Using FogLAMP To Get Your Dark Data Into PI

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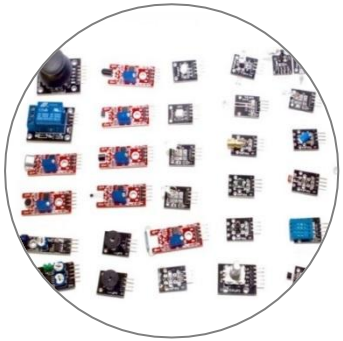
IIoT Enables Digital Transformation



Cheap, and tiny sensors

Decreasing compute and storage costs

New abilities to process and analyze data

Ubiquitous connectivity

Sensors on the Entire Supply Chain will Automate and Transform Business

Secondary IIoT Networks

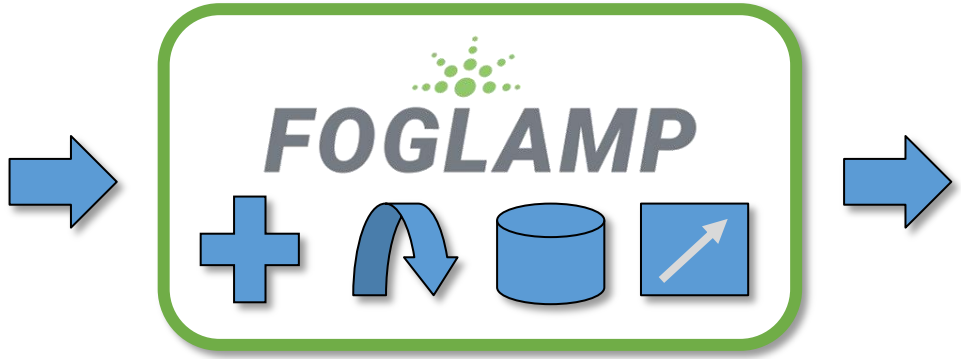
- Industrial SCADA systems are secure and reliable but also
  - Tightly regulated/controlled
  - Geographically challenging
  - Expensive
- Networks of Non-SCADA Data are becoming Common

- Massive Fragmentation and Complexity in Sensors
- Large Brownfield needs to be supported/extended

Dianomic simplifies IIoT data by supplying **FogLAMP**, an open source sensor-to-cloud fabric that connects people to the data they need to operate their business.

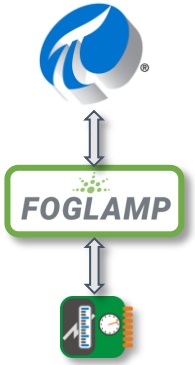
Efficiency is Everything

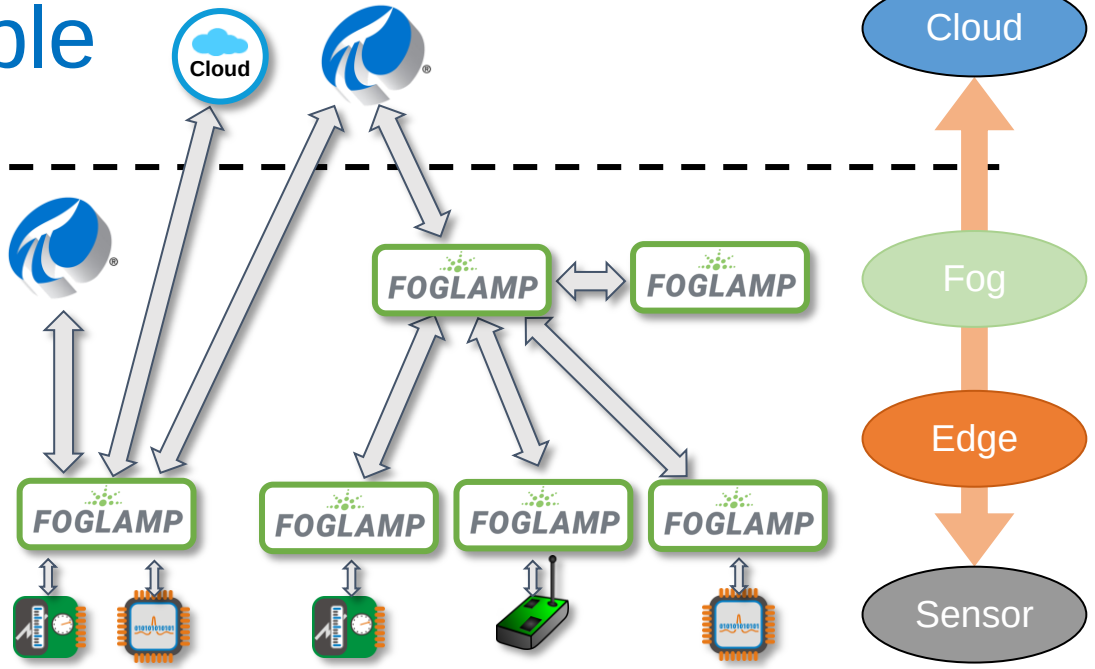
- Maximizing Asset Availability/Usage is Critical
- Strategies
  - Reactive Maintenance (Run-To-Failure)
    - Failures are a surprise, and resolving creates emergencies
  - Preventive (Scheduled) Maintenance
    - Down-time during maintenance/inspection
    - Significant cost of maintenance
    - Can still have surprise failures
  - Predictive (Condition-Based) Maintenance
    - Use data to predict when equipment needs maintenance
    - Ranges from simply monitoring oil temperature to running ML models
    - Reduced downtime and cost



Collect Data	- from any/all sensors
Aggregate	- combine and organize data
Transform	- filter and transform data in-flight
Buffer	- reliability for poor connectivity
Edge Analytics	- visualize data on the edge
Deliver Data	- to multiple local/cloud destinations

