

Centralized Logging & Monitoring System For EPICS IOCs

Enhancing System Reliability

By

Saisrikiran Mudigonda

Sathvika Gambheerrao

Tata Institute of Fundamental Research, Hyderabad

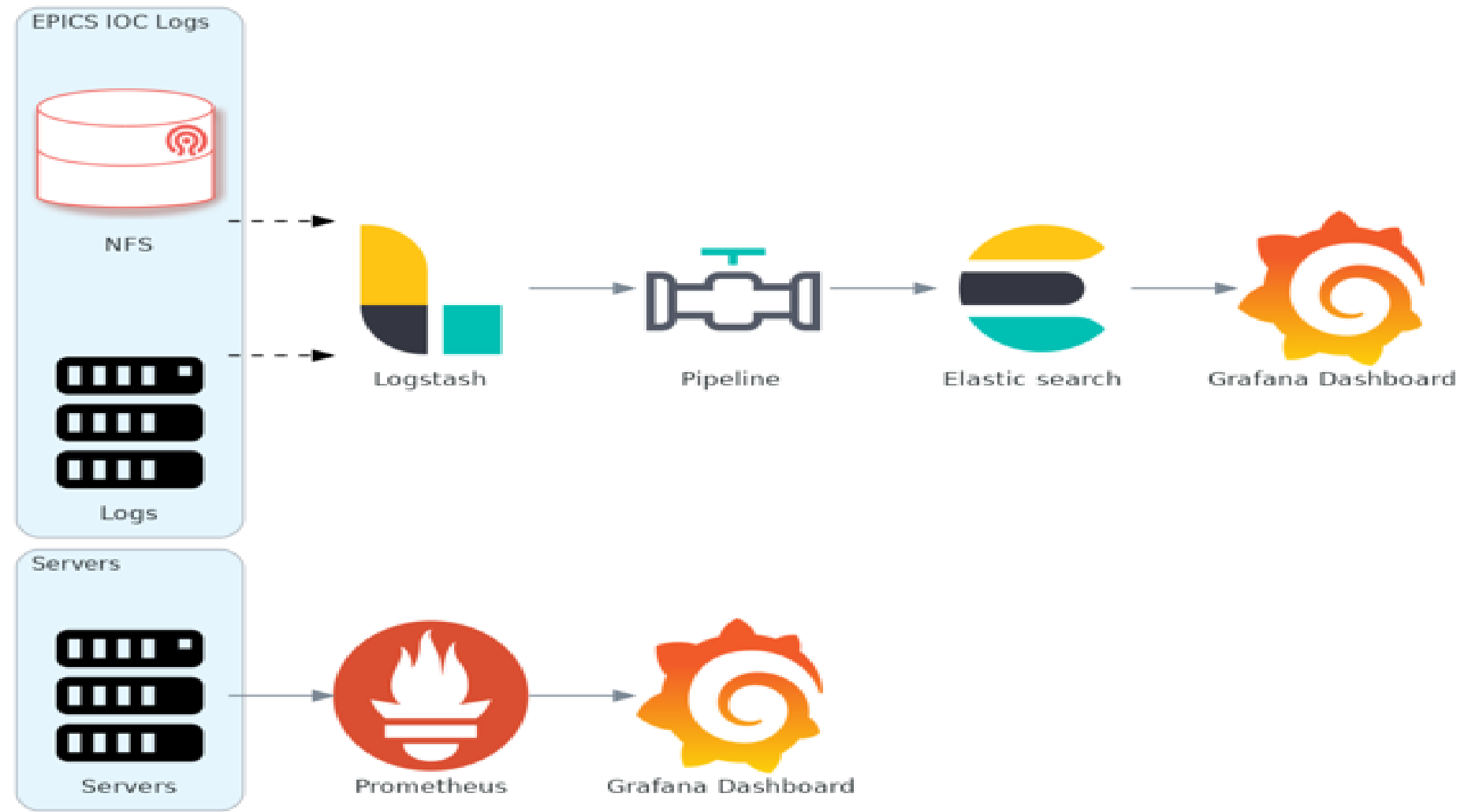
Outline

- Extreme Photonics Applications Centre (EPAC) is a new national facility to support UK science, technology, innovation and industry
- EPAC logging & monitoring is a centralized activity to track and monitor all the logging information from a variety of disparate sources into a single database for easy co-relation and alerting.
- EPAC logging & monitoring system covers hundreds of IOCs.
- EPAC logging & monitoring system monitors two types of data: metrics and logs.

