Welcome! Agenda for today...

1. Overview of LF Edge and Vertical Solution Focus Groups
2. Use Case: Automotive
3. Use Case: Manufacturing/Industrial
4. Use Case: Telco
5. Use Case: Transportation and Logistics
6. Panel: Meeting at the Edge - Cross community collaboration to define Telecom Edge Reference Architectures

- Session will be recorded and posted to LF Edge YouTube post-call and slides posted to the Wiki
- Please utilize the Zoom Q&A feature for questions
Overview of LF Edge

Arpit Joshipura
GM, Edge, IOT & Networking - Linux Foundation

Jason Shepherd
LF Edge Board Member and VP of Ecosystem @ ZEDEDA
Edge Market - Narrowing Down on Top Applications, Use Cases and Deployments
Emerging Edge Applications & Convergence of Technologies are demanding & fueling lower latency + accelerated processing

<table>
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<tr>
<th>NFV Edge Infrastructure</th>
<th>Wireless (vRAN,vEPC)</th>
<th>Wireline (PON)</th>
<th>uCPE (SD-WAN)</th>
<th>IP Enterprise Services</th>
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<tr>
<td>Autonomous Devices</td>
<td>Drones</td>
<td>Autonomous Vehicles</td>
<td>Industry Robots</td>
<td>Medical</td>
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<td>Immersive Experiences</td>
<td>Virtual Reality</td>
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<td>IoT &amp; Analytics</td>
<td>Industrial Sensors</td>
<td>Home Devices</td>
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<td>On-Demand NFV</td>
<td>Hardware Acceleration</td>
<td>A.I.</td>
<td>Microservices</td>
<td>5G</td>
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</tbody>
</table>

2018
5G and Edge Critical in the Next Battle, a new normal!

Edge is 4X the Size* of Cloud Market!

“As businesses and governments establish their own new normal, **5G and Edge computing** will be necessary to deliver the automation, performance and cognitive insight required by many industries—including manufacturing, healthcare, energy and utilities, among others. Telecom operators will need to embrace open ecosystems to externalize innovation and accelerate new services.”

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Image: Statista

How VR and AR will be used in 2025

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THE LINUX FOUNDATION
Top 5 Edge Markets

1. Industrial Manufacturing
2. Energy (Oil & Gas, Utilities)
3. Commerce/Retail
4. Homes (including B2B2C use cases)
5. Automotive
6. Fleet/Transportation
7. Logistics
8. Building Automation
9. Cities and Government
10. Healthcare

Source KPMG
Source LF Edge Community focus
IoT Killer apps 2020

Top 10 IoT Application areas 2020

1. Manufacturing / Industrial
2. Transportation / Mobility
3. Energy
4. Retail
5. Cities
6. Healthcare
7. Supply Chain
8. Agriculture
9. Buildings
10. Other

Note: Not all IoT requires an Edge
Edge Use Cases

- Market Accepting Latency & Bandwidth factors
- Establishing Vertical and Horizontal Solutions
- Akraino – Key pillar for horizontal solutions with focus on Vertical Blueprints
Defining the Edge
LF Edge Taxonomy

User Edge
- Constrained Device Edge
  - Microcontroller-based, Highly Distributed in the Physical World
- Smart Device Edge
  - Includes IoT (headless) and End User Client Compute in Accessible Locations
- On-Prem Data Center Edge
  - Server-based Compute in Secure Locations

Service Provider Edge
- Access Edge
  - Server-based Compute at Telco Network and Edge Exchange Sites
- Regional Edge
  - Server-based Compute at Regional Telco and Direct Peering Sites

Last Mile Networks

Centralized Data Centers
- Server-based Compute in Traditional Cloud Data Centers

Increasing HW + SW customization, resource constraints and deployment scale

Typically owned and operated by users / enterprises but also SPs via CPE

Shared resources (XaaS), typically owned and operated by Service Providers (SPs)

Distributed in accessible to semi-secure locations

Inside secure data centers / Modular Data Centers (MDCs)