Flexible and Scalable





FogLAMP is a single device solution or…

Multiple Sensors

Multiple Destinations

Hierarchy or Mesh

Redundancy / Fail-Over

Pre-process & Buffer Data at all Layers

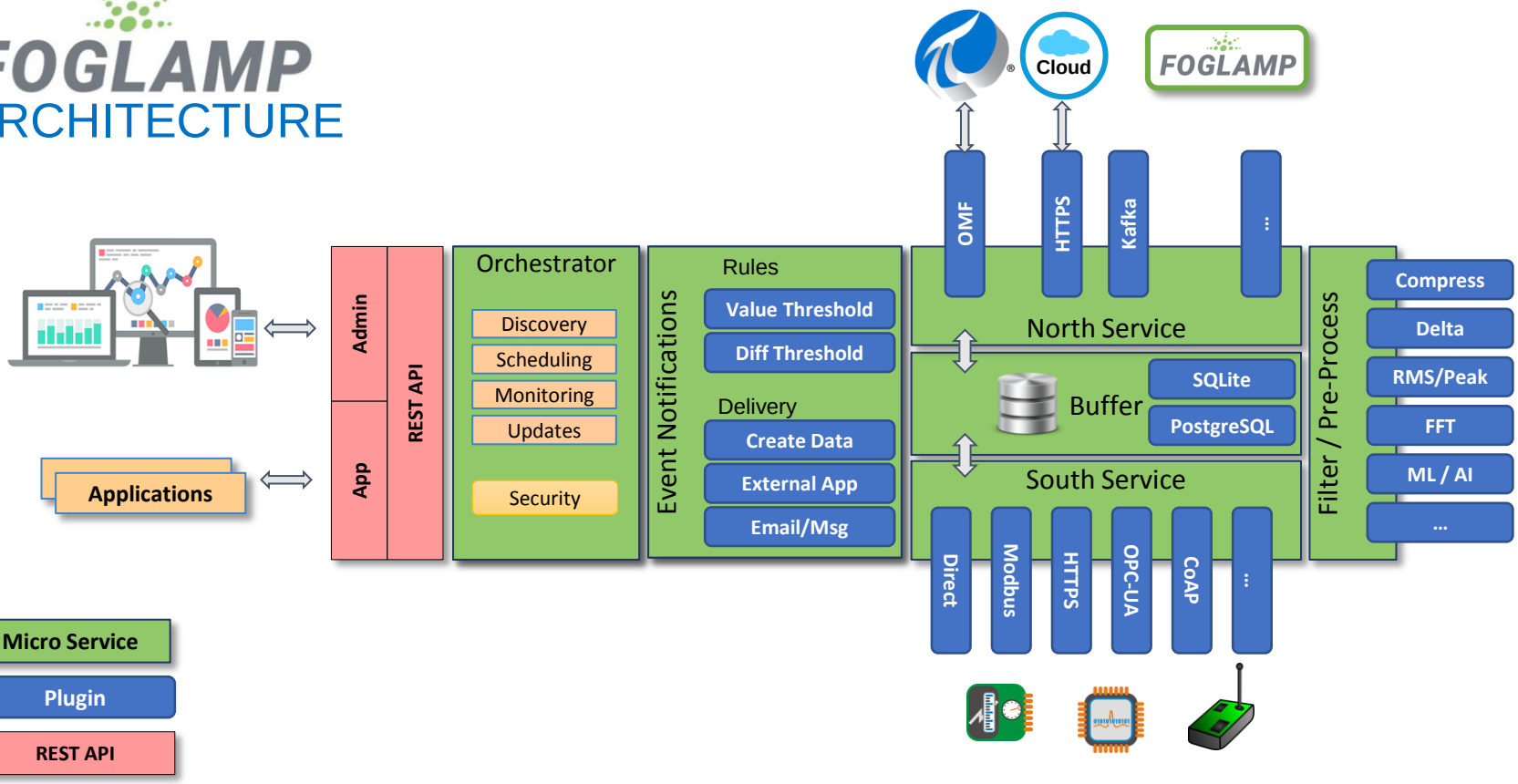
FOGLAMP

- Reliable and Resilient – like a cable modem
- Low-Effort Provisioning and Maintenance

- Small (<50m memory required)
- Fast (15,000 readings/second)

Available on Variety of Industrial Hardware

FOGLAMP ARCHITECTURE



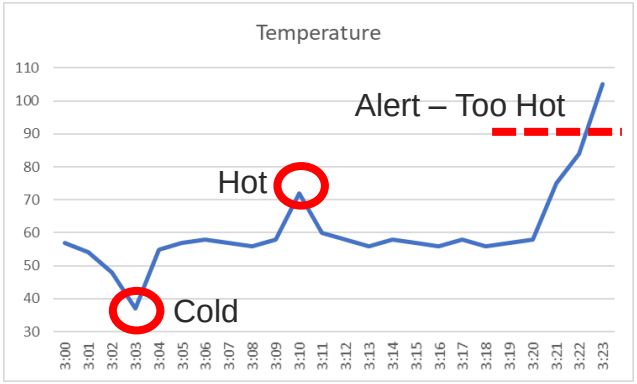
Collect Any Data

- Many Existing South Plugins
  - Directly-connected sensors
    - PT100 temperature, AM2315 humidity, etc
  - Modbus, HTTPS, MQTT, OPC/UA, CoAP
- Pluggable – Build Your Own
  - Easy API and sample code
    - Build your own
    - Customize existing plugins
  - Python or C++
  - Polled or Async
- Open Source Community – many plugins in time

