
facebook
INFRASTRUCTURE

Fault Detection at Scale

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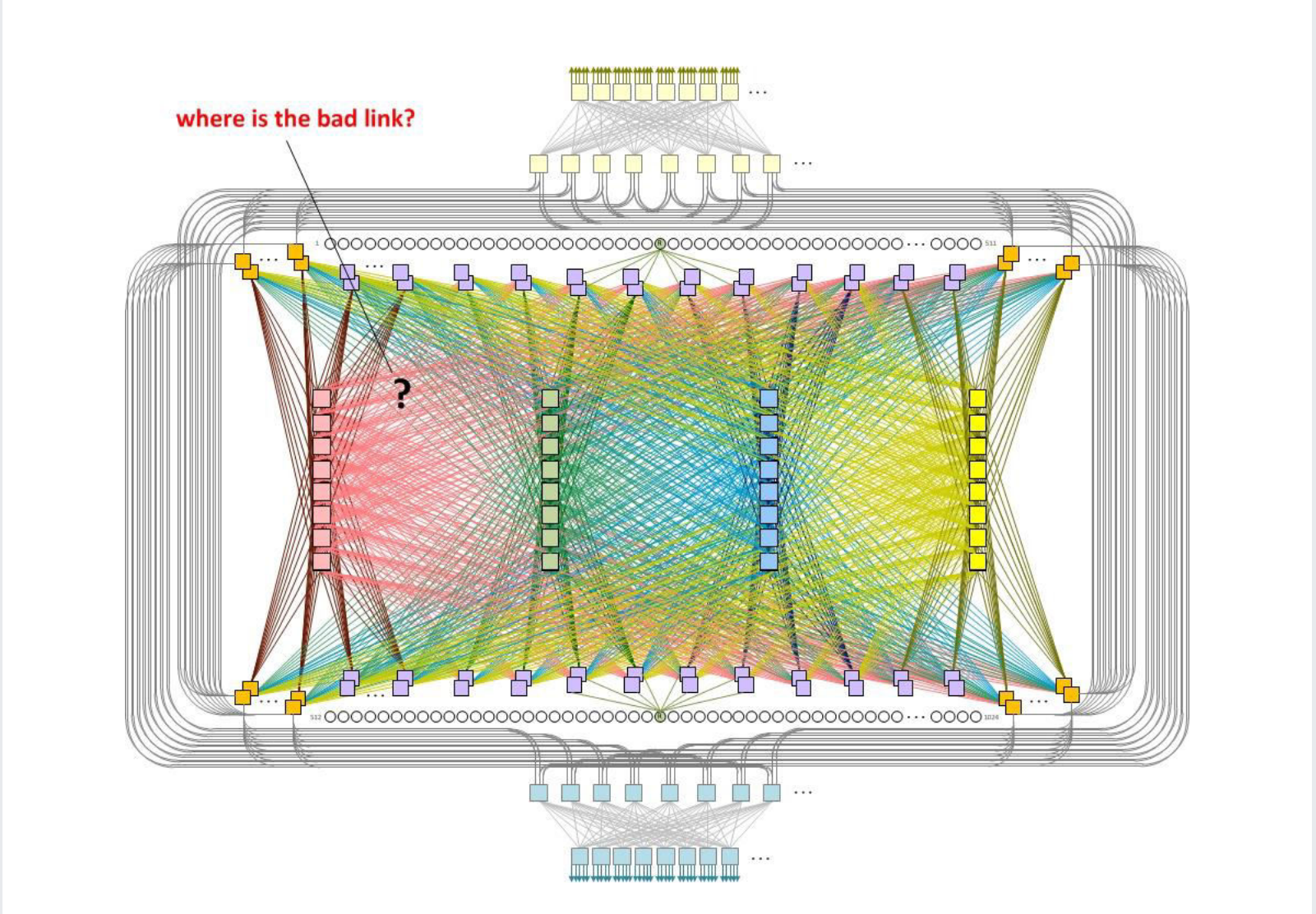
Agenda

