Patchwork

Profiling the Network of a Federated Testbed

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What’s a “network profile”?

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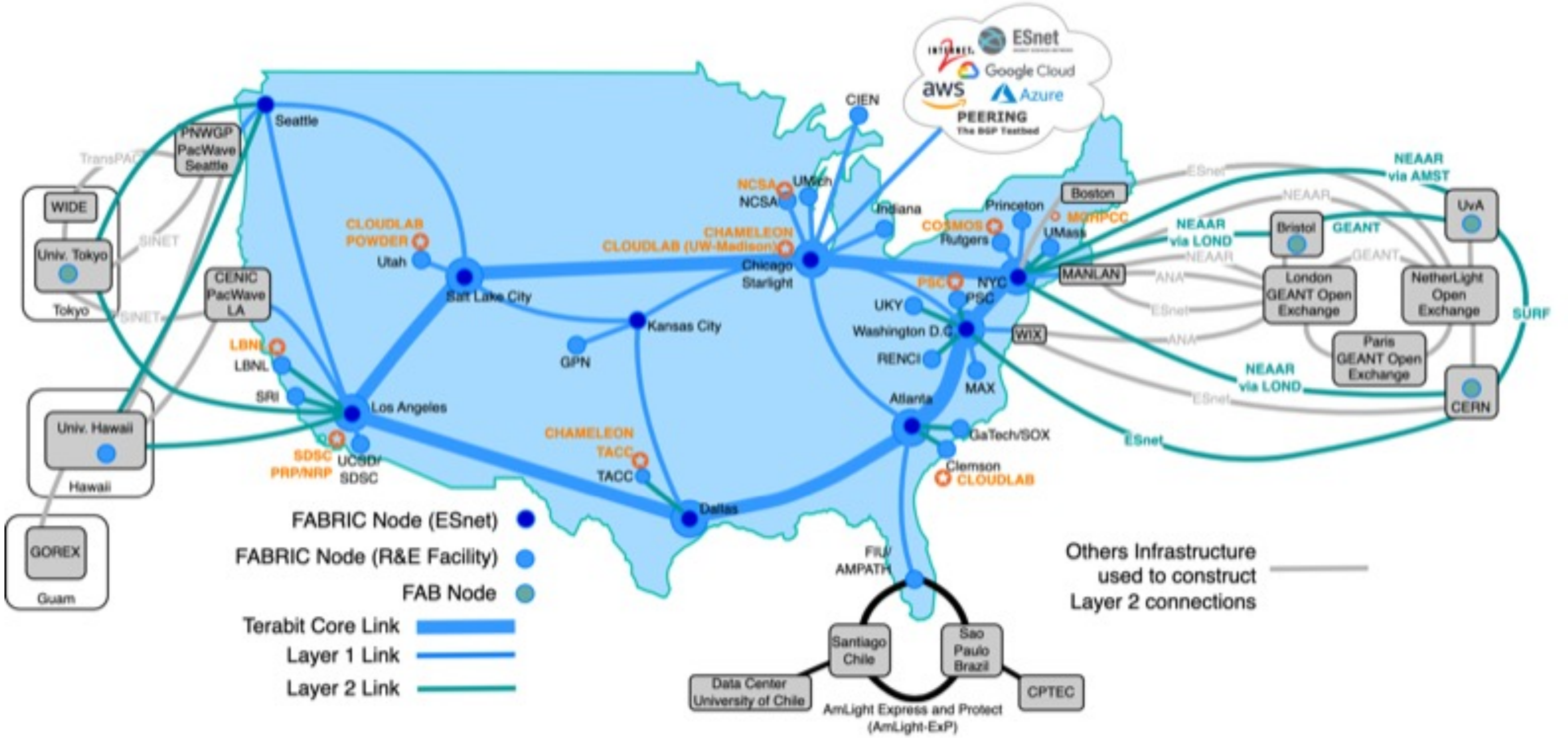
- Traffic composition over time:
  - **Header types**: What protocols are being used.
  - **Encapsulation patterns**: How is the network being used.
  - **Flows**
    - Number of packets
    - Packet sizes
    - Inter-packet delays
    - Other details – e.g., some/all TCP flows contain frequent RSTs.
  - **Relative utilization**: should some types of traffic be prioritized?
  - Indicators of misconfiguration and compromise.

