Problems with existing DetNet bounded latency queuing mechanisms

draft-eckert-detnet-bounded-latency-problems-00

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Why & How ?

- After IETF110, DetNet WG chair asked about problems with current DetNet bounded latency definitions
  - This document attempts to answer this question
  - Background explanations which may look redundant to MPLS experts
    - But DetNet architecture does not seem to take all of them into account

- Not enough time and participation (europe, isreal) to have a good coverage of the topic
- Could DetNet please provide more time to discuss bounded latency ?
  - How about an interrim online meeting early september (after vacations) ?

Problem statements are nice, but:

- If we agreed on the problems, what should DetNet do ?

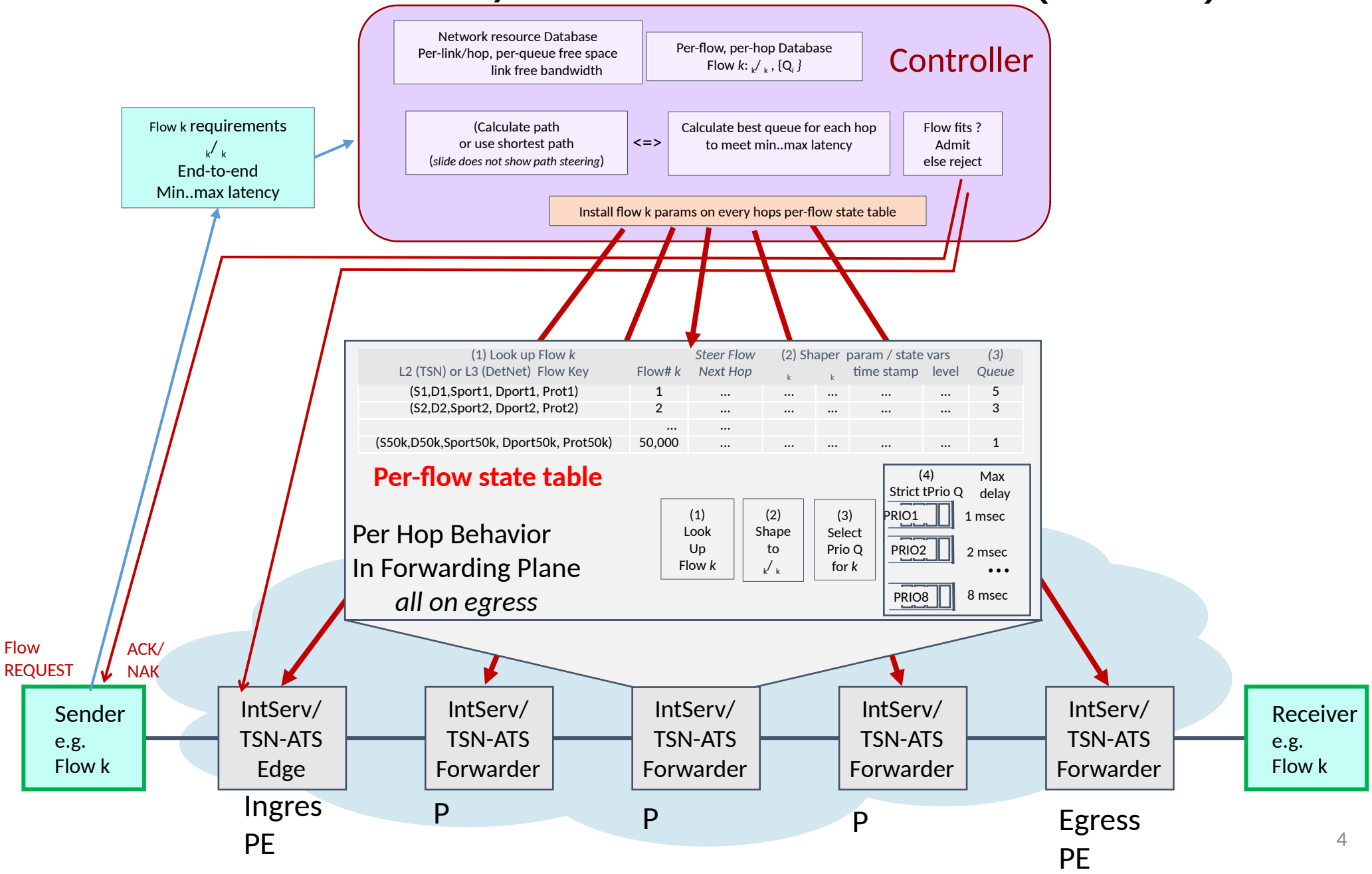
- (* help to) Adopt/work-on mechanisms for scalable/lo—cost/high-performance bounded latency solutions that solve (all or part of) these issues:

  - Tightly bounded jitter for (physically) large scale networks
  - Supporting/enabling source-routing stateless steering (SR, BIER)
  - DiffServ instead of only IntServ QoS model for bounded latency
    - Per-transit-hop/per-DetNet flow stateless latency control
  - Yaakov: close enough to deterministic, but probabilistic bounding models

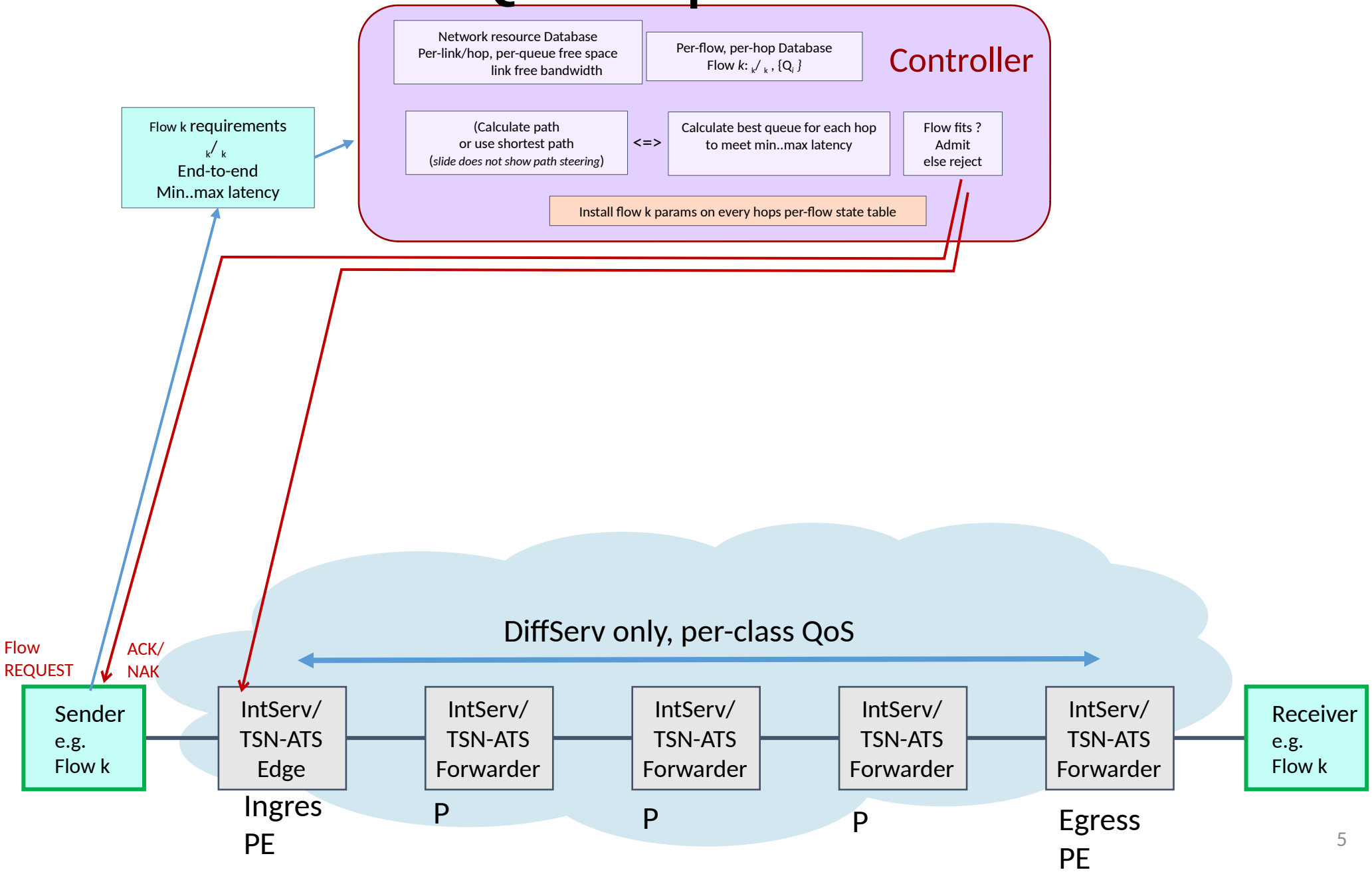
- ENOTIME: Will only address TWO core issue in slides (read draft).

