

A background network diagram consisting of numerous yellow circular nodes connected by thin blue lines, creating a complex web-like structure. The nodes are more densely packed on the right side of the image.

# LF EDGE

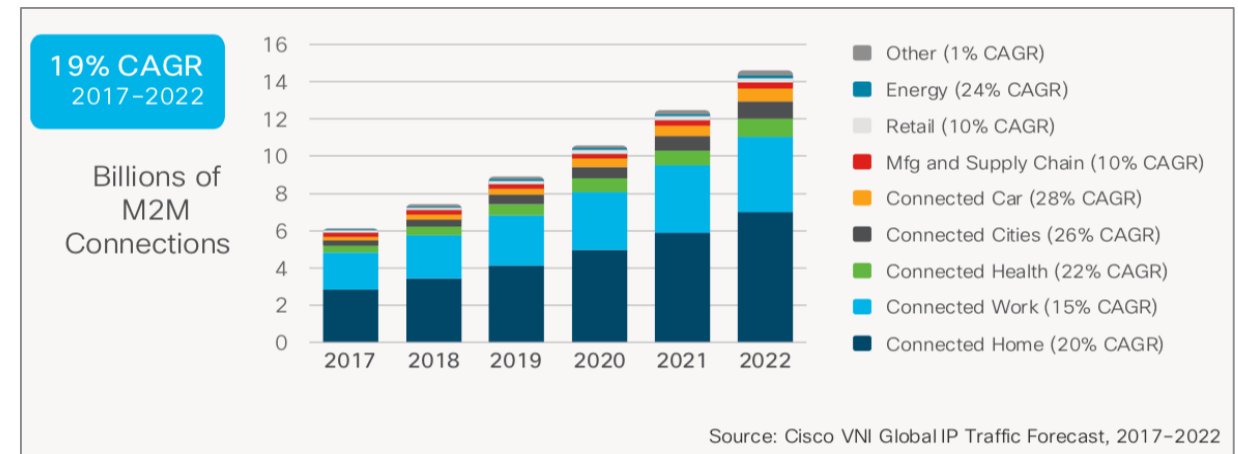
 THE **LINUX** FOUNDATION

# Market Opportunity for LF Edge

Industrial, Enterprise and Consumer use cases in complex environments spanning multiple edges and domains.

Examples:

- › **Industrial Manufacturing**
- › **Energy (Oil & Gas, Utilities)**
- › **Commerce**
- › **Homes (including B2B2C use cases)**
- › **Automotive**
- › **Fleet/Transportation**
- › Logistics
- › Building Automation
- › Cities and Government
- › Healthcare



# LF Edge – New umbrella for Edge Projects

- › Drivers
  - › Complementary and aligned vision on multiple LF projects
  - › Fuels faster adoption and deployment
  - › Edge market is fragmented and creating a larger entity provides leadership



# LF Edge - Premier Members



## The Linux Foundation's platform assists projects in 5 key areas

Governance and Membership	<ul style="list-style-type: none"><li>• Governance, Policies, etc.</li><li>• Ongoing business development and membership recruitment</li><li>• Membership management</li></ul>
Development Process	<ul style="list-style-type: none"><li>• Technical decision making</li><li>• Project life cycle</li><li>• Release processes</li></ul>
Infrastructure	<ul style="list-style-type: none"><li>• CI/CD infrastructure using open source best practices</li><li>• Release engineering, DevOps</li><li>• Security and reliability</li></ul>
Ecosystem Development	<ul style="list-style-type: none"><li>• Evangelism and marketing/outreach projects</li><li>• Events bringing developers, users and solution providers together</li><li>• Help the project training developers and administrators, establish professional certification programs</li></ul>
IP Management	<ul style="list-style-type: none"><li>• Code provenance</li><li>• Trademark management</li><li>• IP Policy, license scanning, IP defense</li></ul>



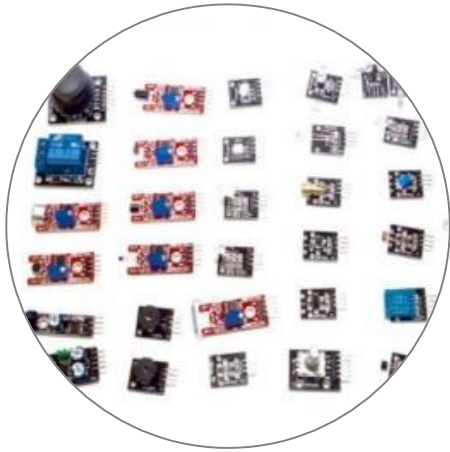
# Fledge

## The Industrial IoT Open Source Project

Making Smart Machines, Plants and Factories  
Simple to Build  
Simple to Integrate  
Simple to Operate