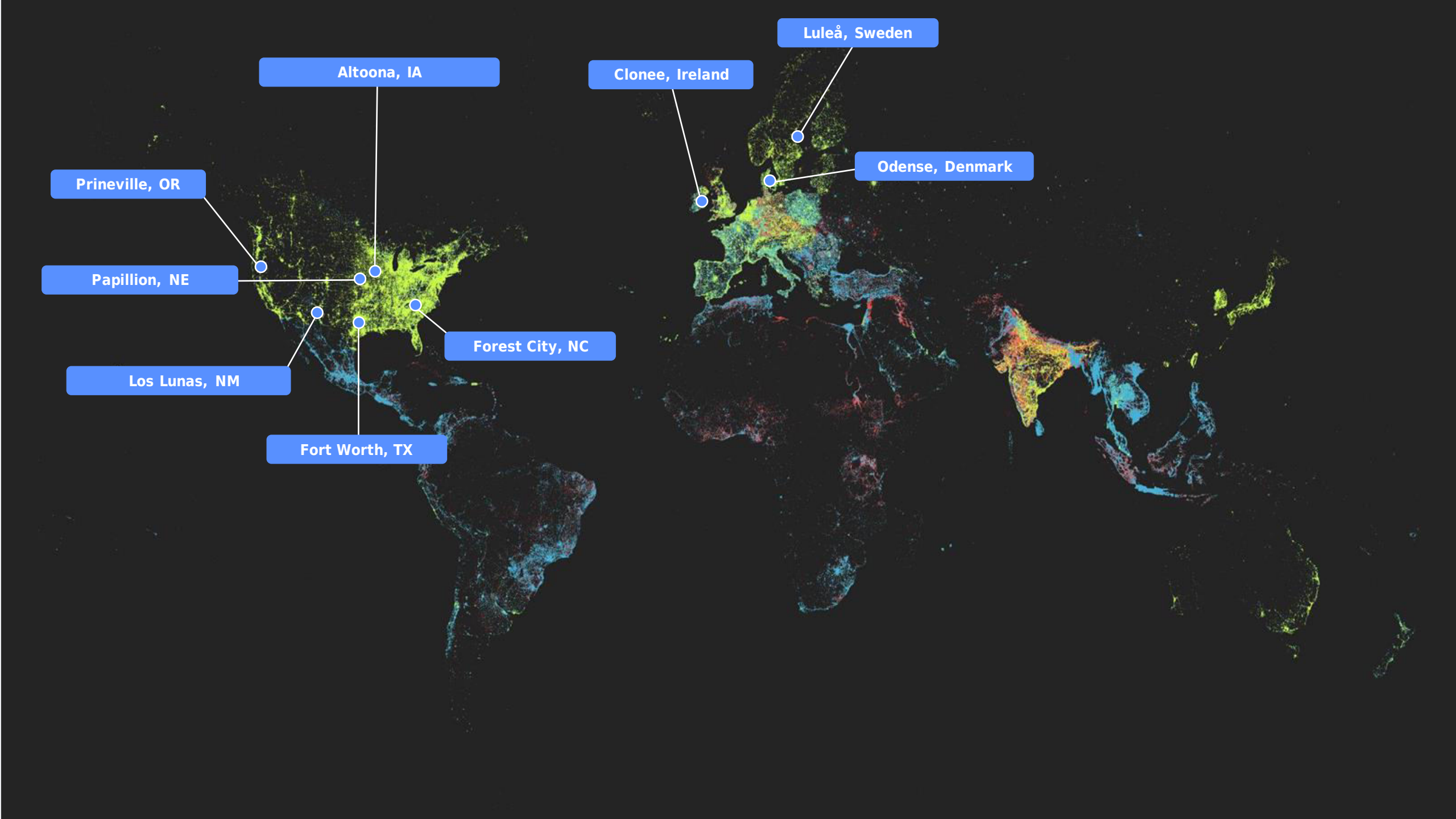
- Monitoring the network
- How and what
  - NetNORAD
  - NFI
  - TTLd
  - Netsonar
- Lessons learned
- Future

Network Monitoring

Fabric Networks

- Multi stage CLOS topologies
- Lots of devices and links
- BGP only
- IPv6 >> IPv4
- Large ECMP fan out




Luleå, Sweden
Altoona, IA
Clonee, Ireland
Odense, Denmark
Prineville, OR
Papillion, NE
Forest City, NC
Los Lunas, NM
Fort Worth, TX

Active Network Monitoring

Why is passive not enough?

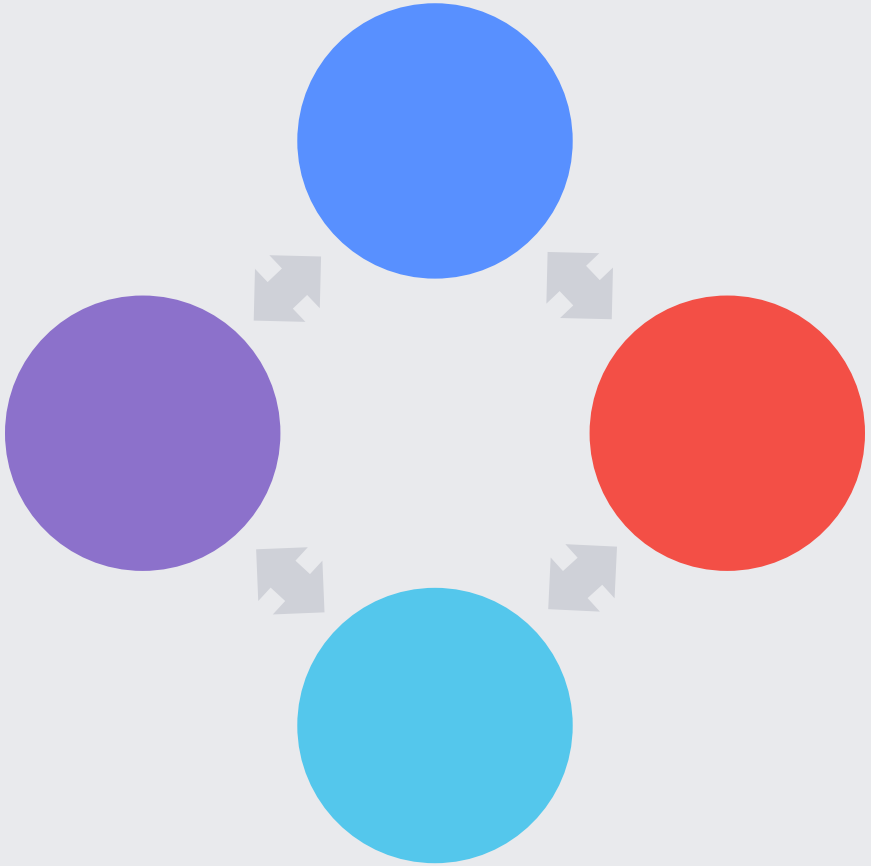
- SNMP: trusting the network devices
- Host TCP retransmits: packet loss is everywhere

- Active network monitoring:
  - **Inject synthetic packets** in the network
  - Treat the devices as **black boxes**, see if they can forward traffic
  - **Detect** which service is impacted, **triangulate** loss to device/interface

NetNORAD, NFI, NetSONAR, TTLd

What!?

