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AI Monitoring Local Cloud
System of Systems Description

Abstract

This document describes the **Monitoring Local Cloud System of Systems (SoS)**, which integrates multiple Arrowhead-compliant subsystems into a unified monitoring and analytics environment. The SoS enables real-time telemetry acquisition, temporary data storage, AI-driven monitoring, and visualization. The local cloud produces a temporary database for external AI training and consumes trained models from another local cloud. Data from the temporary database is periodically transferred to a long-term database through a dedicated **DatabaseUpdater System**, which exposes the **updateDatabase** service to ensure secure and consistent synchronization.

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1 Overview

The **Monitoring Local Cloud (MLC)** is an Arrowhead-compliant System of Systems (SoS) designed for industrial telemetry collection, processing, and analysis. It integrates several micro-systems that operate collaboratively within a secure local cloud environment.

- **Sensor System** – Collects turbine telemetry data.
- **Data Ingestor System** – Normalizes and forwards telemetry data.
- **Data Storage Temp System** – Temporarily stores recent data for analysis.
- **DatabaseUpdater System** – Transfers validated data from the temporary database to the long-term database through the **updateDatabase** service.
- **AI Monitoring Server System** – Performs real-time anomaly detection using AI models.
- **Control Room System** – Displays monitoring results and alerts to operators.

The MLC maintains interoperability with external local clouds:

- A **Model Provider Cloud**, which supplies AI models.
- A **Training Cloud**, which receives temporary data exports for retraining.
- A **Long-Term Data Cloud**, which stores processed telemetry data for historical analytics and compliance.

1.1 How This SoS Is Meant to Be Used

The MLC is deployed in a turbine monitoring environment to provide continuous situational awareness. Its main data flow is as follows:

1. The **Sensor System** collects raw operational data.
2. The **Data Ingestor** validates and structures this data.
3. The **Data Storage Temp System** retains it temporarily.
4. The **DatabaseUpdater System** sends validated data to the long-term database using the **updateDatabase** service.
5. The **AI Monitoring Server** analyzes the data using imported AI models.
6. The **Control Room** visualizes key indicators and alerts.
7. Periodically, the temporary database is exported to a remote **Training Cloud**.
8. Updated AI models are later imported from the **Model Provider Cloud**.

This allows the local cloud to function autonomously while continuously improving through cross-cloud collaboration and maintaining long-term data consistency.

1.2 Data Stored by Individual Microsystem

- **Sensor** – Raw sensor readings and timestamps.
- **Data Ingestor** – Pre-processed data buffers.
- **Temp Storage** – Time-series telemetry data (short retention period).
- **DatabaseUpdater** – Transfer logs and synchronization metadata.
- **AI Monitoring Server** – Imported models, inference results, and alert logs.
- **Control Room** – Visualization metadata and user annotations.

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2 Services

This section describes the services produced and consumed by the Monitoring Local Cloud as a whole.

2.1 Produced Services

- **temporaryDatabaseExportService** – Provided by the Monitoring Local Cloud. This service exports the temporary telemetry database to the external **Training Cloud** for model retraining and improvement.

- **updateDatabase** – Provided by the **DatabaseUpdater System**. This service transfers validated data from the temporary database to the long-term storage system, ensuring data integrity and consistency.

2.2 Consumed Services

- **modelDistributionService** – Consumed from the external **Model Provider Cloud**. Provides trained AI models that are deployed on the local AI Monitoring Server.

- **longTermDatabaseAccessService** – Consumed from the **Long-Term Data Cloud** for data synchronization and verification.

- **Core Arrowhead Services** – Service Registry, Authorization, and Orchestration for local service management.

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3 Security

The Monitoring Local Cloud operates in full **Arrowhead Secure Mode**, ensuring authenticated and encrypted communication for all internal and inter-cloud exchanges.

3.1 Security Model

- **Protocols:** HTTPS/TLS and MQTT/TLS.

- **Authentication:** Managed via Arrowhead-compliant X.509 certificates.

- **Authorization:** Enforced for every inter-service request through the Authorization System.

- **Data Protection:** TLS 1.3 in transit and AES-256 encryption for temporary and long-term data storage.

- **Cross-cloud Federation:** Certificate trust chains established between clouds.

3.2 Handling of Certificates

The system manages both local and federated X.509 certificates. Data export, model import, and database synchronization require signed requests and verified certificate chains between the MLC, Model Provider Cloud, Training Cloud, and Long-Term Data Cloud.

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4 Revision History

4.1 Amendments

No.	Date	Version	Subject of Amendments	Author
1	2025-10-16	4.4.1	Initial release of Monitoring Local Cloud SoSD	Your Name
2	2025-10-18	4.4.2	Added DatabaseUpdater System and updateDatabase service	Your Name

4.2 Quality Assurance

No.	Date	Version	Approved by
1	2025-10-16	4.4.1	
2	2025-10-18	4.4.2	