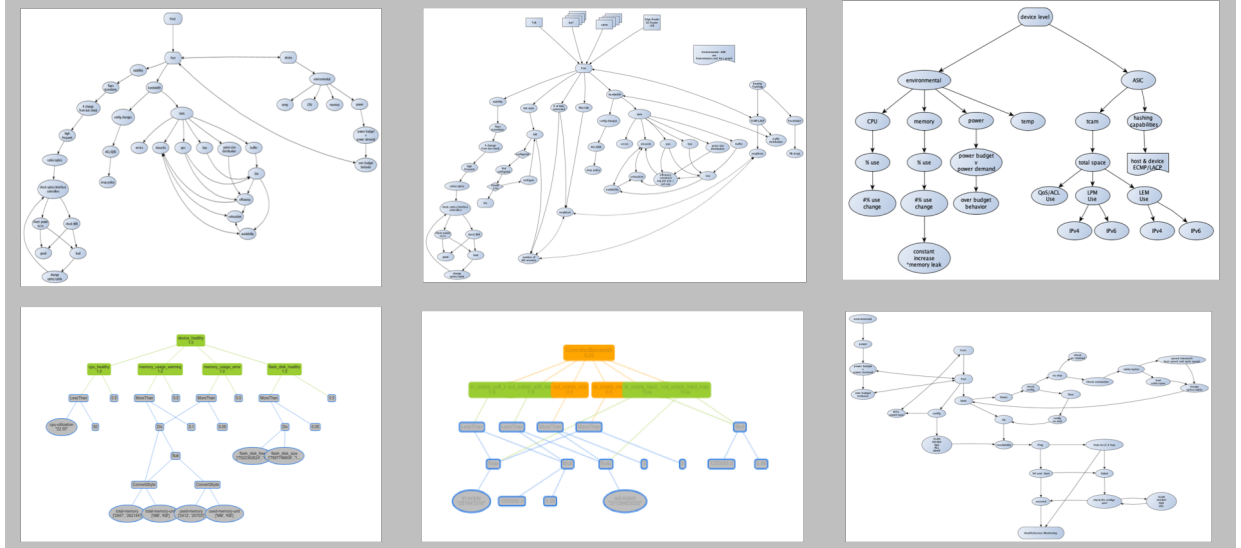
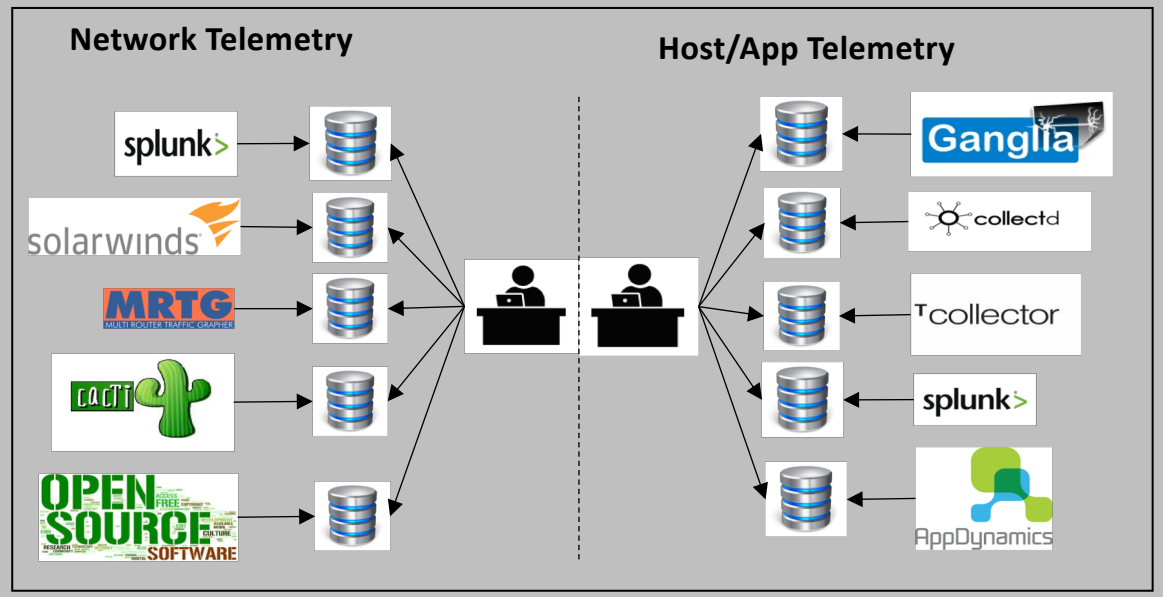
Context and Dependency Awareness of Data and Control Plane Relationship

