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Get More Value Out of PI

Intelligent OT Data Pipelines

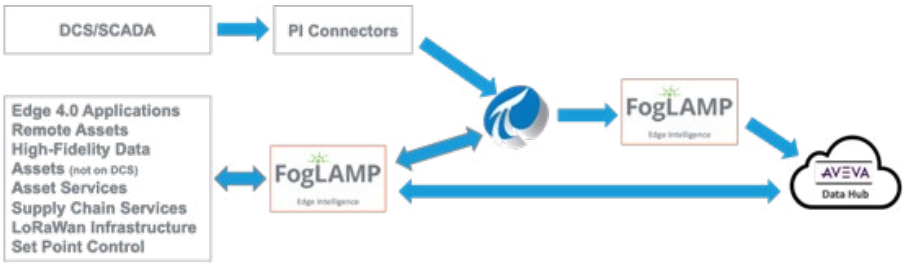
To and From PI and AVEVA Data Hub

The FogLAMP Suite (FogLAMP + FogLAMP Manage) gets more value out of the PI System, AVEVA Connect and OT investments. AVEVA resells and offers first line support for the FogLAMP Suite. FogLAMP collects, processes, transforms and integrates edge data with PI and ADH. FogLAMP has a set point control service to write "target values" back to machines and other systems. FogLAMP Manage is the enterprise's scalable solution for configuring, updating, deleting, securing and backing up FogLAMP's applications / data pipelines, configurations and machine learning models.

The PI System traditionally uses PI connectors and interfaces to connect to DCS and SCADA systems to get its data. Pat Kennedy, founder of OSIsoft, had the realization more and more data in modern factories were not connected to the DCS. Remote assets, cameras, high fidelity sensors (vibration, acoustic, Lidar, etc), edge 4.0 applications, OT cloud services, LoRaWan sensors, and IIoT applications are just a few of these untapped data sources. So, OSIsoft funded Dianomic to create FogLAMP; integrating more data in context with PI, AVEVA Connect and the larger AVEVA / SE product portfolio.

DCS and SCADA systems are mission critical and strictly regulated. They are often not available or affordable in remote locations. They were not designed to support some sources of data, types of data, high-fidelity data (image, vibration) or ML (machine learning) computing workloads. The FogLAMP Suite compliments DCS and SCADA by addressing these challenges. The three primary requirements being:

1. Collect, process, transform and integrate more data types and sources to any / multiple destinations — resulting in Intelligent OT Data Pipelines.
2. A platform to build, deploy and execute edge applications and set point controls.
3. Enterprise scale and management for all OT data pipelines — from sensors to clouds.



IIoT Data to PI and the Cloud

Fog LAMPs connect to any machine or sensor, collect, transform, and integrate data with the PI data archive, AF and ADH. Some common use cases include:

Assets and protocols without connectors or interfaces

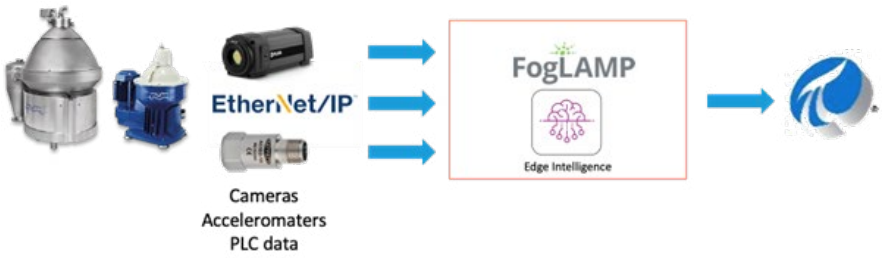
There are hundreds of machine protocols. If AVEVA doesn't have a connector, FogLAMP can help. If FogLAMP doesn't already support a certain protocol new ones can be added very rapidly. Examples include Bechhoff Twincat, S7, IEC103, IEC104, TASE2, HNZ, OPC UA and many more. FogLAMP's supported protocols.

