IIoT- Predictive Maintenance using a Thermal Imaging Camera Using LF Edge’s Fledge and EVE
Use Case

› Many times the health of a device on a factory floor can be determined by its operating temperature

› Manual Monitoring-
  › Monitoring can be done manually by an operator, but that has many limitations: 1. operator must be physically be there 2. no continuous coverage 3. no predictive component

› Continuous/ Automatic Monitoring-
  › Monitoring can be done by connecting the thermal imaging camera to a local computer/server but there are many issues with this: 1. connectivity might be poor 2. Older systems might be present, and the owner needs to keep them because of previous investment.
UC- Needs

› A system that allows:
  › Continuous monitoring of the system
  › Able to react to an out of bounds condition (i.e. too hot)
  › Remote monitoring of the system
  › Able to send data to another system (OSI’s Pi server, historian, MS Azure Cloud, AWS, Google Cloud)
  › No touch maintenance of the system (remote updating, monitoring)
  › Security of the data and the components
  › ML both near the edge (or on) and in the cloud
UC- Solution EVE and Fledge

› EVE sits on the bare metal and ensures:
  › The security of the device
  › Software updates
  › Hardware independence

› Fledge
  › Can be packaged with a VM and distributed/updated via EVE
  › API’s that allow the abstraction of hardware device
  › Local processing to react to conditions
<table>
<thead>
<tr>
<th>Attributes</th>
<th>Description</th>
</tr>
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<tbody>
<tr>
<td>Type</td>
<td>New</td>
</tr>
<tr>
<td>Industry Sector</td>
<td>Industrial IoT</td>
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<tr>
<td>Business driver</td>
<td>Predictive Maintenance</td>
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<tr>
<td>Business use cases</td>
<td>Many devices give off hints that they will need to have maintenance earlier than their schedule maintenance. Through Machine Learning (ML), we can create models that will allow us to know that a device will soon need maintenance. For many machines, we can gain a great deal of information on the health of the device by looking at the temperature of the device. This requires collecting the data and then sending it to a Historian or similar device. These data points can be sent to the cloud to be modeled. Other requirements</td>
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| Informational       | Predictive maintenance: There are many different types of models. For example, many models do not need to be done in real time. Thus, the data can be sent to the Cloud and processed. The data is not time critical, so if there is a delay in sending/receiving data, the data will need to be stored and then sent when the network is available. |
## Use Case Details

### Attributes

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<tbody>
<tr>
<td>Other requirements</td>
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<tr>
<td>• Need to take the current temperature of the device and react in near real time to rising temperature</td>
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<td>• Example: If over 150 C- send out a warning to an email list, show warning on a UI</td>
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<td>• If over 180 C trigger light or horn</td>
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<td>• If over 200 C trigger shutdown process</td>
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### Business use cases

(Continued)

Other variations:

- Monitoring restricted spaces
- If a human enters in a space,
  - first level of restriction- sound an alarm and turn on lights
  - second level- start shutdown process

### Informational

Yet, there are many scenarios, where real time or near real time is required. An example of this would be a machine reaching a maximum temperature. As it approaches this, we would want to send out a warning and then if it reached this critical temperature, the device needs to be shut down.

For this type of scenario, there needs to be a server or space on the IoT gateway that can process the data in real time.

### Business Cost - Initial Build Cost

Cost is only for the hardware-

### Target Objective

Varies widely depending on accessories. The IoT Gateway can be under $500 to over $5,000

### Business Cost – Target Operational Objective

Because of the remoteness of the devices, need the ability to control ports (turn on/off)

### Security need

Varies depending on local regulations

### Regulations

Other restrictions
Simplified Drawing of System

- FLIR Camera
- Ethernet Cable
- Cloud System(s)
- Fledge
- EVE
- IoT Gateway
- EVE Controller
- HTTPS

THE LINUX FOUNDATION

OLF EDGE
**EVE Edge Computing Engine Architecture**

**Edge Computing Engine**
Agnostic interface supported by API libraries, open to all hardware/network/apps

- Optional driver domain
- EVErouter ACLs secure overlay
- EVEagent config, status, events
- image downloader
- EVEmanager orchestrator
- Verifier sha sigs
- identity manager keygen
- domain manager
- dom0

**Hardware Layer (CPU or GPU)**

**Application Layer (Any VM or Container)**

- EVEagent
- EVEmanager
- EVErouter
- EVEagent

**Project Scope**

- Establish standardized Edge Container Object (ECO) format
- Build EVE edge computing engine and controller (EVC) interface
- API + CLI reference implementation
EVE SCALABILITY

Eve connects to an Adam controller bundled into Eden as a control plane.

Adam + Eden allow:
- Mass Fledge installation.
- Single control point.
- Easy update and devOps.
- Single logs repo.

./eden --config eve1 test ./tests/flir  - to deploy and run the test.
Fledge is architected to enable industrial interoperability, advanced application development, cloud portability and system management.

**ARCHITECTURE**

- Collect Data - from any/all sensors
- Aggregate - combine and organize data
- Transform - filter and transform data
- Buffer – protect data
- Edge Analytics - understand data
- Deliver Data - to multiple destinations
FLEDGE In Energy Condition Based Monitoring - Transformers

- Data Collection & Aggregation
- Edge Analytics
- Alerting
- IT-OT System Integration

- Monitors substation
- High-Low-Avg Temp Any Object
- Security
- Safety zones
- Safety policy
FLIR Scenario

External cloud, ML, Big Data

Historian, SCADA, etc.

GUI- Warning, graphs, etc.

Industrial Machine

Thermal Image

FLIR Camera

On Site Analytics, ML, AI, etc.

EVE Controller

Monitoring of device(s)

Updates (EVE, Fledge, etc.)

Remote Security

Cloud

On Site

EVE

IoT Gateway
DEMO
CI/CD

make build
./eden --config flir clean
./eden config delete flir
./eden config add flir --devmodel general
./eden config set flir --key adam.eve-ip --value 35.227.137.74
./eden --config flir setup
./eden --config flir start --redis-force=false --adam-force=false --eserver-force=false
./eden --config flir eve onboard
make build-tests
./eden --config flir test ./tests/flir -v debug > ../archives/flir.log
Next Steps

LF Edge Community Lab