Hewlett Packard
Enterprise

CADDY

Scalable Summarizations over Voluminous Telemetry Data for Efficient Monitoring

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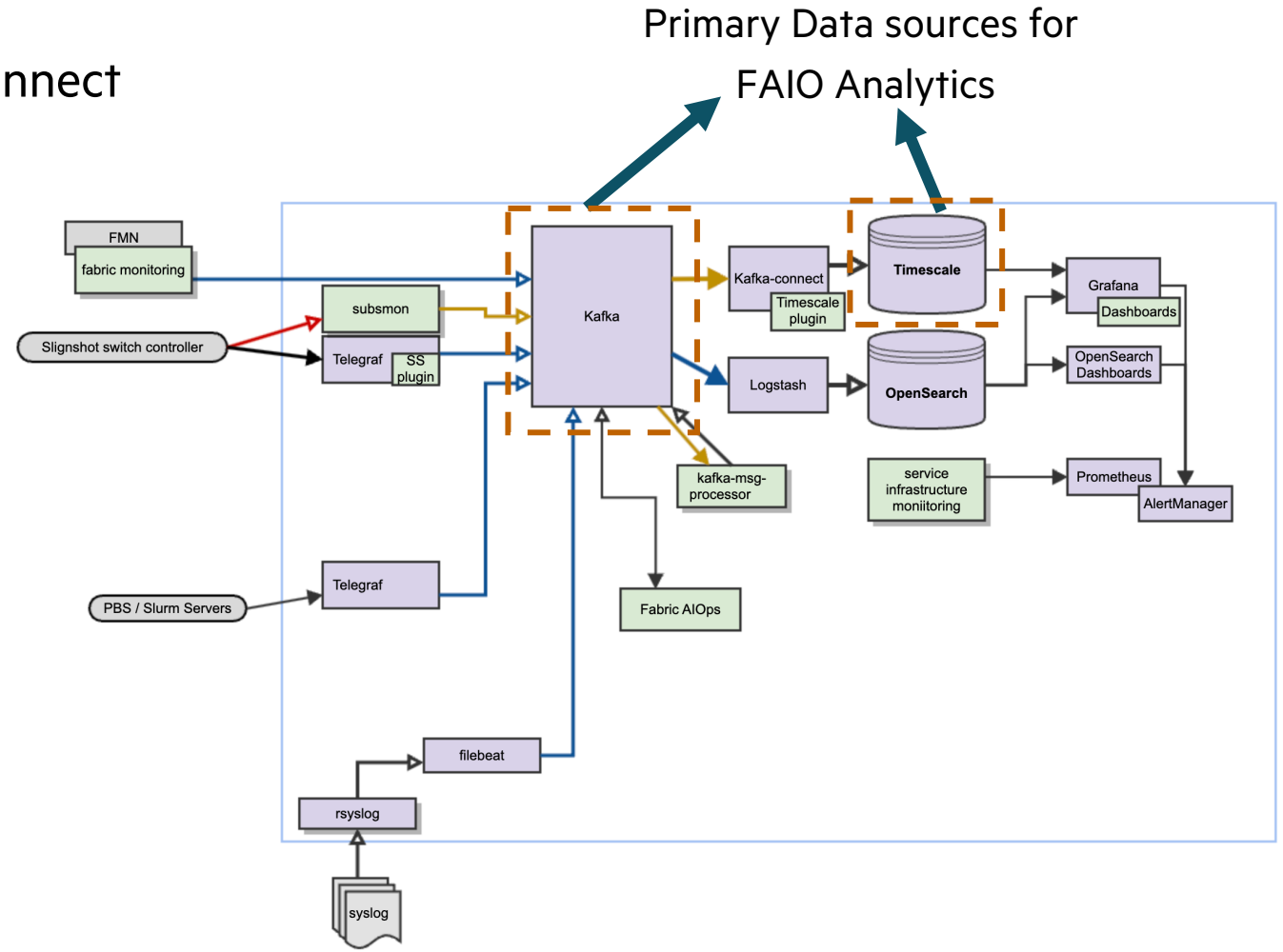
Problem Definition

Overview: Fabric AIOps (FAIO)

- Monitoring framework over Slingshot interconnect
  - HPCM, CSM
    - telemetry data
  - High-Volume
  - High-Velocity

