Towards a Deterministic Ethernet Networking Solution for Software Defined Vehicles

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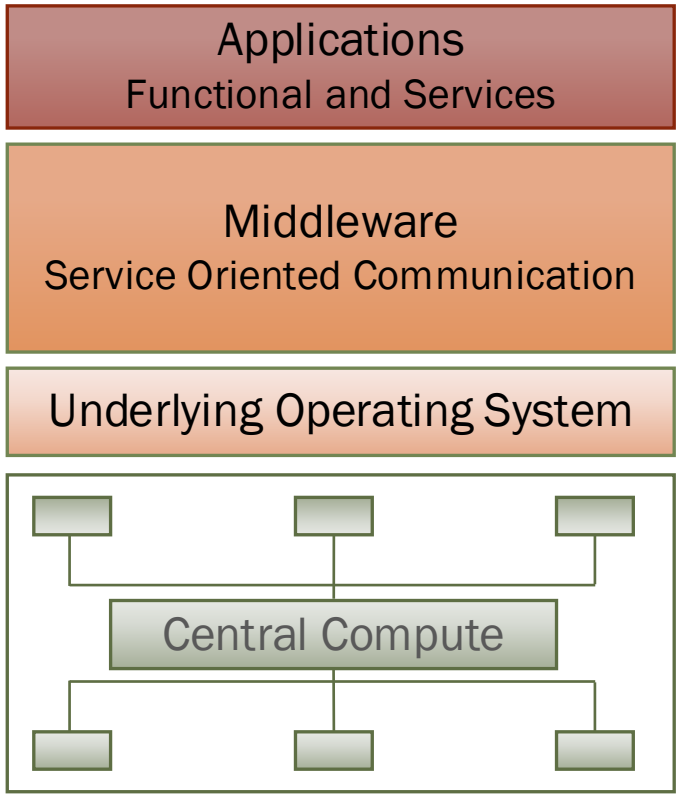
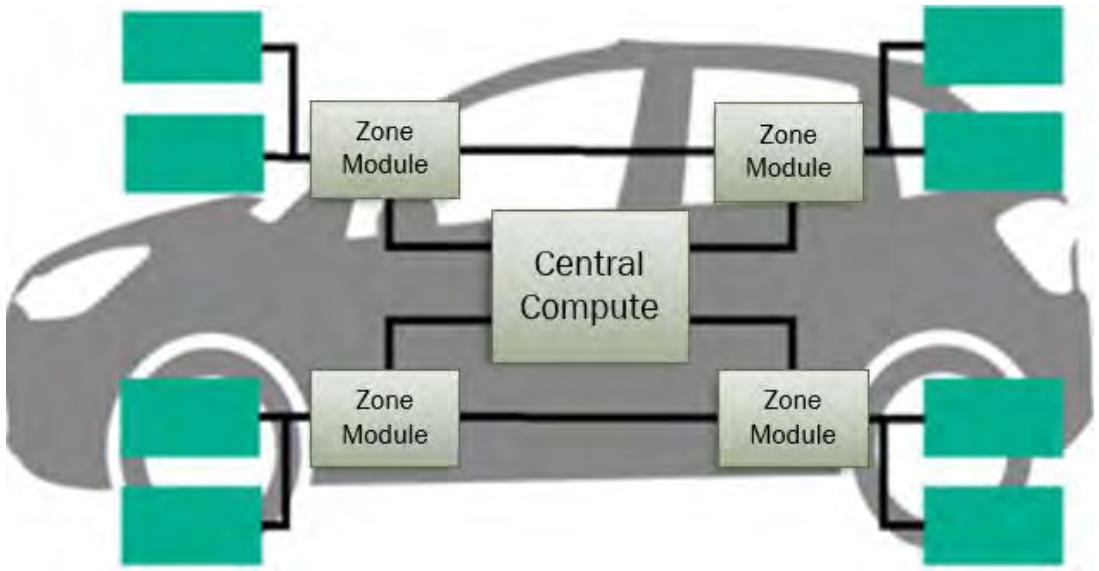
Software Defined Vehicle (SDV)

- Decoupling of software and hardware
- Central Computing Architecture (CCA)
- Service Oriented Communication (SOC)
- Dominance of Ethernet
- Values
  - On demand features
  - Fast and frequent updates
  - In-market Enhancement