# 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

# IIoT Sensor Fragmentation



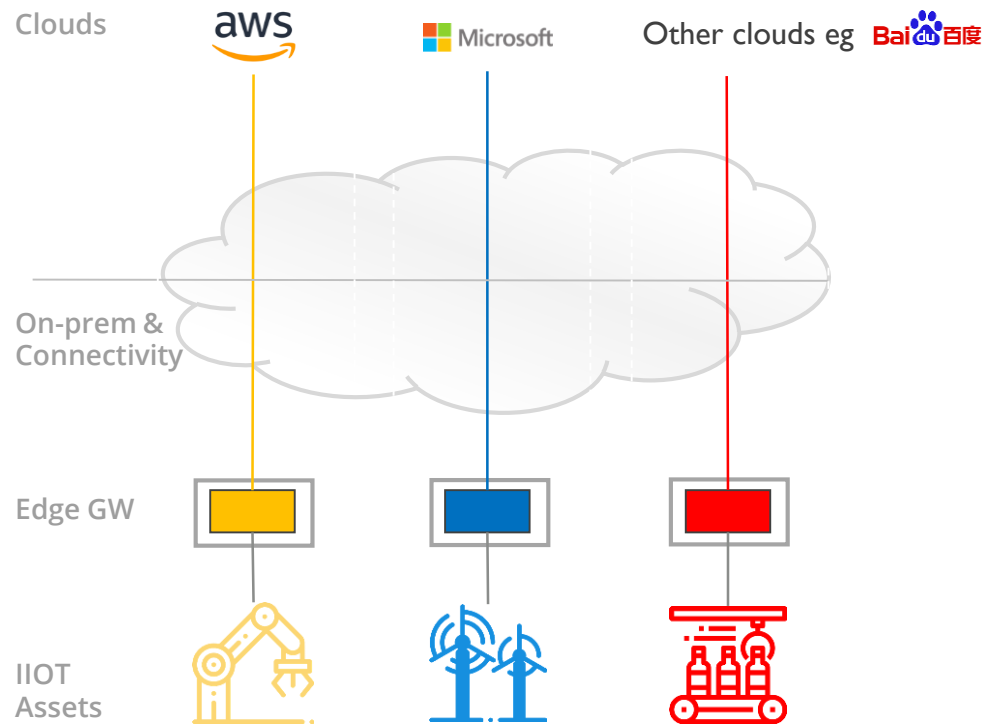
- › Fragmentation
  - › Sensor Protocols (CAN Bus, Modbus, OPC-UA, Bluetooth, ZigBee, BLE, DECT, Z-Wave ...)
  - › Industrial Systems (SCADA, PLC, Historians, HMI, Actuators)
  - › Hardware (ARM, Intel, Qualcomm)
  - › Protocols to Cloud (HTTP, HTTPS, MQTT, CoAP, LWM2M, AllSeen)
  
- › Complexity
  - › Lifecycle Management (Provisioning, Configuration, Update, Upgrade)
  - › Integration (OT/IT, Sensor, Edge, Fog, Historian, Cloud)
  - › Reliability (Store & Forward, Best Effort, Guaranteed)
  - › Network (LAN, WAN, Cell)
  - › Security (Sensors, Data, Network, Cloud, Control, PKI, SKI, Blockchain)



# Cloud Silos – Open Source Fledge is the Answer

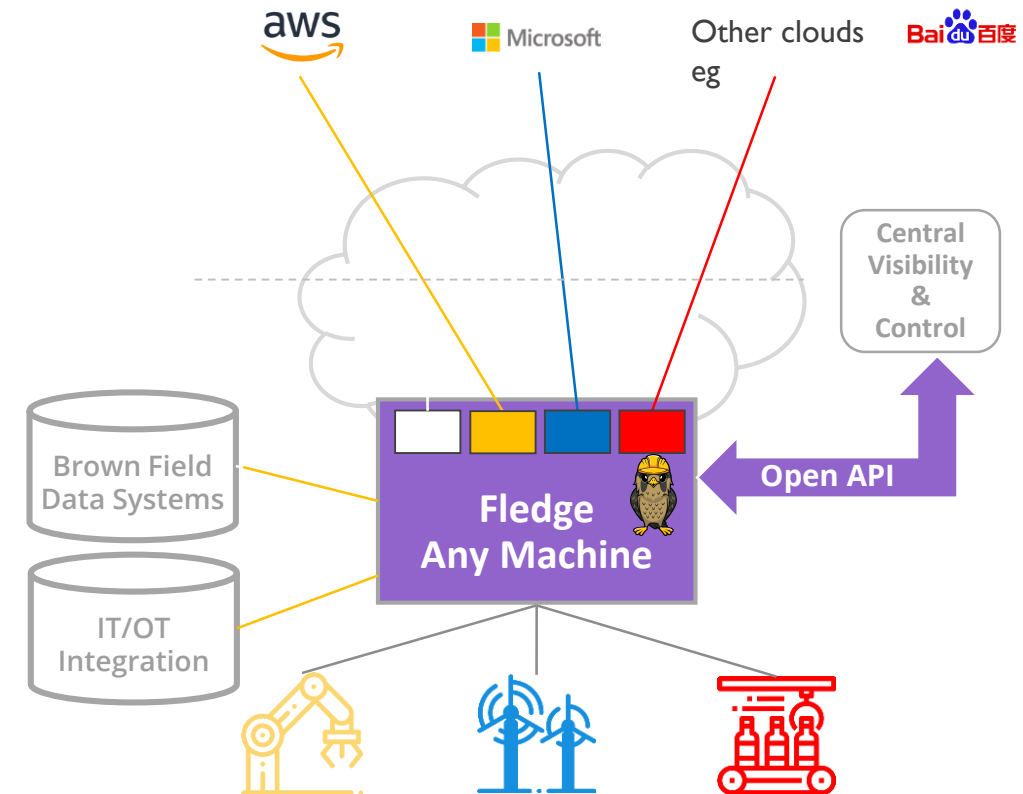
## IIoT Today

Vertical data silos & platform lock-in  
Data/edge sovereignty & control issues  
Hardware-defined & unmanaged edge



## IIoT with Fledge

Open IoT data architecture, no lock-in  
Data & edge belong to the factory, plant, mine  
Software-defined & ubiquitous edge

