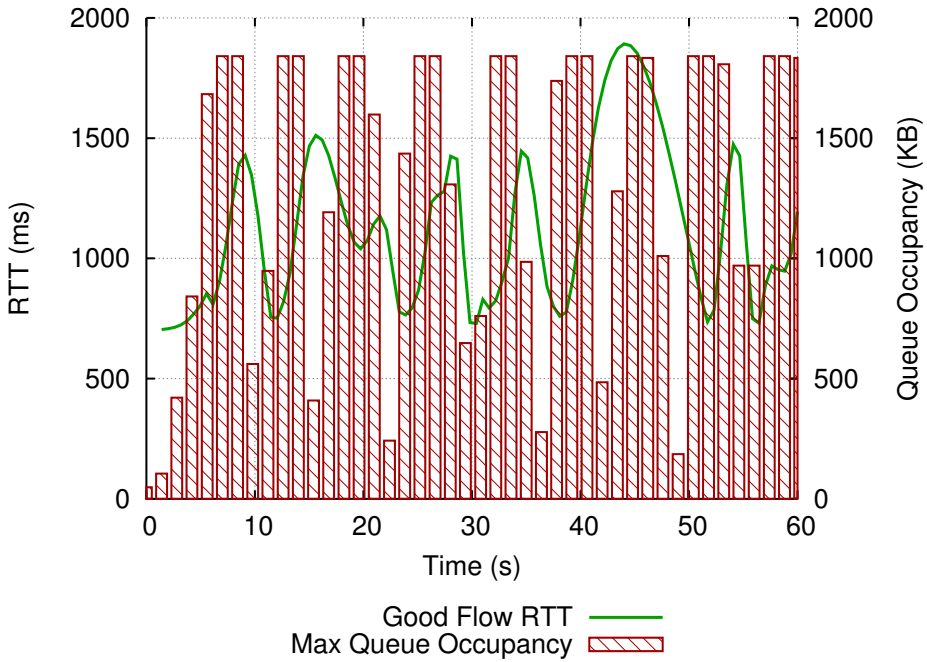
CoDel vs QRM: Rate and fairness

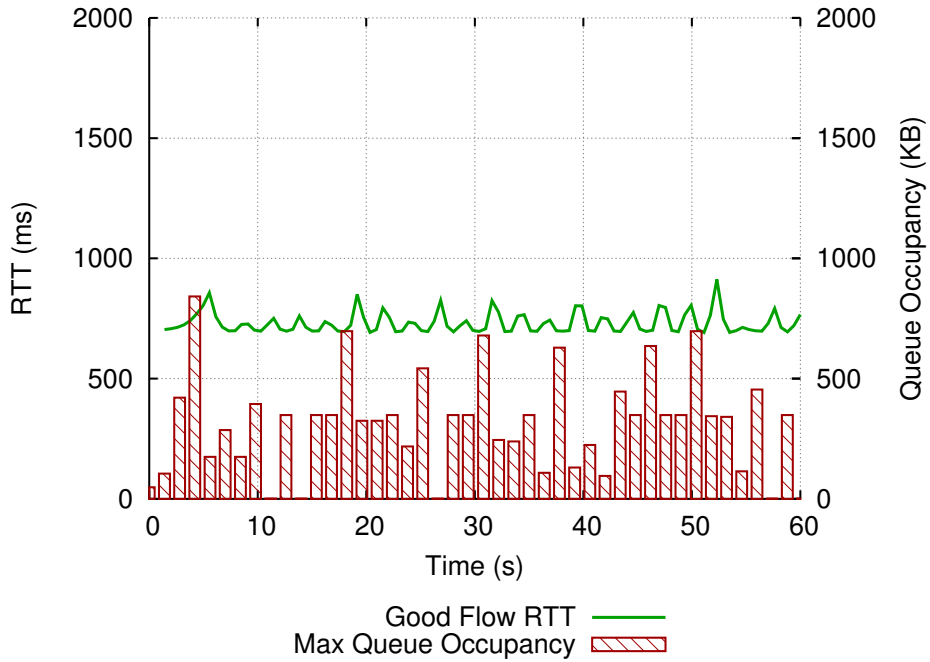
5 ns-3 client nodes, 1 node is an attacker