(*) Adoption of Per-Hop-Behavior specifications could as necessary be done in whaever the best IETF WG is, but problem and solution overview documents should be in DetNet to clearly express the desire for DetNet to get these problems solved

IntServ / TSN-ATS, DetNet model (issues)



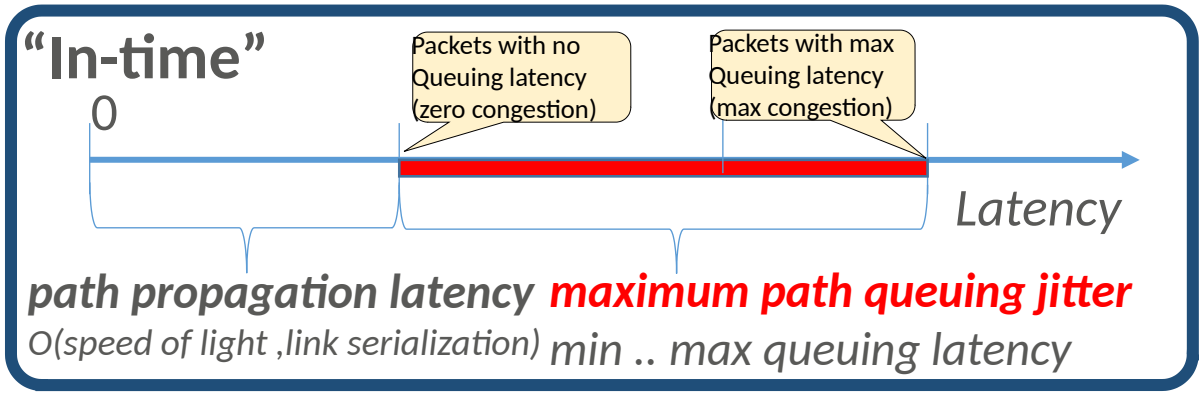
Desirable DetNet QoS option

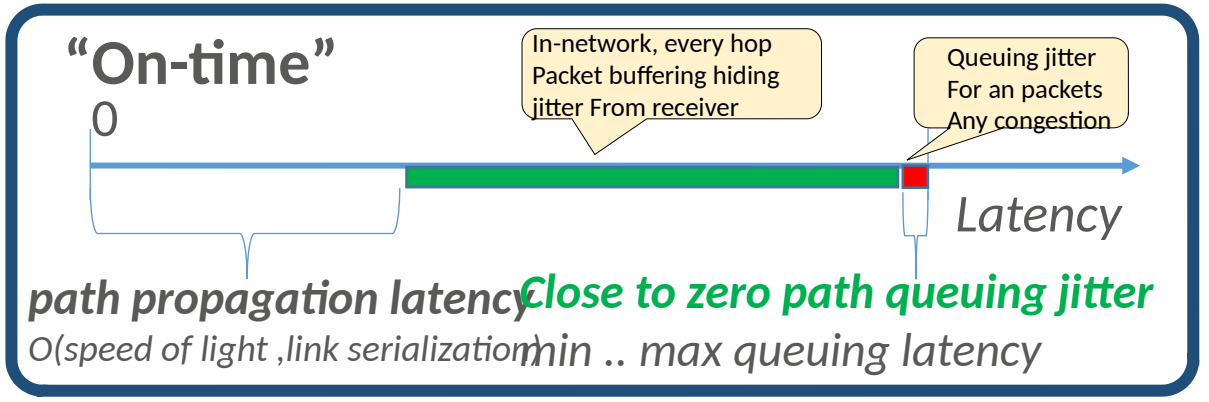


Per-Hop, Per-flow state issues

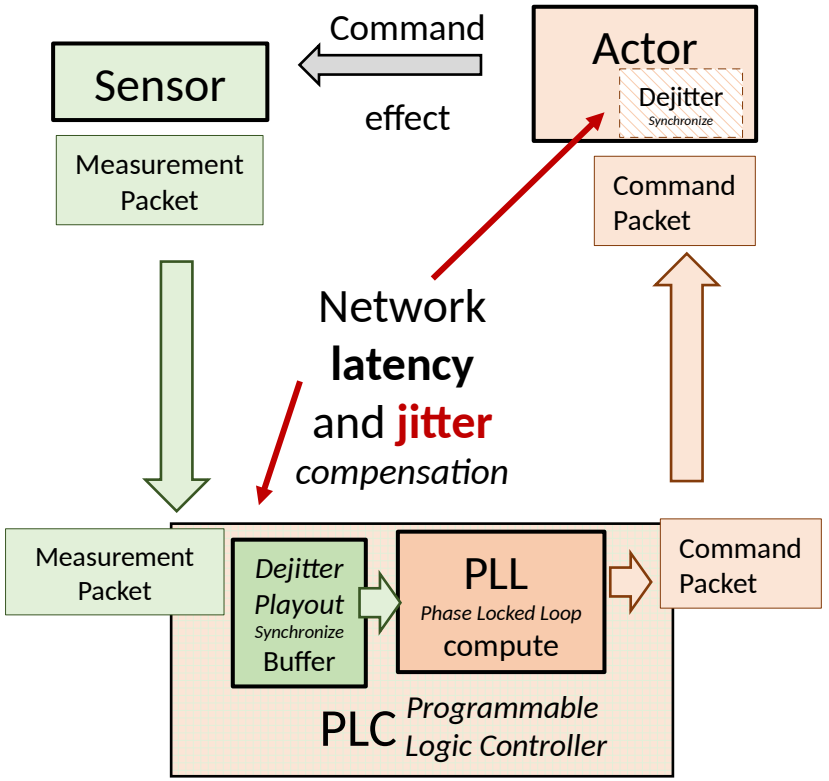
- Core of IntServ (RFC2212), quickly amended by DiffServ. No DiffServ deployed significantly in networks larger than campus.
  - Reduced IntServ, RSVP-Traffic-steering, NOT-per-hop-queuing was used until better technology was available (Segment Routing).
  - This is more expensive the faster the network is.
- Several issues with per-hop, per-flow state
  - QoS hardware cost limitation: Shaper – IntServ -> Interleaved Regulators (UPS, TSN-ATS), still too expensive for large-scale, high-speed forwarders with many interfaces.
  - Churn through signaling updates. Per-Hop, Per-Flow state upates upon chage: new/dead flows, path changes. Update to hardware.
  - If state is driven by application, state on P nodes even more problematic (unplannable). Biggest experiences from IP multicast and evolution of IETF standards for that.
- Current standard or proposed standard for large-scale network models: no per-hop, per-flow statee: Segment Routing (source routing), BIER(-TE) or multicast , simple DiffServ QoS
  - Need DetNet QoS option supporting SR, BIER…