NetNORAD
Rapid detection of faults



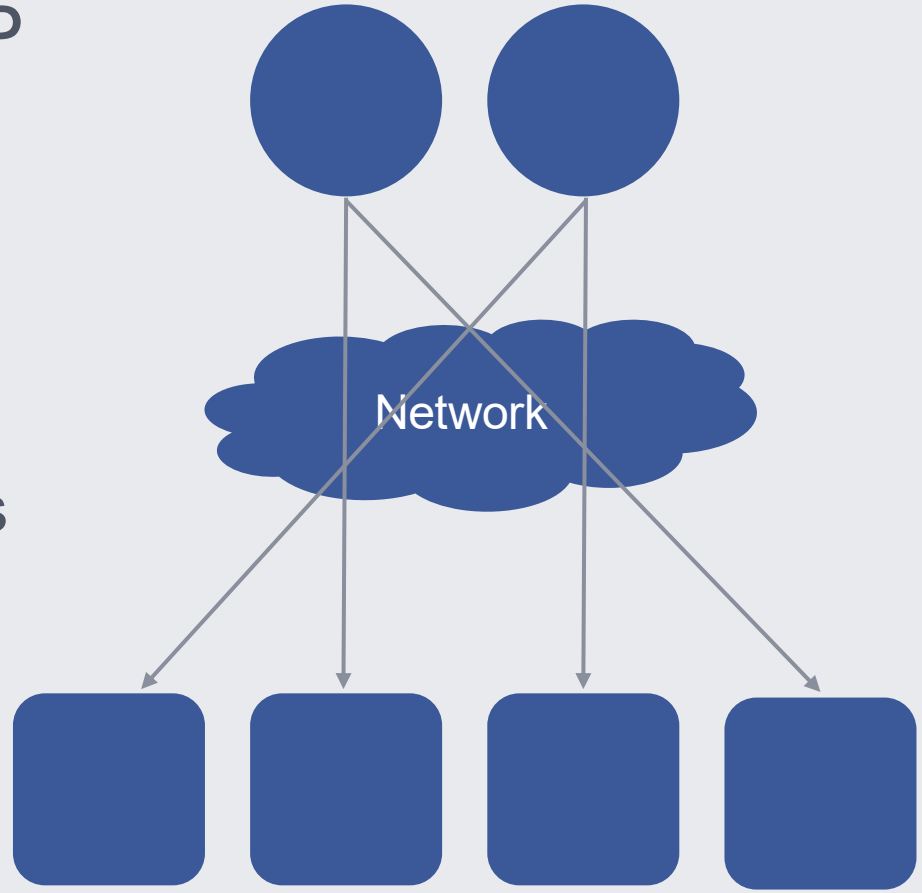
NFI
Isolate fault to a specific device or link