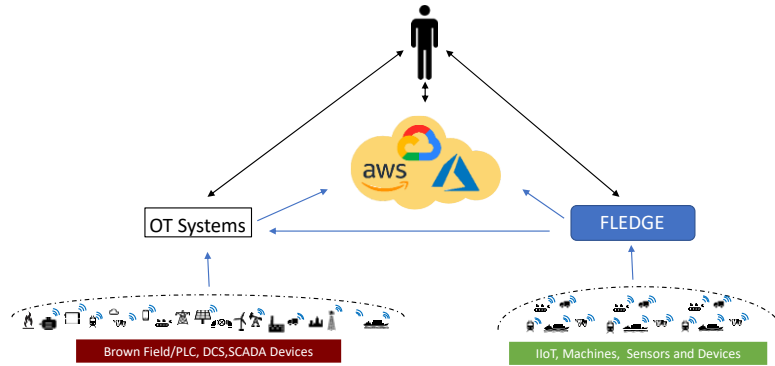


# Why Fledge?



- › Fledge is an open source framework and community for the industrial edge.
- › Fledge is architected to integrate IIoT, sensors and modern machines all sharing a common set of administration and application APIs with industrial “brown field” systems.
- › Fledge developers build smarter, better, cheaper industrial solutions for:
  - › Condition-based monitoring
  - › Predictive maintenance
  - › Situational Awareness for security and safety
  - › Smarter/Autonomous machines
- › Using Fledge APIs, modern factories and plants operate efficiently and securely.
- › The Fledge community consists of Industrial Users, Equipment Suppliers, Integrators, OT System Suppliers and Technology Suppliers to accelerate Industrial 4.0 adoption – **join us!**

# Industrial Operators



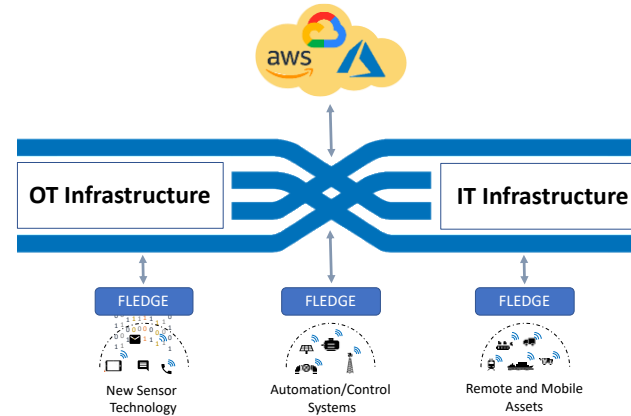
## Critical Operations Plant Wide

- Condition-Based maintenance
- Predictive maintenance
- Situation awareness
- Increased safety
- OEE, TPM

## How

- Connect all machines, sensors
- Put all data in plant wide context
- Eliminate fragmentation and complexity
- Use FLEDGE's common APIs to manage, secure and operate as a system

# Industrial SIs



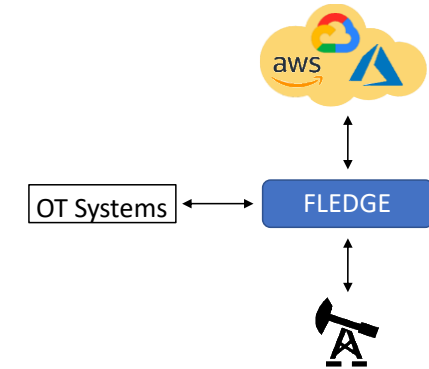
## Lead Industrial 4.0 Transformations

- Accelerate deployments
- More/tighter Integrations
- Own and re-use your value-add code
- Develop ML/AI expertise
- Increase value delivered/hour

## How

- Connect all machines, sensors to old and new OT/IT Systems
- Put all data in plant wide context
- Build services around latest ML/AI tools
- Use FLEDGE's common APIs to manage, secure and operate as a system

# Industrial Equipment Vendors

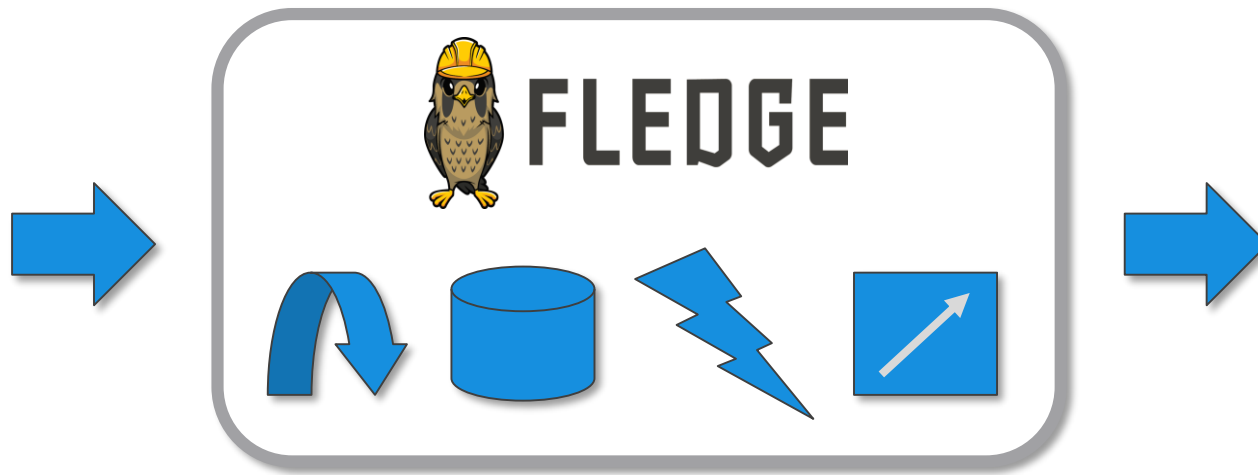


## Smarter, More Autonomous Machines

- Machines that learn
- Machines that maintain themselves
- Machines that integrate
- New business models/higher margins
- Machines that compete

## How

- Use latest ML/AI tools
- Use modern architectures
- Avoid proprietary APIs and cloud lock-in
- Save development time and money
- Use FLEDGE's common APIs to manage, secure and operate as a system