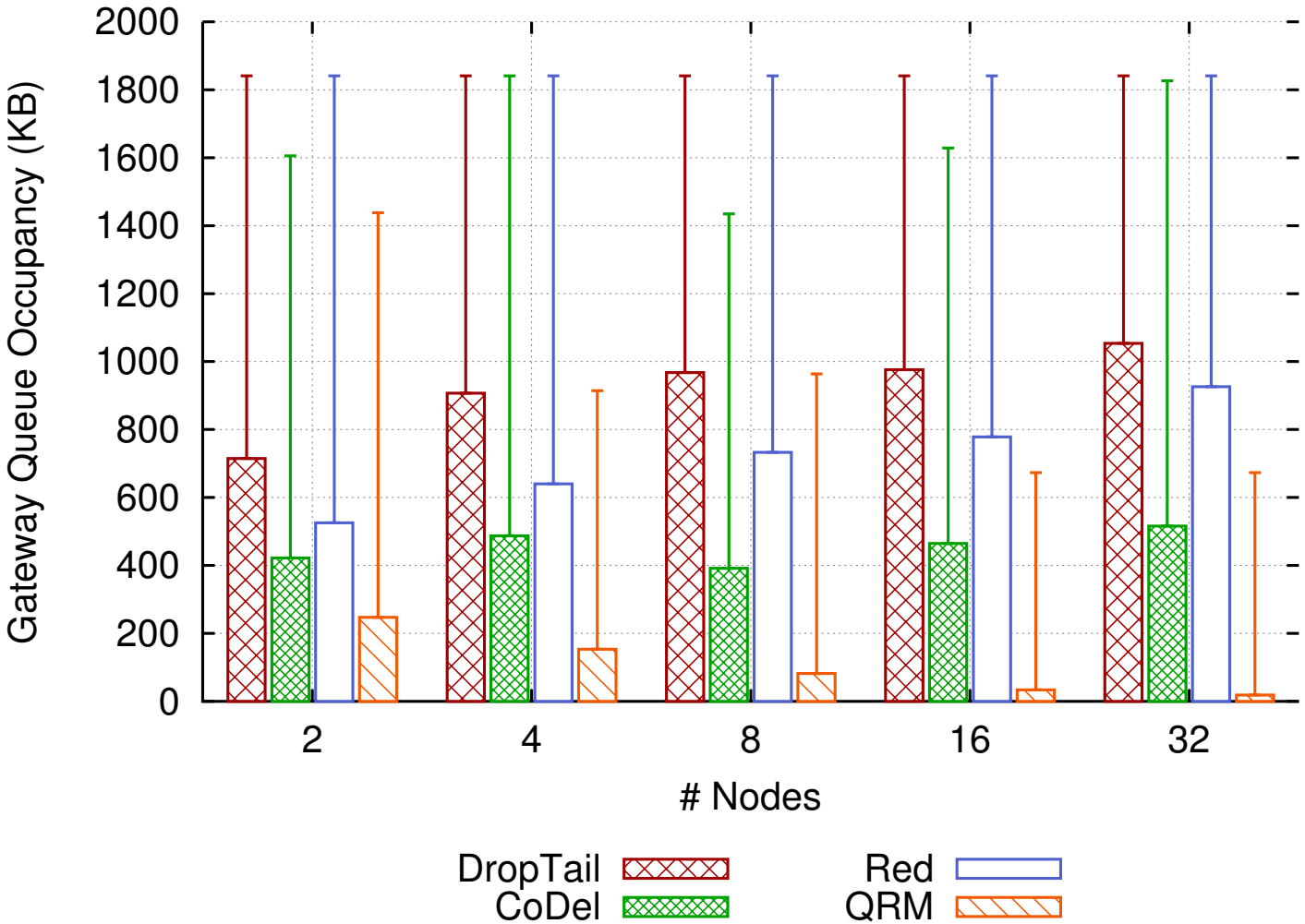


No buffer management vs QRM: RTT and queue length





QRM Scalability: queue length



Conclusions

Buffer Manager: QRM

a novel timestamps based AQM for infer and bound the flow rate

- efficiently insulate malicious traffic (flooding attack)
- effective use of the typical BDP standard buffer-size
- optimal run-time time and space complexity
- preserves all the cooperative feature (QoS, Latency, etc)