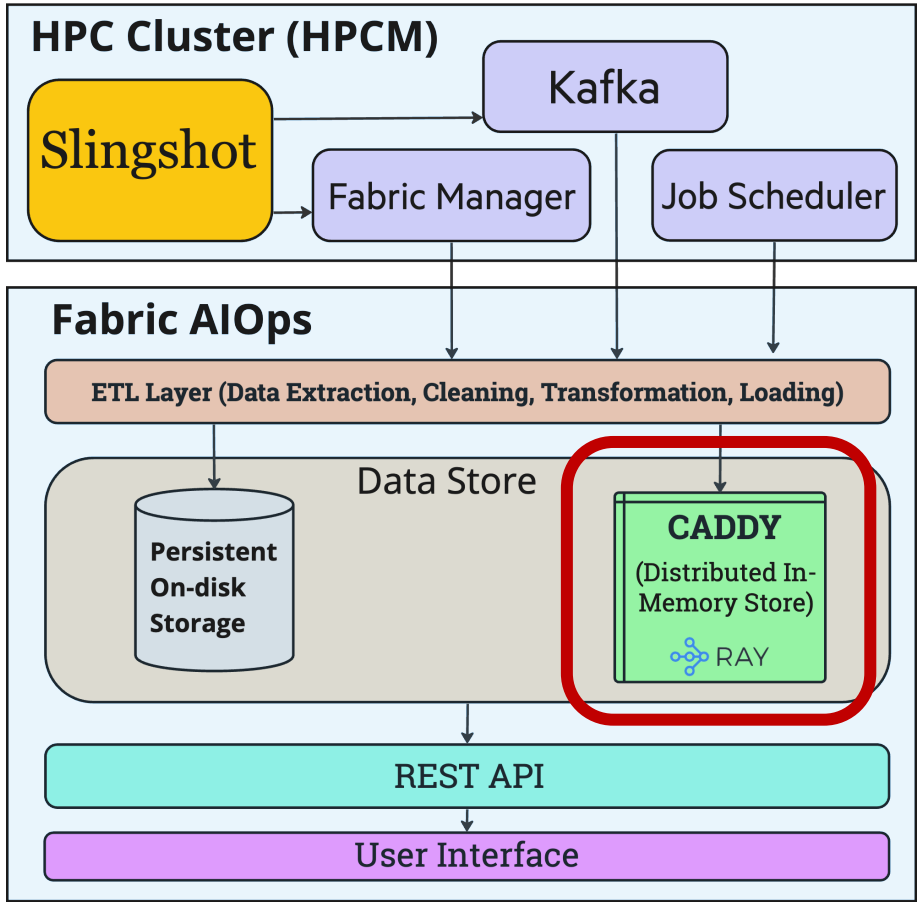
- System Performance analysis
  - Insight into fabric performance
    - Consolidated information
  - Visualize various cross sections of the fabric



Overview: Live Mode

- Live mode (*currently*)
  - Rapid analytics over most recent telemetry (10 mins)
  - Ray In-memory Store
  - Monitor traffic over the n/w for running workloads
  - Impact of job(s) over a network

- Enhance live mode
  - Allow sysadmins to playback fabric telemetry statistics
    - Diagnose fabric state
  - Interactive UI
  - In-memory storage
    - Improved storage capacity (*in the order of hours*)

