CENTRALIZING HPC CLUSTER USAGE REPORTING ACROSS WORKLOAD MANAGERS WITH ALTAIR® INSIGHTPRO™ AND ALTAIR® PANOPTICON™

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Challenge

Altair supports more than one hundred Altair® Unlimited™ high-performance computing (HPC) cluster appliances, including two different types: virtual appliances (running in the cloud) and physical appliances (running on-premises). Users of each Altair Unlimited cluster need reports that detail how it's being used, by which users, and how often.

Summary

Efficient cluster usage reporting and job analytics are critical for maximizing resource utilization, ensuring accuracy, and enabling informed decision-making in HPC environments. Traditional reporting methods can be time-consuming, error-prone, and inefficient, particularly when reporting is required frequently or across multiple appliances. This paper discusses the challenges associated with manual report generation and introduces a centralized reporting infrastructure utilizing Altair® InsightPro™, Altair® Panopticon™, NGINX, and Podman to streamline and optimize the reporting process. With this solution, organizations can improve report generation speed, consistency, and scalability while reducing operational burden and enhancing decision-making.

Altair InsightPro gives users comprehensive visibility into their HPC clusters, with fast, intuitive HPC and cloud reporting for any Altair workload manager including Altair® PBS Professional®, Altair® Grid Engine®, and Altair Accelerator™. Altair InsightPro helps users understand resource utilization for chargeback, efficiency and tuning, and troubleshooting – and it connects with Altair's data analytics tools for full data analytics monitoring and AI-powered insights.

Introduction

In modern HPC and cloud environments, organizations face growing demands for accurate, timely, and comprehensive cluster usage reports. These reports often support critical tasks like resource optimization, troubleshooting, and efficiency tuning. However, generating detailed reports has traditionally been a time-intensive manual process, often requiring experienced engineers to spend several hours to generate a single cluster appliance report.

This white paper outlines the problems with traditional reporting methods, explores the benefits of a centralized reporting infrastructure, and describes how leveraging tools like Altair InsightPro and Panopticon can improve operational efficiency, scalability, and decision-making.

Challenges with Traditional Reporting Methods

The traditional approach to cluster usage reporting often involves a mix of manual data collection, ad-hoc analysis, and custom scripting. This process is time-consuming and prone to human error, which can lead to inconsistent or inaccurate reports.

Key Challenges

- **Time-intensive**: An experienced engineer typically needs a lot of time to generate a report for a single appliance, depending on their skill level and tools — which is inefficient for organizations that require frequent updates or have multiple appliances.
- **Scalability issues**: As the number of clusters or appliances grows, the report generation process becomes increasingly cumbersome, making it difficult to meet reporting demands in large-scale environments.
- **Consistency and accuracy**: The ad-hoc nature of reporting can lead to discrepancies and data inconsistencies, undermining reports' reliability.
- **Operational burden**: Engineers spend a lot of time preparing reports rather than focusing on higher-value tasks like optimization, troubleshooting, and innovation.

The Centralized Reporting Infrastructure

A centralized reporting infrastructure overcomes common challenges by streamlining the generation of cluster usage reports. This solution integrates advanced tools such as Altair InsightPro and Panopticon to automate and accelerate the reporting process while maintaining accuracy and consistency.

Core Components

1. **Altair InsightPro:** A comprehensive reporting tool designed for HPC environments, Altair InsightPro offers real-time, intuitive analytics for cluster usage. It helps teams assess resource utilization, troubleshoot issues, and optimize performance.
2. **Panopticon:** A powerful data visualization and streaming analytics tool that connects to various data sources and provides actionable insights through dynamic visualizations. Panopticon helps engineers and decision-makers interpret massive datasets and take informed actions.
3. **NGINX:** A flexible, high-performance web server used for load balancing, reverse proxy, and API gateway functionality. NGINX enhances security and scalability within the reporting infrastructure.
4. **Podman:** A container management tool that provides lightweight, secure, containerized environments for running applications. By using Podman, teams can efficiently deploy and manage infrastructure components, improving scalability and reducing resource overhead.