Intelligent edge applications / pipelines

Due to latency, data volume, networks, security, compliance or cost some applications can not run in the cloud. FogLAMP is an IIoT platform to build and operate these applications at the machine edge. These applications can then be integrated with your current PI System. Read more about intelligent OT-data pipelines.

Aggregate different types of data from multiple sources

Many condition monitoring and predictive maintenance applications require data from multiple sources per asset. In the example below a single FogLAMP collects data from a PLC, camera and vibration sensor transforming the data for advanced workloads like edge ML.



Splitting data pipelines to feed multiple / different users and systems

The PI system is often the system of record for a batch or historical data for the entire plant, making PI a primary destination for most OT data. Often other types of systems may need the same data such as; ML tools for the data scientist, or OPC-UA to the SCADA HMI, or MQTT to a data lake. Using FogLAMP, each data pipeline can have unique transformations, security and administration as required.

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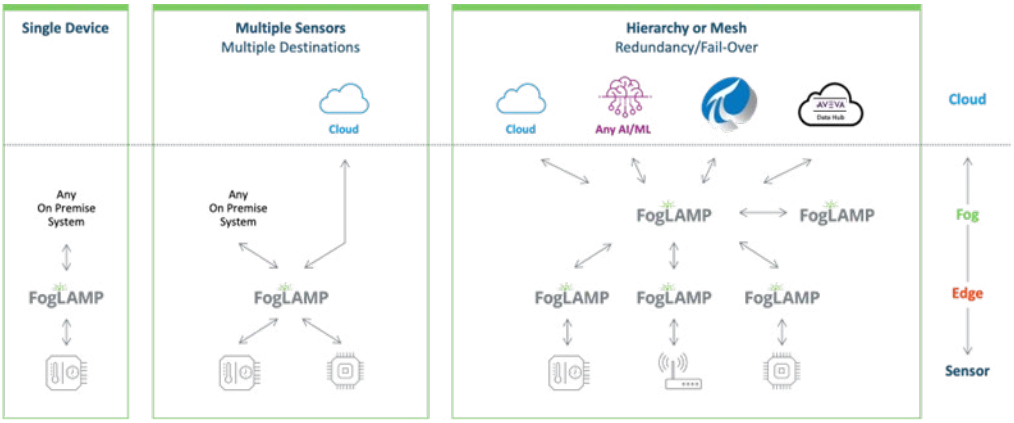
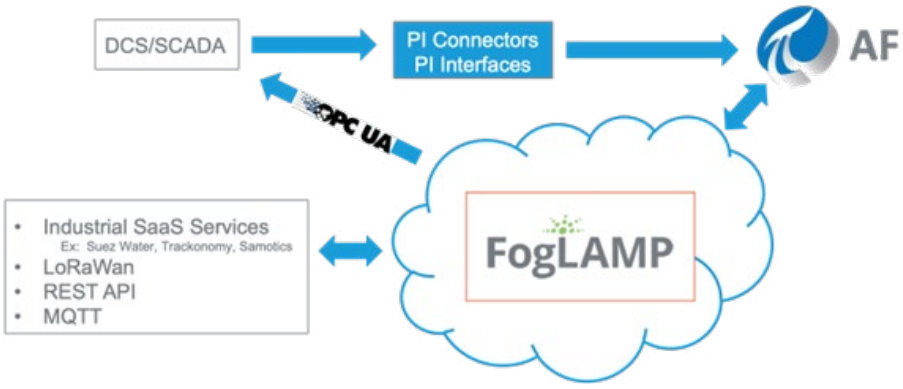
Pipelines to other FogLAMPs

FogLAMPs can connect to other FogLAMPs creating a hierarchy or mesh of intelligent data pipelines from the machine edge to operational systems behind firewalls and to the cloud. Together creating a scalable distributed secure 4.0 edge infrastructure with HA for the enterprise.



