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

![Graph showing billions of M2M connections with 19% CAGR from 2017 to 2022.](chart)

Source: Cisco VNI Global IP Traffic Forecast, 2017-2022
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

arm - AT&T - DELL - EMC - DIANOMIC - ERICSSON - Hewlett Packard Enterprise - HUAWEI

IBM - Intel - inwinstack - Juniper Networks - MobiledgeX - NETSIA

Nokia - NTT - OSIsoft - Qualcomm - Radisys - Red Hat

Samsung - Seagate - Tencent - WIND - Wipro - Zebedea
The Linux Foundation’s platform assists projects in 5 key areas

| Governance and Membership       | • Governance, Policies, etc.  
|                                | • Ongoing business development and membership recruitment  
|                                | • Membership management  
| Development Process             | • Technical decision making  
|                                | • Project life cycle  
|                                | • Release processes  
| Infrastructure                 | • CI/CD infrastructure using open source best practices  
|                                | • Release engineering, DevOps  
|                                | • Security and reliability  
| Ecosystem Development           | • Evangelism and marketing/outreach projects  
|                                | • Events bringing developers, users and solution providers together  
|                                | • Help the project training developers and administrators, establish professional certification programs  
| IP Management                  | • Code provenance  
|                                | • Trademark management  
|                                | • IP Policy, license scanning, IP defense  

Fledge
The Industrial IoT Open Source Project

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

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

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
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

8th Release
>50,000 Commits

Operational Since 2018
Use Cases

THE LINUX FOUNDATION
Thermal Imaging
Fledge and Google Tensorflow
Edge ML/AI for Industrial Applications

- Use Google tools for edge ML/AI applications
- Anomaly Detection, Image Classification
- Run models in Fledge
Replace Route Based Monitoring – Chemical Totes

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

- Monitors chemical levels in totes
- Replace manual processes – RBM
- KPI data for plant efficiency
- Integrated w/ SCADA data
Predictive Maintenance Monitoring - Transformers

- Monitors oil pump and fans
- Monitors oil and air temp
- Predicts transformer life-time
- Eliminates break fix maintenance
- Serves maintenance processes
Condition Based Monitoring – Slurry Pumps

- Data Collection & Aggregation
- Edge Analytics
- Alerting
- IT-OT System Integration
Situation Awareness – Aircraft Paint Booths

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

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