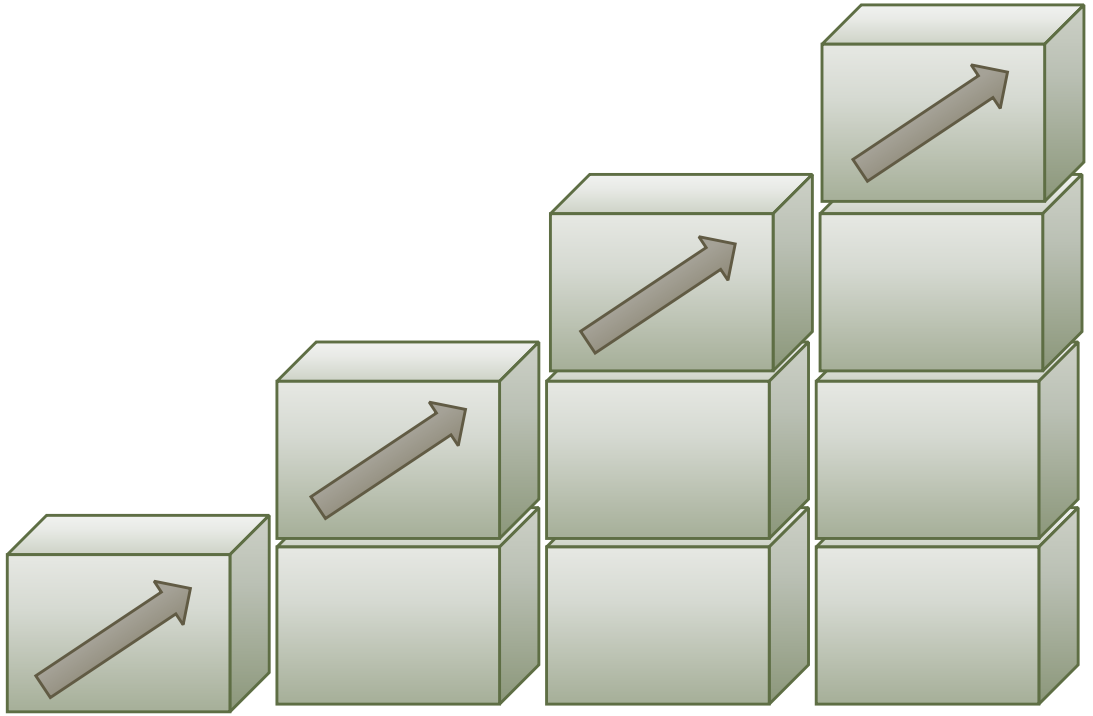
Challenges for Ethernet in SDV

- Longer paths with increased E2E latency
- Mixed critical traffic
- Bounded latency
- Reliability in communication