- ➔ **Collect Data**
  - from any/all sensors
- ↻ **Transform**
  - filter and transform data in-flight
- 🗄 **Buffer**
  - reliability for poor connectivity
- ⚡ **Act**
  - event engine for anomaly detection
- 📊 **Edge Analytics**
  - visualize data on the edge
- ➔ **Deliver Data**
  - to multiple local/cloud destinations

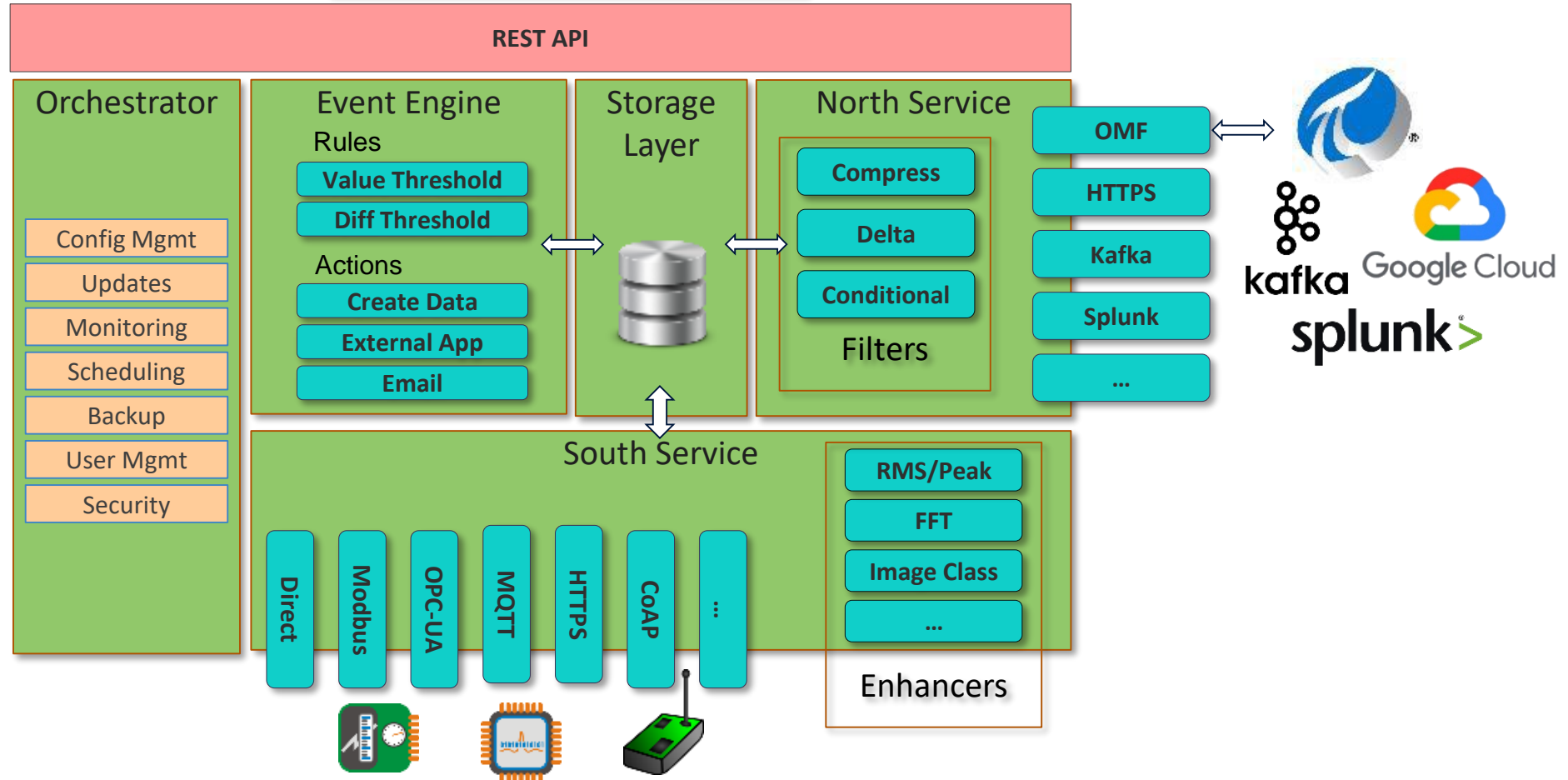


# FLEDGE

## ARCHITECTURE



GUI



# Collect Any Data

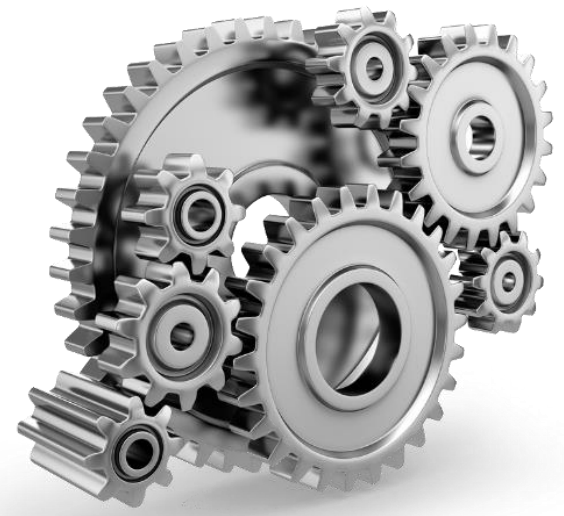
- › Many Existing South Plugins
  - › Temperature, Humidity, Current, etc.
  - › Modbus, OPC/UA, MQTT, HTTPS
- › Pluggable – Create Your Own
  - › Easy APIs and sample code
    - › Build your own
    - › Customize existing plugins
  - › Python or C++
  - › Polled or Async
- › Open Source Community – many plugins in time