Filters and Applications

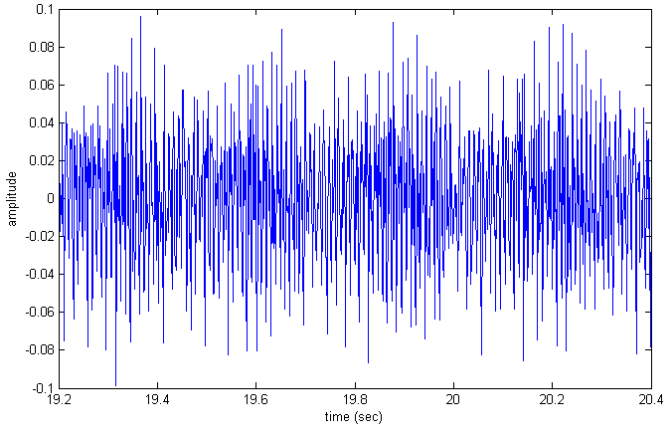
- Filter or transform data in-flight
- Hooks allow access at ingress or egress
- Pre-built Filters
  - Enrich/Transform
    - Expression – apply arbitrary mathematical formula across multiple assets
    - Metadata – modify metadata values
    - RMS/Peak – calculate energy of oscillation
    - FFT – discover frequencies of oscillation/wobble
    - TensorFlow – machine learning / image recognition on the edge
  - Compress/Conserve
    - Delta – only send changes
    - Rate – intelligent filtering – upon error send last 30 minutes
- Pluggable – Create your own
  - Easy APIs and Sample Code
  - Python or C++

High Frequency / Vibration Data



- Graph is Visually Meaningful
- Can Create Alarm Thresholds

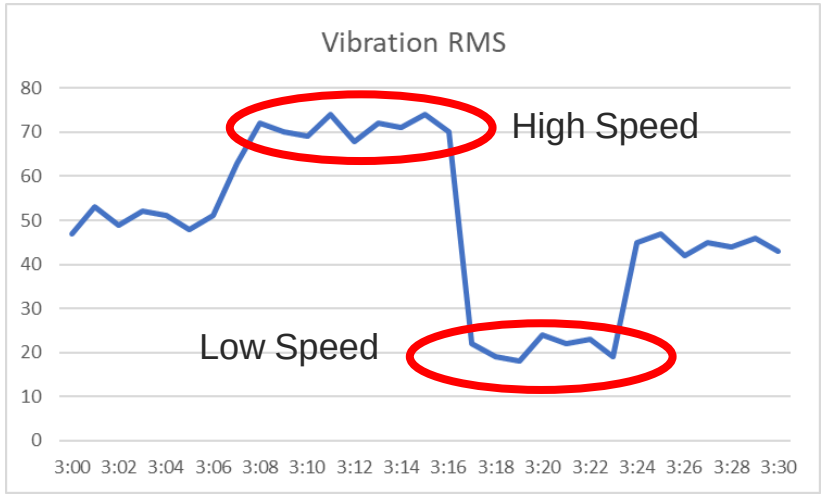
- Low Volume (1 sample/sec)

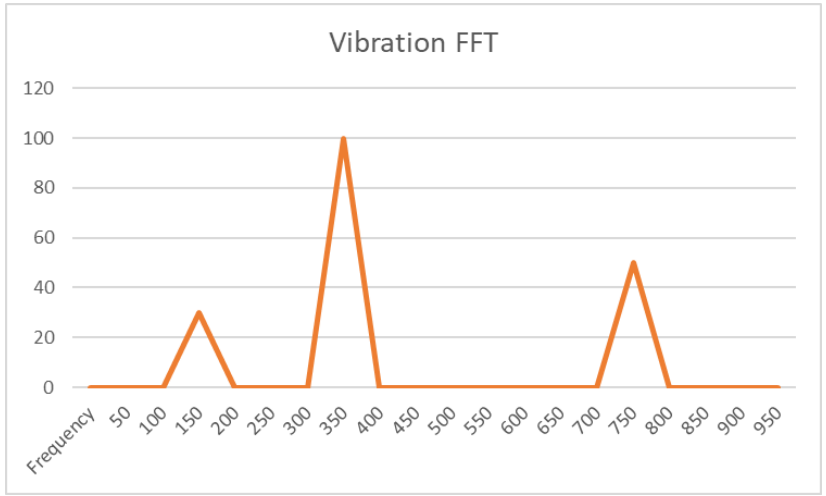


- Is this Graph Good? Is it Bad? Dunno.
- Can't Create Alarm Thresholds.

- High Volume (1,000+ samples/sec)
  - Wastes expensive bandwidth
  - Consumes Disk/CPU

Enriching & Simplifying Data



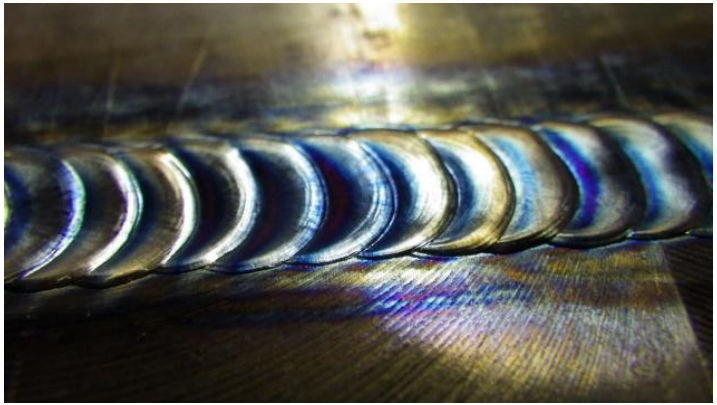


- **RMS** shows energy of vibration
- Conveys speed & fatigue.

- **FFT** shows energy at different frequencies.
- Useful to predict problems.

Machine Learning / Image Recognition

What is this serial number?



Is this weld high quality?