FABRIC Background



Credit: Tom Lehman

Goals of the Patchwork Project

1) **Providing a <u>network profiler</u> for FABRIC.**
   Developing user-provided service for (shared) federated testbeds.

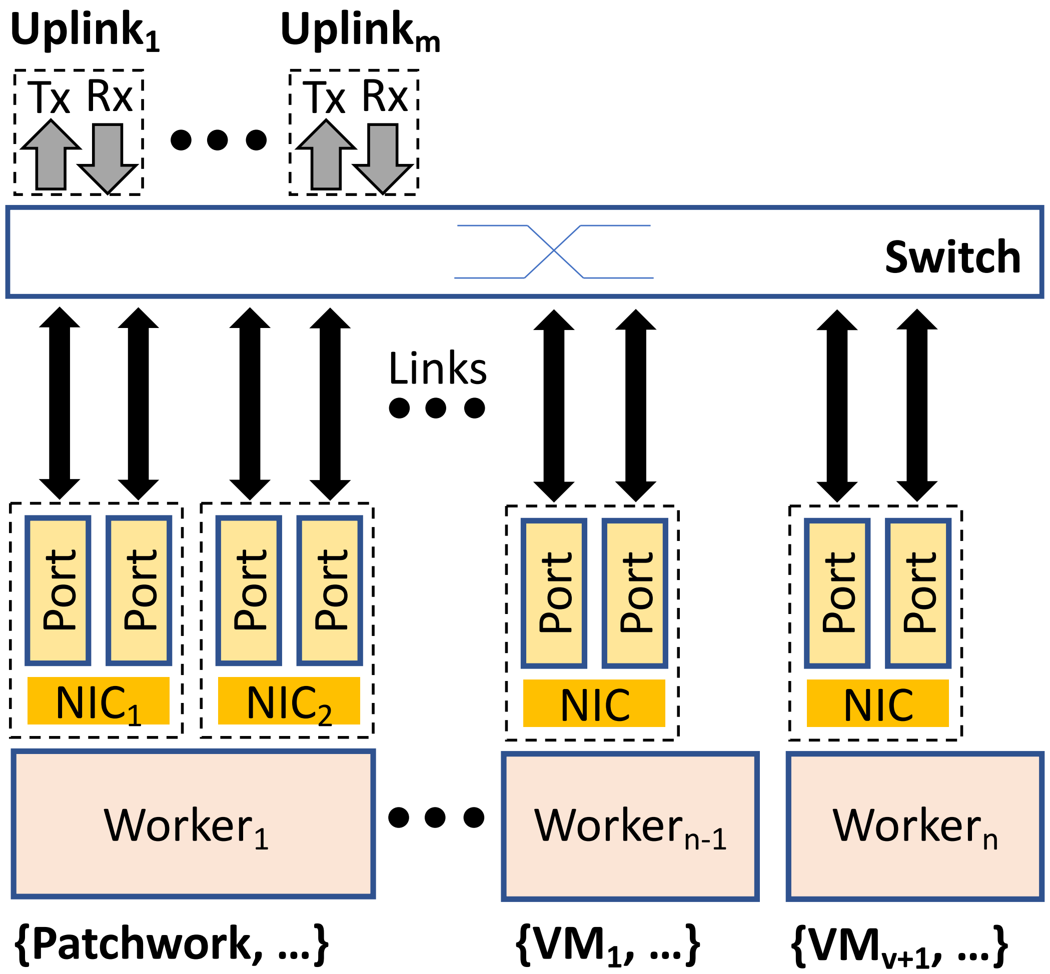
   Two usage modes:

   1. Individual experiment profiling. (“Experimenter mode”)
   2. Testbed-wide profiling. (“Operator mode”)

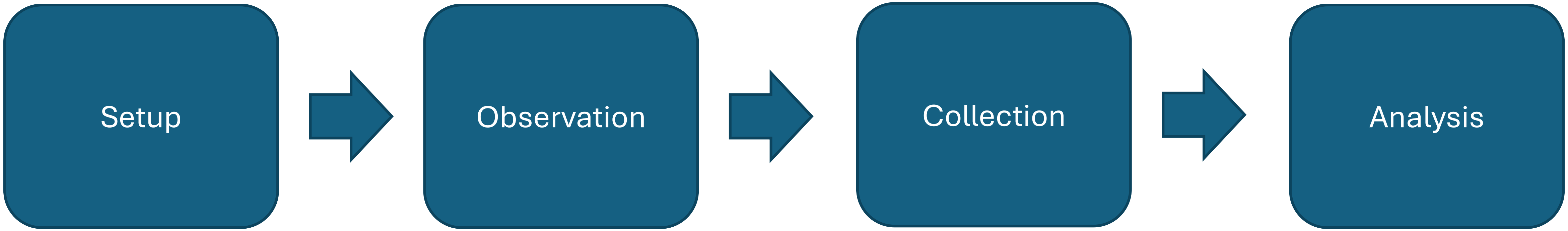
2) **Developing a profile of the entire FABRIC network.**
   And doing this periodically.

Back to Tutorial

Patchwork runs as a FABRIC experiment



Patchwork’s Design



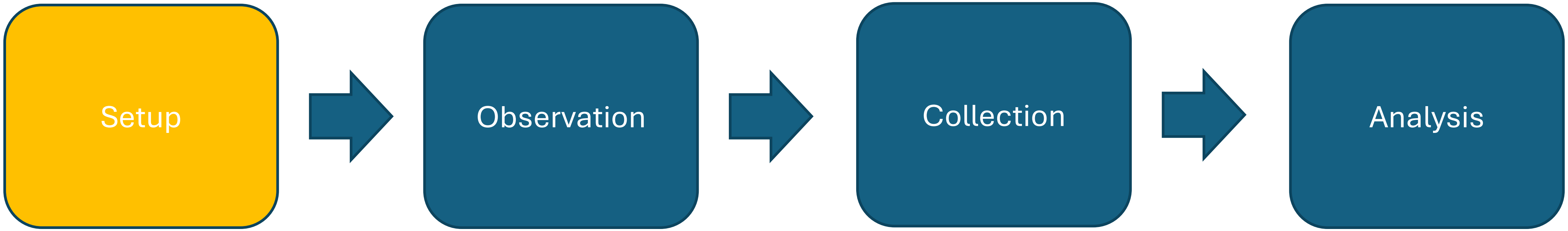
Setup

Observation

Collection

Analysis

Patchwork's Design



- Acquires resources on FABRIC sites.
  - Every site is treated autonomously.
  - NICs + Storage: can have multiple Patchwork VMs, depending on scale of capture.
  - Port mirroring at the ToR.
- Log failures – usually because of lack of resources.

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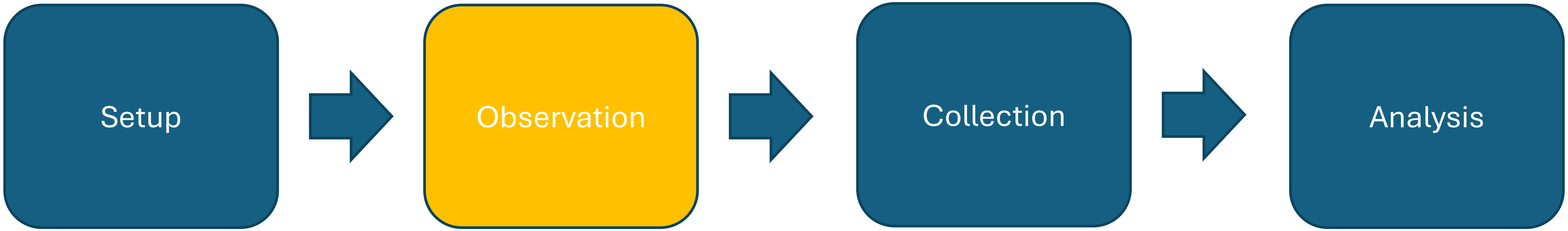

- Runs for 12-24 hours.
- Sampling according to setup parameters:
  200-byte prefix during 20-second interval every 5 minutes.
- Configuration changes: which ports to mirror.
  (Used to be fixed: only uplinks)
- Log metadata from NIC and OS.
- User-specified parameters, including triggers and filters