EPAC Log Management

- EPICS (**Experimental Physics and Industrial Control System**) generates logs.
 - These logs are fed into Logstash for real-time data processing.
- Logstash Processing:
 - Logstash collects the raw EPICS logs and processes them through filters.
 - Filters transform the data into a structured JSON format.
 - Data enrichment, parsing, and filtering occur at this stage to prepare logs for storage and analysis.
- Elasticsearch as Output:
 - Processed logs in JSON format are sent to Elasticsearch.
 - Elasticsearch stores, indexes, and enables search capabilities on the log data.
- Grafana Dashboards for Visualization:
 - Grafana connects to Elasticsearch to query and visualize the log data.
 - Dashboards provide real-time insights and trends based on EPICS logs, enabling monitoring and analysis of system performance.

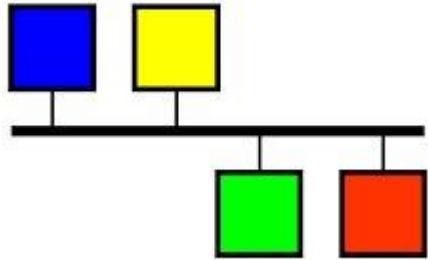
EPAC Logging & Monitoring Architecture



EPAC Logging And Monitoring Architecture

EPAC Process Variable (PV) Logging

EPICS



Archiver Appliance



Grafana

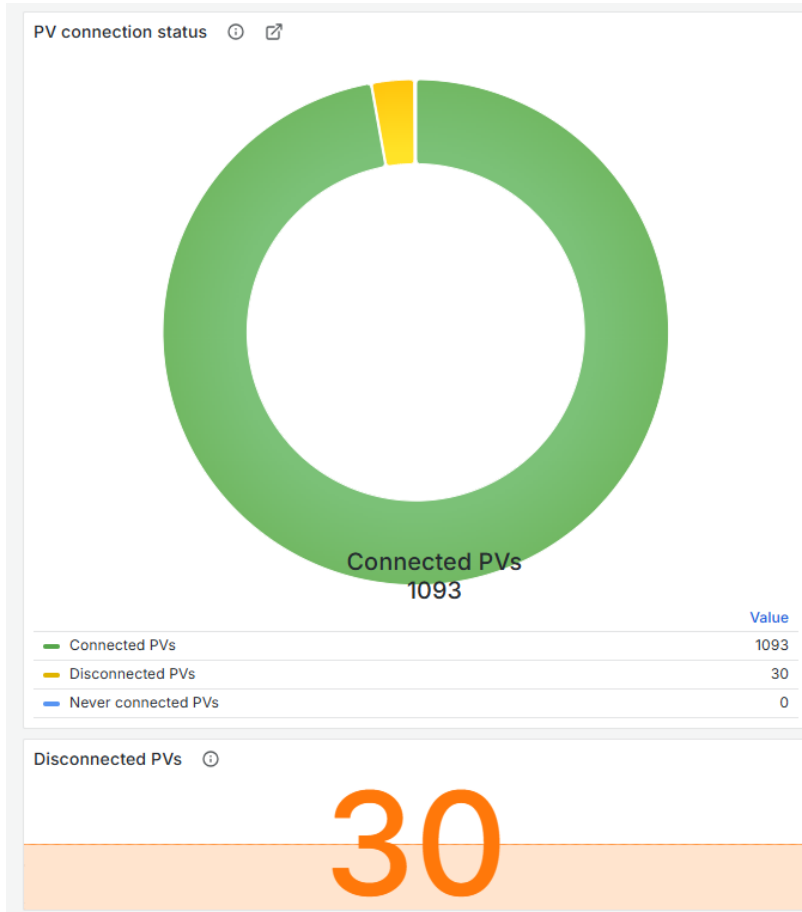
Plugin



Grafana

Dashboard

EPAC Archiver Statistics



EPAC Archiver Appliance

Home Reports Metrics Storage Appliances Integration Help

This is the EPAC Archiver Appliance.

For support, contact the EPAC Data Management Team, c/o [Stephen Dann](#).

To check the status of or to archive some PV's, please type in some PV names here.