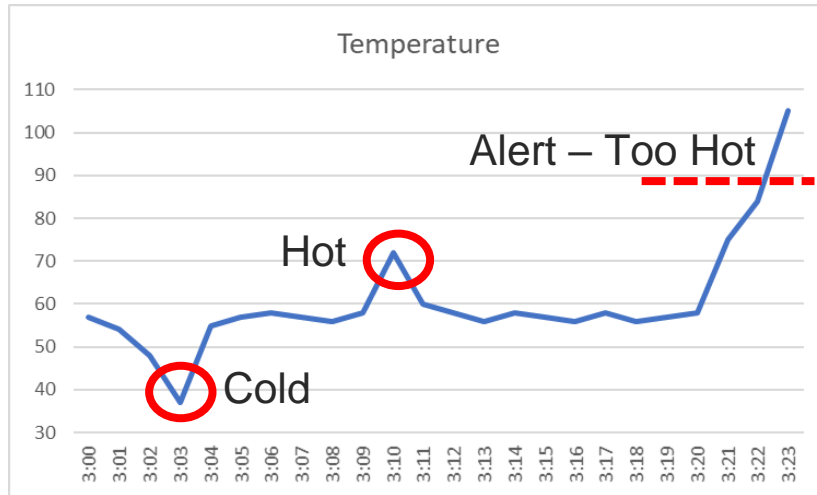


# Transform Data In-Flight

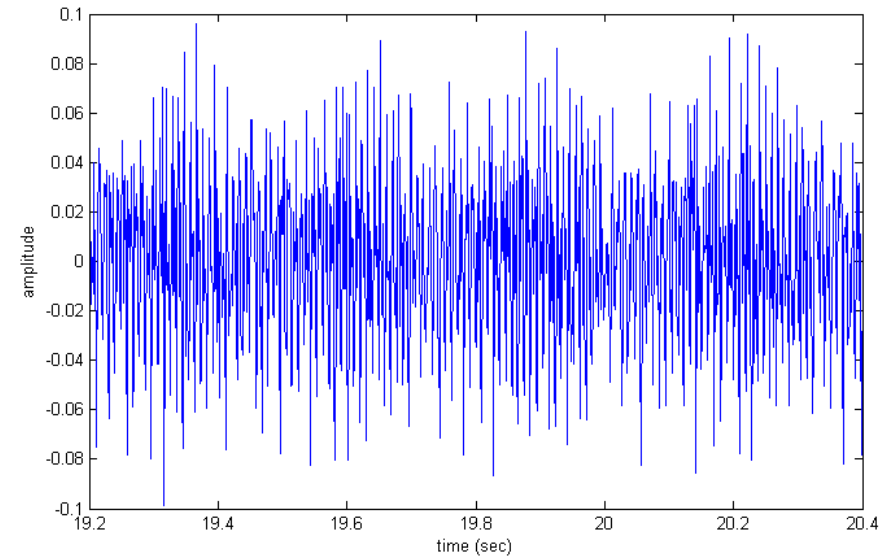
- › Apply Mathematical Formula
- › Modify Metadata Values
  - › Tag data with the machine or the floor it came from
  - › Tag data with the component ID being manufactured
- › Summarize High-Frequency Data
  - › RMS/Peak – calculate energy of oscillation
  - › FFT – discover frequencies of oscillation/wobble
- › Machine Learning / Image Recognition on the Edge
- › Pluggable – Create your Own
  - › Easy APIs and Sample Code
  - › Python or C++



## High Frequency / Vibration Data

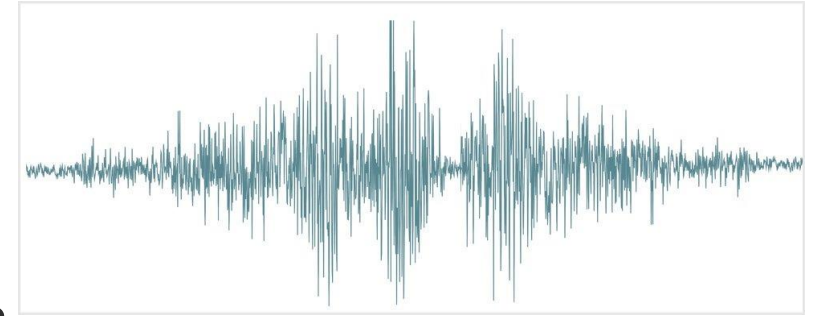


- › Graph is Visually Meaningful
- › Can Create Alarm Thresholds
- › Low Volume (1 sample/sec)



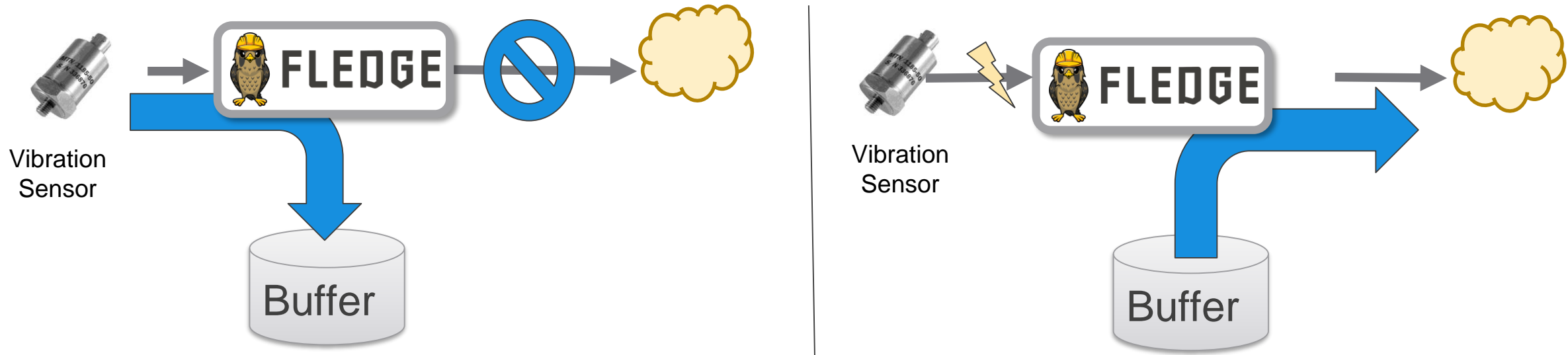
- › Is this Graph Good? Is it Bad? Dunno.
- › Can't Create Alarm Thresholds.
- › High Volume (1,000+ samples/sec)
  - › Wastes expensive bandwidth
  - › Consumes Disk/CPU

