

No Silver Bullet: Extending SDN to the Data Plane

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<http://web.mit.edu/anirudh/www/sdn-data-plane.html>

The Data Plane is continuously evolving.

- ▶ Progression of queue-management/scheduling algorithms:
 - ▶ WFQ, SFQ, RED, BLUE, ECN, XCP, RCP, CoDel, pFabric
- ▶ Each scheme wins in its own evaluation.
- ▶ Tacit belief in knobless queue management/scheduling

Yet, there is no silver bullet.

- ▶ Different applications care about different things.
- ▶ Applications use different transport protocols.
- ▶ Diversity in network conditions.
- ▶ “One size fits all” is overly constraining.

Quantifying “No Silver Bullet”: Network configurations

Network Configurations:

Network Configuration	Description
CoDel+FCFS	CoDel running on a single shared first-come, first-served queue.
CoDel+FQ	A separate queue for each flow with an independent instance of CoDel running on each queue. Queues are serviced using fair queueing.
Bufferbloat+FQ	A separate queue for each flow with a deep buffer that doesn't drop any packets. Queues are serviced using fair queueing.

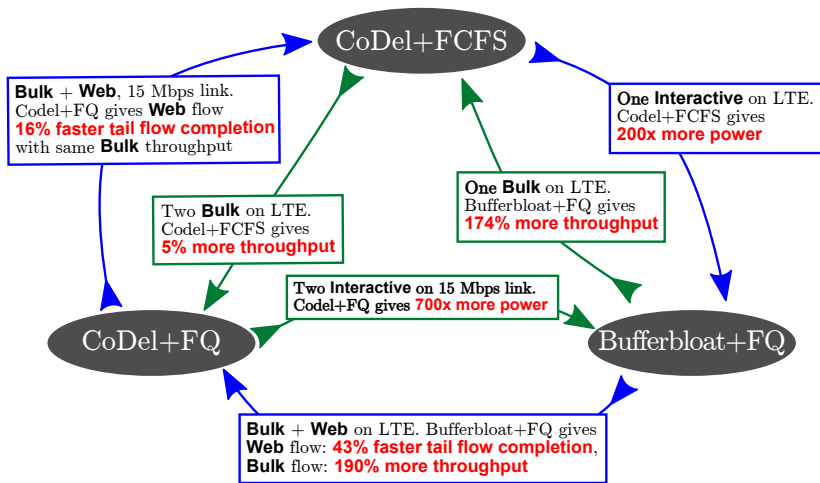
Quantifying “No Silver Bullet”: Simulation Workloads

Workloads:

Workload	Description	Objective
Bulk	Long-running TCP flow.	Maximize average throughput.
Web	Switched TCP flow that alternates between ON and OFF periods.	Minimize flow completion time at the 99.9th percentile.
Interactive	Long-running TCP flow representing a real-time interactive application.	Maximize the ratio of throughput and one-way delay, i.e., “power.”

Quantifying “No Silver Bullet”: Cyclic Preference Loops

No single network configuration is the best.



Explaining cyclic preferences

- ▶ Dropping packets significantly degrades throughput.
 - ▶ Reason: Variable-rate links have an inherent delay-throughput tradeoff, unlike static links.
- ▶ FCFS is preferable to Fair Queuing in some cases.
 - ▶ Reason: When equally aggressive flows compete, they don't need protection from each other.
- ▶ Fair Queuing is required in some cases.
 - ▶ Reason: When competing flows are not equally aggressive, they need isolation from each other.

The Solution

Flexible Switch Data Planes

- ▶ No “Silver Bullet” queue-management/scheduling scheme
- ▶ Application demands continue to evolve.
- ▶ Networks supporting these applications will evolve as well.
- ▶ The Data Plane should support newly developed schemes.

But, do so in a controlled manner.

- ▶ Provide interfaces to the head and tail of switch queues.
- ▶ Operators specify only queue-management/scheduling logic.
- ▶ Code size limits constrain program sophistication.
- ▶ Disallow access to packet payloads.