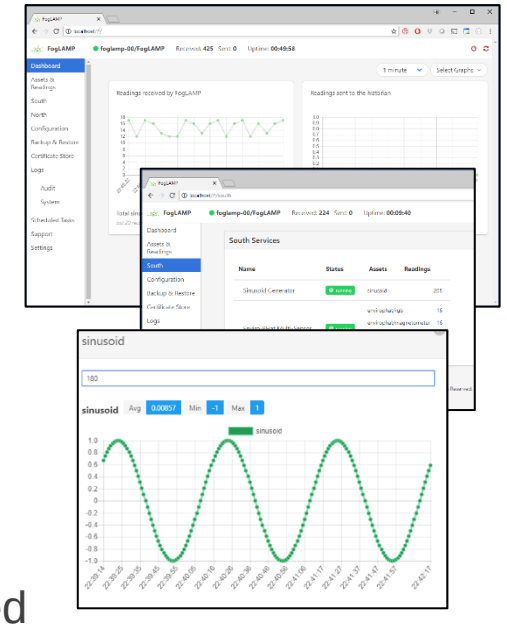
FogLAMP can run ML Models at the Edge
Google TensorFlow Lite Plugin

Event Frames at the Edge

- Rules
  - Temperature goes over threshold
  - Current goes 20% above the average of last 5 minutes
  - Pluggable – Create complex rules across multiple assets
- Delivery Mechanisms
  - Create PI Data
  - Run External Python App
  - Email / Slack / Send Message
  - IFTTT (If This Then That)
  - Pluggable – Create your own

FogLAMP Management

- Out-of-the-box FogLAMP GUI
  - Setup, Configuration, Monitoring, Analytics of a single FogLAMP
  - Source code is open-source and extensible
- REST interfaces make it easy to build:
  - Automated scripts
  - Your own management consoles
  - Integration into existing management consoles & tools
  - All out-of-the-box FogLAMP GUI capabilities are delivered via REST
- Puppet
  - Manage at scale with Puppet
  - Puppet client is available on most Linux's
- Centralized Management in Development



puppet

Implementations

Wind Farm – Con Ed

- **Need:** Predictive maintenance turbine bearings
- **Problem:** Remote, No GE SLA, $150K per incident, monitored in PI with all other power generation
- **Solution:** FogLAMP + Nokia private LTE + Advantech connected to PI
- **Result:** Nokia OEM and Advantech go-to-market FogLAMP contracts

Factory - GA

- **Need:** Exact humidity and temp for autoclaves and paint booths
- **Problem:** Wasted fuselage & wings, monitored by PI w/ rest of factory
- **Solution:** FogLAMP + temp and humidity sensors + PI + monitor for workers
- **Result:** First FogLAMP customer. More GA use cases

Energy Co. - JEA

- **Need:** Monitor $M substation transformers before they overheat
- **Problem:** Transformer's sensors too expensive to connect & no easy way to send to PI
- **Solution:** FogLAMP Modbus Input and Substation wifi to PI
- **Result:** 7x24x365 monitor of transformers as component of grid, proactive maintenance

San Leandro Tech Campus

Efficiency in design

- Old HQ – 26 kWh Sq/Ft
- SLTC – 8.5 kWh/Sq/Ft
- Building Management System (BMS)
- LED Lighting
- Dynamic Window Tinting

Auto-Tinting Window Monitoring

Powered by FogLAMP and OMF

Challenge

SLTC is instrumented with automatic tinting windows called “Viewglass”. When the tinting is set incorrectly, employees are blinded with sun in their eyes. Some folks have even started using umbrellas in the office!

Solution

Install ambient light sensors as a secondary measurement to verify if the windows are behaving properly. This data is then sent to the SLTC’s PI System where it’s combined with data from the Viewglass system. The data is analyzed and used to help tune the Viewglass setting through the year.

Results

Less employees with bad luck by opening up umbrellas indoors! Faster detection of issues with the Viewglass windows and more accurate seasonal tuning.

Conference Room Occupancy Monitoring

Powered by FogLAMP and OMF

Challenge

Conference rooms make up a large portion of SLTC. OSIsoft wants to better understand how much time we spend leaving the lights on in rooms that are unoccupied.

Solution

Install a suite of sensors that monitor motion and ambient light. The motion sensor will determine if the room is occupied. The light sensor will indicate if the lights are left on.

Results

Increased visibility into the energy used to light up conference rooms with they are unattended, with the goal of reducing energy costs.