TTLd
End-to-end retransmit and loss detection using production traffic

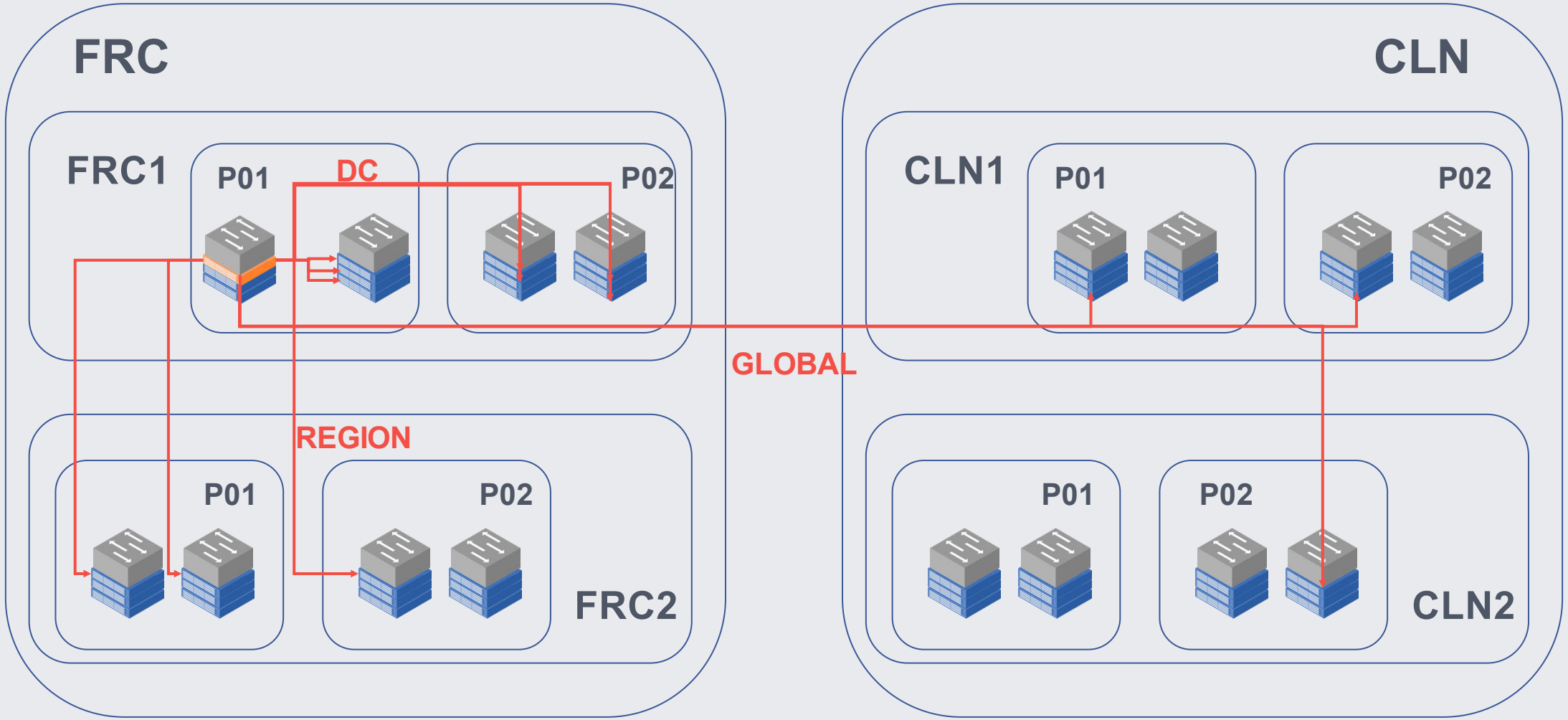
Netsonar
Up/Down reachability info

NetNORAD

- A set of agents injects synthetic UDP traffic
- Targeting **all** machines in the fleet
  - targets >> agents
  - Responder is deployed on all machines
- Collect packet loss and RTT
- Report and analyze