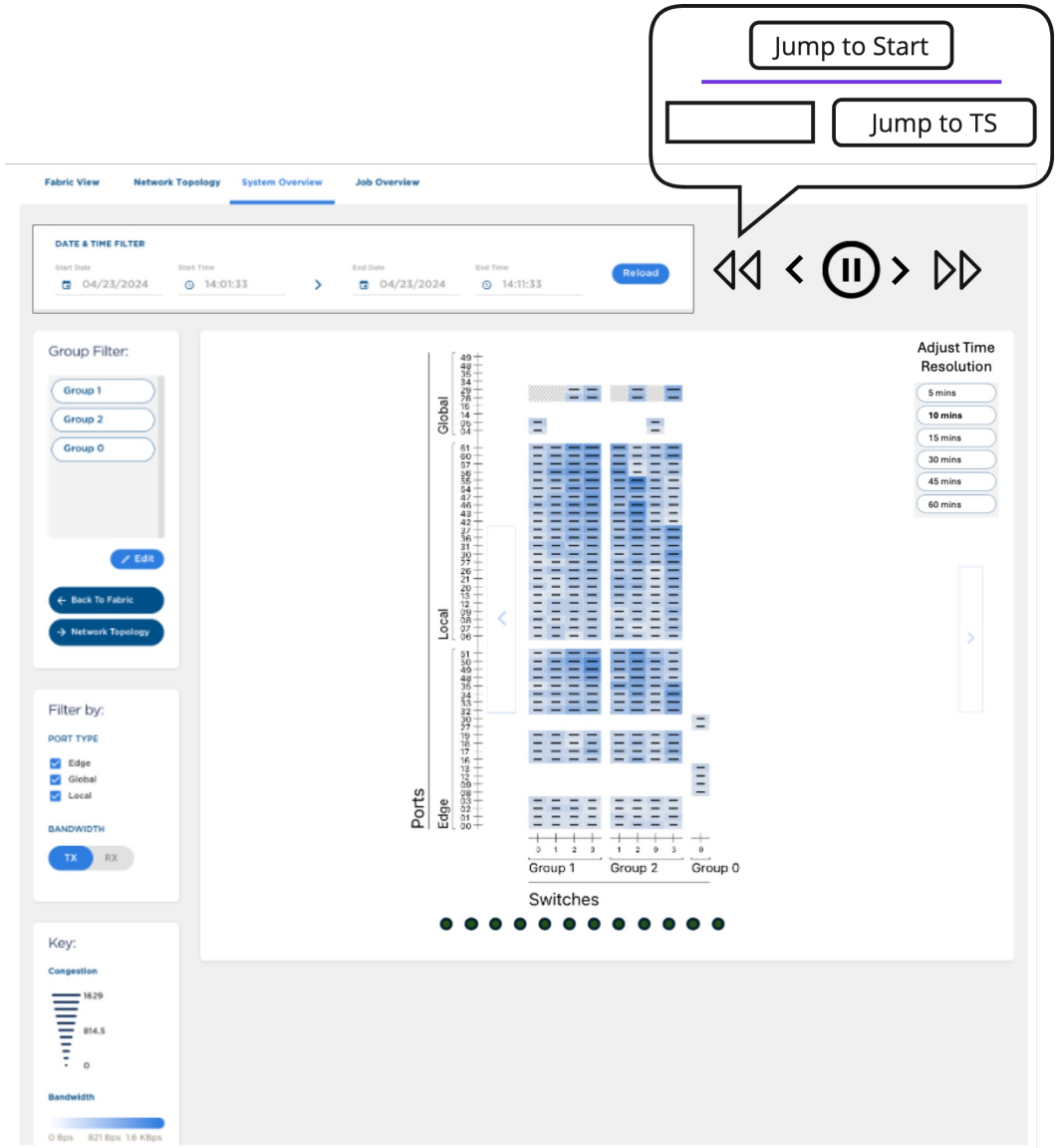


Scopes for Improvements over Live Mode

- Compressed representation of in-memory data
  - Better utilization of in-memory storage
  - *Eg. 500x compression for 10 mins snapshots*
- Optimized indexing
  - Faster identification of relevant data-segments
- Alleviate Redundant computation
  - Pre-aggregation of in-memory data
- Query analytics
  - Improved interactivity

Overall Goal

- Browse fabric state incrementally
  - Over *hours*
  - In small time windows (snapshot)
  - Easy panning (over a sequence of snapshots)
- Bird's eye view of the fabric state
- Analytics for better understanding of telemetry
  - min, avg, max, sum, std
  - Upto 4th order of moment
- Configurability
  - User-specified temporal resolutions for snapshots
  - Configurable Cache Management Strategies



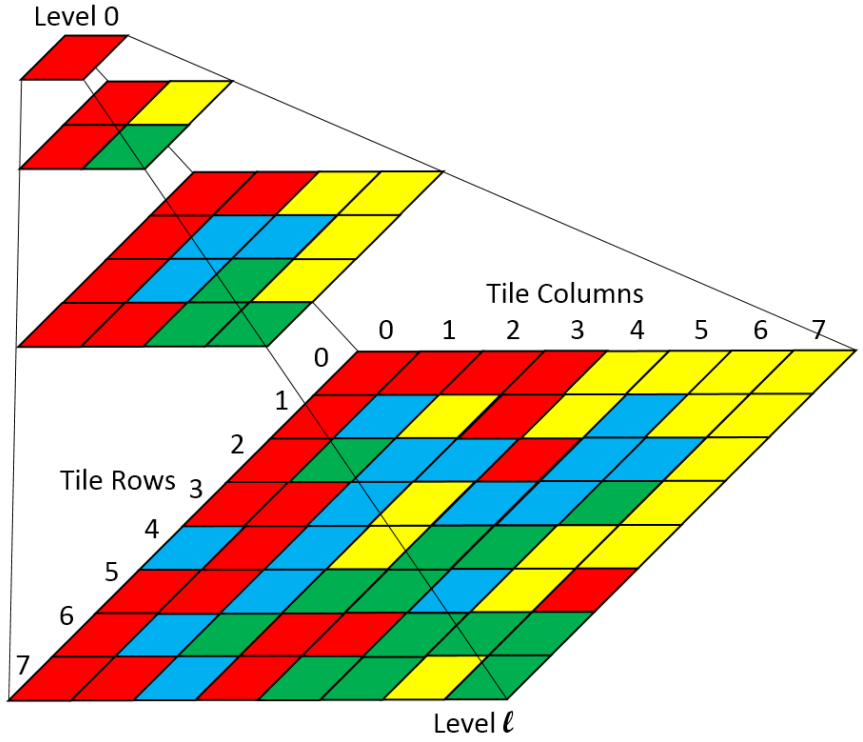
Challenges

- Data compression
  - Loss in accuracy
  - Affects ingestion speed
  - Low overhead
- Sliding window
  - Identify and release *stale* data-elements
  - Low overhead
- Easy integration with current FAIO