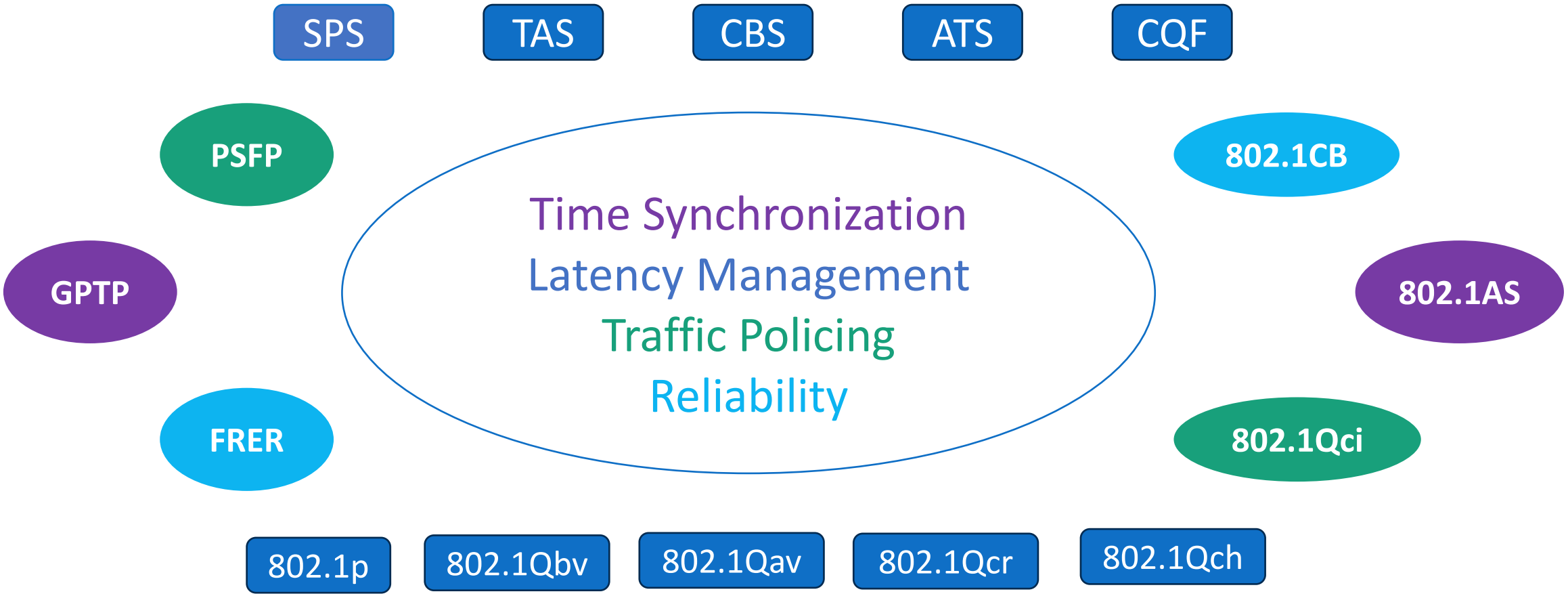


Design Goals for the Deterministic Ethernet

- Utilize standardized technologies
- Multi vendor solutions
- Portable solution
- Keep it simple
- Scalability in design



Tools Available in IEEE TSN Toolbox



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Right Tool for the Right Job

- Time Synchronization
  - Generalized Precision Time Protocol (GPTP)
- Ingress Traffic Policing
  - Per Stream Filtering and Policing (PSFP)
- Reliability
  - Frame Replication and Elimination for Reliability (FRER)
- Shapers for Latency Management
  - Many options to choose the right one/s

Challenges for Ethernet in SDV

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Selection of Right Shapers

- Credit based shaper (CBS)
  - Smooth traffic by debursting
  - Bounded latency not guaranteed for high network utilization
  - Class level shaping
- Asynchronous traffic shaping (ATS)
  - Guaranteed bounded latency
  - Per stream shaping
  - Burst control
- Strict priority shaper(SPS)

Prioritizing traffic by class

Required to address latency requirements

Selection of Right Shapers

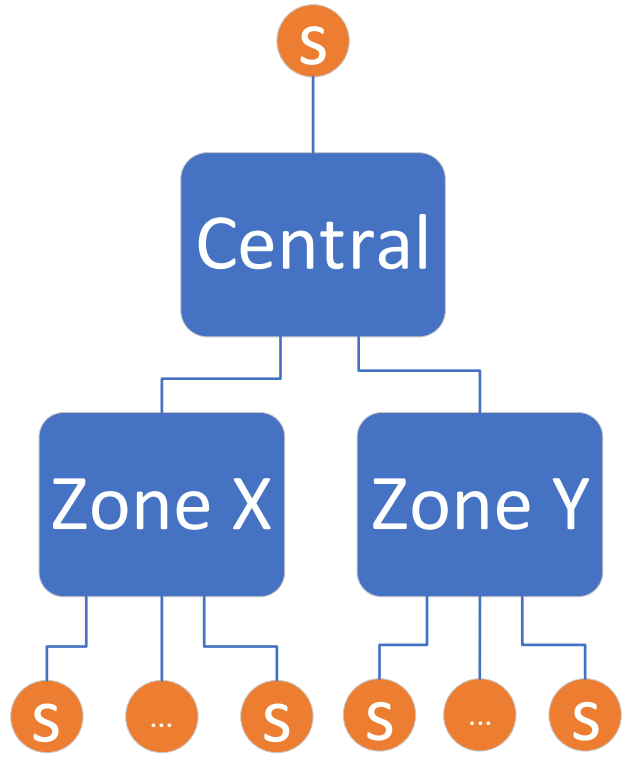
- Time aware shaper (TAS)
  - Lowest possible latency and jitter for scheduled periodic data
  - Engineering the network is very hard
  - Time synchronization is required
- Cyclic queuing and forwarding (CQF)
  - Good for long (many hops) network
  - Time synchronization is required
  - Careful choice of cycle time is needed