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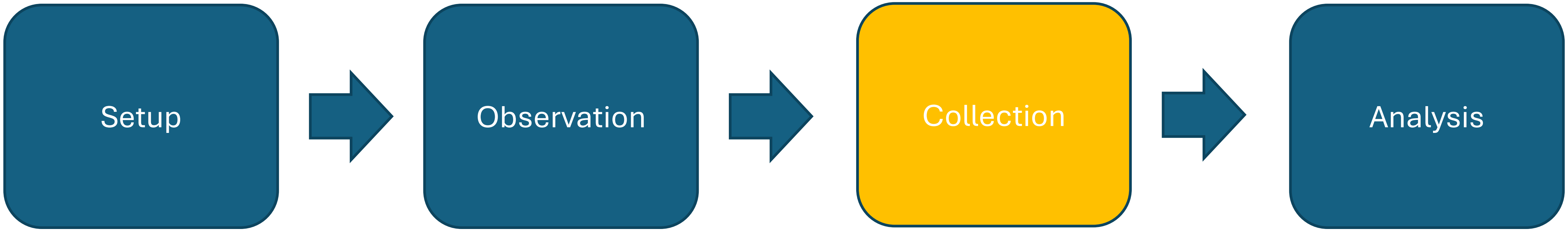

- This step download the capture.
- During observation, the capture is buffered on each site.
- Preserves metadata and capture structure, for use in analysis phase.
- Takes ~20 minutes.

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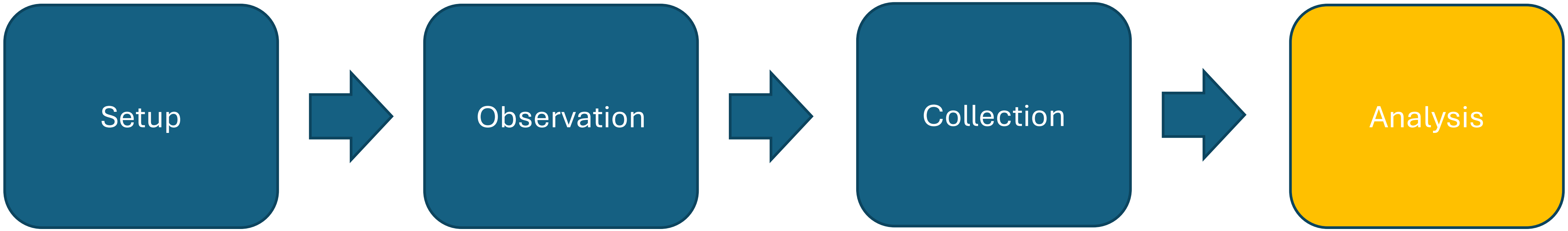
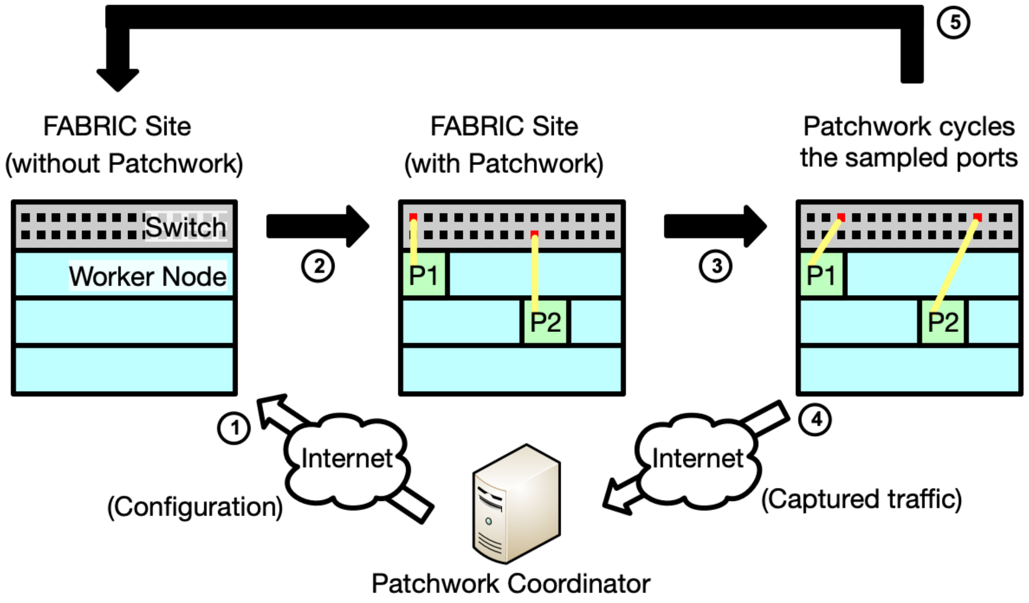