Co2 Statistics

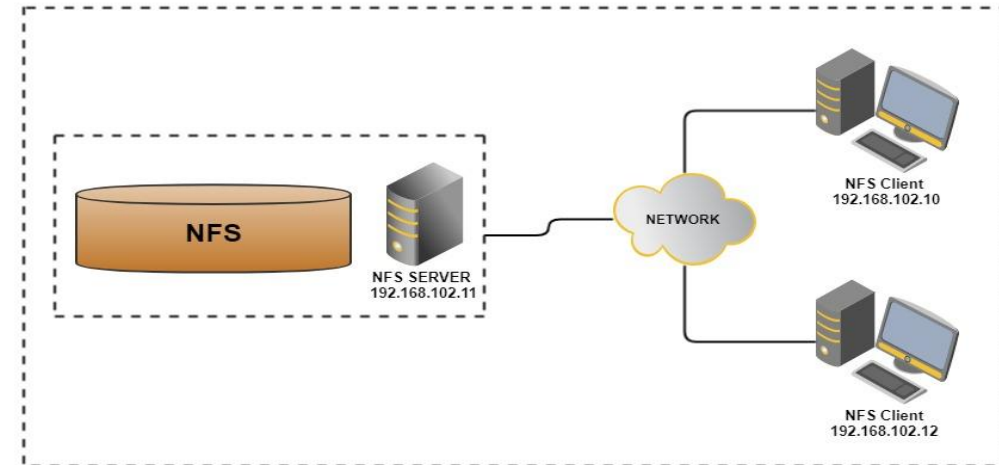


procServ

- ProcServ is a wrapper to start arbitrary interactive commands in the background, with telnet access to stdin/stdout.
- ProcServ listens on a standard IP address and port number to capture the logs into a log file.
- ProcServ writes the timestamp and the log message to Unix socket from where it is read into the log files.

NFS (Network File System)

- **NFS (Network File System)** is a distributed file system protocol that allows users to access files over a network as if they were located on a local machine. NFS enables sharing directories and files between computers on a network, facilitating collaboration and centralized data storage.

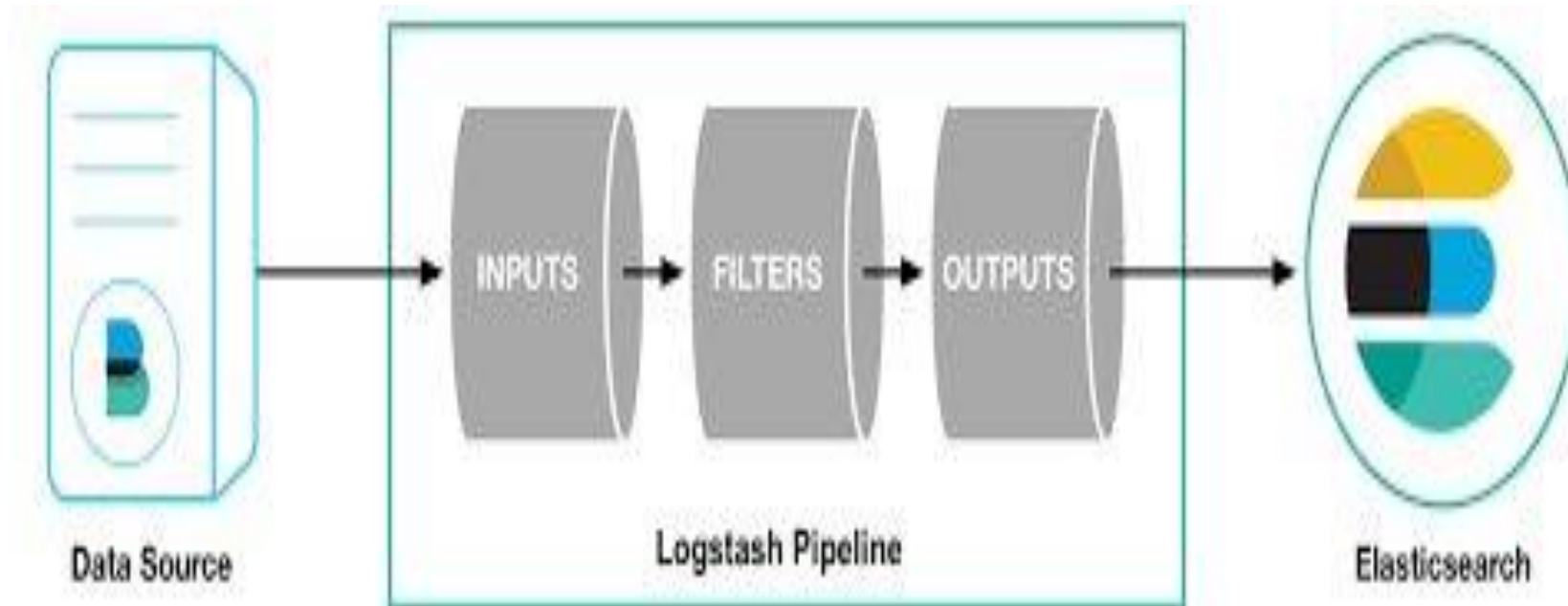


- **NFS Server and Client:**
- NFS Server: The system that hosts and shares files over the network.
- NFS Client: The system that connects to the NFS server to access the shared files.

Logstash

- Logstash is a vital tool for building an efficient and scalable logging system, enabling businesses to gain insights from their data in real time.
- **Logstash** is an open-source, server-side data processing pipeline.
- It ingests, processes, and forwards data to a variety of destinations.
- Part of the **ELK Stack** (Elasticsearch, Logstash, Kibana), commonly used for logging and analytics.