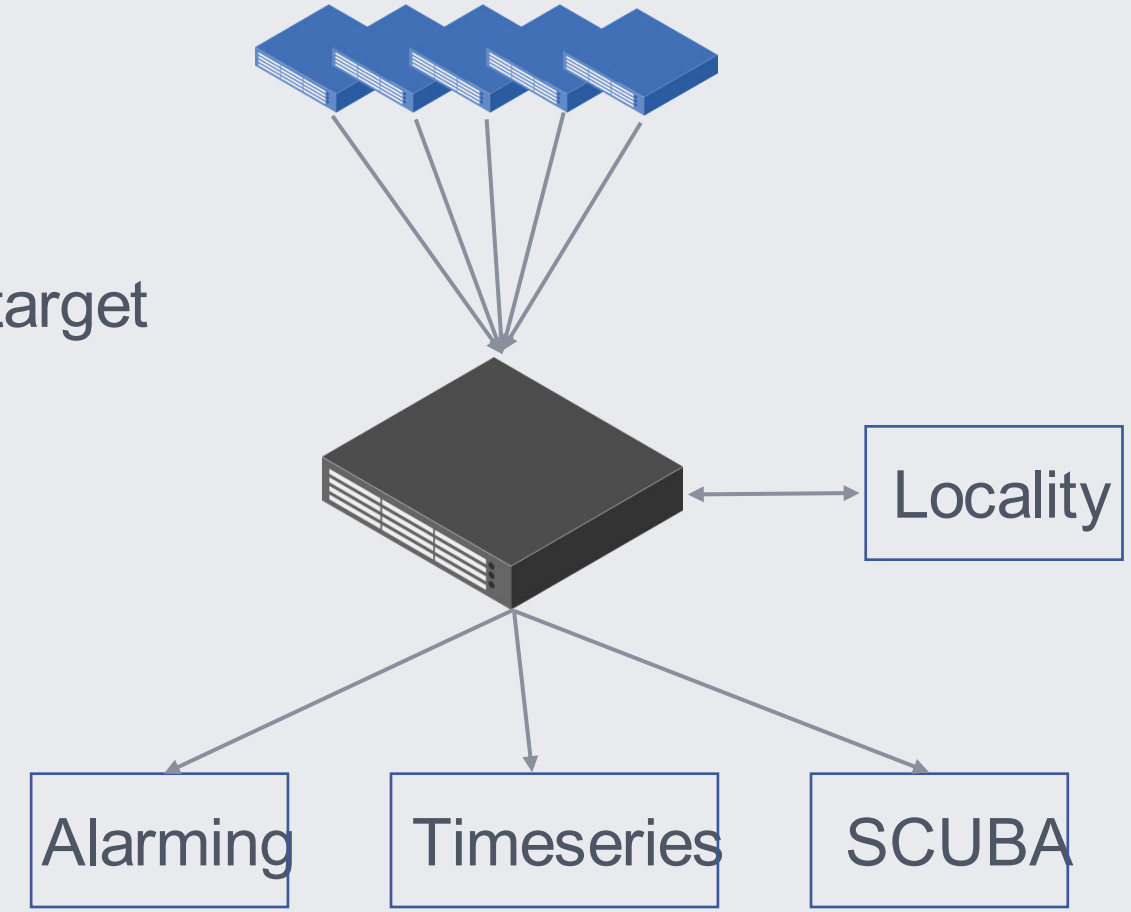


NetNORAD - Target Selection



NetNORAD – Data Pipeline

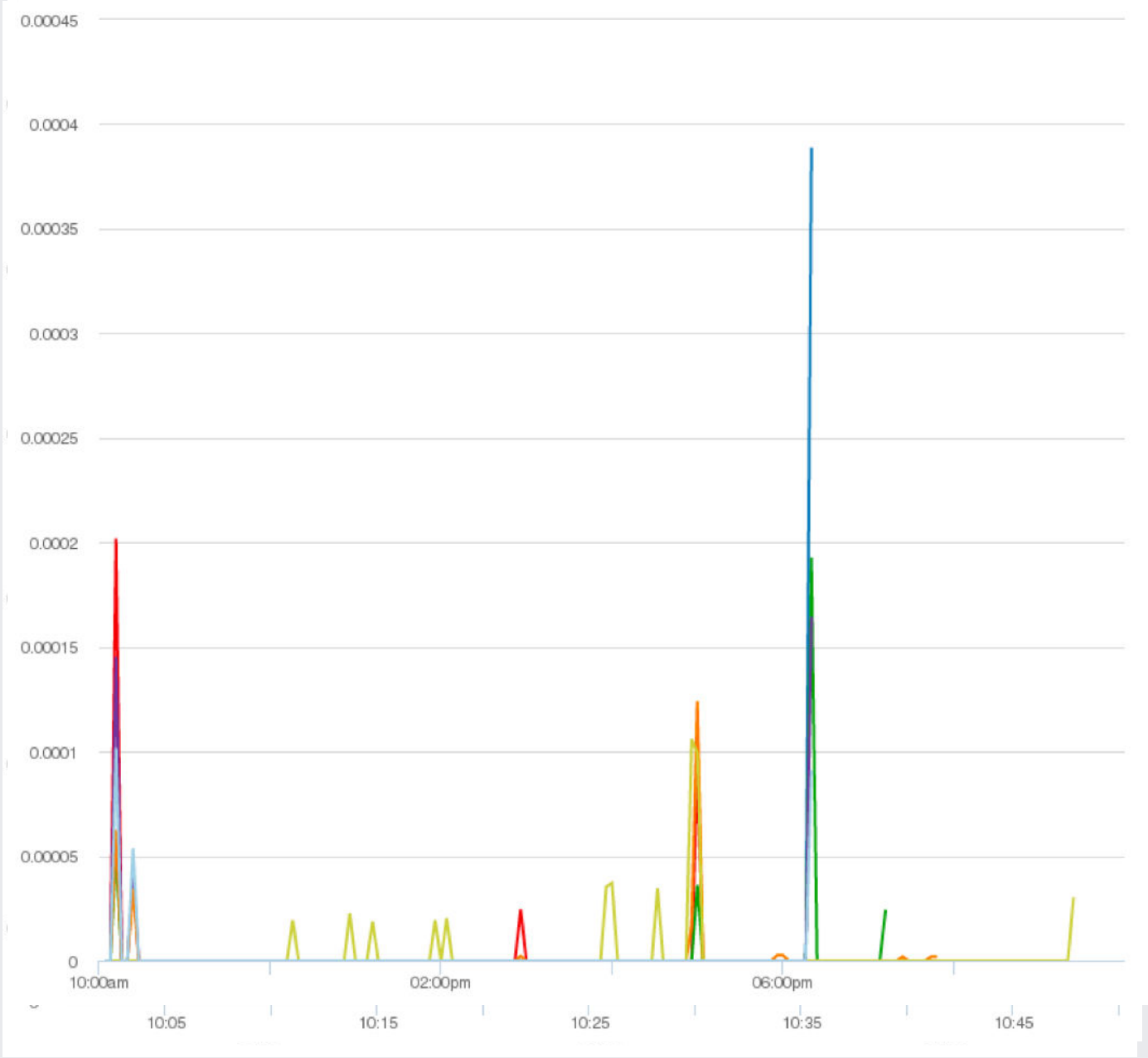
- Agents reports to a fleet of aggregators
  - pre-aggregated results data per target
- Aggregators
  - calculate per-pod percentiles for loss/RTT
  - augment data with locality info
- Reporting
  - to SCUBA
  - timeseries data



Observability

Using SCUBA

- By scope – isolates issue to
  - Backbone, region, dc
- By cluster/pod – isolates issue to
  - A small number of FSWs
- By EBB/CBB
  - Is replication traffic affected?
- By Tupperware Job
  - Is my service affected?



NFI

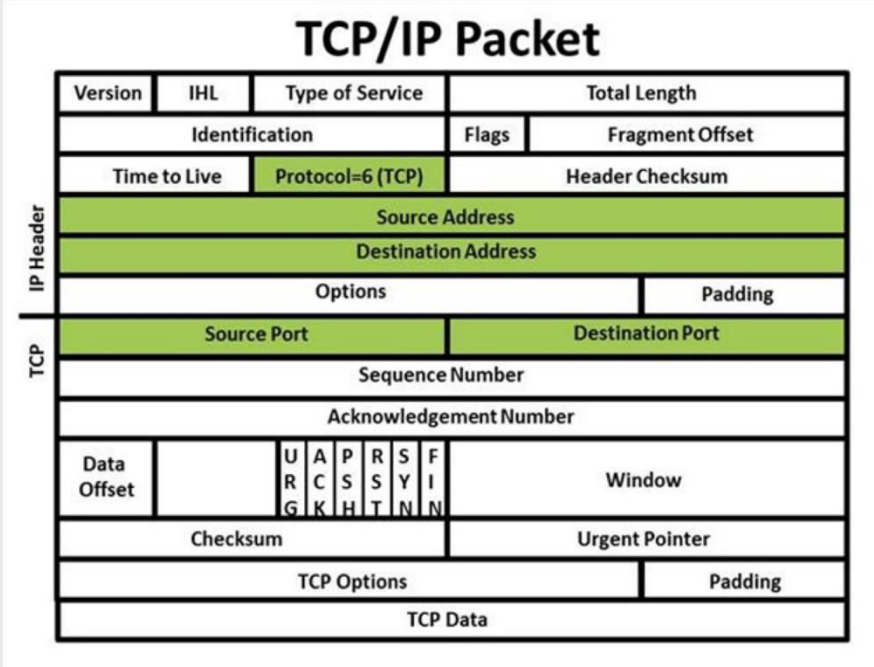
Network Fault Isolation

- Gray Network failures
- Detect and triangulate to device/link
- Auto remediation
- Also useful dashboards (timeseries and SCUBA)