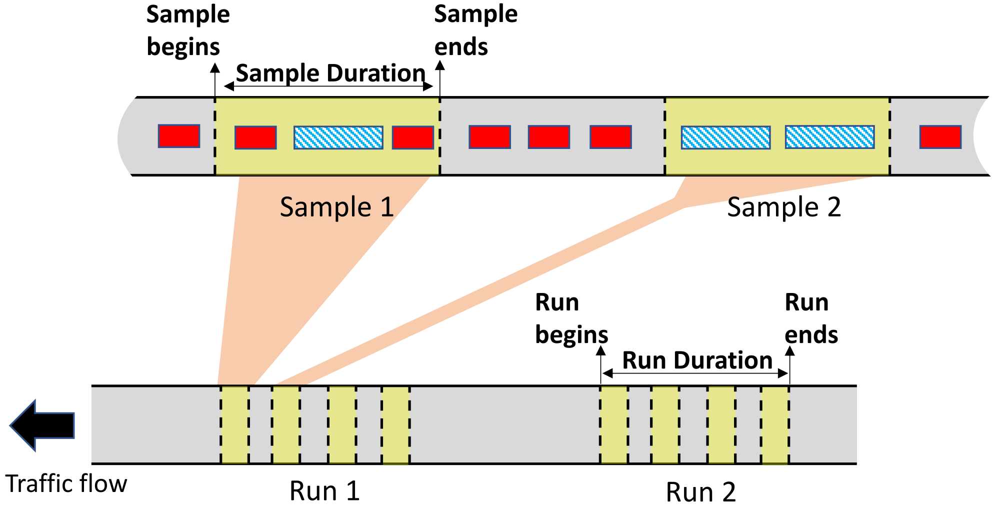
- Out-of-band analysis
- Digesting the capture to:
    - Dissect into headers – we use tshark/Wireshark dissectors for this.
    - Structure the data to facilitate later analysis.
- Highly parallel – but takes days!
  Build index for use by analyses scripts.
- Customizable analysis.

Back to Tutorial

Patchwork

- Runs as any experiment on FABRIC!
  It’s a user-provided extension to the testbed.
- Loss detection: Tx+Rx >= (Mirror)Rx
- Cycling ports to get more coverage.
  - Mitigates disparity between switch ports and mirrors.
  - Ranking ports by activity.
- Offloading to Alveo FPGA NICs.
  - Filter, Truncation, Editing+Anonymisation.
    + custom **DPDK** application for capture serialisation.
  - tcpdump (tuned) can capture up to ~8.5Gbps.
- (Re)usability – and not only by our group!