Complexity in operations and data drives behavior

Operational Workflows



Disconnected Data Paradigm

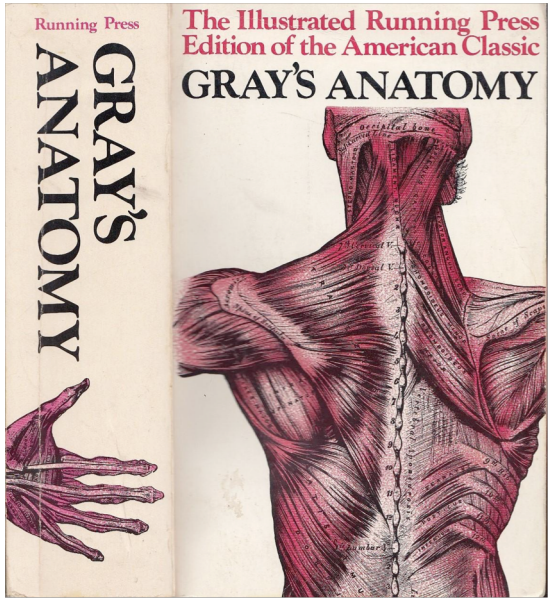


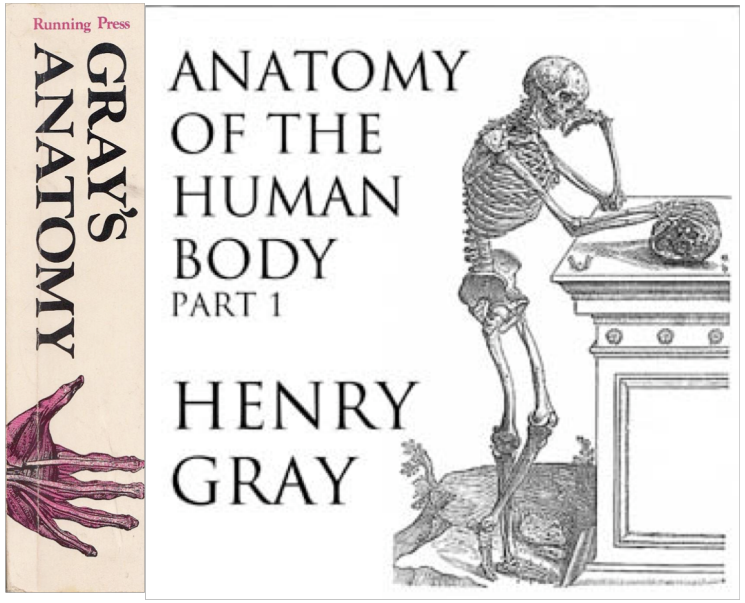
Univariate -> multivariate

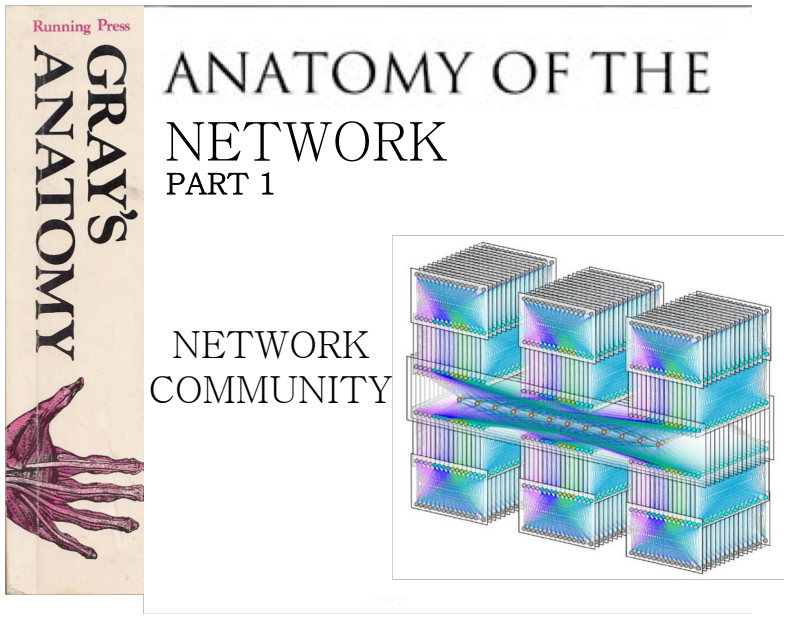
- Single value -> stream
  - If x > delta ? (threshold approach, delta can be time dependent?)
  - [x1, x2, x3, x4, x5, …], does [x4, x5, ..] start to demonstrate a different pattern?
- Univariate -> multivariate
  - [x1, x3, x3, x4, x5, ….]
  - [(x1, y1, z1), (x2, y2, z2), (x3, y3, z3), (x4, y4, z4), (x5, y5, z5), …], are [(x4, y4, z4), (x5, y5, z5), …] different from the rest?

- Single outputs -> Single reaction
  - Chasing singularities all over your universe
  - Challenges to diagnose all the symptoms of an illness, not just one.
- Multiple Outputs -> Educated/Multidimensional reaction
  - Knowing what illness/injury to treat and how it will heal all the associated symptoms