- TAS and CQF: Required highly engineered network and not scalable
- CBS: A good choice, but control is limited
- ATS: Best selection

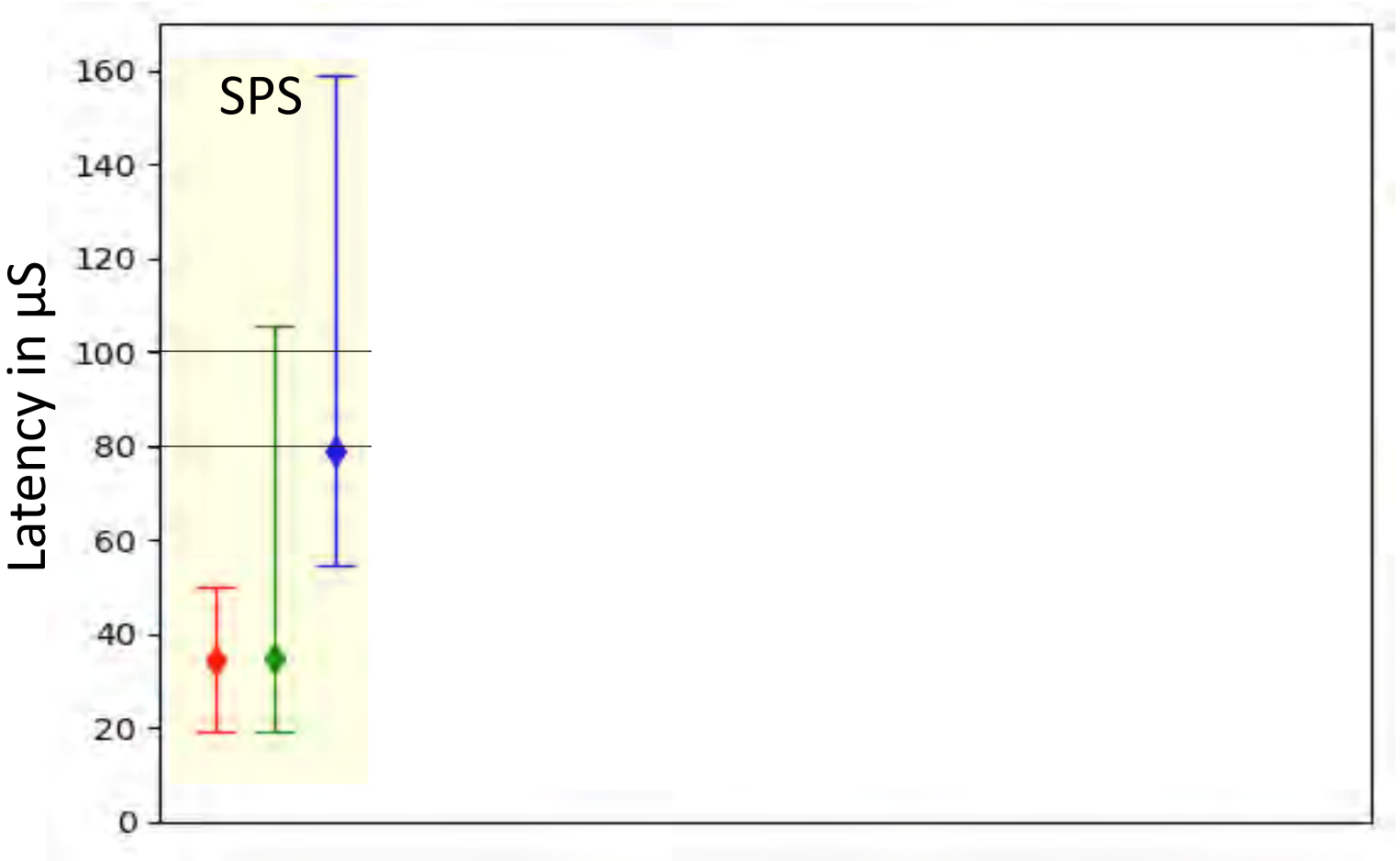
A Simplified SDV Example Use Case

- Streams with 3 different criticalities
- ATS configured for high and medium critical streams
- Maximum link utilization 80%