NFI

How (shortest version possible)

- Probe all paths by rotating the SRC port (ECMP)
- Run traceroutes (also on reverse paths)
- Associate loss with path info
- Scheduling and data processing similar to NetNORAD
- Thrift – based (TCP)



NetSONAR

- Blackbox monitoring tool
- Sends ICMP probes to network switches
- Provides reachability information: is it up or down?
- Scheduling and data pipeline similar to NetNORAD and NFI

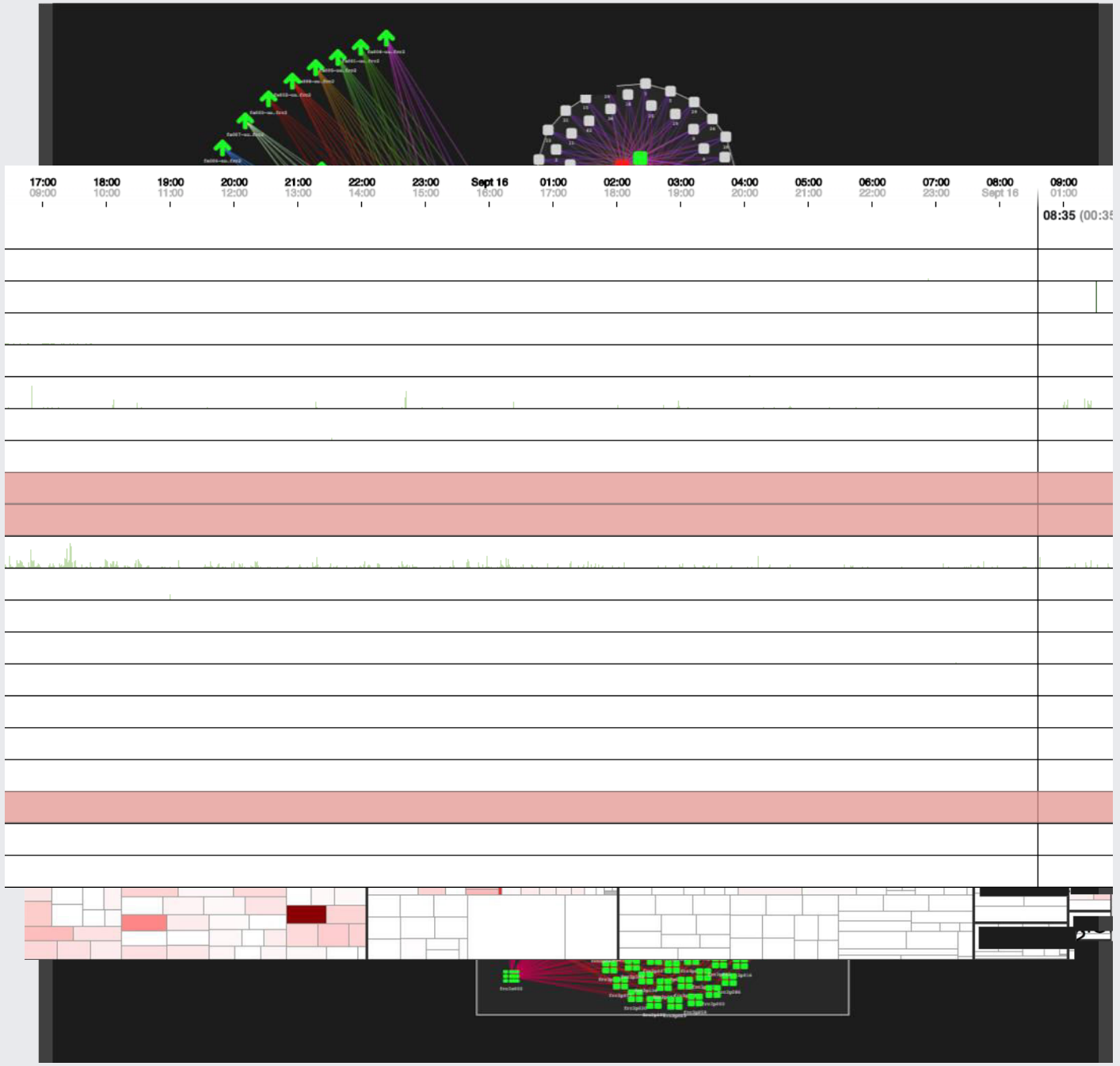
TTLd

Mixed Passive / Active approach

- Main goal: surface end to end retransmits throughout the network
- Use production packets as probes
- A mixed approach (not passive, not active)
  - End host mark one bit in the IP header when the packet is a retransmission
  - Uses MSB of TTL/Hop Limit
  - Marking is done by an eBPF program on end hosts
- A collection framework collect stats from devices (sampled data)