Tightly bounded jitter – “In-time” vs. “On-time”





- In-time delivers packets as soon as possible. No congestion, no in-network queuing latency
- But all deterministic application MUST be prepared for any packet to arrive as late as (guaranteed) bounded latency
- For many synchronuous systems (media playout) and even more so synchronuous control loops packets that are earlier than bounded latency need to be buffered (media-player, PLC).
- Buffer size requirements depends on network size/jitter.
- Dumb devices (actors) may not be able to support dejittering and/or accurate clock
- On-time delivery avoids /reduces these application problems.
  - Network size dependent buffering
  - Clock synchronized



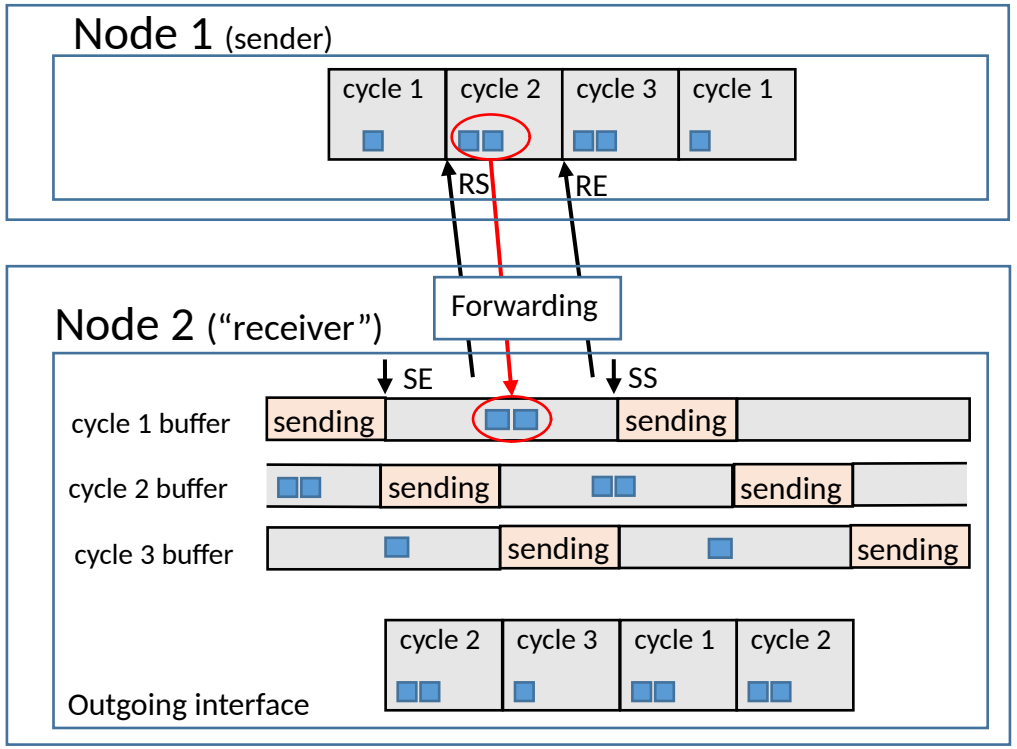
Proposed solution option

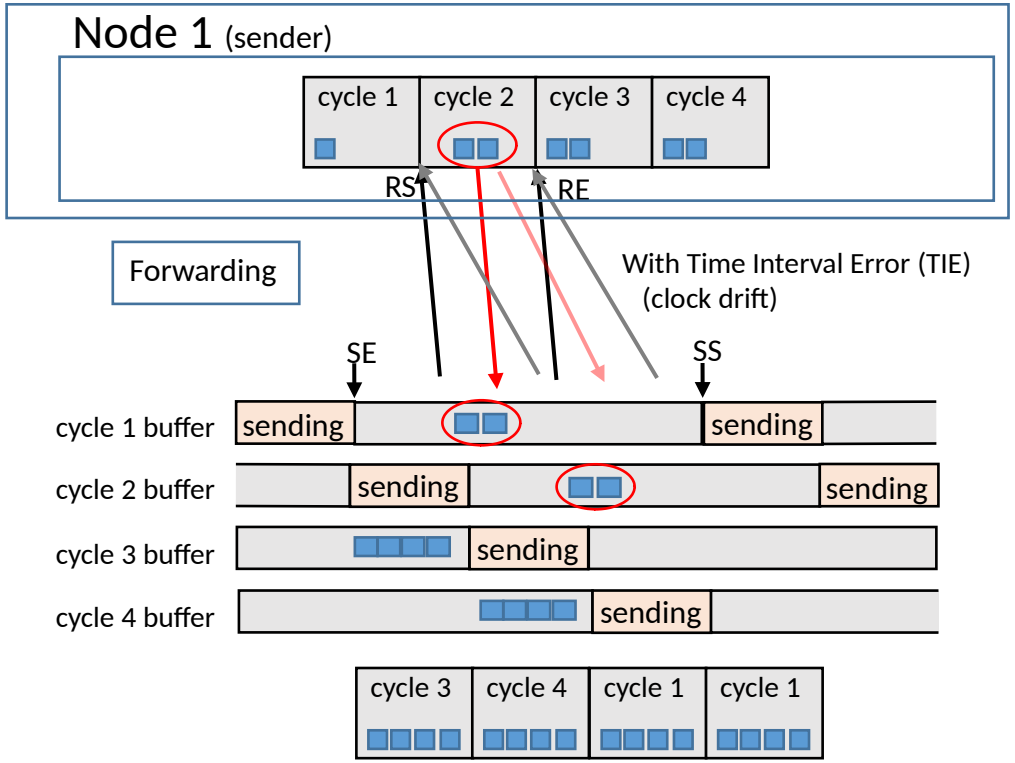
CQF with packet tagged packets

draft-dang-queuing-with-multiple-cyclic-buffers (superceeds draft-qiang-detnet-large-scale-detnet)

Architecture posted, MPLS encap / PHB draft TBD (trivial).

No per-hop/per-flow state, tightly bounded latency, validated high speed implementation
Solves CQF distance limitation through tagging (more cycles, more sync leniency)
Reduces CQF time sync accuracy and link synchronicity requirements through tagging.