Benefits of Centralized Infrastructure

The introduction of a centralized reporting infrastructure offers several key benefits:

1. **Efficiency and Speed:** With the automated reporting capabilities of Altair InsightPro and Panopticon, skilled engineers can generate detailed reports within 30 minutes to an hour, compared to the previous 4-hour manual process. New engineers with minimal training can produce reports in two hours.
2. **Scalability:** The centralized infrastructure scales easily across multiple appliances or clusters, eliminating the bottlenecks associated with manual reporting. As new appliances are added, the solution can handle increased reporting demands without requiring a proportional increase in resources.
3. **Consistency and Accuracy:** Automating the reporting process ensures reports are consistently generated with the same structure, formatting, and accuracy, reducing the risk of human error. This consistency improves quality and decision-making.
4. **Reduced Operational Burden:** By automating routine report generation, engineers are freed from time-consuming tasks and can focus on higher-value activities like optimizing system performance, troubleshooting, and innovation.
5. **Team Empowerment:** The integration of intuitive tools like Altair InsightPro and Panopticon empowers teams to generate reports with minimal guidance, fostering greater autonomy and efficiency across the organization.

Architecture and Deployment

The centralized reporting infrastructure is designed to be platform-agnostic, ensuring seamless deployment across both on-premises environments and cloud platforms. This flexibility enables organizations to tailor the infrastructure to their existing IT ecosystem, whether it's running on-prem or across multiple cloud providers.

Network and Server Design

The centralized reporting infrastructure leverages a two-network design:

- **Internal network:** Secure communication between servers.
- **External network:** Limited to specific servers and ports to ensure secure external access.

Key Components and Communication

- **InsightPro server:** Hosts the Altair InsightPro service and communicates with other servers over the internal/external network. It collects PBS Professional accounting data from all appliances running Altair InsightPro agents. The server isn't directly accessible by users; all access to Altair InsightPro is routed through a configured NGINX server, which acts as an intermediary layer. This adds an additional level of abstraction and security, ensuring the Altair InsightPro server remains shielded from direct external access.
  Panopticon server: Hosts the Panopticon service and provides visualization tools for reports. It communicates with the **Altair InsightPro server database** through an **authenticated connection**. Access to **Panopticon** is strictly limited to SSL-enabled, Altair OKTA SSO **authenticated users**, ensuring secure and controlled access to sensitive data. Like the Altair InsightPro server, the Panopticon service is **not directly accessible by users**. Users can access it only through the configured NGINX server, ensuring proper management of external access and adding an extra layer of security.
- **NGINX server:** Acts as a reverse proxy, ensuring secure, optimized communication between Altair InsightPro and Panopticon servers. The NGINX server serves as the only entry point for users, making it the **sole point of access** for the Altair InsightPro and Panopticon servers. This design ensures the actual servers are not exposed directly to the users, providing an extra layer of abstraction and enhancing security.
- **Podman containers:** Provide a lightweight, secure environment for running appliances that export PBS Professional accounting data for reporting.

Altair InsightPro Server Details

Purpose: Runs the Altair InsightPro server service

Communication

- Communicates with the Panopticon server over port 32445 (internal network)
- Communicates with Altair InsightPro agents for installation on port 32443
- Facilitates Altair InsightPro agent-server communication on port 32444

Network

- Only server exposed to the external network for virtual appliances
- Communicates over both internal (for server communications) and external networks

Access: Limited to infrastructure admin users

Panopticon Server Details

Purpose: Hosts the Panopticon service
Communication: Communicates with the Altair InsightPro server database on port 32445

Security

- SSL-enabled HTTPS communication
- Altair SSO authentication for secure access

Network

- All communications occur via the internal network
- Exposed to normal users for centralized report creation

NGINX Server Details

Purpose: Runs the NGINX service
Communication

- Communicates with the Altair InsightPro server on port 32443
- Communicates with the Panopticon Server on port 443