# Vibration Capabilities



- › Collect – automated collection of vibration data
- › Snapshots – send short bursts to reduce bandwidth
- › Context – collect additional IIoT data like temperature, pressure
- › Enrich – compute and send summary data such as FFT and RMS
- › Act – Anomaly detection at the edge, including ML

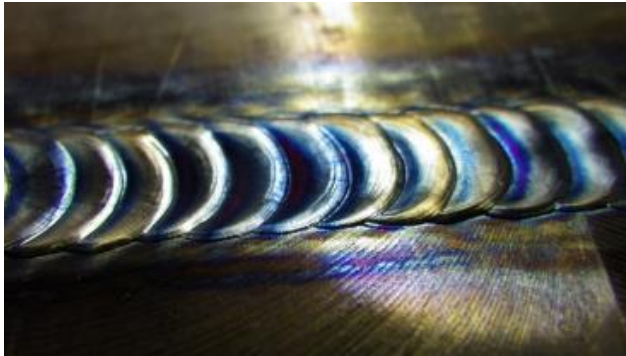
# Conditional Forwarding



- › Reduce Bandwidth and Storage Cost
- › Collect continuously, but don't forward any data
- › When an error is detected, send the last n minutes of data

# Machine Learning / Artificial Intelligence

## Intelligent Sensors – Image Classification



Is this weld  
high quality?



Are there people  
in this  
dangerous area?

## Anomaly Detection



Is this machine  
healthy?

Google TensorFlow Lite - Run ML Models at the Edge  
Can leverage TPU for ML acceleration  
Image Recognition / Object Detection / Anomaly Detection



# Fledge

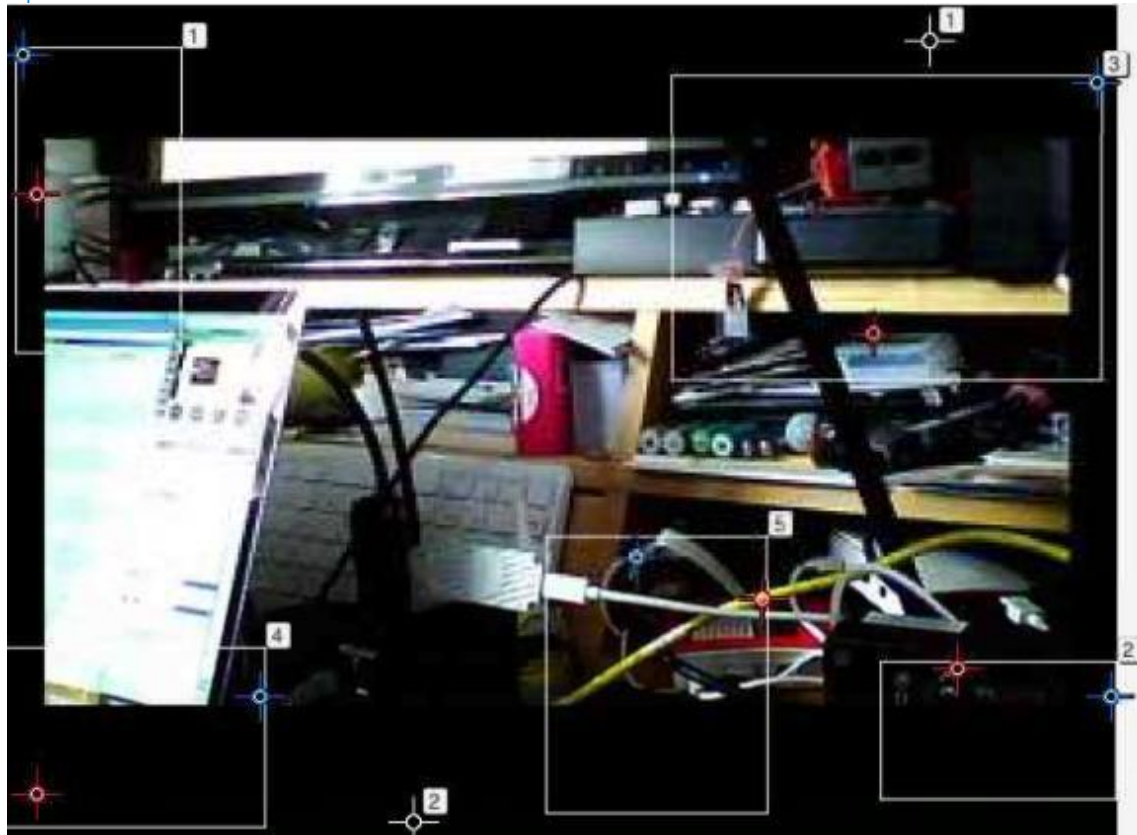
8<sup>th</sup> Release  
>50,000 Commits

Operational Since 2018  
Use Cases

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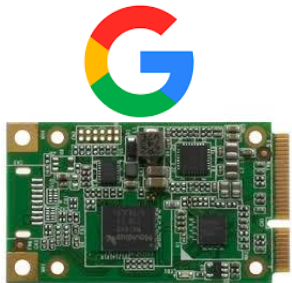
# Thermal Imaging