Latency control through ATS and SPS



Latency Control with ATS & SPS



Failed to meet latency of Medium critical stream

High critical streams

Medium critical streams

Low critical streams

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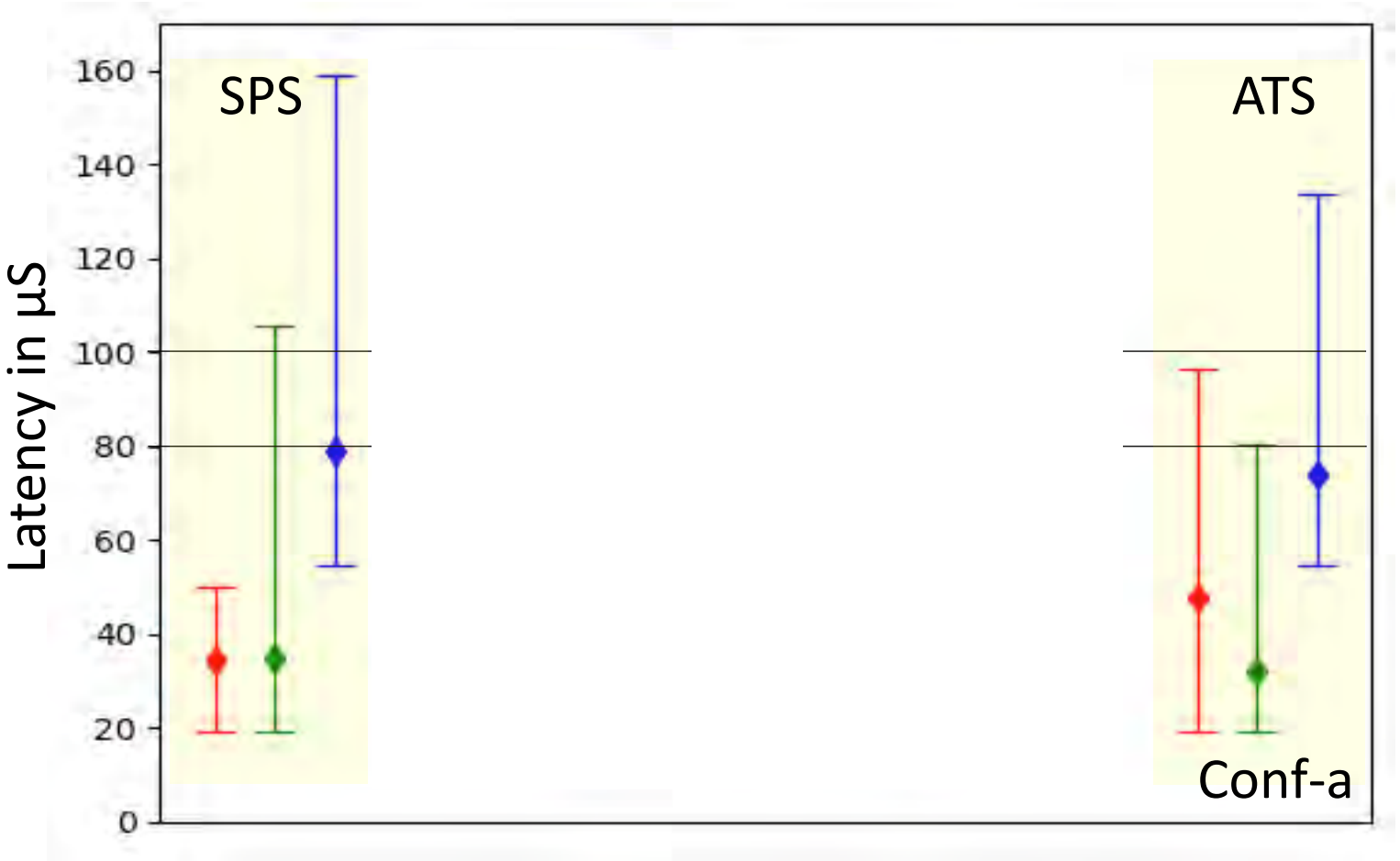
Latency Control with ATS & SPS