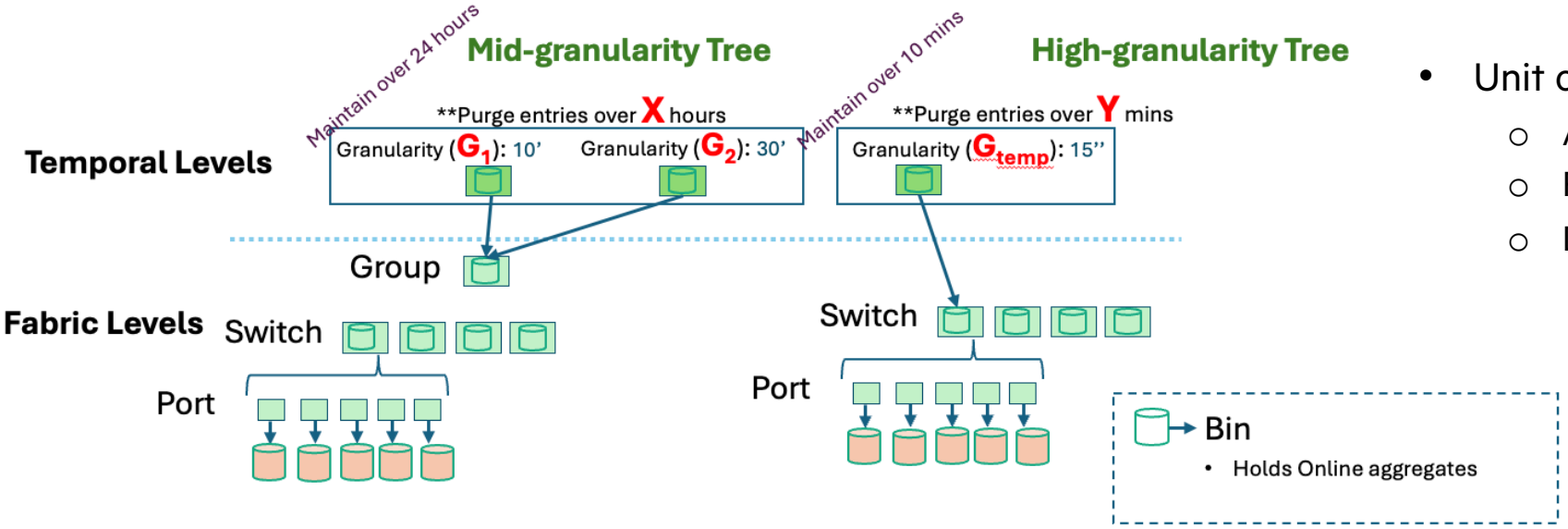
Methodology

Background

- Pre-aggregation of data
  - Faster Analytics
    - – Avoids redundant computations
  - Pre-processing overhead
  - Accuracy for streaming data
- Tile Layer
  - Aggregations at multiple resolutions of data
  - Faster query times
  - Links grow exponentially in number



Caddy: In-memory Telemetry



- Unit of Data: **Bin**
  - Aggregations at multiple levels of telemetry
  - Facilitates fast merging
  - Dynamic Hierarchical Aggregations

- Supported aggregations
  - min, avg, max, sum, std
  - Up to 4^{th} order of moment

Bins: Compression and Accuracy

- Bounds
  - Timerange
  - Telemetry bounds {group, switch, port_range}
  - Key: (timestamp, group, switch, port)

- Store only fixed set of attributes (compression)
  - Irrespective of underlying telemetry events

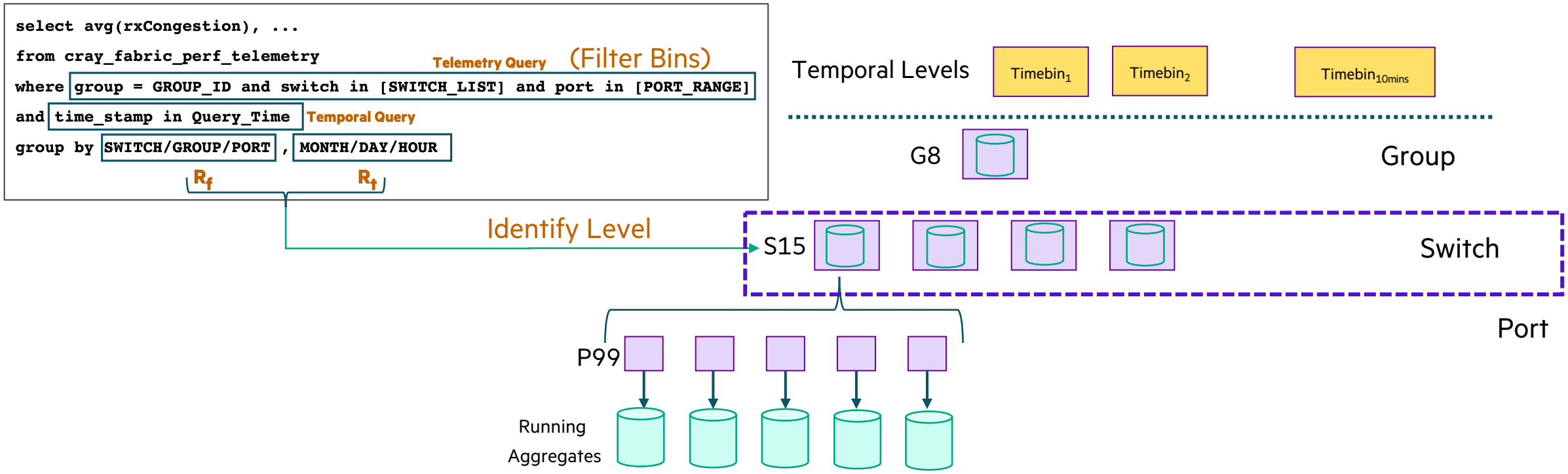
- Statistically accurate online aggregation
  - **Welford's online statistics**
    - Fast updates
    - Statistically accurate
    - Constant memory footprint
      - Irrespective of data size