Machines-as-a-Service, energy use, logistics and other data

A growing source of OT data is coming from outsourcing, suppliers, customers and third party services. Utilities offer usage, pricing, forecasting, discount programs and more via RestAPIs. Companies that purify water, manage logistics, outsource storage, transport goods, maintain equipment, route base monitor or inspect safety all have data FogLAMP can integrate and PI can maintain. FogLAMP puts all these additional services in context, improving overall operations at the plant and throughout the enterprise



High-Fidelity sensors and new data types (vibration, acoustic, image, radiometric)

Accelerometers are used to monitor high-value rotating equipment. With FogLAMP they are affordable for all equipment. Cameras with computer vision can be used to inspect quality and increase safety. These sensors produce Gigs of data/day and have unique properties and complexity. FogLAMP's edge based signal processing enables next generation edge applications to use these highly accurate sensors, integrate them into PI and deliver the automations and predictive monitoring envisioned by industrial 4.0.

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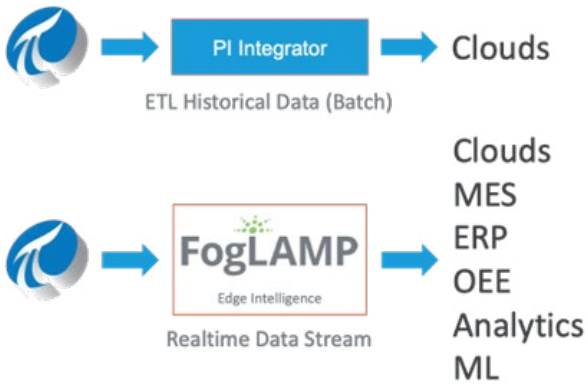
Real Time Streaming Data From PI

PI Systems are collecting, aggregating and storing considerable amounts of process data. With years of historical data, the PI integrator was designed to extract, transform and load (ETL) PI data to the cloud and other systems. ETL is good for moving large amounts of stored data but not for streaming data to real time systems or workloads. FogLAMP PI Access has a PI WebAPI south plugin that registers for tag or AF updates, collecting and streaming those updates in real time, resulting in intelligent OT Pipelines to any destination. This same pipeline can be used for FogLAMP's industrial 4.0 applications and machine learning inference.



PI System of record integration

PI Systems are often used as the OT system of record for batch processes. The top 25 pharmaceutical companies use PI. Keeping track of every step per batch, PI is used for FDA compliance. However, other systems like ERP, MES and OEE may need notification of batch start, stop, etc, supporting the ISA S88 Batch Standard and other actions throughout the progression of the batch. FogLAMP PI Access enables streaming of PI data to these other systems, as necessary, while PI maintains its status as the system of record.

Stream PI Data to intelligent applications and ML Models

PI already collects and aggregates SCADA and DCS data. Using FogLAMP PI Access, PI can now be used as a source of streaming data from the DCS. New real time applications using ML (machine learning) are supported.

Connect PI to OPC-UA, MQTT, Kafka and Clouds

OPC-UA, MQTT and Kafka are protocols often used to help eliminate silos of data enabling uniform data sets between brownfield, new plants/sites and the cloud. FogLAMP PI Access allows the PI server to support these new architectures by collecting PI data updates in real time and streaming them to OPC-UA and/or MQTT backbones. FogLAMP PI Access also supports streaming to all major cloud provider's preferred IoT ingress including Microsoft Azure IoT, AWS Greengrass and Google's Pub/Sub.

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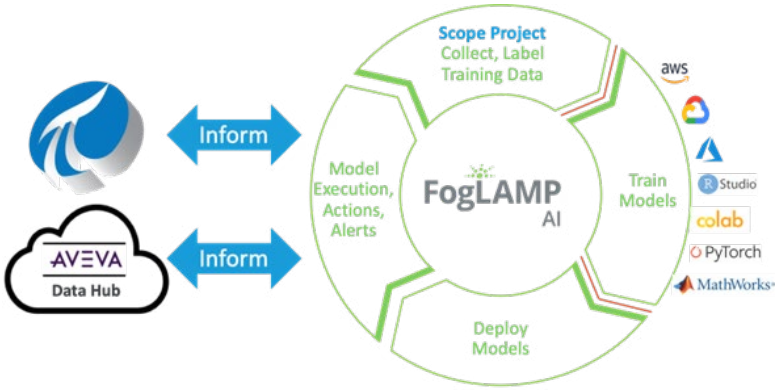
Machine Learning on the Edge — Edge MLOps 4.0

Using computers and mathematical models to improve yield, quality, safety and efficiency started in the 70s. Digital twin describes a computer model where simulations can be tested before being used in the "real world". Today's digital twins and models can use machine learning to build programs that monitor normal behavior, detect anomalies with root cause, predict maintenance and inspect process or part quality in real time. These new ML models use large data sets, labels, neural networks, deep learning, data science techniques and cloud resources. DCS and SCADA systems are not designed for these workloads. This is where FogLAMP comes in.