thank you
for your attention

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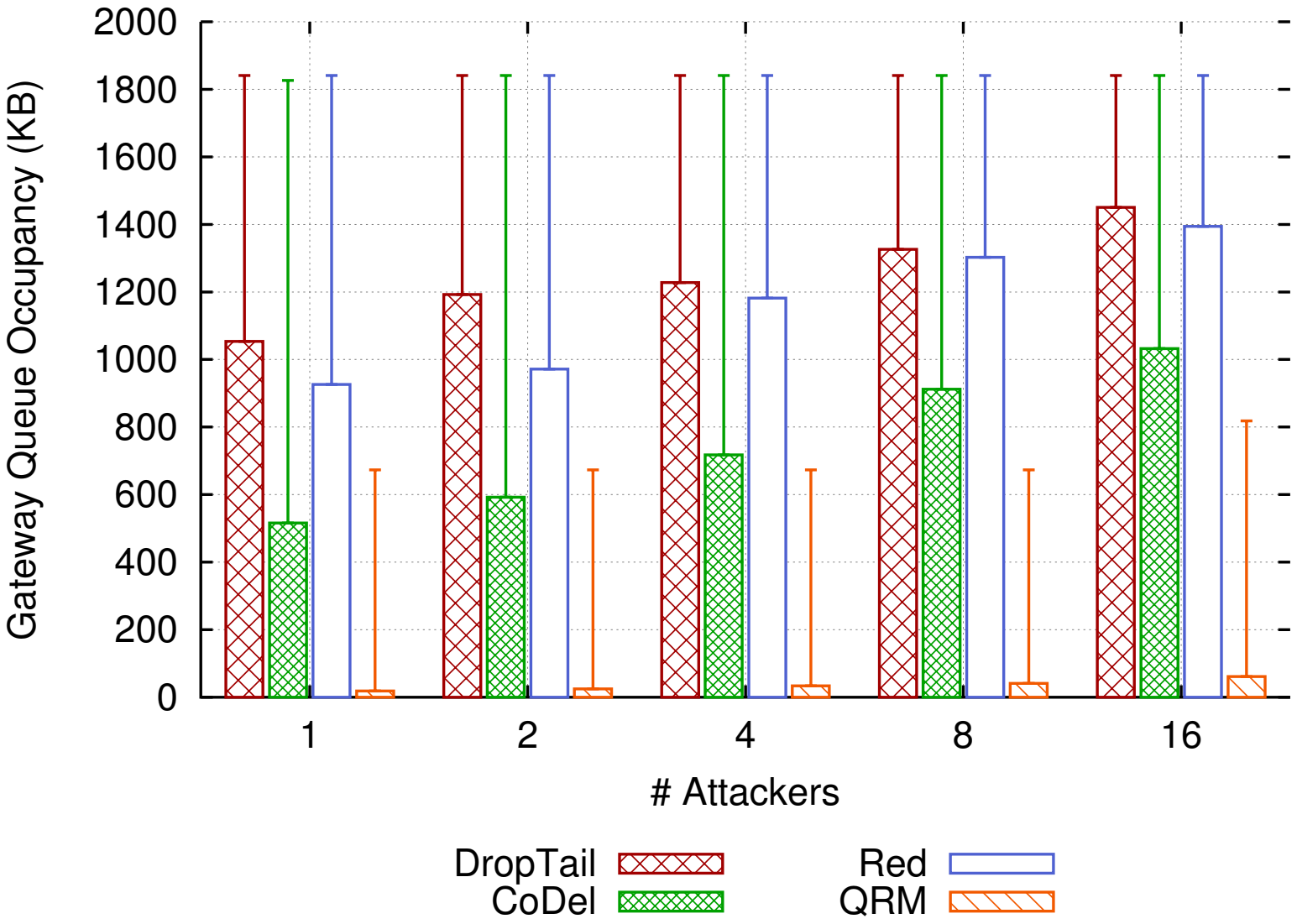
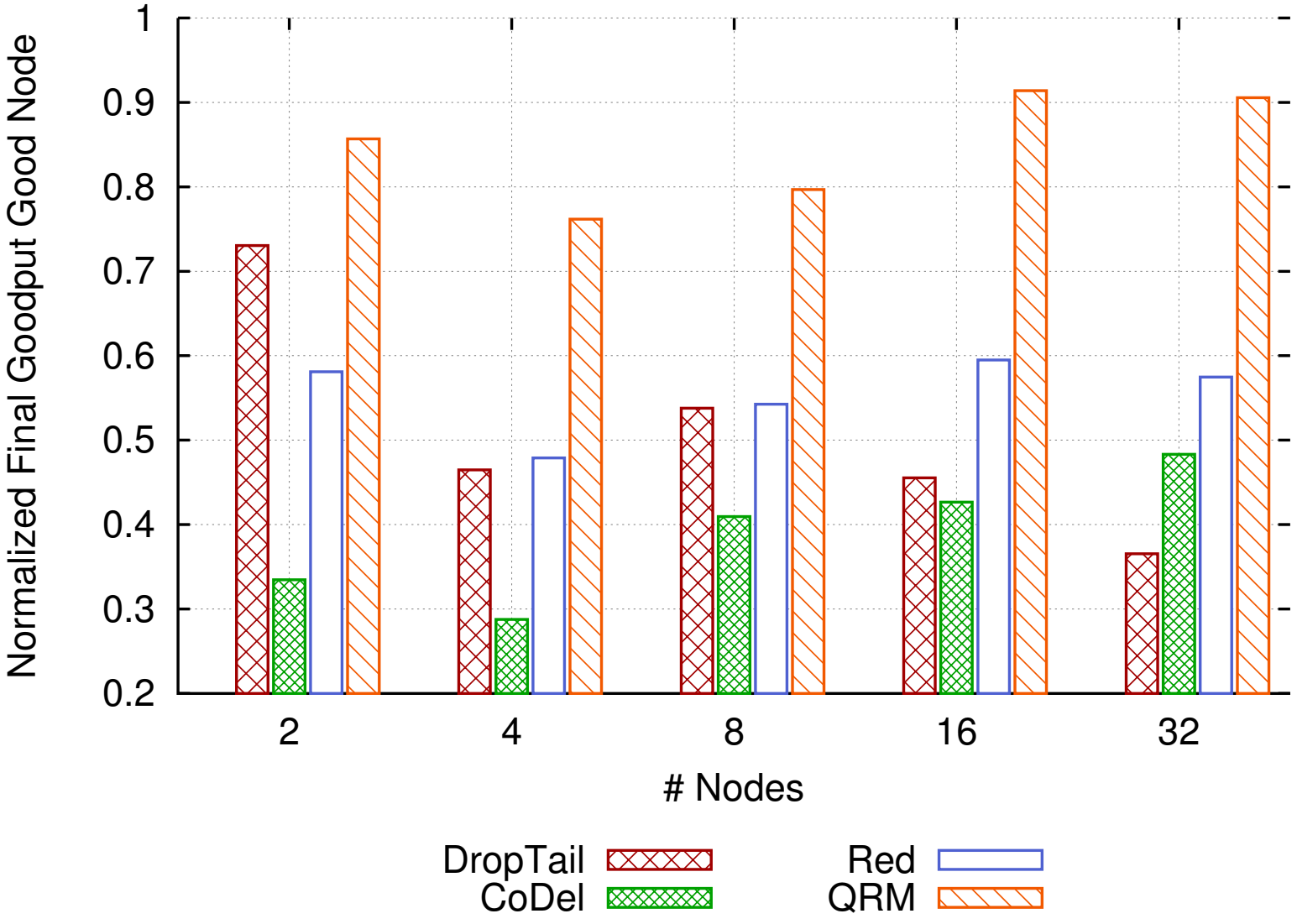
extra slides

QRM Defense Scalability: queue length with attackers growth over 32 total nodes



QRM Worst-case Tx Data: good nodes



QRM Worst-case Tx Data: good nodes with attackers growth over 32 total nodes