Initialize:
m1 $\leftarrow$ 0 (mean)
m2 $\leftarrow$ 0 (variance)
m3 $\leftarrow$ 0 (skewness)
m4 $\leftarrow$ 0 (kurtosis)
n $\leftarrow$ 0 (number of samples seen)
for each new data point x **do**
$n \leftarrow n + 1$
$\delta \leftarrow x - m1$
$m1 \leftarrow m1 + \delta/n$
$m2 \leftarrow m2 + \delta * (x - m1)$
$\delta 2 \leftarrow \delta * \delta$
$m3 \leftarrow m3 + \delta 2 * (x - m1) - 3 * m2 * \delta/n$
$\delta 3 \leftarrow \delta 2 * \delta$
$m4 \leftarrow m4 + \delta 3 * (x - m1) - 6 * m2 * \delta 2/n + 4 * m3 * \delta/n^2$
end for

Caddy Implementation

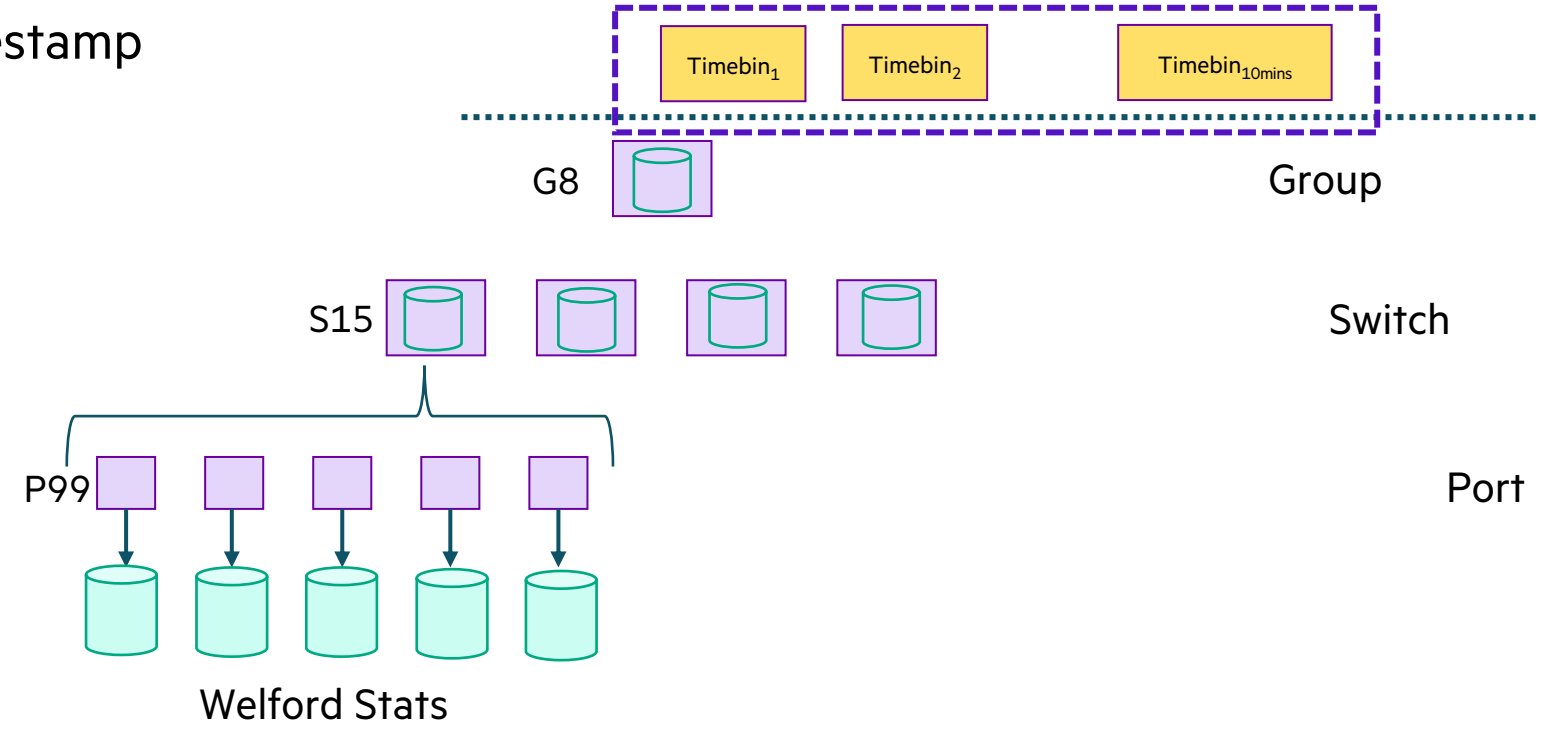
- Organization
  - Logically as a hierarchical tree of tiles
  - Physically
    - A hierarchical list of hashmaps
    - Each key has sufficient information to infer
      - Neighborhood
      - Position in hierarchy
    - Avoid need for links