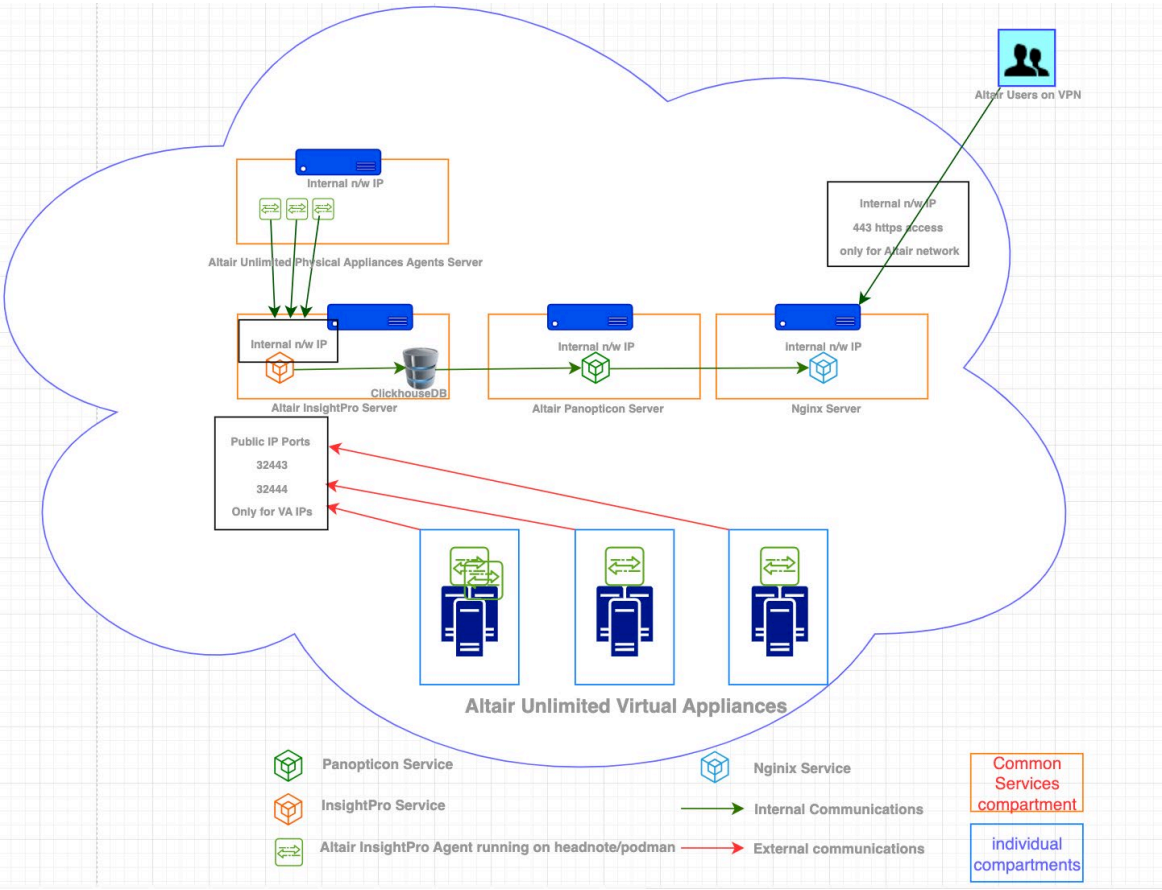
Network: All communications occur via the internal network.
Access: Limited to infrastructure admin users

Physical Appliance (Offline/Darksite) PBS Professional Accounting Data Exporter Details

Purpose: Runs Podman containers for each physical appliance
Communication

- Communicates with the Altair InsightPro server on port 32443 (installation) and port 32444 (Altair InsightPro server-agent communication).