Latency critical applications

Latency sensitive applications

Embedded software

Increasing cloud-native development practices

Source: June 2020 LF Edge Taxonomy white paper
**LF Edge Projects**

**Stage 1: At Large Projects**
- Baetyl, Open Horizon, Secure Device Onboard

**Stage 2: Growth Projects**
- EVE, Fledge, Home Edge, State of the Edge

**Stage 3: Impact Projects**
- Akraiino Edge Stack, EdgeX Foundry

**Applications**

**Infrastructure**

**Dedicated, Operated**

**Shared, XaaS**

**LOCATIONS**

- Aggregation Hubs/COs
- Centralized Data Centers
- Last Mile Networks
- On-Prem Data Center Edge
- Access Edge
- Service Provider Edge

**Distributed Devices and Systems**
- MCU-based devices
- Embedded compute

**Buildings / Factories / Smart Homes**
- Smartphones, PCs, ruggedized IoT gateways and servers in accessible to semi-secure areas

**On-Prem Data centers, MDCs**

**Access Networks**

**Aggregation Hubs/COs**

**Regional Data Centers**

**Servers in traditional cloud data centers**

**Server-based compute at Telco Network and Edge Exchange Sites**

**Server-based compute at Regional Telco and Direct Peering Sites**

**Stage 1:**
- Construction and deployment of foundational infrastructure

**Stage 2:**
- Expansion and optimization of edge infrastructure

**Stage 3:**
- Implementation of advanced edge technologies and applications

**Research and Reports**

**User Edge**

**Service Provider Edge**
Deployment Ready Open Source

Mobile

Residential

SMB/ROBO

User Edge

Service Provider Edge

Cloud

Carrier Access

Carrier Data Center

Carrier Interconnect

Internet / Web

Public Cloud

Hosted Private Cloud

kubernetes

openstack

eg Google, Microsoft, AWS, Facebook, TIP, Alibaba, Baidu, Tencent...

X-Project Collaboration

ORAN

HOME EDGE

AKRAIN

ONAP

OPNFV

Acumos AI

PROJECTS

PROFITS

PRODUCTS

Collaboration

THE LINUX FOUNDATION
LF Edge - Deployment-ready Open Source Edge Foundation

Telco Edge Blueprints (Radio Edge Cloud, Network Cloud) + Vertical Edge Application Blueprints (Connected Vehicle; AR Classroom) + Enterprise Edge Cloud Automation Blueprints (ICN, KNI Provider Access Edge), Private LTE, Cloud and Telco Edge (PCEI).

IIoT: DevOps at Scale for on-prem devices with partial connectivity

IIoT - Predictive Mtce & condition based monitoring - Turbines, Transformers, pumps. Tensorflow ML/AI for Edge Apps

Example Use Cases

IIOT: DevOps at Scale for on-prem devices with partial connectivity

IIOT - Predictive Mtce & condition based monitoring - Turbines, Transformers, pumps. Tensorflow ML/AI for Edge Apps
LF Edge Community is Growing Stronger by the Day
LF Edge Member Survey – Why Participate?

› Announced at ONES this week

› True Recognition of the value of Open Source Software

**Top Reasons**

Market Creation, Adoption Acceleration & Collaboration

Source: LF Edge Community Survey, Sept 2020
LF Edge Accelerating Community Collaboration

25+% New Member Y/Y increase
80% New Projects increase
SOTE, OpenHorizon, SDO…

25+ Global Deployments & Commercial Products
6M+ /18+ EdgeX Downloads and Akraino Blueprints

160% Growth in Developers Y/Y, 4X Commits Y/Y

15,800 global mentions since Launch
LF Edge Interactive Landscape

The LF Edge landscape (fig. 48) is dynamically generated from a community-supported GitHub account. It is modeled after the CNCF landscape and based on the same open source code.