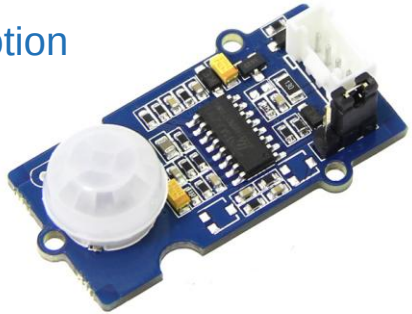
Light

Temperature & Humidity

Sound

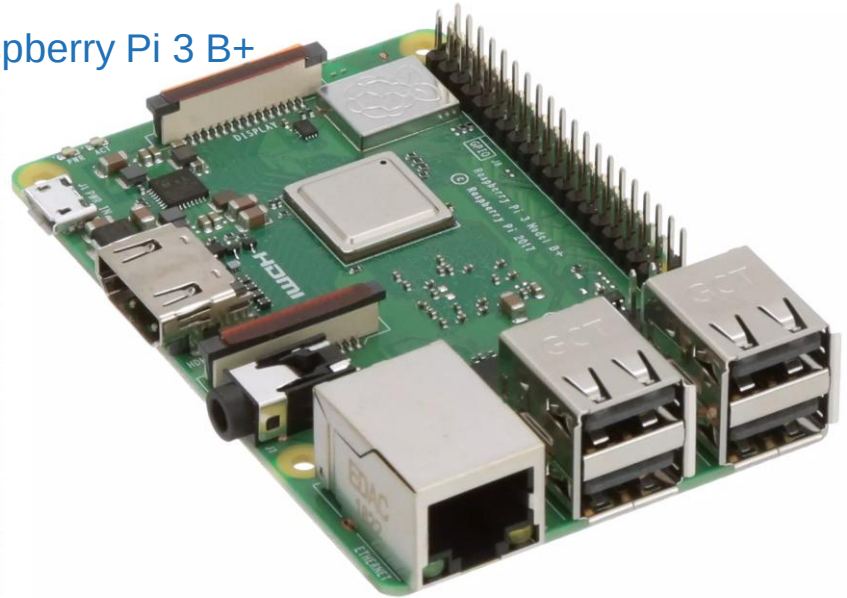
Air Quality

Motion



FOGLAMP

Raspberry Pi 3 B+



Sensor Hub

Sound

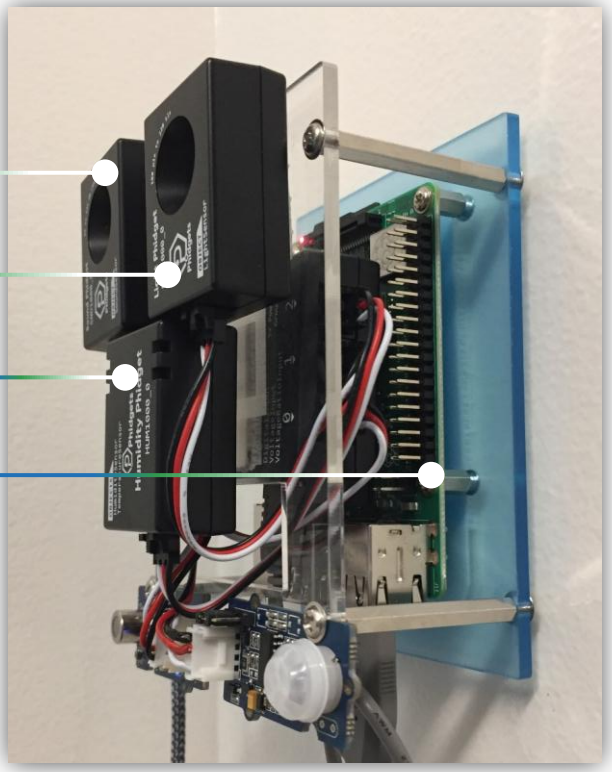
Light

Temperature & Humidity

Raspberry PI 3

Air Quality

Motion

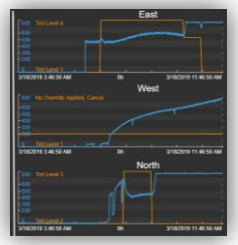


North Plugin
OMF to PI

Buffering

Configurable
South Plugin
for Data
Collection

North
South
East
West



ViewGlass Windows
Conference Rooms

Sensor Set

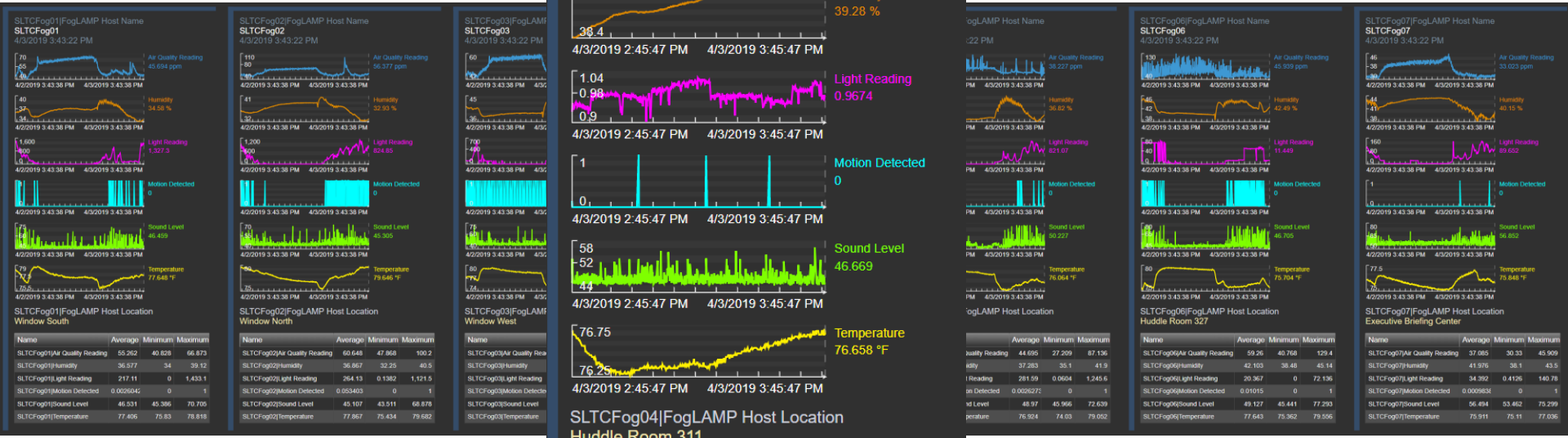
FOGLAMP

PI System

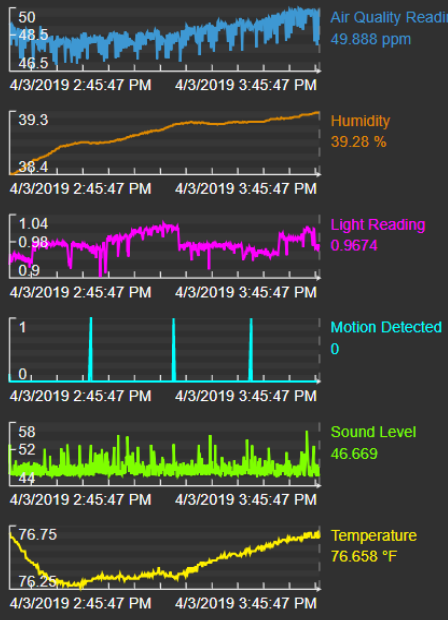
PI Vision

Huddle Room (Small) 327
Meeting Room (Large) 311
Executive Briefing Center

Notifications



SLTCFog04|FogLAMP Host Name
SLTCFog04
4/3/2019 3:45:22 PM



SLTCFog04|FogLAMP Host Location
Huddle Room 311

Name	Average	Minimum	Maximum
SLTCFog04|Air Quality Reading	48.549	46.643	49.981
SLTCFog04|Humidity	38.975	38.41	39.28
SLTCFog04|Light Reading	0.97523	0.902	1.0209
SLTCFog04|Motion Detected	0.0033334	0	1
SLTCFog04|Sound Level	47.386	45.94	56.177
SLTCFog04|Temperature	76.451	76.262	76.712