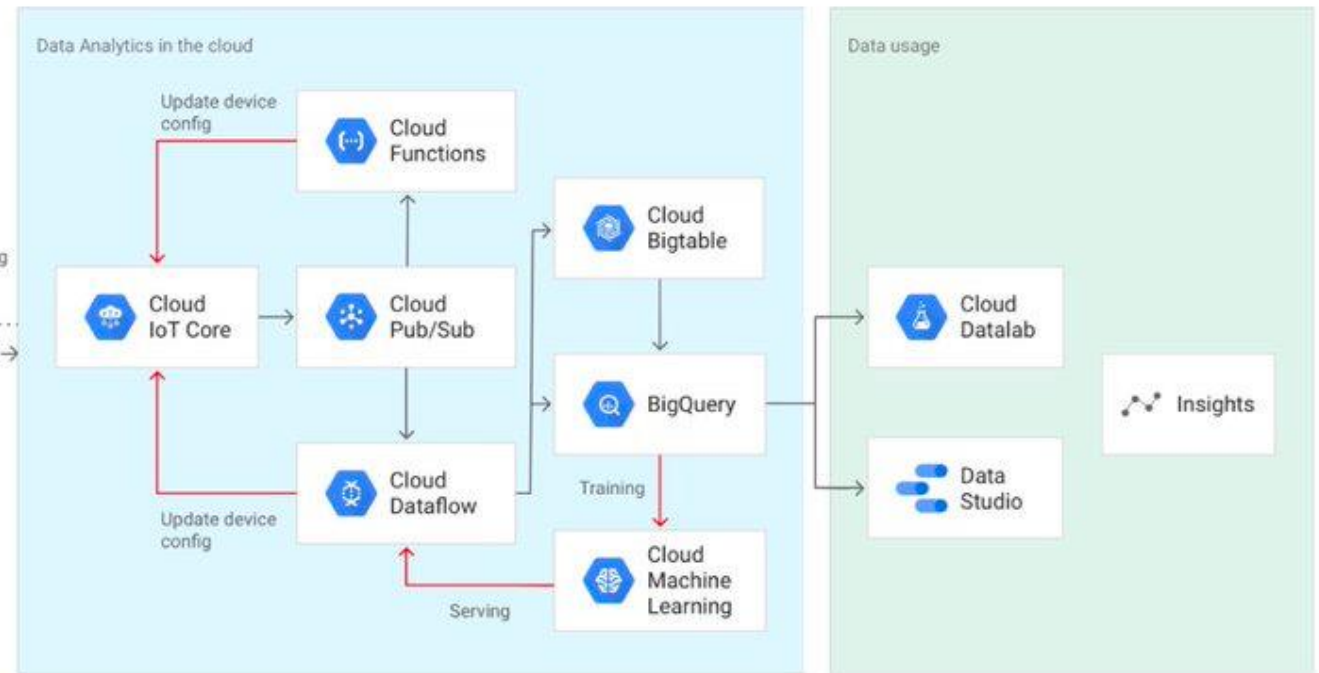
# Fledge and Google Tensorflow Edge ML/AI for Industrial Applications