Fetching Snapshots (Query Evaluation)



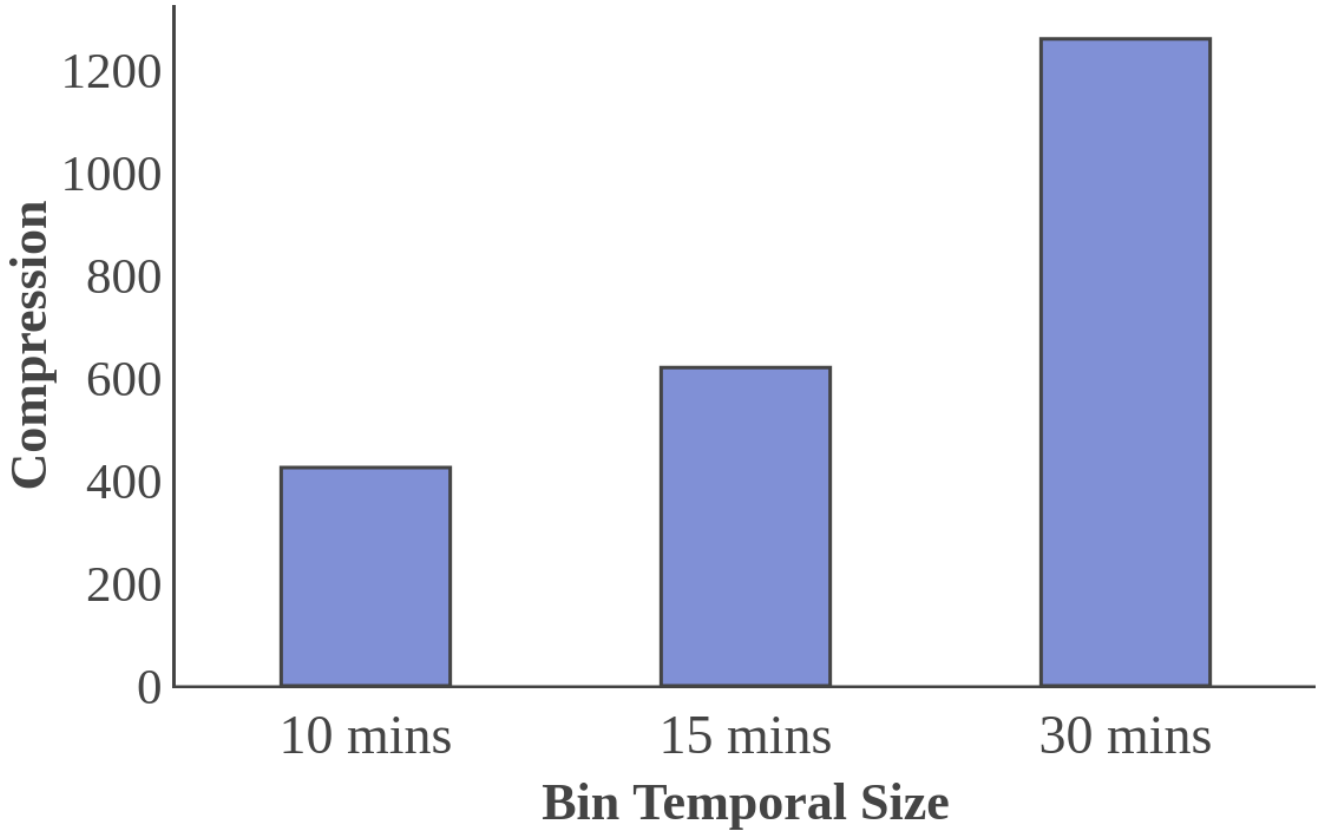
Purging

- Sort temporal level based on timestamp
  - Ascending order
- Remove entire subtree
- Faster purging