Building the Gray's Anatomy for Networks



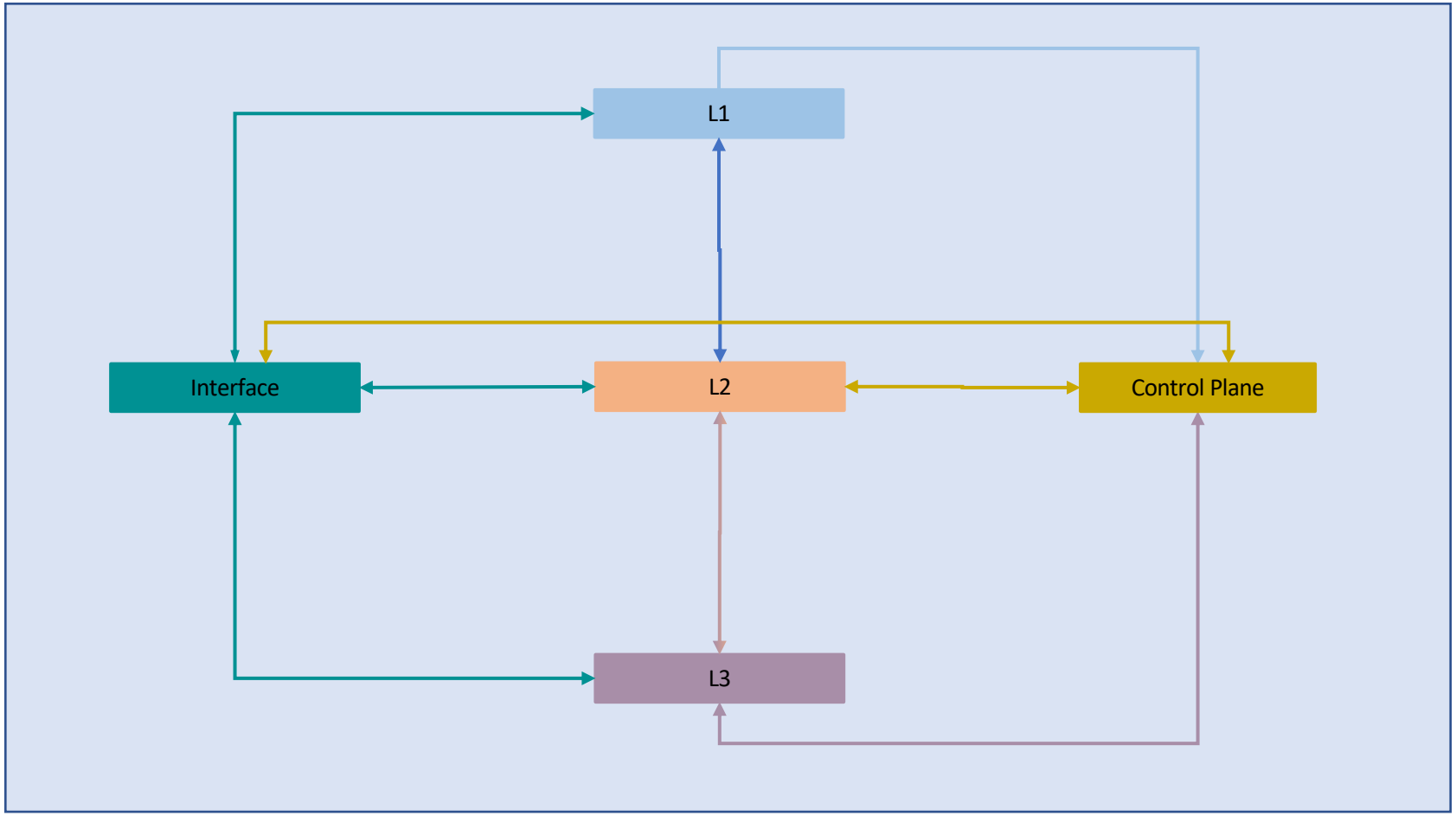


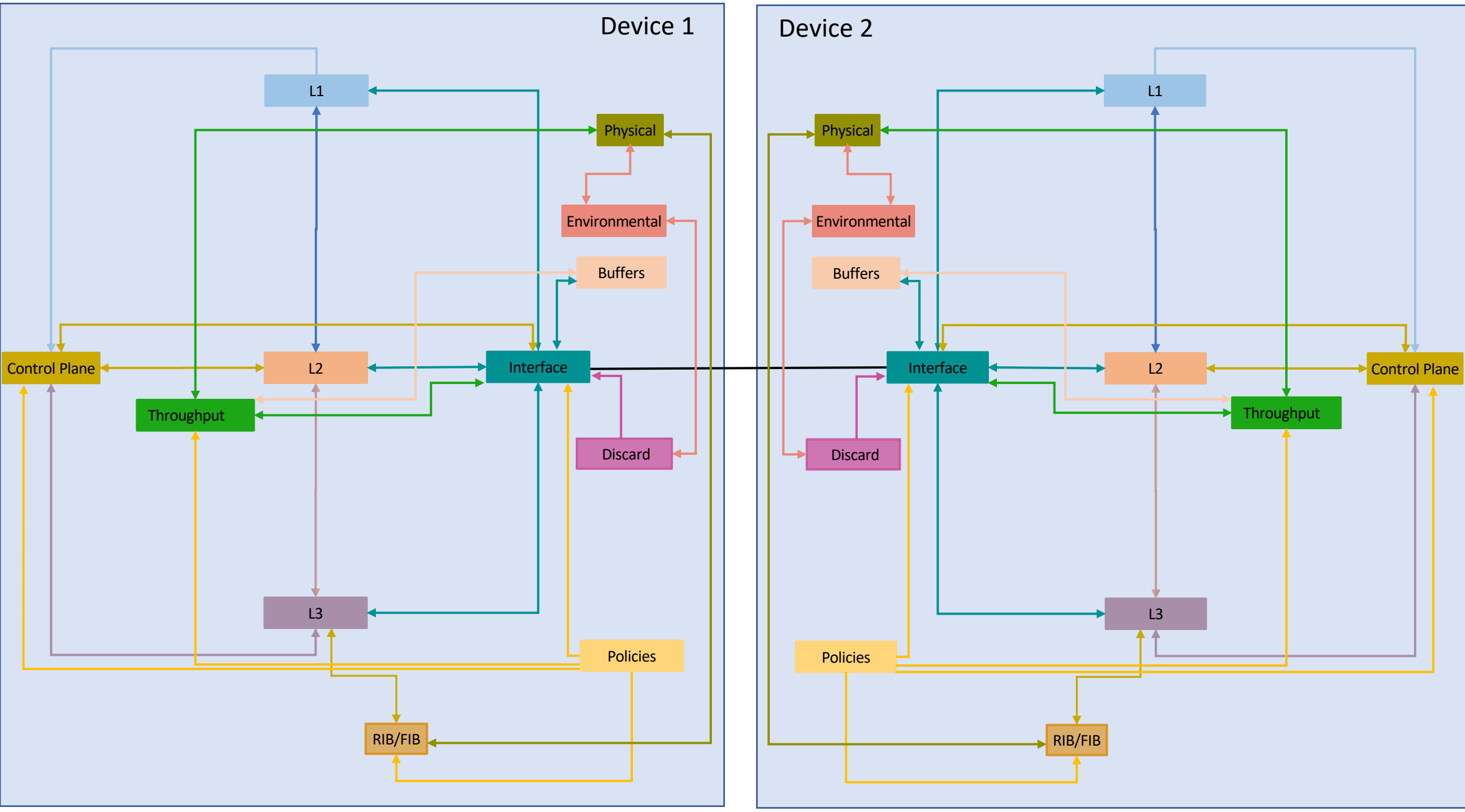


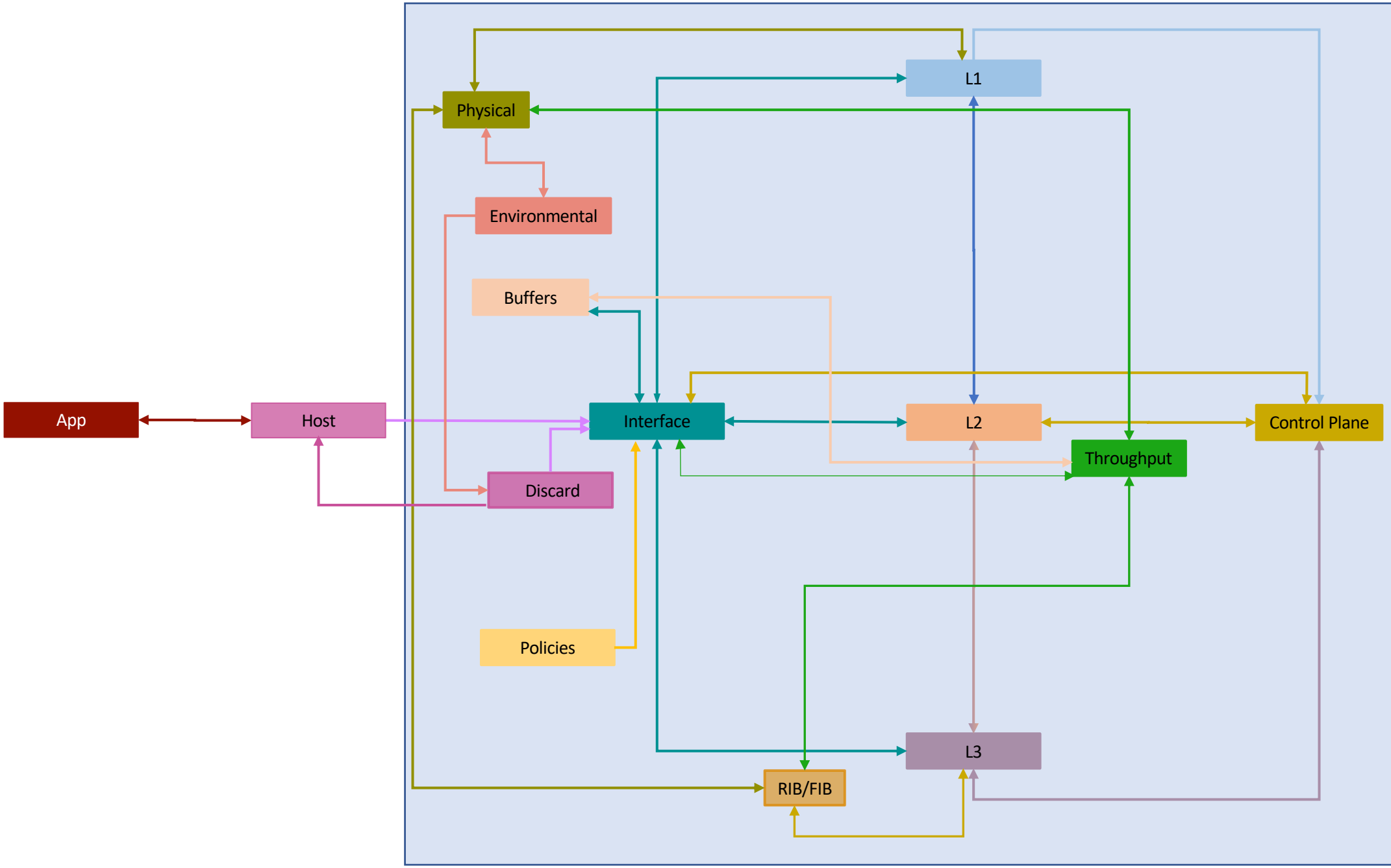
Data Types, Causal Connections and Event Vectors

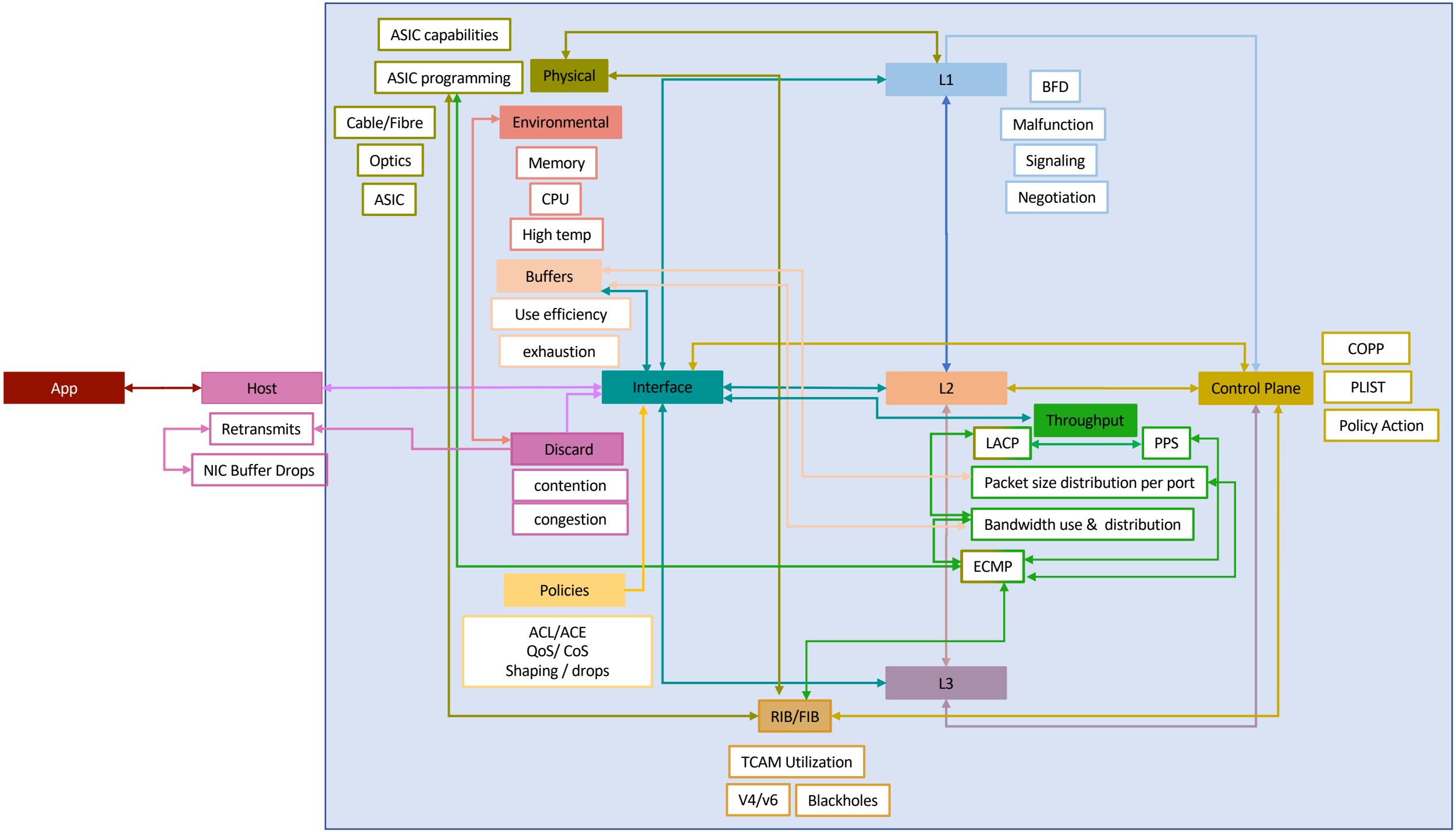
State/Data Types	Behavioral		Events	
Configuration	ACL / ACE	Link speed	ASIC ECC errors	Mac move
Environmental	ASIC	Link stability	BFD state change	Memory Leak
Feature	Bandwidth utilization	Maintenance windowing	Buffer starvation	MTU mismatch
Flow	Buffer utilization	Quality of service	CDP drop	Neighbor state change
Hardware	Buffer utilization efficiency	RIB/FIB consistency	CEF punts	Packet drops
Availability	Congestion	RIB/FIB utilization	DDoS	Port state change
Operational	Contention	Route convergence	Device failure	Power budget exceeded
Platform	Control plane policing	Route stability	Disk full/failure	Power supply failure
Protocol	Device environmental	Route updates	ECMP imbalance	Process failure
Routing	Device health	Router health	Fan failure	Route failure out of memory
Security	ECMP load distribution	Telemetry health	Fat fingered config	Route Flap
Compute	Flow path	Transceiver health	High CPU	Route loop
Application	Incast	Transceiver state	High fan speed	Route mis-programmed
	Interface health	Tunnel health	High temperature	Routing blackhole
	Interface state	Quality of service	Interface Errors	Telemetry failures/congestion
	LACP load distribution	RIB/FIB consistency	LACP imbalance	Transceiver power issue
	Link health		LACP member failure	Transceiver TX lane degradation
			Link failure	Tunnel/midpoint drop
			LLDP drop	