Home KPI Energy Management Fault and Site Management

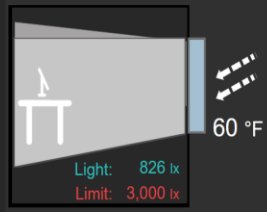
SLTC SAN LEANDRO TECH CAMPUS

Dynamic Glass Light Level Monitoring

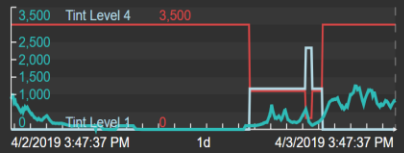
East

Window location: E07

Good



Window Tint: Tint Level 1



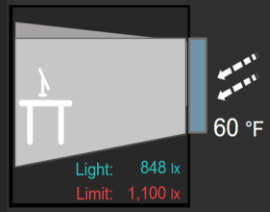
High Light Level Events: 2

Event Name	Reason
High Light Level - East - Tint Level 3: 552 > 325 lx on 04/03 10:13	

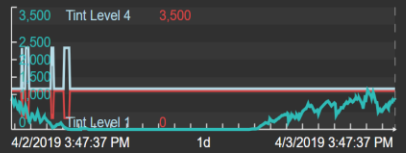
North

Window location: N01/N01 Day

Good



Window Tint: Tint Level 2



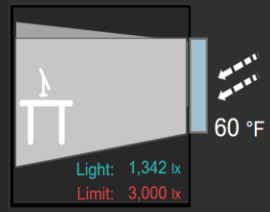
High Light Level Events: 2

Event Name	Reason
High Light Level - North - Tint Level 2: 1101 > 1100 lx on 04/03 14:02	
High Light Level - North - Tint Level 2: 1100 > 1100 lx on 04/03 14:03	

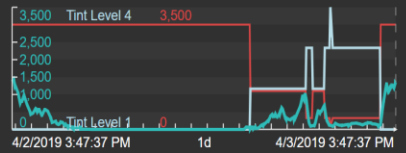
South

Window location: S01/S01 Day

Good



Window Tint: Tint Level 1



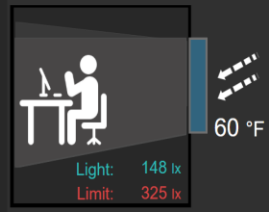
High Light Level Events: 2

Event Name	Reason
High Light Level - South - Tint Level 3: 701 > 325 lx on 04/03 10:13	
High Light Level - South - Tint Level 3: 526 > 325 lx on 04/03 11:22	
High Light Level - South - Tint Level 4: 105 > 75 lx on 04/03 11:44	

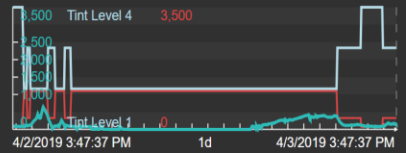
West

Window location: W13

Good

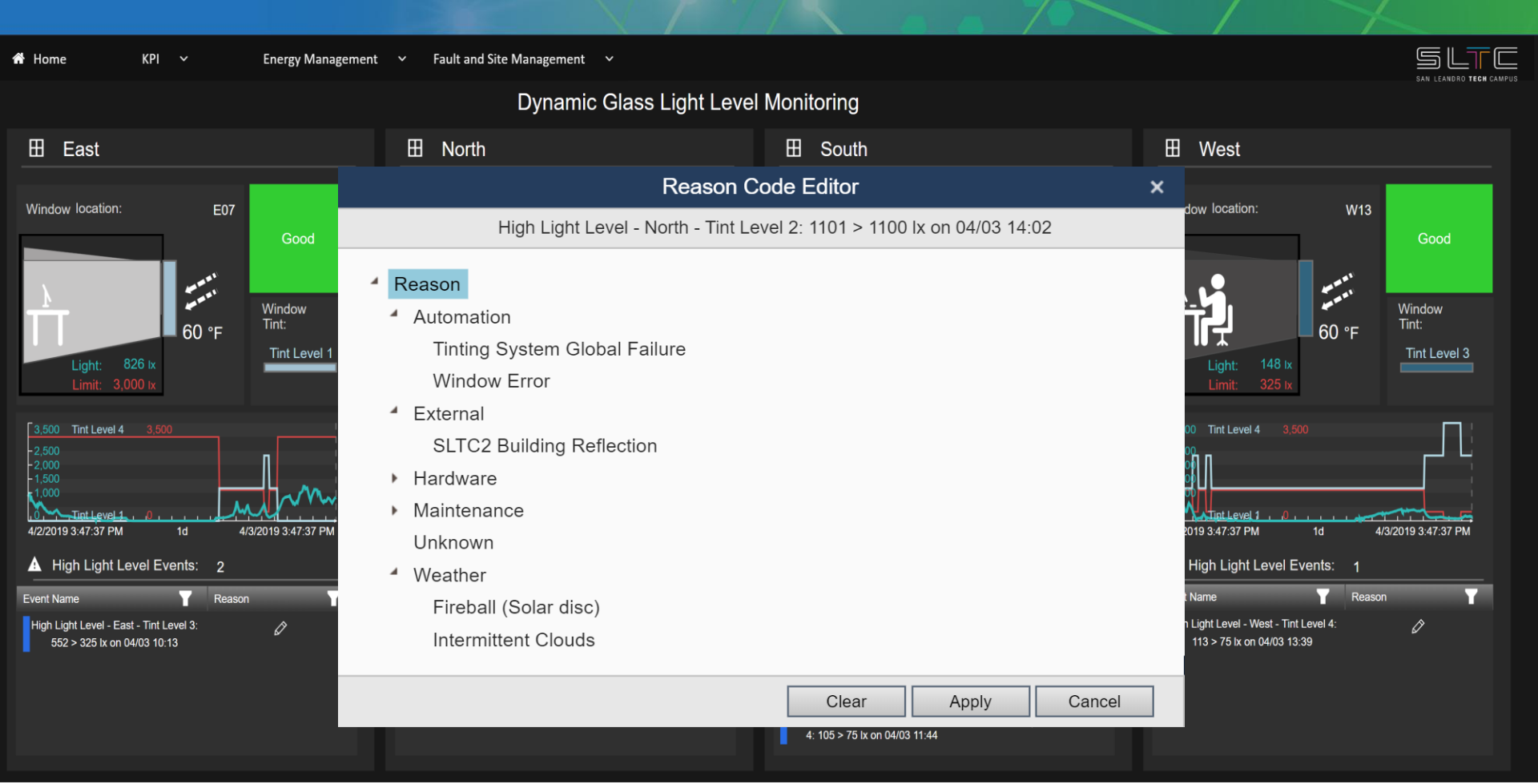


Window Tint: Tint Level 3



High Light Level Events: 1

Event Name	Reason
High Light Level - West - Tint Level 4: 113 > 75 lx on 04/03 13:39	