Nexcom Gateway  
NISE 105

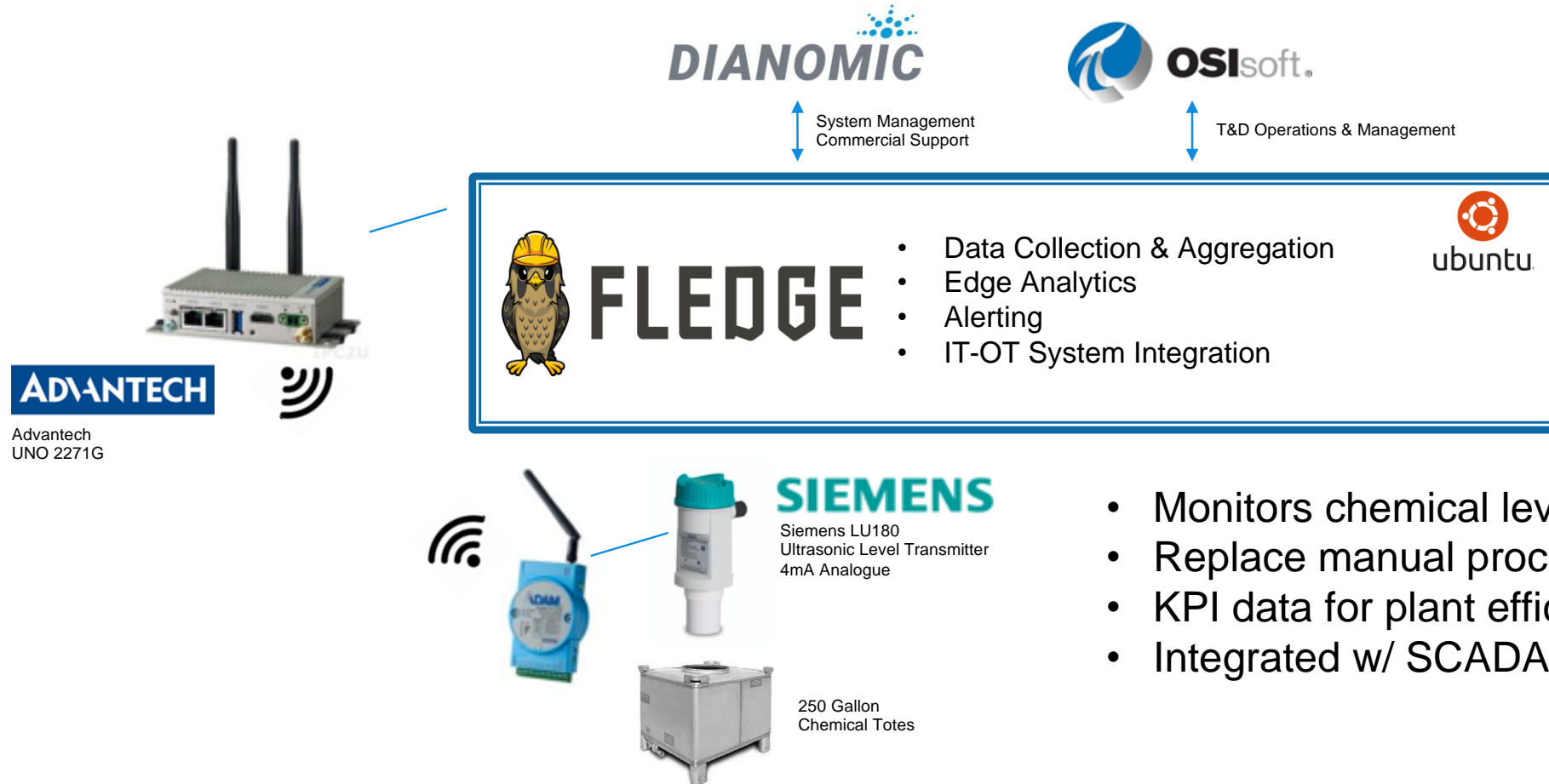


Google's  
PCIe Coral TPU

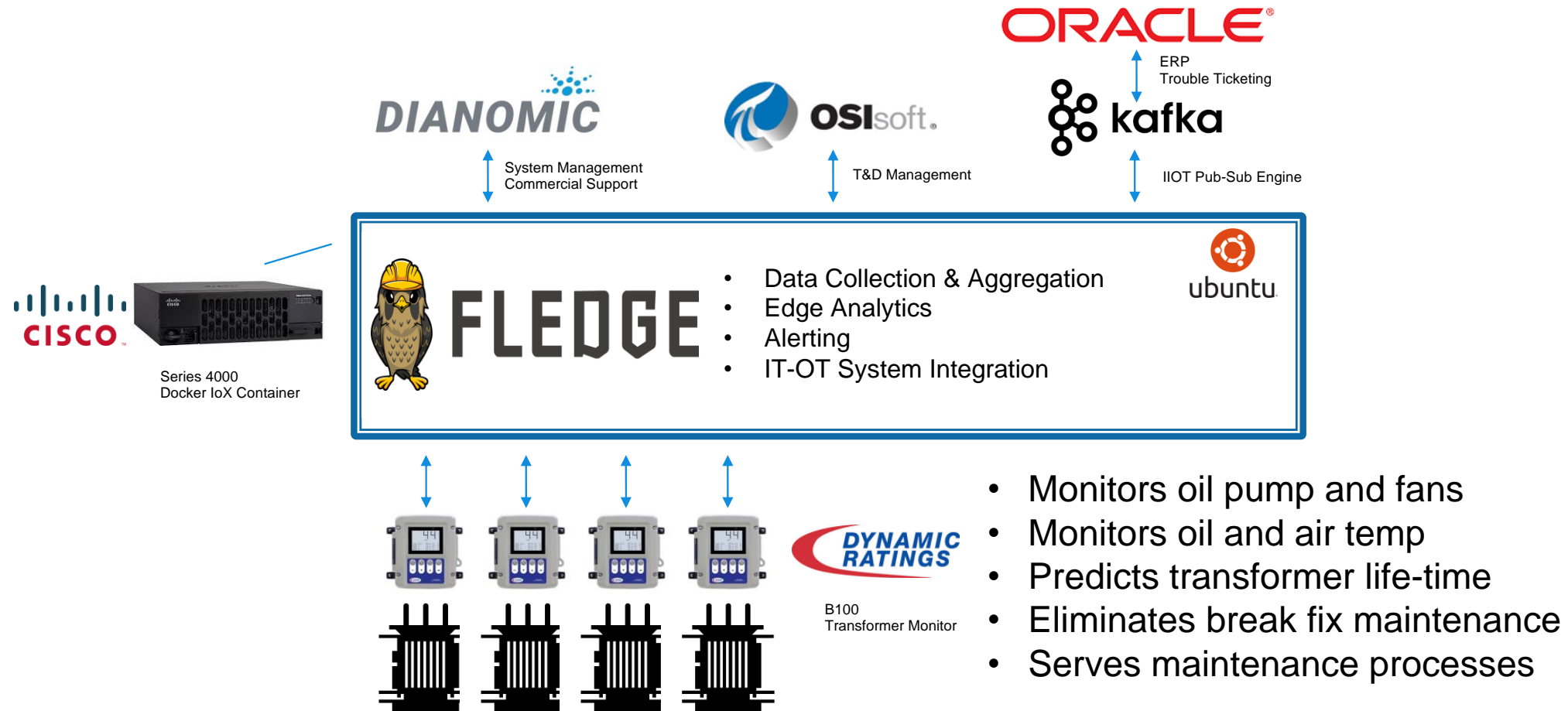


- Use Google tools for edge ML/AI applications
- Anomaly Detection, Image Classification
- Run models in Fledge

# Replace Route Based Monitoring – Chemical Totes



# Predictive Maintenance Monitoring - Transformers



# Condition Based Monitoring – Slurry Pumps





# Situation Awareness – Aircraft Paint Booths

**ADVANTECH**

Advantech  
ARC 1124



ADVANTECH ADC

**Dwyer**

Dwyer  
TTE-109-W-LCD  
HHT-EU



**DIANOMIC**

System Management  
Commercial Support

**OSIsoft**

T&D Operations & Management



**FLEDGE**

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

**Red Hat**



- Monitors paint booth micro-climates
- Go/No-Go start paint process
- Integrated with CNC machine and autoclave status



# Thank You!