Logstash Pipeline



Logstash Tags

- **Logstash tags** are labels or markers you can assign to events as they pass through your data processing pipeline.
- These tags help with Data Filtering, Conditional Processing, Debugging and Error Handling, Custom Routing.
- Tags can be added in the Logstash configuration file at any stage (input, filter, output):
 - **Input Stage:** Assign tags as events enter the pipeline to label their source.
 - **Filter Stage:** Conditionally apply tags based on processing, such as tagging failed events.
 - **Output Stage:** Use tags to direct events to specific outputs, like distinct indices in Elasticsearch.

Elasticsearch

- Elasticsearch is a crucial tool for organizations needing fast, scalable, and real-time search and analytics capabilities, making it ideal for use cases from monitoring infrastructure to powering search engines.
- **Elasticsearch** is a powerful, open-source, distributed search and analytics engine.
- It is part of the **ELK Stack** (Elasticsearch, Logstash, Kibana).
- Designed for **real-time search, scalability, and data analysis.**

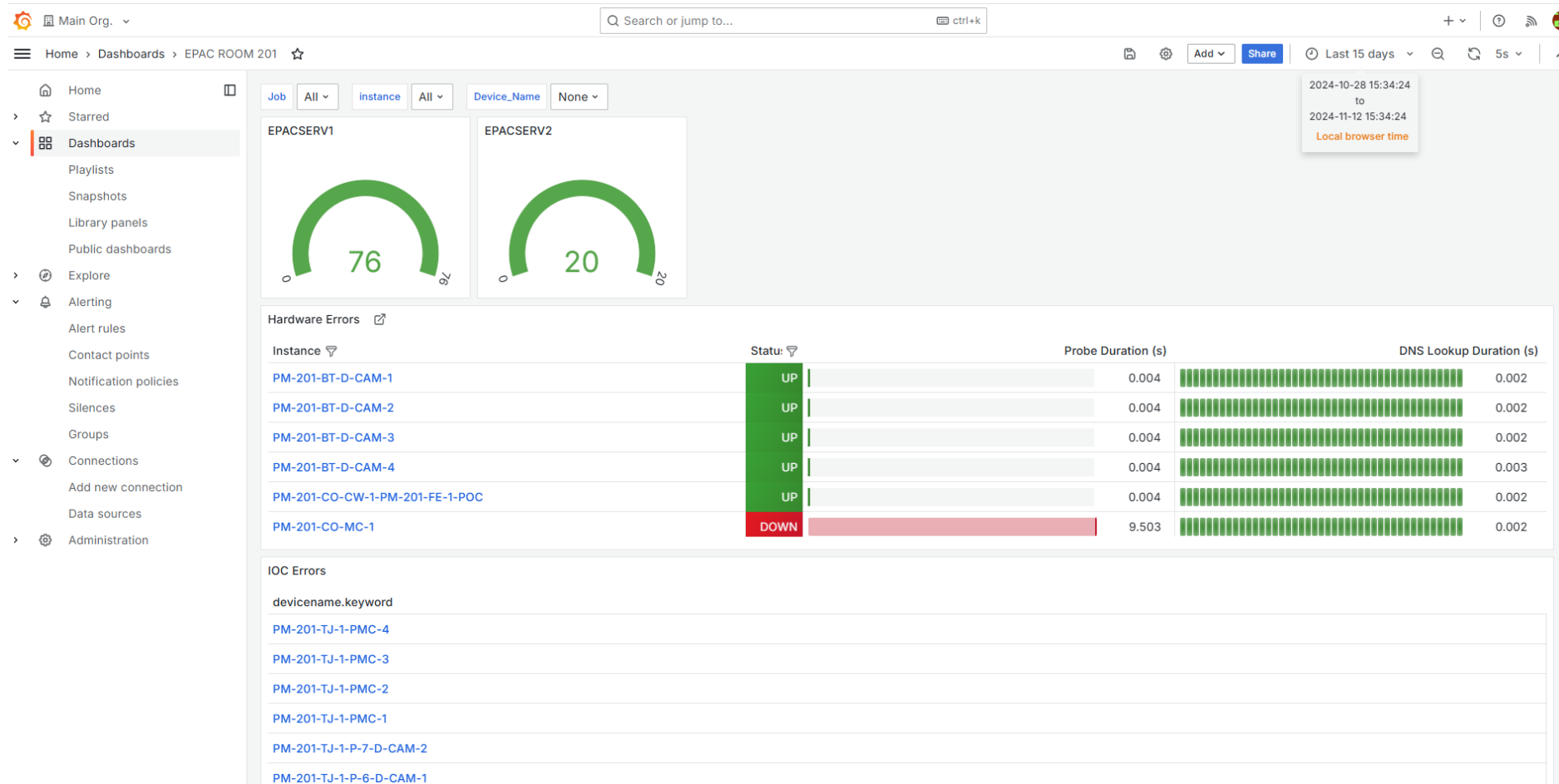
Grafana

- Grafana is a flexible and powerful tool for visualizing and monitoring data across a range of industries, making it indispensable for both technical monitoring and business intelligence applications.
- **Grafana** is an open-source platform for monitoring, visualization, and analytics.
- It allows you to query, visualize, and alert on metrics and logs from a variety of data sources.
- Designed to create **interactive, customizable dashboards**.