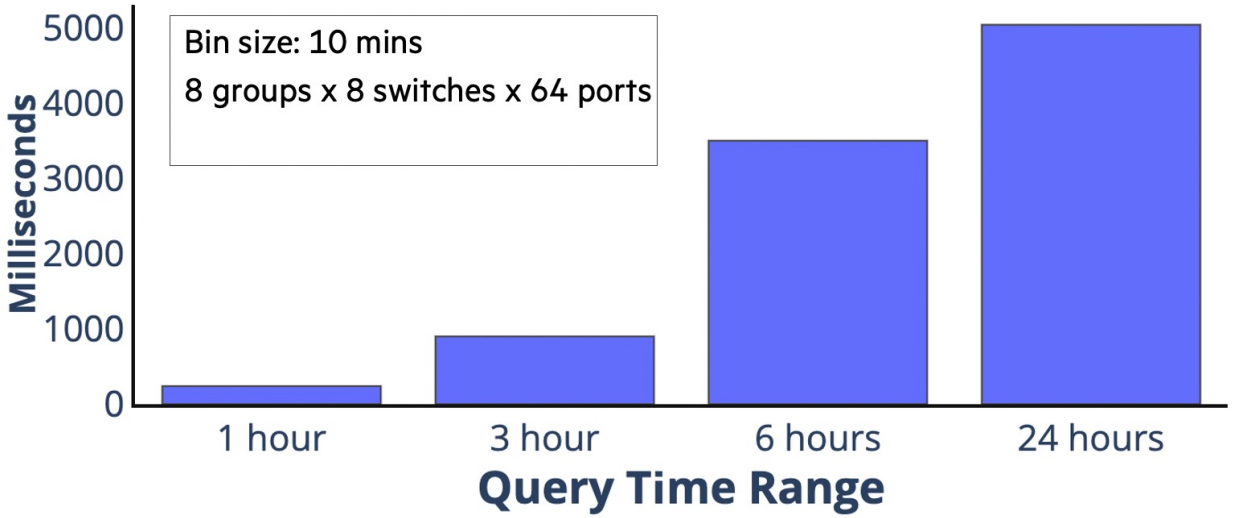
Results

Compression Factor



Query Latency

Single Frame Fetch Time		
Mode	**Time (ms)**	
Live Mode	355	
Live Mode + Caddy	Group Level	151
	Port Level	267.51



Maintenance Overhead

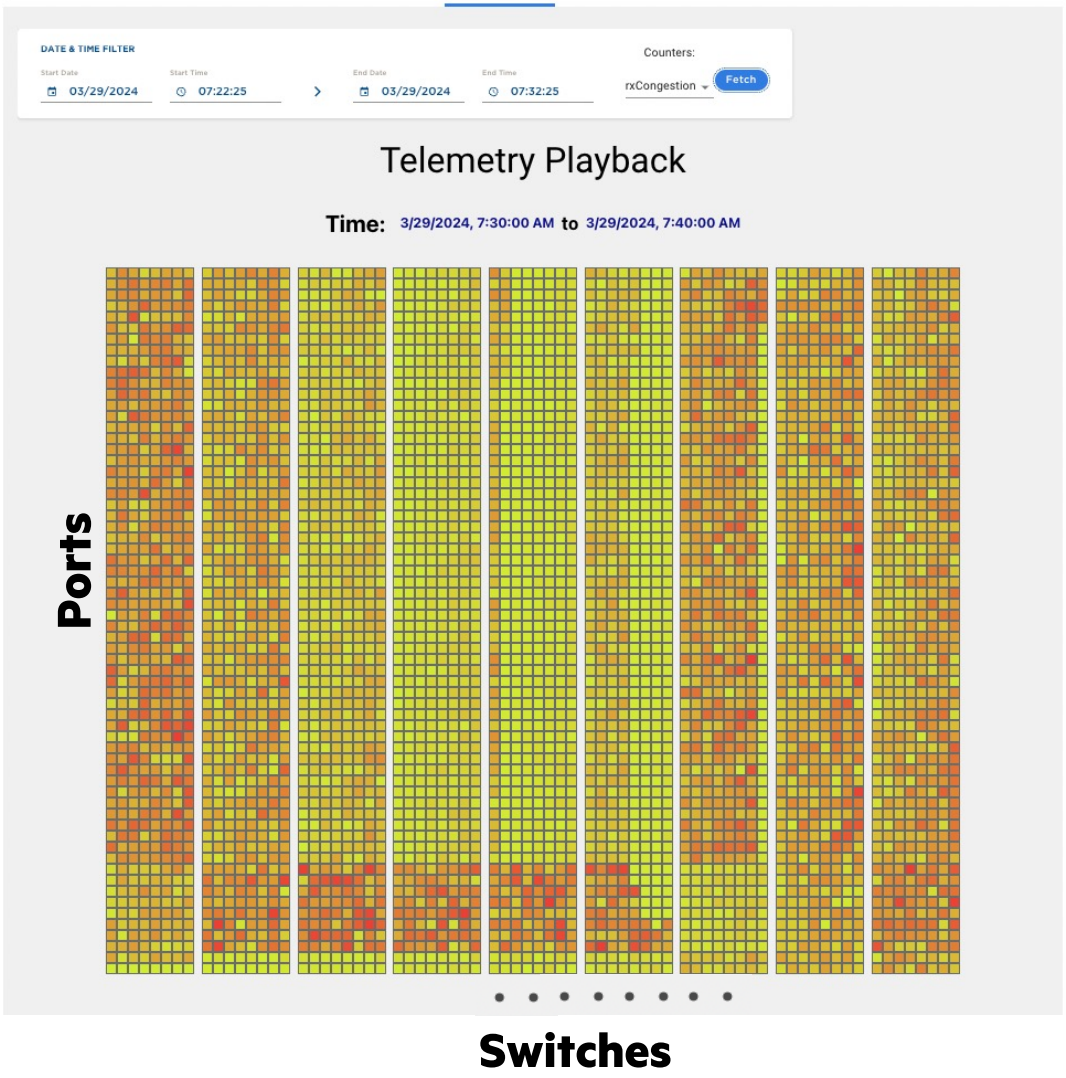
- Data Ingestion
  - Ingestion of 1M telemetry events
  - Over 1 hour period