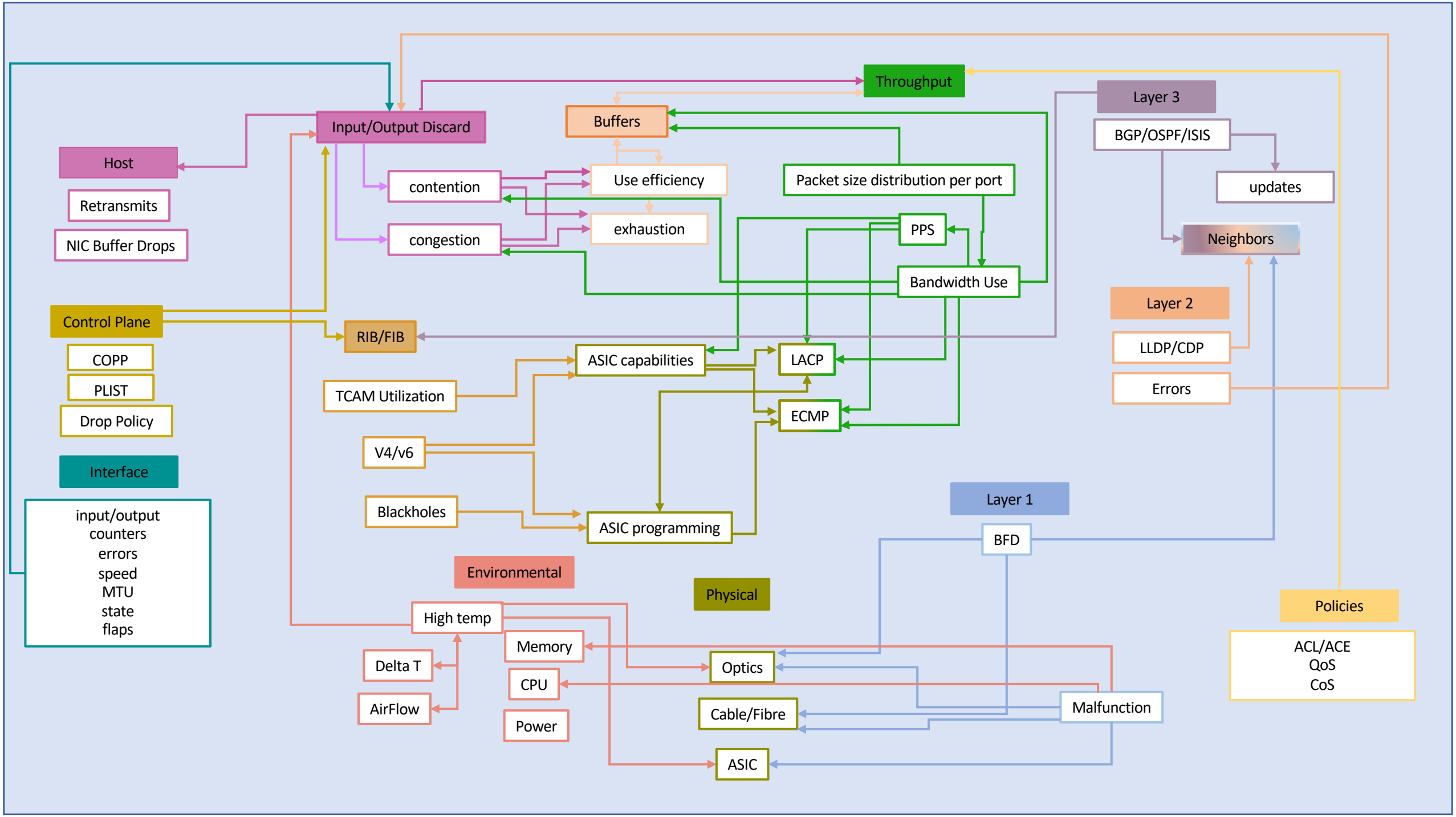
Relationships start out Simple

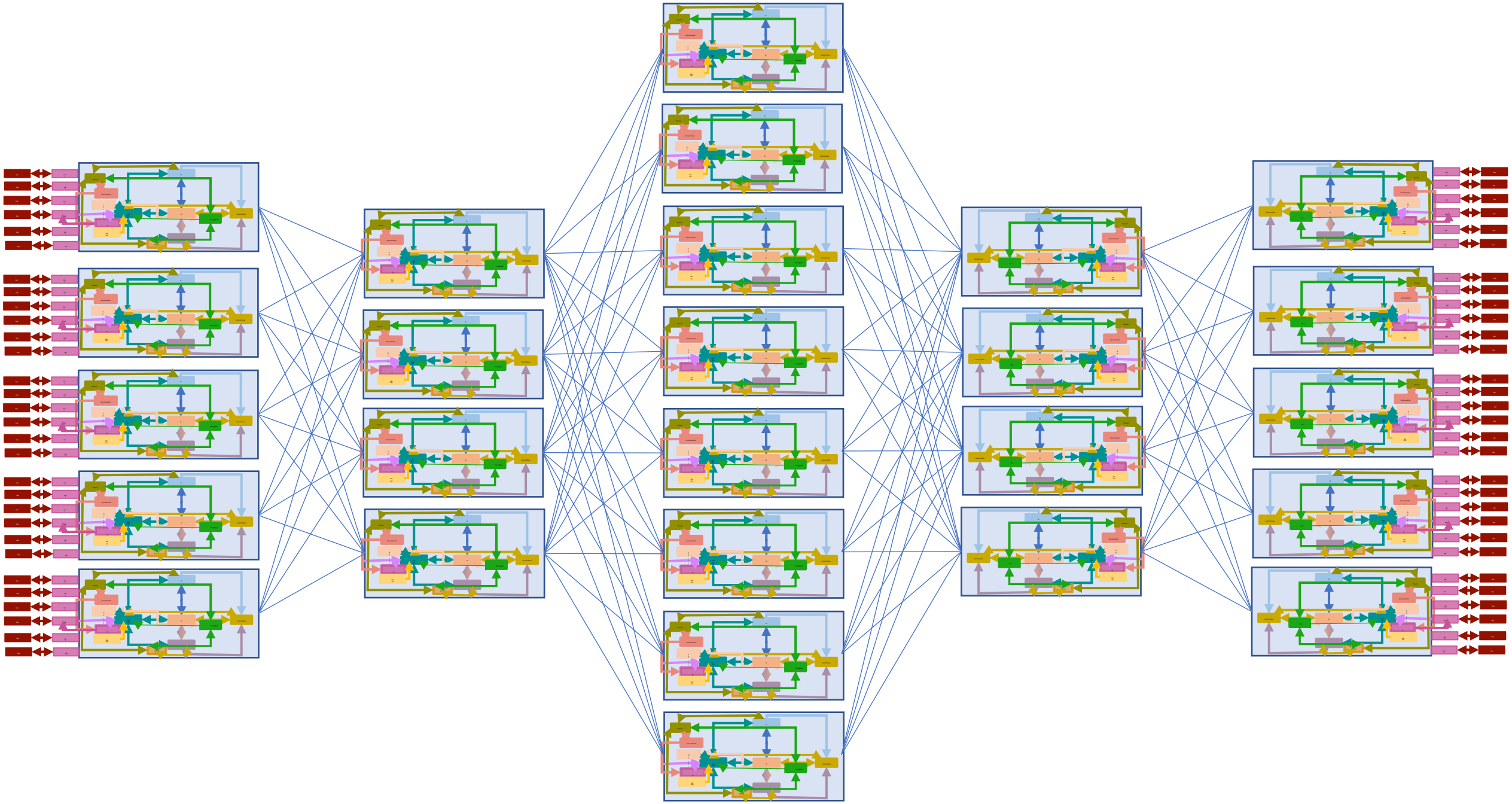



Device 1
L1
Physical
Environmental
Buffers
Control Plane
L2
Interface
Throughput
Discard
L3
Policies
RIB/FIB
Device 2
L1
Physical
Environmental
Buffers
Interface
L2
Control Plane
Throughput
Discard
L3
Policies
RIB/FIB


L1
Physical
Environmental
Buffers
App
Host
Interface
L2
Control Plane
Throughput
Discard
Policies
L3
RIB/FIB


ASIC capabilities
ASIC programming
Physical
L1
BFD
Malfunction
Signaling
Negotiation
Cable/Fibre
Optics
ASIC
Environmental
Memory
CPU
High temp
Buffers
Use efficiency
exhaustion
COPP
PLIST
Policy Action
App
Host
Interface
L2
Control Plane
Throughput
LACP
PPS
Retransmits
NIC Buffer Drops
Discard
contention
congestion
Packet size distribution per port
Bandwidth use & distribution
ECMP
Policies
ACL/ACE
QoS/ CoS
Shaping / drops
L3
RIB/FIB
TCAM Utilization
V4/v6
Blackholes


Throughput
Layer 3
Input/Output Discard
Buffers
BGP/OSPF/ISIS
Host
Use efficiency
Packet size distribution per port
updates
Retransmits
contention
exhaustion
PPS
Neighbors
NIC Buffer Drops
congestion
Bandwidth Use
Layer 2
Control Plane
RIB/FIB
LLDP/CDP
COPP
ASIC capabilities
LACP
PLIST
TCAM Utilization
Errors
ECMP
Drop Policy
V4/v6
Interface
Layer 1
Blackholes
ASIC programming
BFD
input/output
counters
errors
speed
MTU
state
flaps
Environmental
Physical
Policies
High temp
Memory
Optics
ACL/ACE
QoS
CoS
Delta T
CPU
Malfunction
AirFlow
Cable/Fibre
Power
ASIC