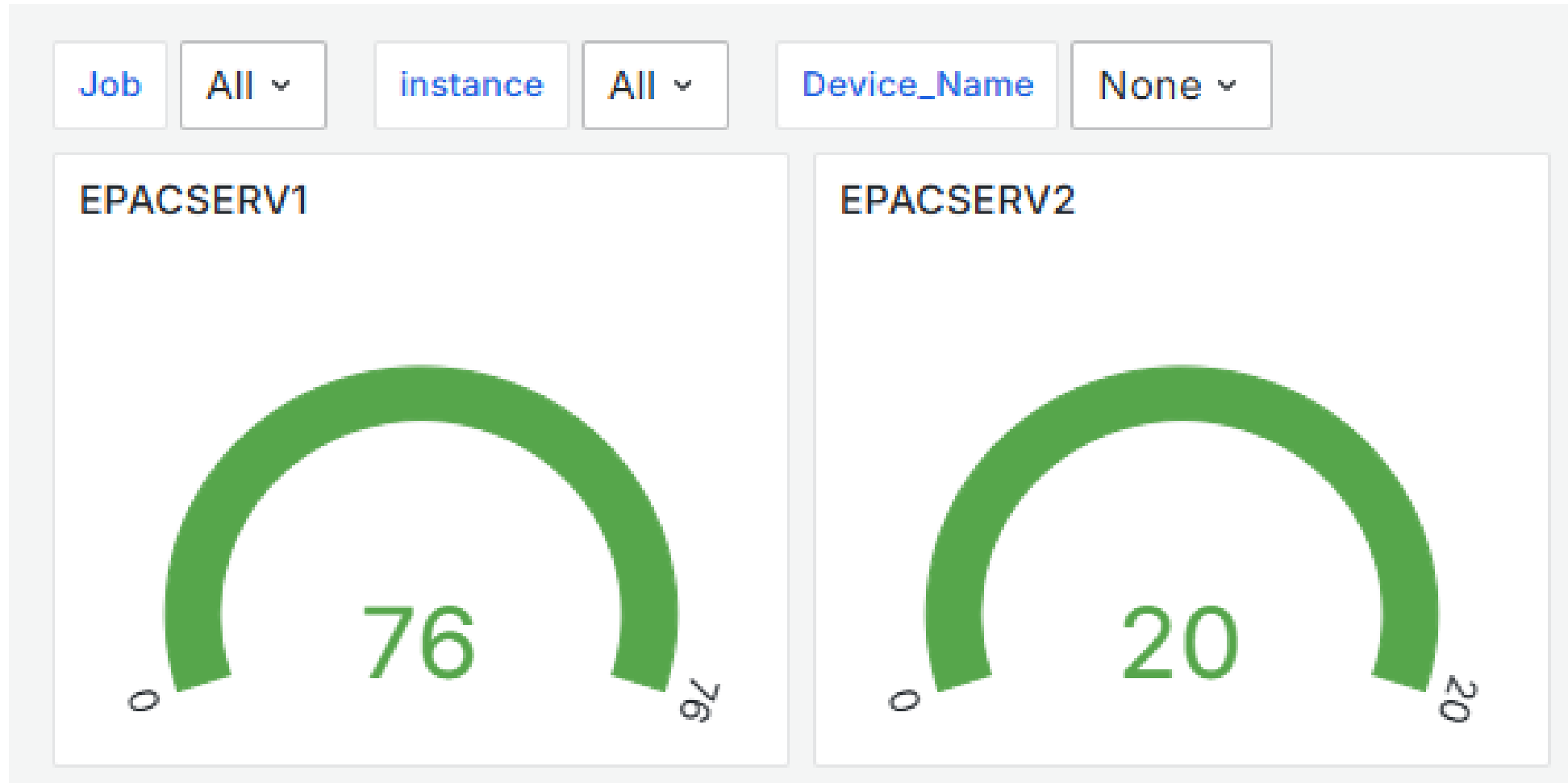
Grafana Dashboard Settings

- **Variables:**
 - **Define Variables:** Variables let you filter data dynamically (e.g., by date or region).
 - **Multi-Select & Defaults:** Choose if variables allow multiple selections and set default values.
- **Links:**
 - Add links for easy navigation to related dashboards.
 - Set up drill-down links to explore more detailed data.
- **JSON Model:**
 - View and edit the dashboard's JSON code to make detailed customizations or export/import it.
- **Time Range:**
 - Set default time ranges (like last 24 hours) and auto-refresh options for real-time monitoring.