Network: All communications occur via the internal network.
Access: Limited to infrastructure admin users



Network Architecture Diagram

Security Considerations

Security is paramount in any infrastructure, especially when handling sensitive data in HPC environments. The centralized reporting infrastructure ensures secure data handling by:

- **NGINX as the Gateway:** Both the Altair InsightPro and Panopticon servers are not directly exposed to users. Instead, users access these services through the configured NGINX server, which acts as an intermediary. This design provides an extra layer of abstraction, ensuring that the actual servers running Altair InsightPro and Panopticon are protected from direct external access.
- **Authenticated Database Connection:** The connection between the Panopticon server and the Altair InsightPro database is authenticated to ensure that only authorized users can access sensitive data.
- **SSL Encryption and HTTPS for Web Access:** All web access to the Altair InsightPro and Panopticon services is secured using SSL-enabled HTTPS, ensuring user communications with the servers are encrypted in transit.
- **Altair SSO Authentication:** Altair single sign-on (SSO) authentication is employed for secure web access, ensuring that only authenticated users can access the reporting services.

External Access Limitation: The external network is tightly controlled, with access restricted to specific ports and servers, ensuring only necessary services are exposed.

Technical Implementation Steps

The following steps outline the process for setting up the centralized reporting infrastructure, starting from configuring security and networking to deploying the required components. This setup ensures a secure, scalable, efficient solution for generating detailed cluster usage reports.

Step 1: Configure Security and Networking

Before creating instances, ensure the network architecture, security groups, and network configurations are set up to guarantee secure communication between servers.

Create a Virtual Cloud Network (VCN):

- Log in to the **OCI Console** and create a **Virtual Cloud Network (VCN)** in the appropriate compartment.
- Configure **subnets** for the internal and external networks:
    - **Internal Network Subnet:** Used exclusively for communication between the internal servers (InsightPro, Panopticon, NGINX, and Podman).
    - **External Network Subnet:** Used to expose the **Altair InsightPro Server** to the public for specific communication ports. This subnet should be restricted to allow access only on specific ports from specific appliance servers.

Configure Network Security Groups (NSGs):

- Set up **network security groups** (NSGs) to define the allowed inbound and outbound traffic for each server:
    - Open port **32443** for **Altair InsightPro agent communication** between the Altair InsightPro Server and the appliances.
    - Open port **32444** for communication between **Altair InsightPro Server** and the agents.
    - **Panopticon Server** and **NGINX Server** will be restricted to internal network communication only.
    - The **Altair InsightPro Server** will be exposed to **external access** via **specific ports** (32443 and 32444) but **only for appliances that need to send data**. This ensures that only trusted appliances can access Altair InsightPro.
- Ensure **internal communication** between the servers (Altair InsightPro, Panopticon, NGINX, Podman containers) is only allowed within the **internal subnet**.

Public IP to Altair InsightPro Server (Limited Access):

- **Only the Altair InsightPro Server** should be assigned a **public IP** to allow specific external access.

- Configure **firewall rules** on the **Altair InsightPro Server** to restrict access to only **certain appliance servers** (specific IPs or ranges) and allow communication only on the required ports (**32443** for installation of agents, 32444 for agent server communication).
- The **NGINX Server** will **not be exposed** to the external network and will only operate on the **internal network**.

Network Configuration:

- Confirm that **internal communication** between the servers is working correctly and the **external access** to the **Altair InsightPro Server** is restricted to only authorized appliances and ports.
- **NGINX** is accessible internally and routing traffic appropriately within the private network.

Step 2: Create Instances in OCI for Four Servers

Once networking and security configurations are in place, proceed with creating the required instances for each component.

Create Virtual Machines (VMs):

- In the **OCI Console**, create **four separate instances** for the following key components:
    - **Altair InsightPro Server** – Responsible for collecting PBS Professional accounting data and generating reports.
    - **Panopticon Server** – Hosts the Panopticon service and provides data visualization for reports.
    - **NGINX Server** – Acts as a reverse proxy for secure communication between internal users and the Altair InsightPro/Panopticon servers.
    - **Podman Containers** (for PBS Professional Accounting Data Exporter) – Hosts containers running the PBS Professional Accounting Data Exporter for physical appliances located on offline dark sites.