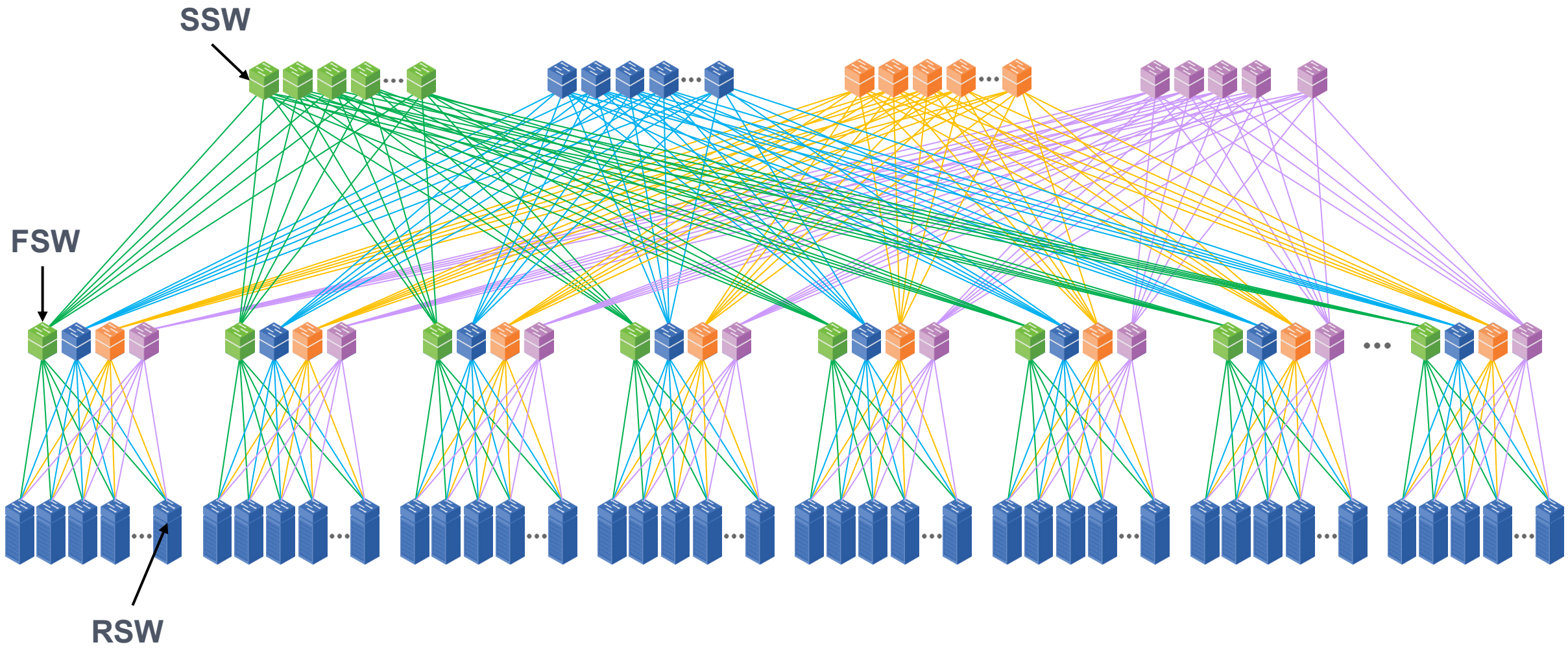
Visualization

- High density dashboards
  - Using cubism.js
- Fancy javascript UIs
  - (various iterations)
- Other experimental views



Examples

Example Fabric Layout



Example 1

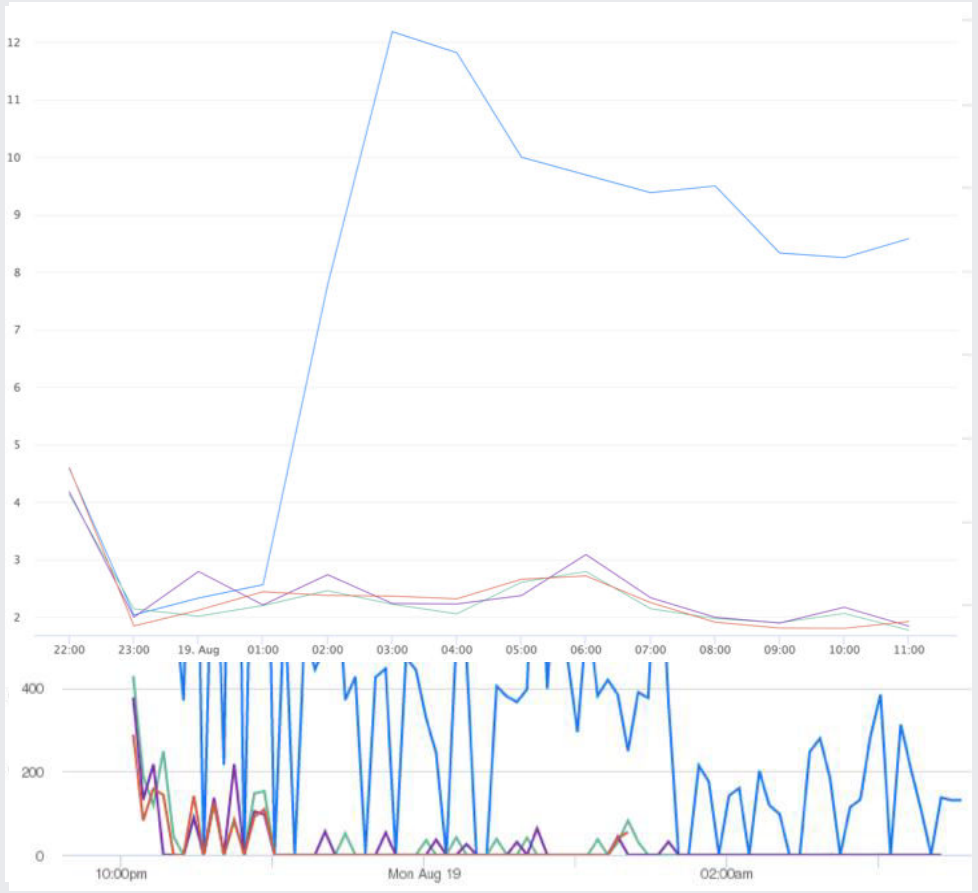
Bad FSW causing 25% loss in POD

- Clear signal in NetNORAD
- Triangulated successfully by NFI
- Also seen in passive collections