Grafana Dashboard



Active/Inactive IOCs

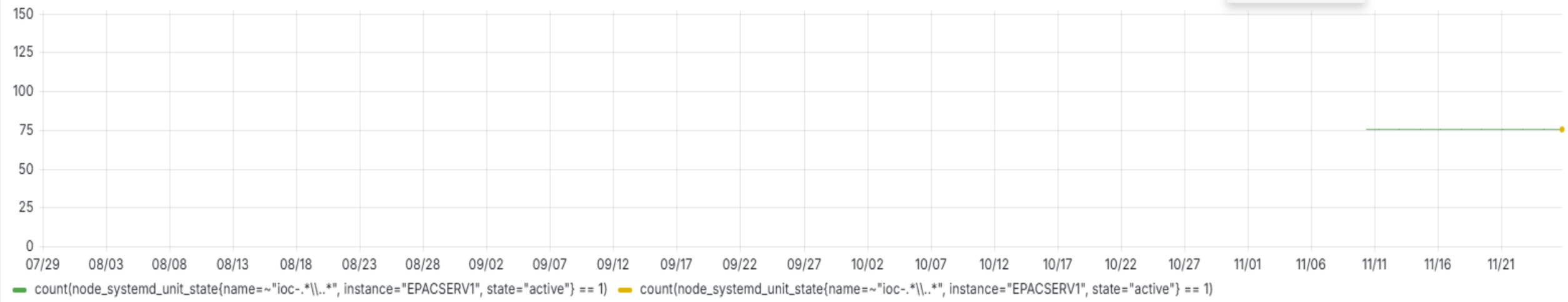


Active/Inactive IOCs

Instance EPACSERV1 ▾

2024-07-28 17:12:27
to
2024-11-25 17:12:27
Local browser time

Active IOC Services Count



Inactive IOCs List

name ↑ 🔍

ioc-PM-201-FE-1-FFE-b4b224f.service

IOC_NAME PM-201-TJ-1-PMC-4 ▾

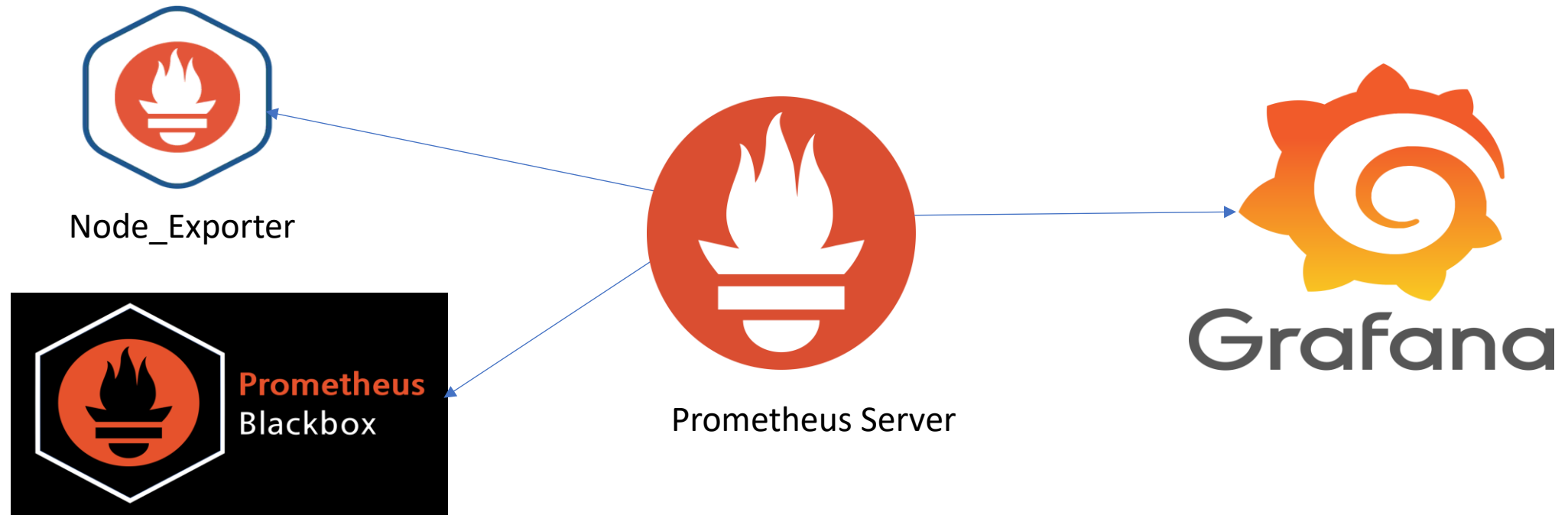
Panel Title

date_string ▾	log_message ▾	tags ▾
2024-11-1 10:13:07	ERROR at or before ')' in file "/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db" line 23	["error"]
2024-11-1 10:13:07	ERROR at or before ')' in file "/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db" line 23	["error"]
2024-11-1 10:13:07	ERROR at or before ')' in file "/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db" line 23	["error"]
2024-11-1 10:13:07	ERROR at or before ')' in file "/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db" line 23	["error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 24 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 23 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 24 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 23 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 24 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 23 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 24 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 23 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 24 has undefined macros	["macros_error"]
2024-11-1 10:13:07	Warning: '/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db' line 23 has undefined macros	["macros_error"]
2024-11-1 10:13:07	ERROR [31;1mERROR [0m failed to load '\$(MOTOR)/db/basic_asyn_motor_clf.db'	["error", "db_error"]
2024-11-1 10:13:07	ERROR [31;1mERROR [0m failed to load '\$(MOTOR)/db/basic_asyn_motor_clf.db'	["error", "db_error"]
2024-11-1 10:13:07	ERROR [31;1mERROR [0m failed to load '\$(MOTOR)/db/basic_asyn_motor_clf.db'	["error", "db_error"]
2024-11-1 10:13:07	ERROR [31;1mERROR [0m failed to load '\$(MOTOR)/db/basic_asyn_motor_clf.db'	["error", "db_error"]
2024-10-24 11:55:38	ERROR at or before ')' in file "/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db" line 23	["error"]
2024-10-24 11:55:38	ERROR at or before ')' in file "/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db" line 23	["error"]
2024-10-24 11:55:38	ERROR at or before ')' in file "/usr/local/epics/support/motor/current/db/basic_asyn_motor_clf.db" line 23	["error"]

EPAC Monitoring

- EPAC logging & monitoring application consists of monitoring
 - Different IOCs
 - Different system services
 - Different hardware resources
- Monitoring activity is achieved using Prometheus in our facility.
- Prometheus is an open-source monitoring system with a dimensional data model, flexible query language, efficient time-series database and modern alerting approach.
- Prometheus collects and stores its **metrics** as time series data, i.e., **metrics** information is stored with the timestamp at which it was recorded, alongside optional key-value pairs called labels.