Select the Compartment and Shape:

- Choose the **appropriate compartment** and **VM shape** based on your resource requirements (e.g., CPU, memory).

Assign Networking Configuration:

- **Internal Network Subnet:** Assign the **Altair InsightPro Server**, **Panopticon Server**, **NGINX Server**, and **Podman Containers** to the **internal network subnet**. The NGINX server will route requests internally but will not be accessible from the external network.
- **External Network Subnet:** Assign the **Altair InsightPro Server** to the **external network**.
- For **InsightPro**, assign a **public IP** but restrict access using firewall rules to specific appliance servers.

Verify Instance Creation:

- Confirm that all instances are running and accessible within the **internal network**, and that the **Altair InsightPro Server** is exposed to specific appliance servers through the public IP on required ports.

Step 3: Install and Configure Altair InsightPro Server

Install Altair InsightPro Software:

- Log in to the **Altair InsightPro Server** instance and install the necessary software packages.
- Follow the **Altair InsightPro installation guide** to configure the server for data collection and reporting.

```
1. unzip AltairInsightPro_2025.1.0.zip
2. yum -y install git curl wget
3. cd dist
4. ./prerequisite_check.sh
5. ./AltairInsightPro_install_server.sh
6. systemctl start insightpro.service
7. systemctl is-active insightpro.service
8. inpro set config --agent-server-communication-interface <public IP>
      o  Only one IP is allowed here as of now latest version
```

9. `inpro set config --register-url https://<IP/DNShostname>/insightpro`
    - `multiple IP/hostnames allowed`

Configure Altair InsightPro Communication:

- Set up **Altair InsightPro agents** on the appliances that will send PBS Professional accounting data to the Altair InsightPro Server.

```
1. curl --tlsv1.3 -s -k https://<Insighpro server
   IP>:32443/insightpro_agent/artifacts/agent_installer_script.sh | sudo -E
   INSIGHTPRO_AGENT_INSTALLATION_PATH=/opt/altair -E CLUSTER_ALIAS_NAME=${AUL_ID} bash
2. systemctl start insightpro_agent
3. systemctl is-active insightpro_agent
```

- Configure the Altair InsightPro Server to communicate securely over the internal network with the Panopticon Server and Podman containers.
- Configure firewall rules to allow only specific appliance servers to connect to Altair InsightPro over public IP on port 32443 (for agent installation) and 32444 (for agent server communication)

Set Up Authenticated Database Access:

- Configure the **authenticated connection** between the **Panopticon Server** and the **Altair InsightPro database**. Ensure that only authorized users can access the data for report generation.

```
1. source /etc/altairinsightpro.conf
2. sudo $SERVER_INSTALLATION_DIR/exec/scripts/yq e -i
   '.insightpro.external_database_port=32445'
   $SERVER_INSTALLATION_DIR/home/config/server/values.yaml
3. sudo $SERVER_INSTALLATION_DIR/exec/scripts/yq e -i
   '.insightpro.service.database.port=8123'
   $SERVER_INSTALLATION_DIR/home/config/server/values.yaml
4. sudo vim $SERVER_INSTALLATION_DIR/home/config/server/helm/insightpro/templates/svc.yaml
5. sudo vim $SERVER_INSTALLATION_DIR/home/config/database/config.xml
6. systemctl restart insightpro.service
7. /usr/local/bin/kubectl get services -n insightpro
```

Step 4: Install and Configure the Panopticon Server

Install Panopticon Software:

- Log into the **Panopticon Server** instance and install the necessary Panopticon software packages.
- Follow the **Panopticon installation guide** to set up the server for report visualization.

Set Up Authenticated Database Access:

- Configure the authenticated connection between the Panopticon Server and the Altair InsightPro database.
- Test that Panopticon can retrieve data from Altair InsightPro based on the authenticated access configuration.

Step 5: Set Up NGINX Server as Reverse Proxy

Install NGINX Software:

- Log into the **NGINX Server** instance and install the necessary NGINX software.
- Configure **NGINX** to act as a reverse proxy to manage internal requests and forward them to the **Altair InsightPro Server** or **Panopticon Server** as needed.