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High critical streams

Medium critical streams

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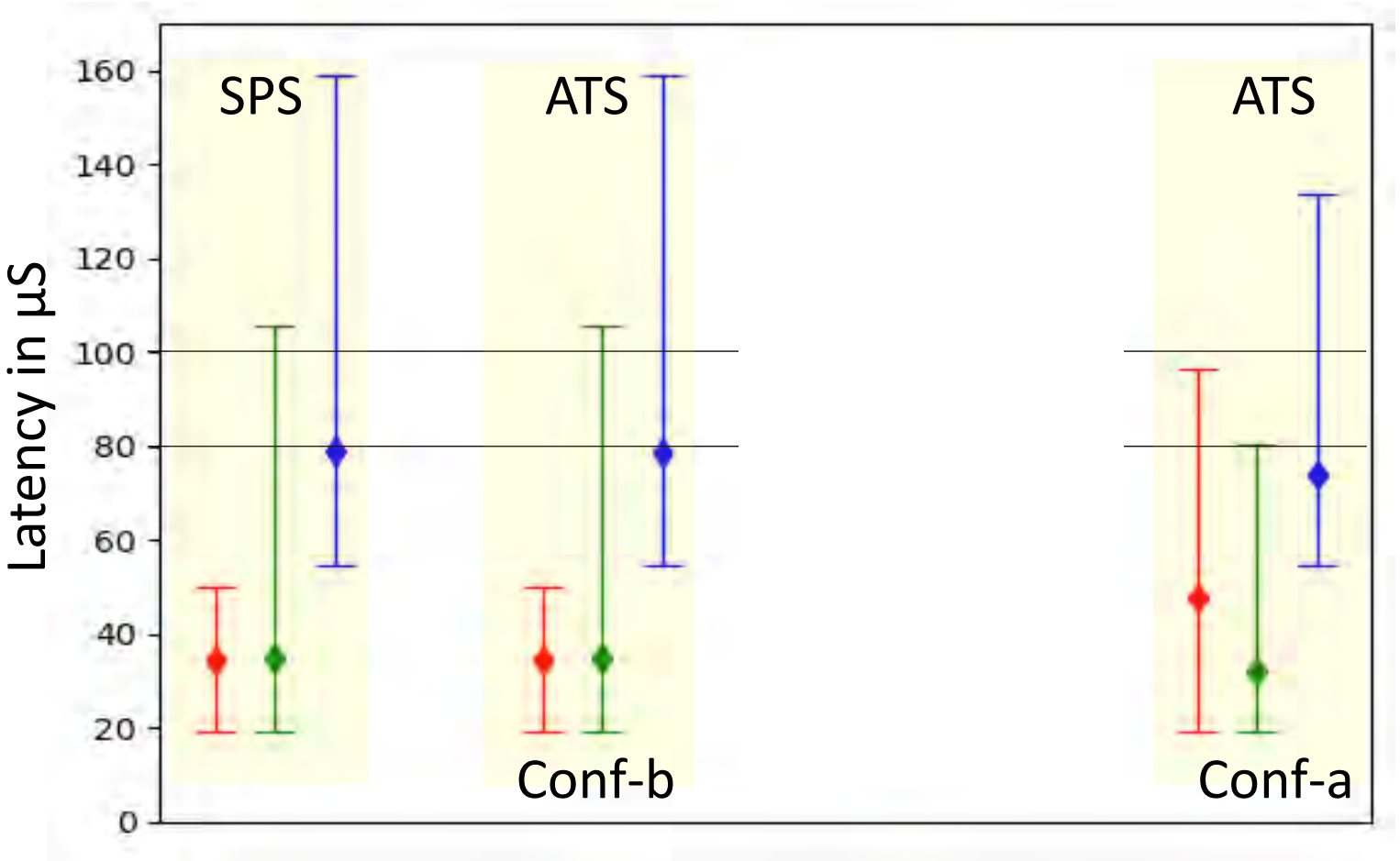
Latency Control with ATS & SPS