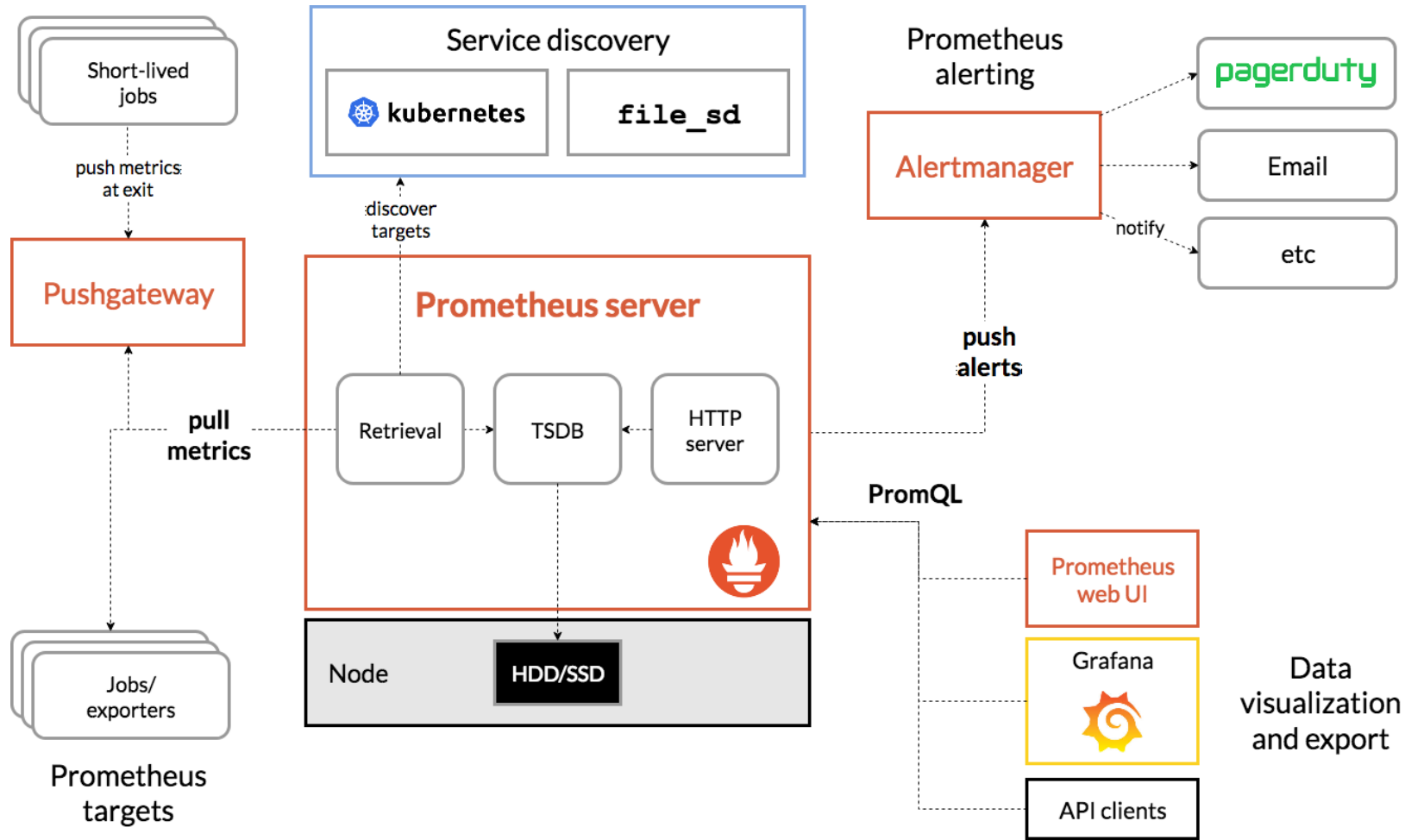
EPAC Monitoring



Prometheus Exporters

- Metrics are numerical measurements in layperson terms.
- Metrics play an important role in understanding why your application is working in a certain way.
- There are a number of libraries and servers which help in exporting existing metrics from third-party systems as Prometheus metrics.
- **Node Exporter:**
 - Used for **system and hardware metrics** such as CPU usage, memory, disk I/O, and network statistics.
 - Essential for monitoring Linux/Unix servers.
- **Blackbox Exporter:**
 - Used for **endpoint monitoring** (e.g., HTTP, DNS, TCP, and ICMP protocols).
 - Enables health checks for services by performing requests to endpoints and recording response metrics.

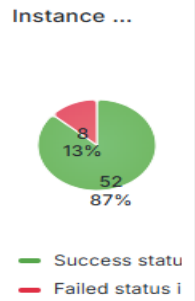
Prometheus




Hardware Errors

Overview


T.. 60
F.. 8



Overview

Instance 

- PM-201-BT-D-CAM-1
- PM-201-BT-D-CAM-2
- PM-201-BT-D-CAM-3
- PM-201-BT-D-CAM-4
- PM-201-CO-CW-1-PM-201-FE-1-POC
- PM-201-CO-MC-1
- PM-201-CO-OSC-1
- PM-201-CO-OSC-2

Statu: 

Probe Duration (s)

DNS Lookup Duration (s)