Configure NGINX for Internal Access:

- Configure NGINX to handle **internal requests** only and **not expose the NGINX server** to external users.
- Set up SSL encryption for **secure internal communication** (if required) and configure **NGINX** to forward requests internally to the correct backend servers.

Step 6: Set Up Podman Containers for PBS Professional Accounting Data Exporter (Offline Dark Sites)

Install Podman:

- Log in to the Podman server instance and install the Podman container management software.

Deploy Podman Containers for Offline Appliances:

- For physical appliances running in offline dark sites (without direct internet access), Podman containers will be used to run the Altair InsightPro agent service and send the PBS Professional accounting data and pbsnodes -av output to the Altair InsightPro server.

Run the Altair InsightPro Agent Service in Podman Containers:

- Inside the Podman containers, the Altair InsightPro agent service will be deployed and configured to collect PBS Professional accounting data and the output of the pbsnodes -av command, which provides information about node status.
- The Altair InsightPro agent running in the Podman containers will then send the collected data (both PBS Professional accounting and node status information) to the Altair InsightPro server over a secure internal network.
- The Podman containers effectively act as lightweight agents, ensuring that appliances in offline dark sites can still contribute to central data collection and reporting even though they don't have direct internet access.

Verify Data Export:

- Conduct tests to ensure that the Altair InsightPro agent inside the Podman containers can successfully collect and send both the PBS Professional accounting data and the pbsnodes -av output to the Altair InsightPro server.
- Verify that the data is correctly received and processed by the Altair InsightPro server.

Step 7: Final Testing and Validation

Test Server Communication:

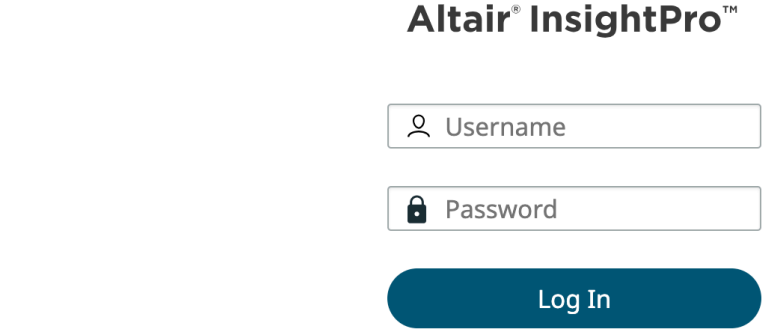
- Confirm that the **Altair InsightPro**, **Panopticon**, **NGINX**, and **Podman containers** (for offline appliances) are properly communicating over the internal network, and that the **Altair InsightPro server** is securely exposed to authorized appliances through public IP only.

Test Report Generation:

- Verify that reports are generated correctly by **Altair InsightPro** and **Panopticon**, and that the data is accurately flowing through the infrastructure.

Perform Security Validation:

- Confirm that **NGINX** is not exposed to external users and that **only the Altair InsightPro server** is exposed on specific ports to the trusted appliance servers.
- Verify that **SSL/HTTPS encryption** and **SSO authentication** are properly set up for secure access.
- Access the Altair InsightPro login page, cluster information page, and initial cluster usage report page.