Home KPI Energy Management Fault and Site Management

SLTC SAN LEANDRO TECH CAMPUS

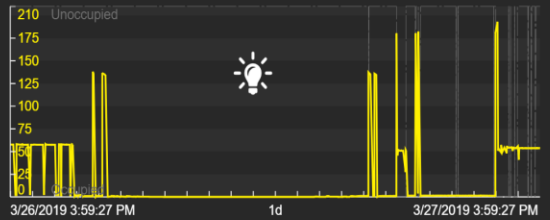
Estabrook Conference Room (311)

Lighting On

Occupied
Building

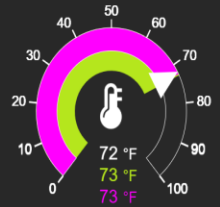
Unoccupied
Room

Occupancy Status
Light 53.7 lx

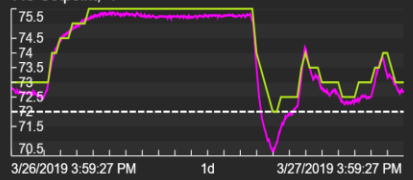


Event Name	End Time	Duration
Estabrook (311) Occupied 03/27 at 13:58	3/27/2019 2:34:11 PM	35m 30s
Estabrook (311) Occupied 03/27 at 09:29	3/27/2019 9:55:01 AM	25m 41s
Estabrook (311) Light Left On 03/26 at 18:18	3/26/2019 6:43:01 PM	24m 20s

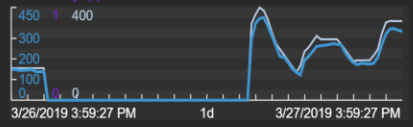
Temperature Status Good



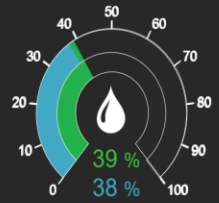
FogLamp Temperature Sensor, °F
BMS Temperature Sensor, °F
AC Setpoint, °F



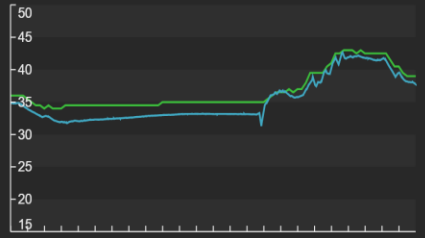
Actual Air Flow, ft3/m
Desired Air Flow , ft3/m
Air Quality, ppm



Humidity



FogLamp Humidity, %
BMS Humidity, %

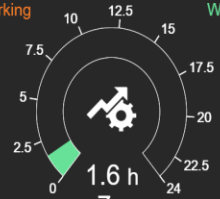


Description	Value	Units	Average	Minimum	Maximum
% cooling	82.2	%	23.2	0.0	99.9
% heating signal	0.0	%	0.0	0.0	0.0

Daily Utilization

Outside Working Hours
0.0 h

Within Working Hours
1.6 h

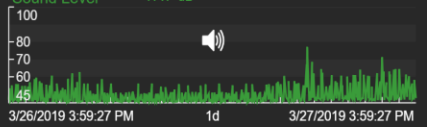


0 %
of 11 h total

13 %
of 13 h total

Building Working Hours: 7:00 am - 7:00 pm

Sound Level 47.7 dB



Event Name	Duration
Estabrook (311) After Hours Light On 03/26 at 20:09	9m 59s
Estabrook (311) After Hours Light On 03/26 at 19:43	7m 55s

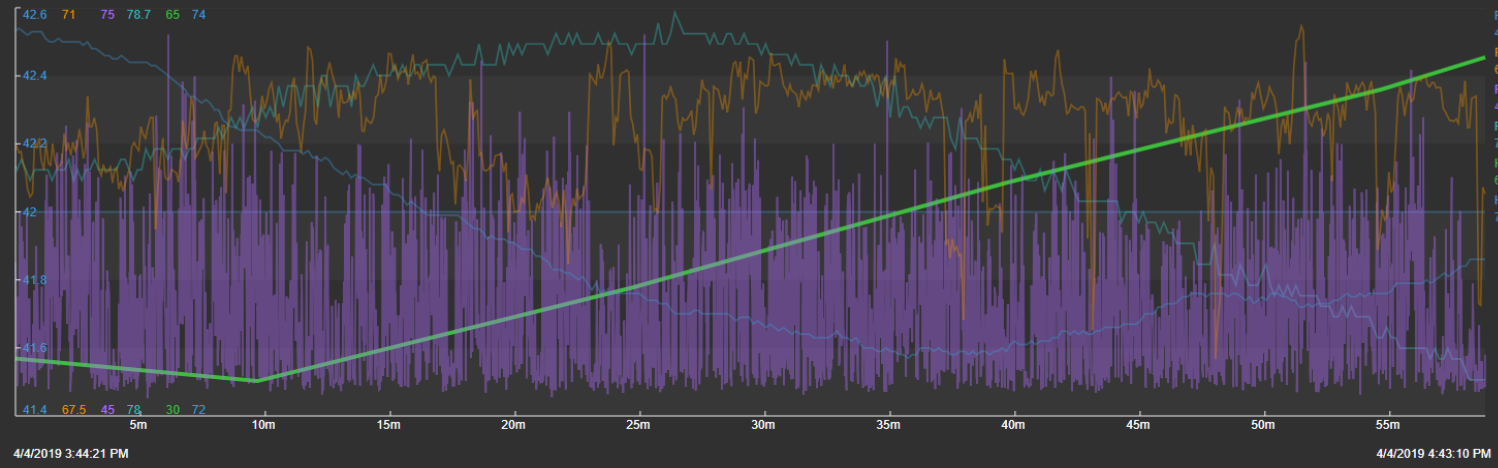
Rivendell (327) Occupied 04/04 at 15:44

Acknowledge

Information

4/4/2019 3:44:21 PM - 4/4/2019 4:43:10 PM

Event Type: Monitored Room Occupancy
Asset: ...\SLTC\Monitored Rooms\Huddle Room 327