OT-Data pipelines that build, operate, maintain and manage edge ML models

The edge ML life-cycle (aka: Edge MLOps) has 5 steps.

1. Scope the project. What is the purpose of the model, necessary data and subject matter expertise needed to complete the project?
2. Collect and label training data. This is often an iterative process. Trying different camera angles, vibration frequencies, signal processes, sensor types is often required. FogLAMP's data collection flexibility is excellent at this critical step. Ex: Is a camera or LIDAR better for self-driving cars?
3. Train and test models. The data is sent to the cloud where data scientists work.
4. Deploy models. Using FogLAMP Manage, the resulting model is deployed to the appropriate FogLAMP usually near the equipment's / machine's location.
5. Model execution. This is also known as model inference. The real time operational data from the machine and sensors is processed by the model. The resulting information / automations / predictions are then acted upon. This new real time data is then used to keep models up to date — repeating the cycle.



FogLAMP integrates edge ML results with PI and ADH

Edge applications using ML methods need to be integrated with the OT systems used by engineers, maintenance teams, operators and business users. Real time streaming data is analyzed by the model on the edge. Alerts, notifications and data are then sent to PI, ADH and other OT systems.

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Managing an Enterprise OT Edge

The fourth industrial revolution changes manufacturing forever. Operational data is mission critical. Acquiring, transforming and integrating that data needs an enterprise edge solution agnostic to data's volume, type, source, destination, physical location, network, use case, users, administrators and time.

FogLAMP Manage

FogLAMP Manage is included in the FogLAMP Suite. It is an enterprise scale solution for configuring, updating, deleting, versioning, rolling back FogLAMP applications and pipelines. It monitors all OT data pipelines from sensors to clouds alerting when data is delivered or has issues. It maps physical and logical views of data pipelines by abstracting assets, data sources, FogLAMP's computing environment, integrations (to PI and ADH) and ML model life cycles.

- Scale-Up and Scale-Out
- Enterprise Grade Intelligent Pipelines
- Enterprise Grade ML Life-Cycle
- Auto Discovery Provisioning
- Central Configuration Management
- Application Update, Delete, Rollback
- Audit
- Templating
- Security - Device to Destination
- Pipeline Monitoring/Alerting

A few more details

FogLAMP

Consists of 6 Linux microservices that can be installed on raw HW (as small as a Raspberry PI 0), virtual machines or containers. It can be installed near OT assets deep behind firewalls or in the cloud. Read more.

FogLAMP Manage

Is microservice based, runs on Linux and can be installed in raw HW, virtual machines or containers. It too can be installed behind firewalls, in the DMZ or in the cloud. Written in GO, it is architected for multi-tenancy with role based access control helping scale data centric OT operations and OT/IT integrations. FogLAMP Manage supports modern CI/CD tools like Kubernetes and Rancher. Read more.

Compare FogLAMP to AVEVA EDS

EDS (Edge Data Store) is designed to collect various non-DCS data sources, store the data using OCS for up to a year, visualize the data and integrate the data with PI and ADH. Like a PI server, it stores, visualizes and processes OT data.

FogLAMP's focus is on bi-directional intelligent pipelines from any source to any destination. Like PI and ADH, EDS is a destination and visualization tool for the data managed by FogLAMP's pipelines. Unlike EDS, FogLAMP includes: An open architecture for any / multiple data sources to any / multiple destinations, support for high-fidelity sensors, signal processing, image processing, other non-time-series data, intelligent edge applications using ML, set point controls and enterprise grade data pipeline management.

FogLAMP buffers data for reliability and HA but is not a data store or historian.