Altair InsightPro Access Page

Clusters

Last Updated: Dec 13, 2024, 2:13:08 PM GMT+5:30 UPDATE CLUSTERS

Alias Name	Workload manager	Registration time	Total Jobs	Oldest job start time	Latest job start time	Oldest Node Availability Time
	PBS	Dec-12-2024 2:13 PM	39,668	Aug-29-2023 8:34 PM	Dec-13-2024 1:29 PM	Dec-12-2024 2:13 PM
	PBS	Dec-12-2024 2:17 PM	37,785	Sep-21-2022 7:28 PM	Dec-13-2024 1:17 AM	Dec-12-2024 2:17 PM
	PBS	Dec-10-2024 5:11 PM	14,026	Jan-18-2022 2:34 AM	Aug-01-2024 4:52 PM	Jan-01-1970 5:30 AM
	PBS	Dec-12-2024 2:14 PM	13,188	Feb-01-2023 11:18 AM	Dec-13-2024 1:27 PM	Dec-12-2024 2:14 PM
	PBS	Dec-12-2024 2:13 PM	8,784	Jan-25-2022 3:51 PM	Dec-11-2024 8:16 PM	Dec-12-2024 2:13 PM
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	PBS	Dec-12-2024 2:14 PM	7,816	Jun-17-2021 9:33 AM	Dec-13-2024 1:57 PM	Dec-12-2024 2:14 PM
	PBS	Dec-10-2024 5:11 PM	7,034	Oct-19-2019 12:52 AM	Oct-10-2024 8:10 PM	Jan-01-1970 5:30 AM
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	PBS	Dec-12-2024 2:13 PM	4,954	Feb-23-2023 3:22 AM	Dec-13-2024 8:03 AM	Dec-12-2024 2:13 PM
	PBS	Dec-10-2024 5:10 PM	4,754	Mar-11-2024 8:12 PM	Jul-08-2024 5:36 PM	Jan-01-1970 5:30 AM
	PBS	Dec-12-2024 2:13 PM	4,348	Feb-15-2022 2:04 AM	Dec-13-2024 11:27 AM	Dec-12-2024 2:13 PM
	PBS	Dec-10-2024 5:11 PM	4,110	Oct-19-2019 12:52 AM	Sep-12-2024 10:00 PM	Jan-01-1970 5:30 AM
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	PBS	Dec-12-2024 2:14 PM	1,020	Mar-22-2022 3:06 AM	Dec-04-2024 1:12 AM	Dec-12-2024 2:14 PM
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	PBS	Dec-12-2024 2:14 PM	821	Nov-24-2022 1:30 AM	Dec-04-2024 8:00 AM	Dec-12-2024 2:14 PM