Instance	Status	Probe Duration (s)	DNS Lookup Duration (s)
PM-201-BT-D-CAM-1	UP	0.004	0.002
PM-201-BT-D-CAM-2	UP	0.003	0.002
PM-201-BT-D-CAM-3	UP	0.005	0.002
PM-201-BT-D-CAM-4	UP	0.004	0.003
PM-201-CO-CW-1-PM-201-FE-1-POC	UP	0.004	0.002
PM-201-CO-MC-1	UP	0.003	0.002
PM-201-CO-OSC-1	DOWN	9.501	0.003
PM-201-CO-OSC-2	DOWN	9.501	0.003

PM-201-TJ-1-PMC-4 status

Status
UP

Certificat...
No data

HTTP Duration

No data

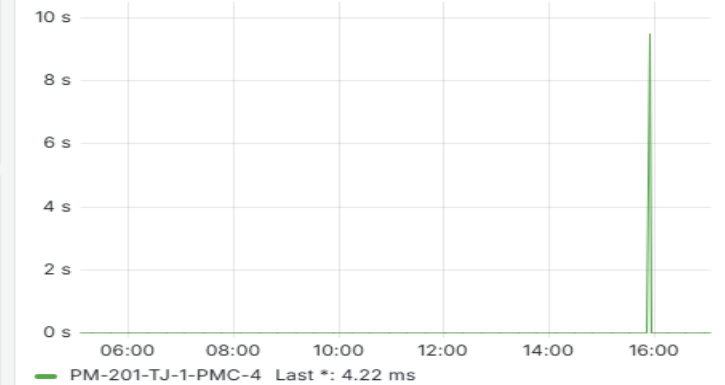
Average P...

2.32 ms

Average ...

1.56 ms

Probe Duration



EPAC Logging Summary

- EPICS (**Experimental Physics and Industrial Control System**) generates logs raised by the st.cmd console.
- These logs are generated using procServ.
- The log files generated by the procServ are stored in the centralized storage system called NFS(Network File System).
- These log files are injected into Logstash.
- Logstash filters out the errors and pushes them to Elasticsearch.
- These filtered errors are visualized using Grafana.

Thank You!

Feel free to contact us at:

✉ smudigonda@tifrh.res.in
sathvikagambheerrao@tifrh.res.in