Room Occupancy Status

Event Attributes (7) Rivendell (327) Occupied 04/04 at 15:44	Value	Units
Rivendell (327) Occupied 04/04 at 15:44 Actual Airflow	60.759	ft3/m
Rivendell (327) Occupied 04/04 at 15:44 Average Humidity	41.886	%
Rivendell (327) Occupied 04/04 at 15:44 Average Light	70.015	lx
Rivendell (327) Occupied 04/04 at 15:44 Average Sound Level	52.823	dB
Rivendell (327) Occupied 04/04 at 15:44		

What's Next?

- Portable version of the sensor set (Facilities Manager)
- Rollout to production network, expand footprint
- Fine tune (data, detection…)
- Analyze data further (aggregate of events, totalize…)
- Expand with different sensors

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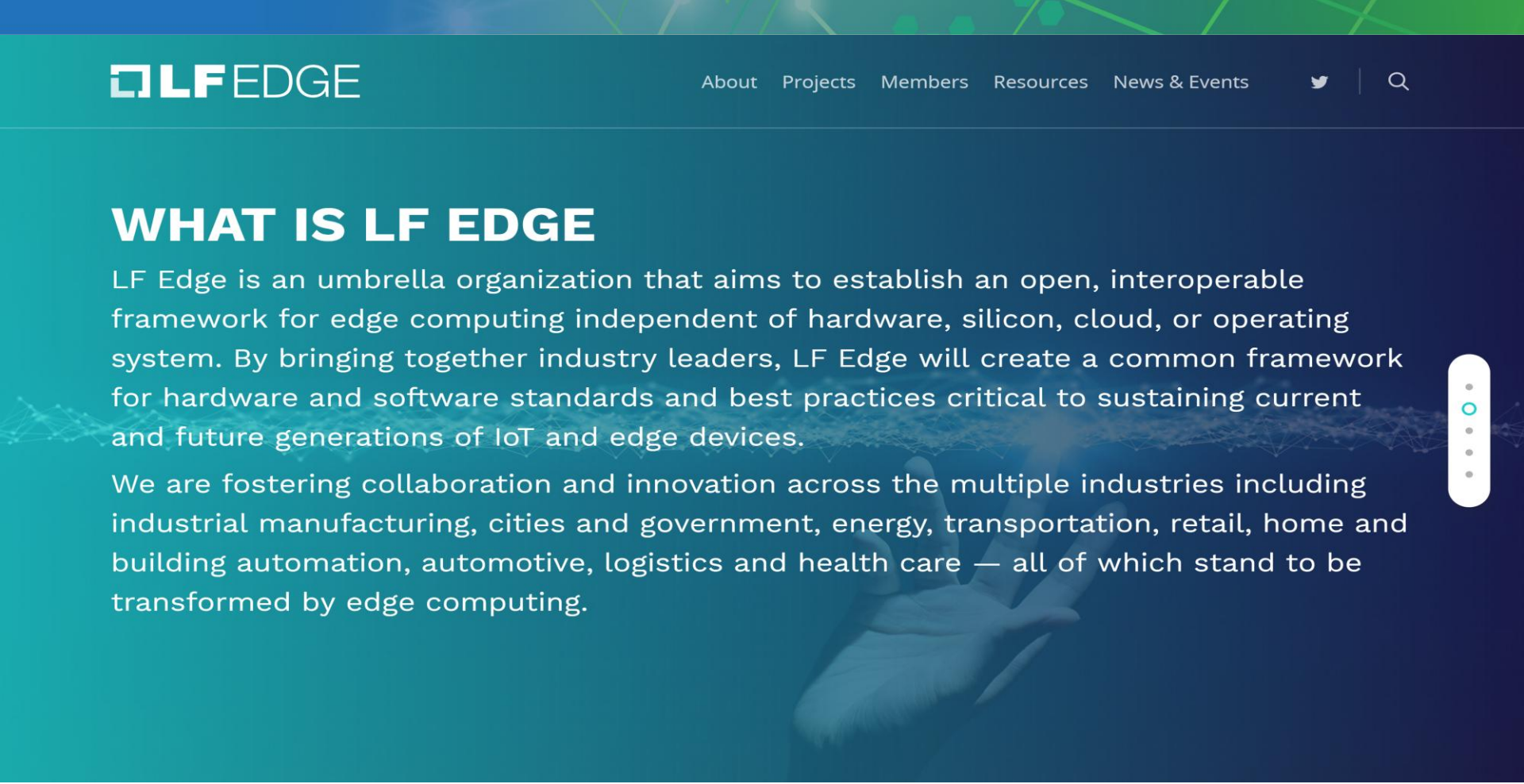
The Linux Foundation is dedicated to building sustainable ecosystems around open source projects to accelerate technology development and industry adoption.

Founded in 2000, The Linux Foundation provides unparalleled support for open source communities through financial and intellectual resources, infrastructure, services, events, and training. Working together, The Linux Foundation and its projects form the most ambitious and successful investment in the creation of shared technology.



Be Sure to Check Out

- FogLAMP Community Booth
- FogLAMP Lab
- JEA Energy Implementation
- GA Manufacturing Implementation

- github.com/foglamp
- dianomic.com

- Bill Hunt, CTO
- Dianomic
- bill@dianomic.com

- Daniel Lazaro, CTO Office
- OSIsoft
- dlazaro@osisoft.com

Questions?

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