	PBS	Dec-12-2024 2:14 PM	819	Oct-16-2023 9:49 PM	Dec-12-2024 10:54 PM	Dec-12-2024 2:14 PM
	PBS	Dec-12-2024 2:13 PM	765	Mar-09-2022 3:52 AM	Jul-13-2024 5:25 AM	Dec-12-2024 2:13 PM
	PBS	Dec-12-2024 2:14 PM	755	Jan-12-2023 5:50 AM	Dec-12-2024 3:58 PM	Dec-12-2024 2:14 PM
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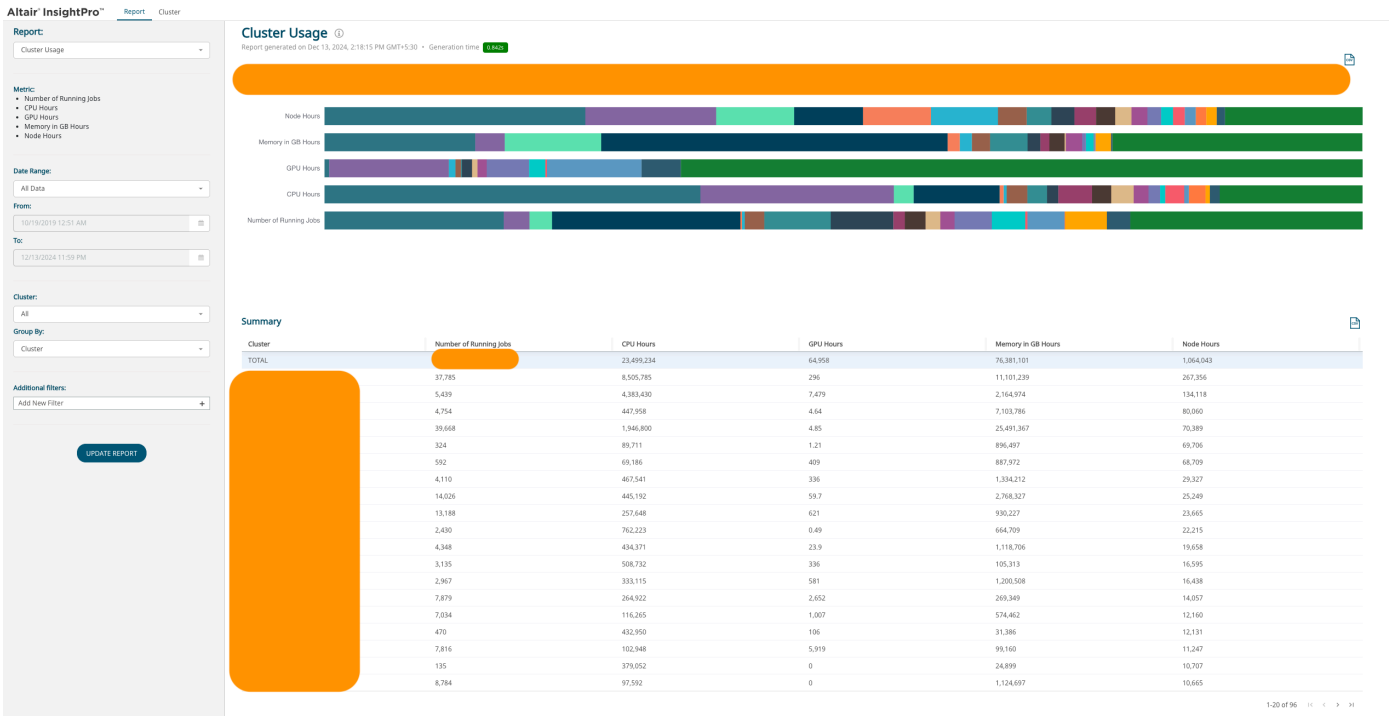
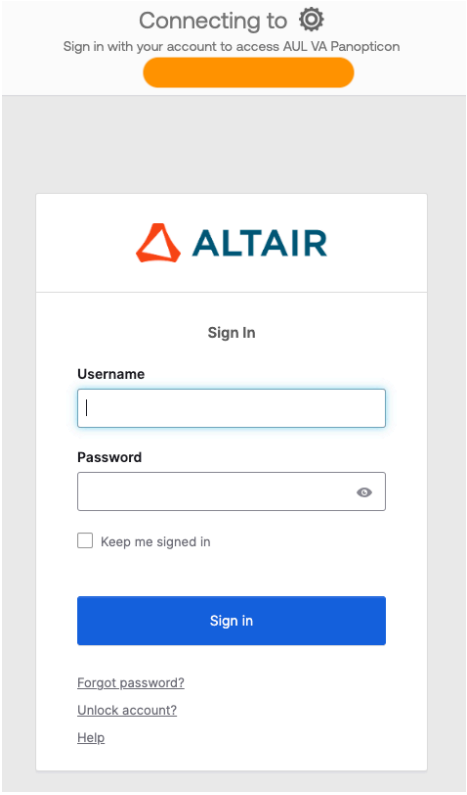
Cluster Information Page



Initial Cluster Report Page for Admins Only



Panopticon Login Page

Panopticon Report Page

Conclusion

By implementing a centralized reporting infrastructure that integrates Altair InsightPro, Panopticon, NGINX, and Podman, organizations can significantly improve the efficiency, scalability, and accuracy of their cluster usage reporting processes. This solution reduces the operational burden of manual report generation and empowers teams to focus on more strategic tasks, streamlining efficiency and decision-making and throughout the organization.

The infrastructure has been deployed and validated to monitor over 100 clusters in real time without any delays. In practice, it can handle even greater loads, demonstrating its scalability and robustness. As HPC environments grow more complex, the need for automated, scalable reporting tools becomes increasingly critical. This centralized reporting infrastructure offers a future-proof solution that can evolve with the changing needs of the organization, ensuring sustained operational excellence and improved resource utilization.