IIoT - Predictive Maintenance using a FLIR 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 FLIR 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 allows:
  › For the security of the device
  › For the updating of the software
  › 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
## Use Case Details

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

### Attributes

<table>
<thead>
<tr>
<th>Business use cases (Continued)</th>
<th>Description</th>
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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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<tr>
<td>• Example: If over 150 C, send out a warning to a email list, show warning on UI</td>
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<td>• If over 180 C, trigger light or horn</td>
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<tr>
<td>• If over 200 C, trigger shutdown process</td>
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<tr>
<td>Other variations:</td>
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<tr>
<td>Monitoring restricted spaces</td>
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<tr>
<td>• If a human enters in a space,</td>
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<tr>
<td>• First level of restriction - sound an alarm and turn on lights</td>
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<tr>
<td>• Second level - start shutdown process</td>
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### 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

<table>
<thead>
<tr>
<th>Objective</th>
<th>Cost is only for the hardware.</th>
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<tbody>
<tr>
<td>Build Cost Target</td>
<td>Varies widely depending on accessories. The IoT Gateway can be under $500 to over $5,000</td>
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<tr>
<td>Operational Objective</td>
<td>Because of the remoteness of the devices, need the ability to control ports (turn on/off)</td>
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<tr>
<td>Security need</td>
<td>Varies depending on local regulations</td>
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<tr>
<td>Regulations</td>
<td>Other restrictions</td>
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</tbody>
</table>
Simplified Drawing of System

- FLIR Camera
- Ethernet Cable
- Cloud System(s)
- EVE Controller
- HTTPS
- Fledge
- EVE
- IoT Gateway
## EVE Edge Computing Engine Architecture

### Project Scope

- Establish standardized Edge Container Object (ECO) format
- Build EVE edge computing engine and controller (EVC) interface
- API + CLI reference implementation
Fledge is architected to enable industrial interoperability, advanced application development, cloud portability and system management.
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 A310
High-Low-Avg Temp
Per Object in Substation

THE LINUX FOUNDATION

FLEDGE

DIANOMIC

OSIsoft.

ORACLE

FLIR

ETHERNET TO CISCO 4000

IIOT Pub-Sub Engine

ERP Trouble Ticketing

Trouble Ticketing

T&D Management

System Management
Commercial Support

IIIOT Pub-Sub Engine
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

IoT Gateway

Monitoring of device(s)

Updates (EVE, Fledge, etc.)

Remote Security

Cloud

EVE Controller