Comparison of TSN/DetNet options	IntServ/GS RFC2212	TSN-ATS Latest (2020) TSN standard, also prime target for Detnet	TSN-CQF (Qcr) Original/simplified TSN option (over Qbv)	Packet taged CQF draft-dang-queuing-with-multiple-cyclic-buffers	Packet tagged per-hop deadlines draft-stein-srtsn
DiffServ / SR-MPLS,v6 / BIER design goal compatible	**NO**	**NO**	**YES**	**YES**	**YES**
Per-hop-per-flow state *Hardware-cost/scale* *Signalling-complexit/churn*	**YES**	**YES** Interleaved regulators (simplified over GS)	**NO**	**NO**	**NO**
Clock synchronization required *Additional PTP hardware and network operational requirements*	**NO**	**NO**	**YES** High accuracy (nsec)	**YES** Low accuracy (usec)	**TBD ?** *Not considered to be a deployment cost by author ?!*
Tighly bounded jitter	**No**	**No**	**Yes** Usec jitter (cycle size)	**Yes** Usec jiter (cycle size)	**No ?**
Target deployment scale	**1990th "Internet"**	**Building/ Campus?**	**Building/ Campus?**	**Campus/Metro/ Country (tested)**	**Metro ?**
Arbitrary physical distance network / network links	**YES**	**YES**	**NO** Throughput deteriorating to 0 at ca. 2 km	**YES**	**Yes ?**
Latency calculus (for PCE)	Complex, deterministic	Simple, deterministic	Trivial, deterministic	*Trivial, deterministic*	*TBD – ongoing work to be published*

Q & A