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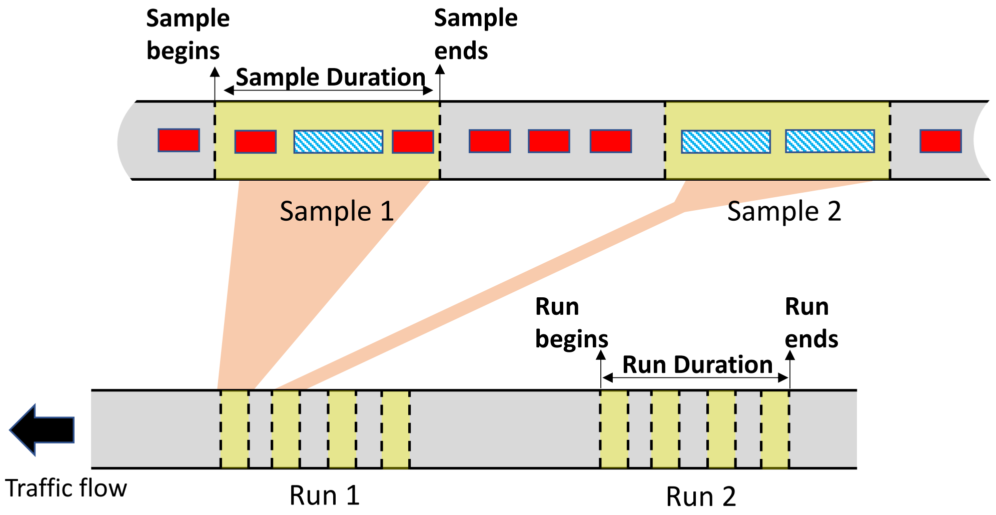

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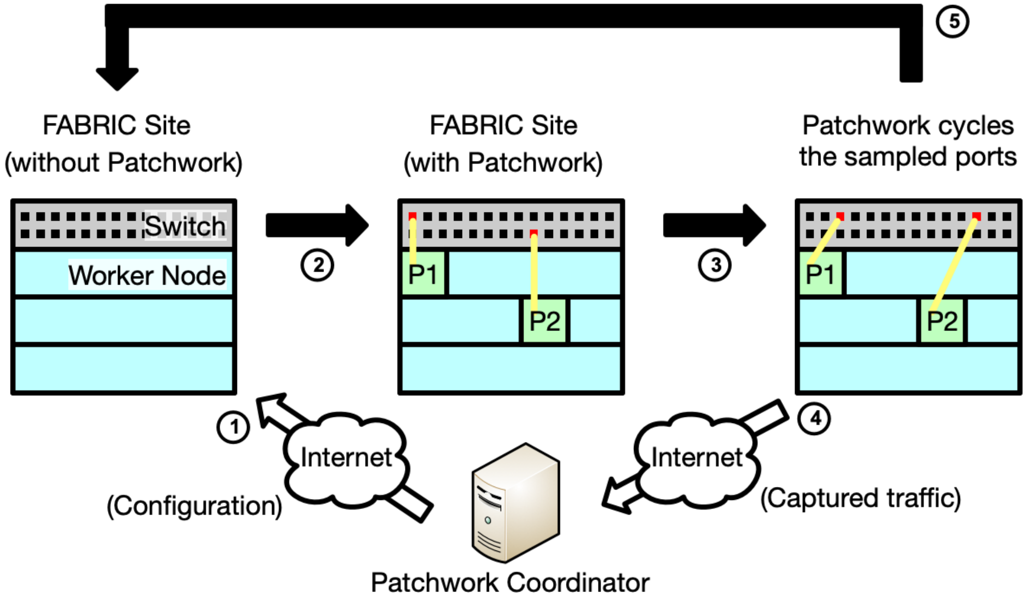
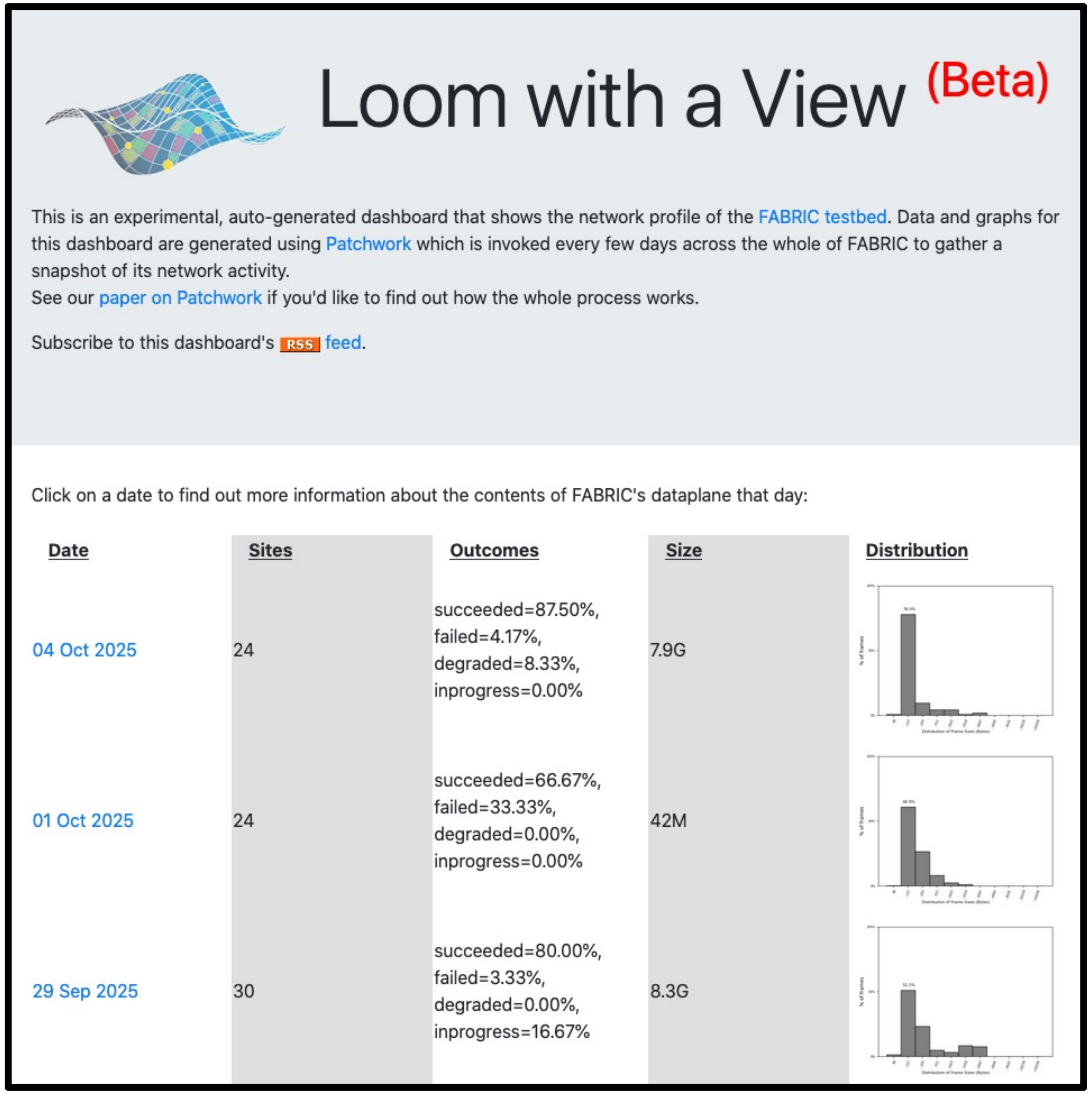