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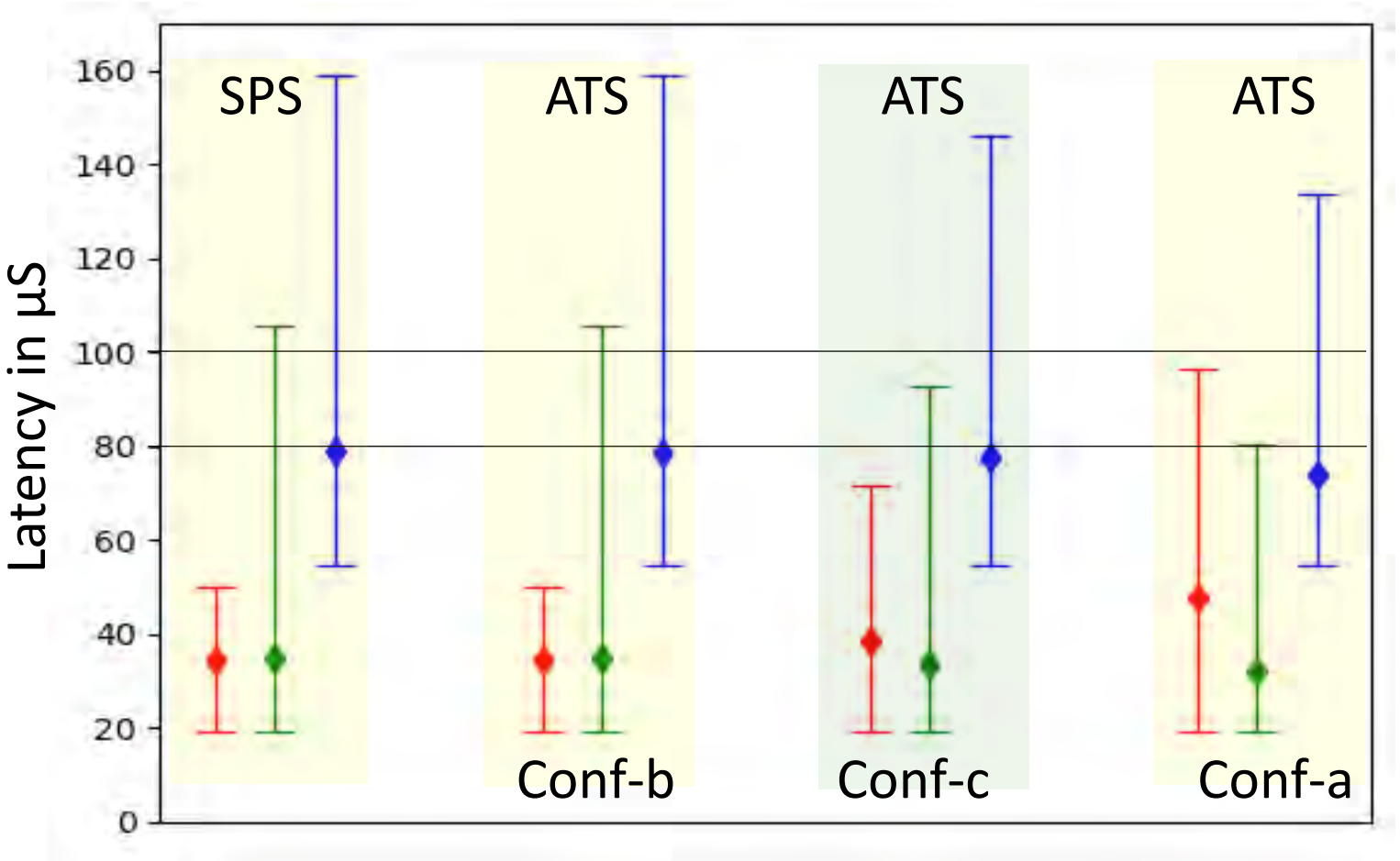
Latency Control with ATS & SPS



Latency goal is met

High critical streams

Medium critical streams

Low critical streams

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Key Takeaway

SPS alone cannot satisfy the latency goal

ATS with SPS enable fine tuning to satisfy the latency goal

Thank You!