Example 2

Bad FSW could not be drained (failed automation)

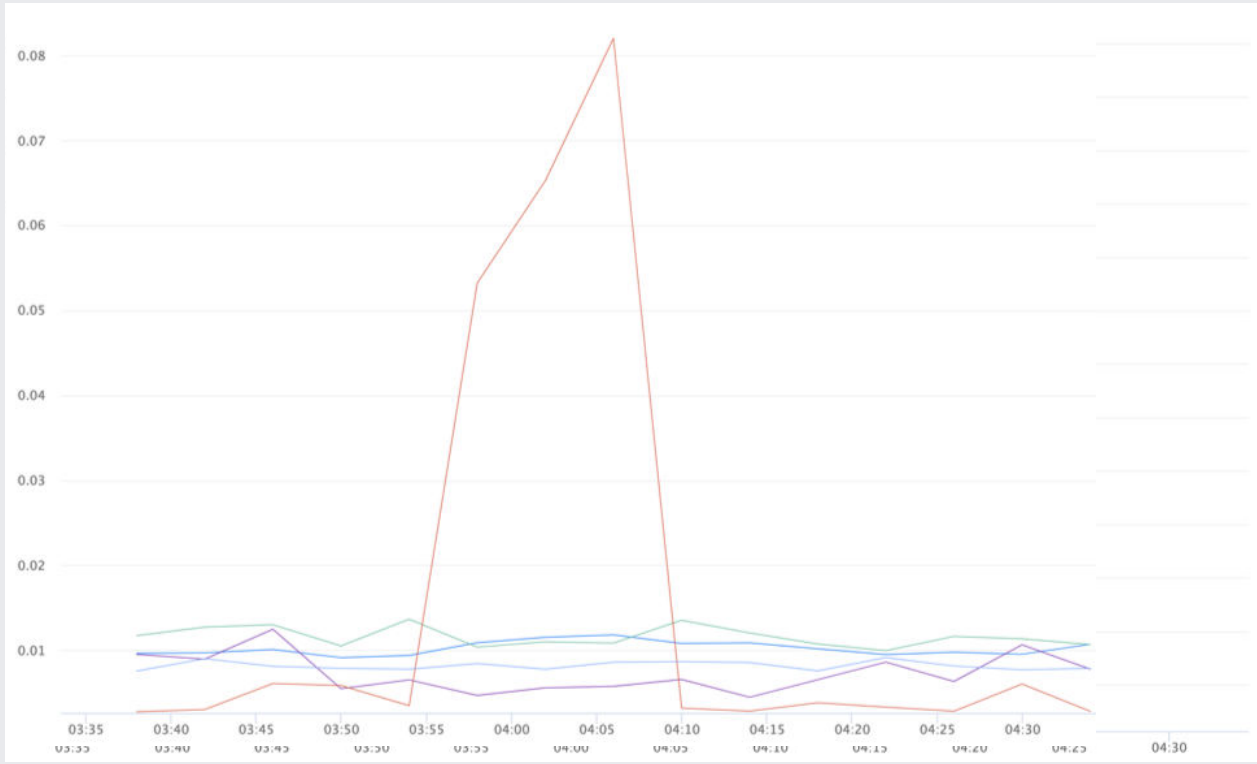
- Low loss seen in NetNORAD
- NFI drained the device
  - But the drain failed
- NFI alarms again
- Clear signal in TTLd too



Example 3

Congestion, false alarm

- Congestion happens
- NFI uses outlier detection
  - Not perfect
- Loss in NetNORAD was just limited to a single DSCP



Lessons Learned

Lesson learned

Multiple tools, similar problems

- Having multiple tools helps
  - Separate failure domains
  - Separation of concerns
  - But also adds a lot of overhead
- Reliability:
  - Regressions are usually the biggest problem
  - Holes in coverage are the next big problem
  - Dependency / cascading failures

How to avoid regressions or holes?

i.e. how to know we can catch events reliably.

- After validating the proof of concept
- How to make sure it continues working?
- … that it can detect failures
- … maintaining coverage
- … and keeping up with scale
- … and doesn’t fail with its dependencies?

Coverage

- It’s a function of time and space
  - e.g. we cover the 90% of the devices 99% of the time
- Should not regress
  - New devices should be covered once provisioned
- Monitor and alarm!

Accuracy

false positive vs true positive

- Find a way to categorize events
  - Possibly automatically
- Measure and keep history
- Make sure there’s no regressions

Regression detection

Not just for performances

- How do we know we can detect events?
  - **Before** we get an event, possibly!
- End-to-End (E2E) testing:
  - Introduce fake faults and see if the tool can detect them
  - Usually done via ACL injection to block traffic
- Middle-to-End (M2E) testing:
  - Introduce fake data in the aggregation pipeline
  - Useful for more complex failures

Performance

- Time to detection
- Time to alarm
- But also more classic metrics (cpu, mem, errors)
- Measure and alarm!

Dependencies failures

Or how to survive when things start to fry

- Degrade gracefully during large scale events
  - i.e. what if SCUBA is down?
  - or the timeseries database?
- “doomsday” tooling:
  - Review dependencies, see if you can drop as many as we can
  - Provide a subset of functionalities
  - Make sure it’s user friendly (both the UI and the help)
  - Make sure it’s continuously tested

Future

Future work

Lots of work to do

- Keep up with scale
- Support new devices and networks
- Continue to provide a stable signal
- Exploring ML for data analysis
- Improve coverage