Patchwork Dashboard



Loom with a View (Beta)

This is an experimental, auto-generated dashboard that shows the network profile of the FABRIC testbed. Data and graphs for this dashboard are generated using Patchwork which is invoked every few days across the whole of FABRIC to gather a snapshot of its network activity.
See our paper on Patchwork if you'd like to find out how the whole process works.

Subscribe to this dashboard's RSS feed.

Click on a date to find out more information about the contents of FABRIC's dataplane that day:

Date	Sites	Outcomes	Size	Distribution

04 Oct 2025	24	succeeded=87.50%,
		failed=4.17%,
		degraded=8.33%,
		inprogress=0.00%
			7.9G	

01 Oct 2025	24	succeeded=66.67%,
		failed=33.33%,
		degraded=0.00%,
		inprogress=0.00%
			42M	

29 Sep 2025	30	succeeded=80.00%,
		failed=3.33%,
		degraded=0.00%,
		inprogress=16.67%
			8.3G	

https://packetfilters.cs.iit.edu/patchwork/dashboard/

Thank you

- Vaneshi Ramdhony and Alexander Wolosewicz **at Illinois Tech**
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- Tom Lehman at **FABRIC** and Xi Yang at **ESnet**
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- Chris Neely at Xilinx/AMD
- Cees de Laat at **UAmsterdam**
- Joe Mambretti at **StarLight/ICAIR/Northwestern**

Find out more:

https://packetfilters.cs.iit.edu/patchwork/