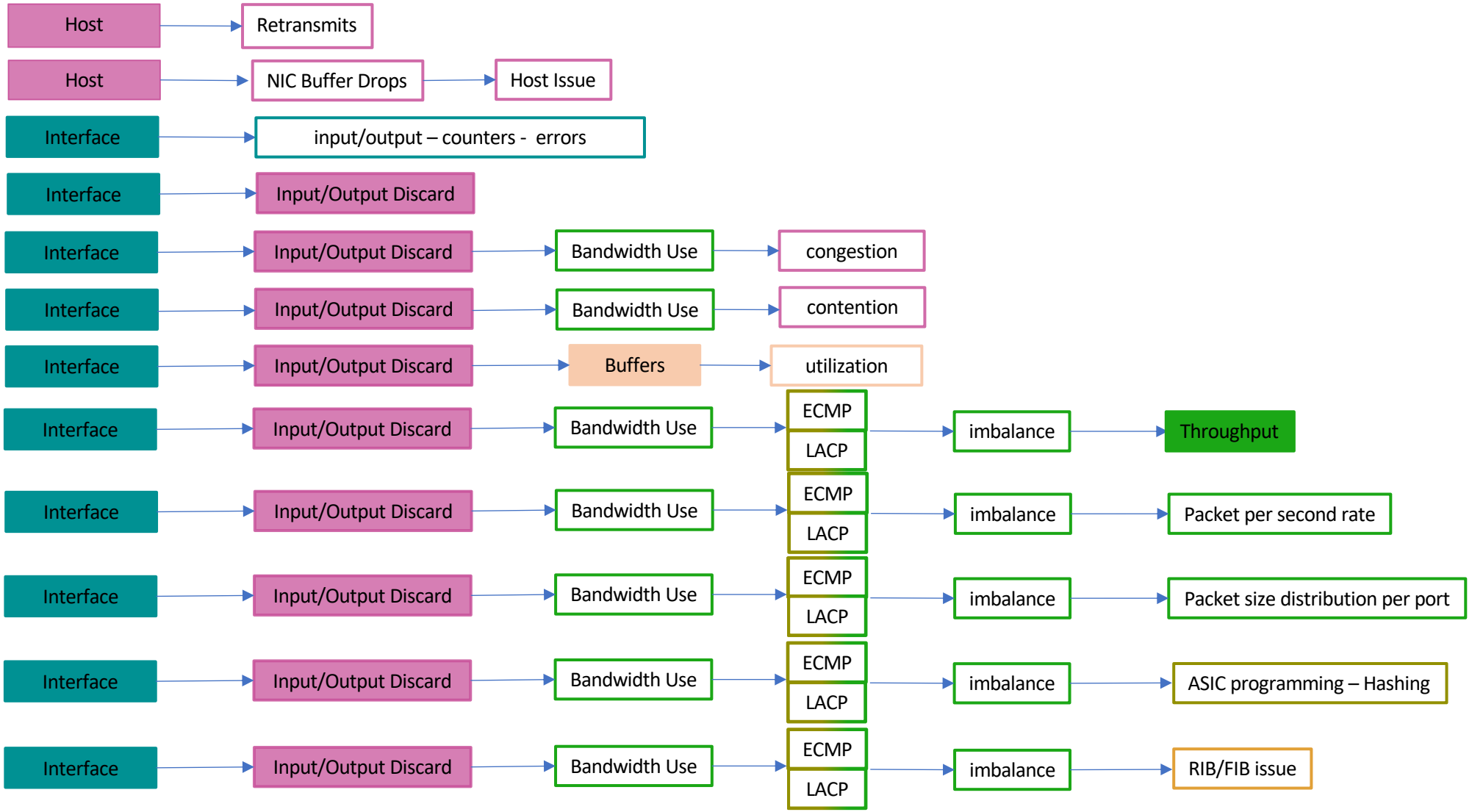


Causal Connections and Event Vectors

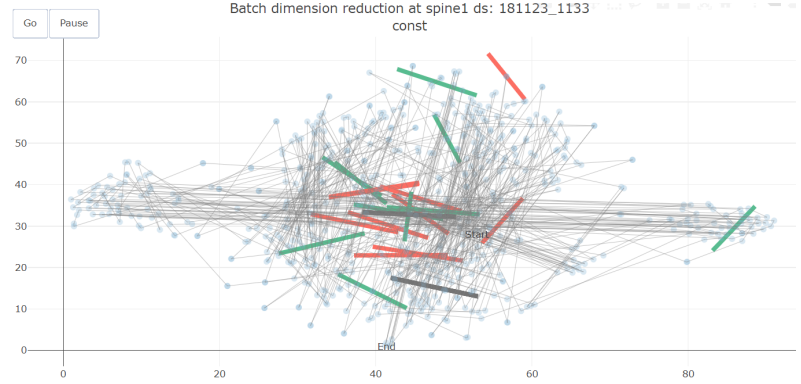
Behavioral				Events	
ACL / ACE		Link speed		ASIC ECC errors	Mac move
ASIC		Link stability		BFD state change	Memory Leak
Bandwidth util.		Maintenance window		Buffer starvation	MTU mismatch
Buffer utilization		Packet (size dist, freq.)		CDP drop	Neighbor state change
Buffer util. efficiency		Quality of service		CEF punts	Packet drops
Congestion		RIB/FIB consistency		DDoS	Port state change
Contention		RIB/FIB utilization		Device failure	Power budget exceed
Control plane policing		Route convergence		Disk full/failure	Power supply failure
Device environmental		Route stability		ECMP imbalance	Process failure
Device health		Route updates		Fan failure	Route failure OOM
ECMP load dist		Router health		Misconfigured	Route Flap
Flow path		Telemetry health		High CPU	Route loop
Incast		Transceiver health		High fan speed	Route programming
Interface health		Transceiver state		High temperature	Routing blackhole
Interface state		Tunnel health		Interface Errors	Telemetry fail/congestion
LACP load dist		Quality of service		LACP imbalance	Transceiver power
Link health		RIB/FIB consistency		LACP member fail	Transceiver lane power
				Link failure	Tunnel/midpt drop
				LLDP drop	

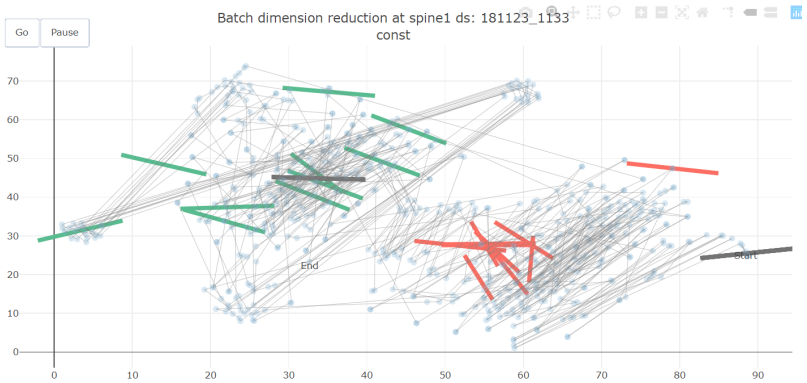
Buffers
Interface
Throughput
Control Plane
RIB/FIB
Policies
Physical
Environmental
Discard
Layer 3
Layer 2
Layer 1