- 18 - 32.5% overhead

	Time (s)
Live Mode + Caddy	1.007
Live Mode	0.7589

Telemetry Playback

- Prototype interface

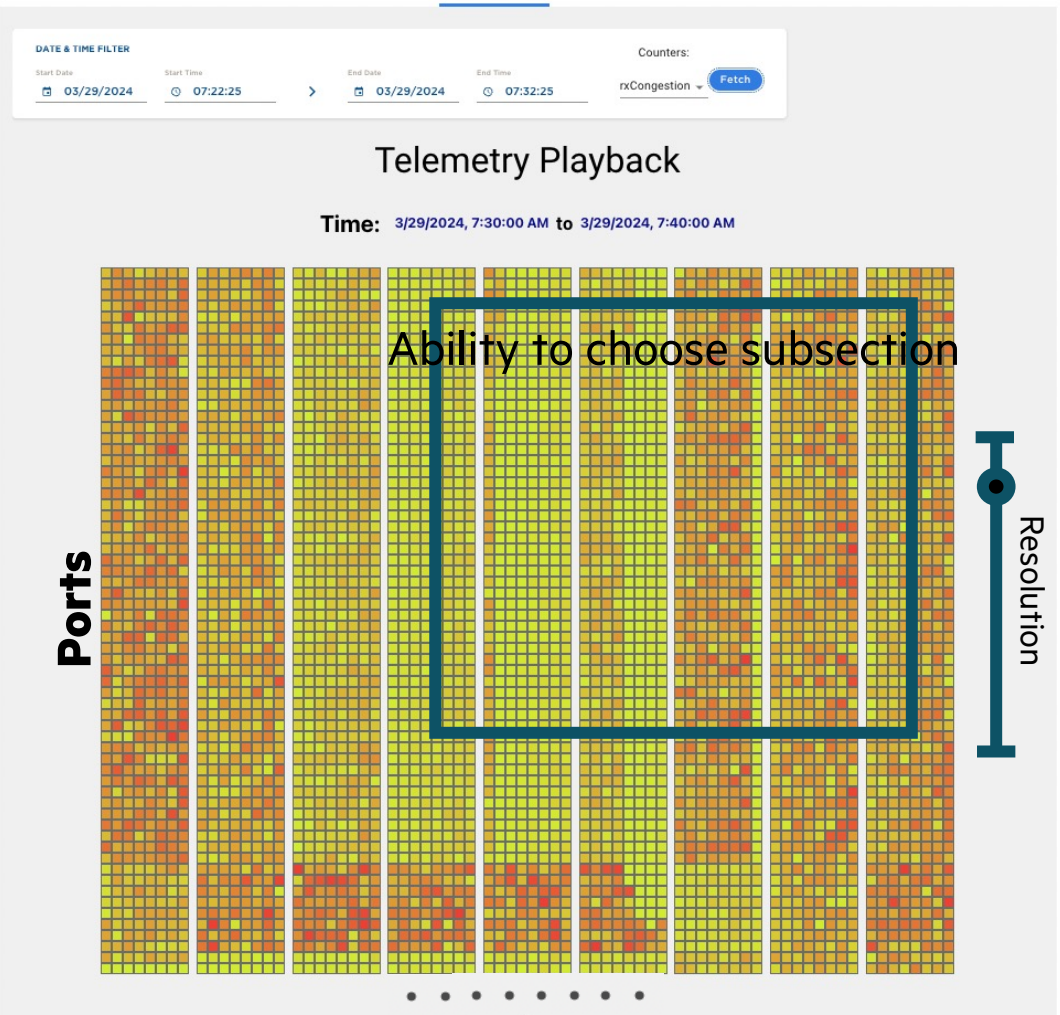


Overview of Features

- New changes are transparent to the UI
  - No loss in accuracy
- Improved interactivity
  - Adjustable queries

Utilities & Upcoming Features

- Allows for “exploratory browsing”
- View the overall fabric at a coarse resolution
  - Limited range of temporal resolutions
- Zone-in on problematic temporal/fabric sections
  - View detailed statistics over problematic regions
    - Through historical mode data from persistent storage
    - Or from lower-level in-memory nodes
- View subsections of the fabric
- Support more complex multivariate analysis
- Use granular aggregates for predictive models



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Thank you