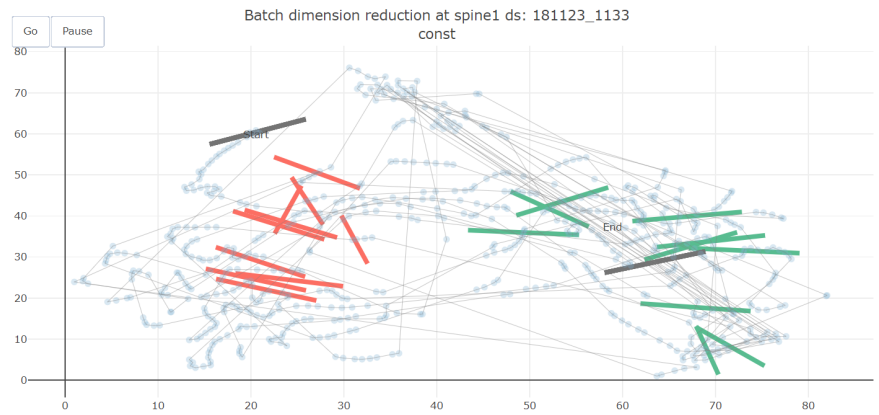
Event Vectoring – Retransmits/Drops

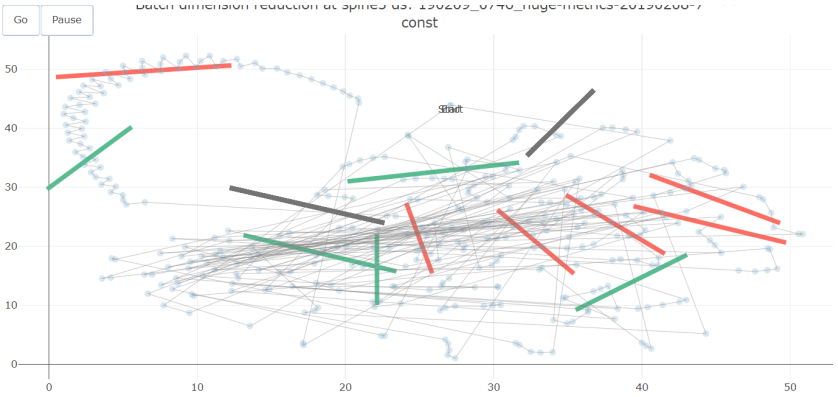


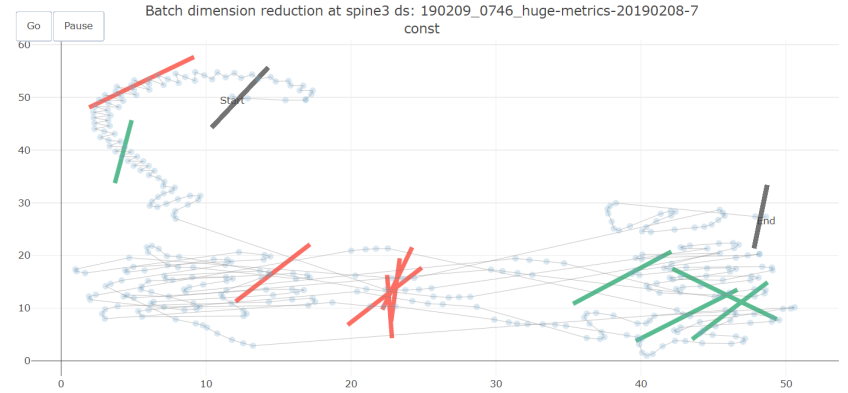
Value to ML/AI of Network Domain Knowledge

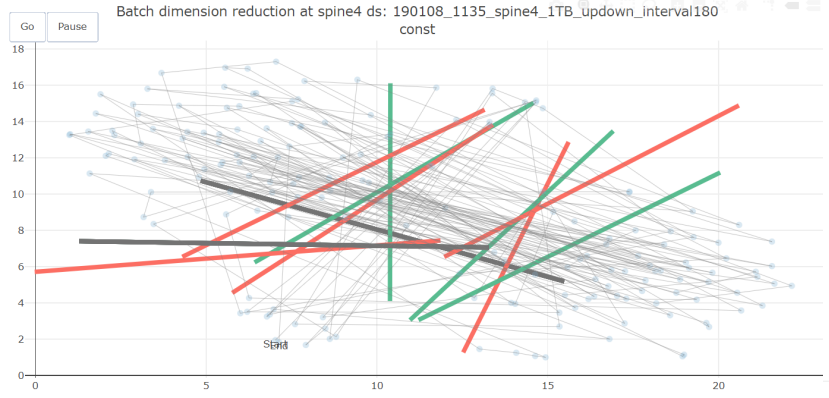


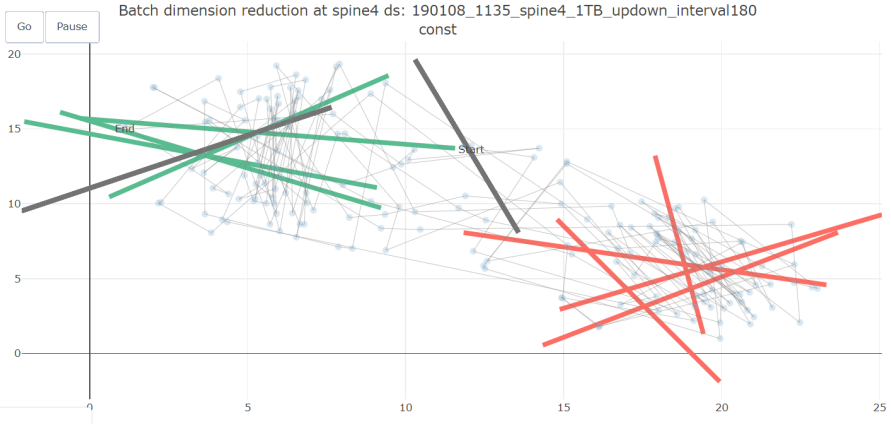


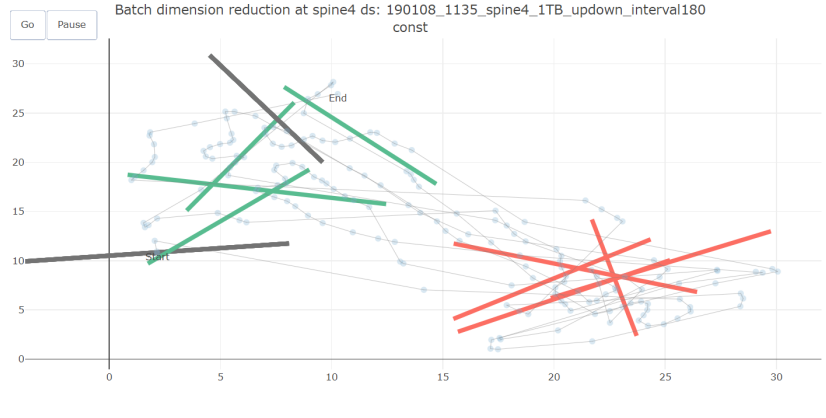












Where do we go from here?

- Goal: a Network Anatomy, Diagnostic and Treatment reference guide
- The knowledge is out there, but it is tribal with the network engineers/network operators
- Let’s build a community-based information base
  - Starting with event vectors

URL: https://github.com/apletcher/NADT-Guide

Q&A

Thank You