If you would like to contribute, please open a pull request with projects in the edge ecosystem. Please note all new projects must include a URL to the community wiki. For a complete list, please open a pull request to connect any issues. Grayed logos are not open source. Last updated: 2020-03-06 15:49 UTC

You are viewing 185 cards with a total of 100,149 stars, market cap of $0.617T and funding of $3.578T.

landscape.lfedge.org
LF Edge Summary

Vision: Our software & projects enable rapid productization of Edge platforms by leveraging end user input to drive and supply the necessary building blocks (and/or frameworks, reference solutions) to facilitate integration and interoperability for Edge Computing across Telecom Service Providers, Cloud Providers, IOT & Enterprises

Projects

**Premier Members**

- altran
- arm
- AT&T
- Baidu
- Charter Communications
- Dell Technologies
- Dianomic
- Equinix
- Ericsson
- Fujitsu
- Futurewei
- GE
- HP
- Hewlett Packard Enterprise
- Huawei
- IBM
- Intel
- Inwinstack
- MobiledgeX
- Nokia
- NTT
- OSIsoft
- Qualcomm Technologies, Inc.
- Radisys
- Red Hat
- Samsung
- Seagate
- Tencent
- Western Digital
- Wipro
- Zededa
- The Linux Foundation

IMPACT - STAGE 3

GROWTH - STAGE 2

AT LARGE - STAGE 1
General Members

Associate Members and Liaisons
LF Edge: Key Takeaways

1. Harmonizing Open Source Edge Communities across IoT, Enterprise, Cloud & Telecom

2. Keeping LF Edge Open & Interoperable with
   › Hardware, Silicon, Cloud, OS, Protocol independence
   › Bringing the best of telecom, cloud and enterprise – location, latency & mobility
   › In collaboration with Consortiums/SDO (IIC, AECC, OEC, ETSI)

3. Hosted by the Linux Foundation similar to other Open Source Communities like CNCF (Kubernetes), LF Networking (ONAP) and many more.
Introduction to LF Edge
Vertical Solution Focus Groups
Introducing LF Edge Vertical Solution Focus Groups

› Precedent set by CNCF and LF Networking

› Goal: highlight unique requirements for use cases spanning Industrial, Enterprise and Consumer markets

› Diverse vertical-specific feedback will ensure that LFE projects are delivering maximum value from shared technology investment

› Output of VSFGs to include feature requirements, demos, messaging, white papers and other collateral
Opportunities to Engage

› Join one of the three emerging Vertical Solution Focus Groups

a. Manufacturing: https://lists.lfedge.org/g/VSFG-Manufacturing
b. Retail: https://lists.lfedge.org/g/VSFG-Retail
c. Telco Cloud: https://lists.lfedge.org/g/VSFG-Telco

› As with any LFE community effort, participation is open to all!
Opportunities to Engage (cont.)

› **Join the second End User Kickoff event** co-located with **EDGE Computing World** on October 20
  
  › Registration information will be added soon to [https://wiki.lfedge.org/display/LE/2020+Fall+Kickoff+Virtual+Event+Series](https://wiki.lfedge.org/display/LE/2020+Fall+Kickoff+Virtual+Event+Series)

› Email [info@lfedge.org](mailto:info@lfedge.org) if you would like to **lead a new VSFG**
  
  › Areas of interest include energy/utilities, oil and gas, smart buildings, smart cities and beyond
  
  › Proposal of a new group requires inclusion of at least one LF Edge Project

› **Join the LF Edge TAC** to keep updated as new VSFGs are added ([https://lists.lfedge.org/g/TAC](https://lists.lfedge.org/g/TAC))
Get Involved in the LF Edge Technical Communities

› Participation in LF Edge Projects is open to all

› Getting involved in the technical communities is the best way to learn

› **Step 1:** Get a Linux Foundation ID Here:
  
  https://identity.linuxfoundation.org/

› **Step 2:** Visit LF Edge Wiki (https://wiki.lfedge.org/)

› **Step 3:** Join workflows for the projects and working groups, subscribe to mailing lists, ask questions, contribute and participate below

› Attend project meetings
› Attend developer events
› Join approved projects
› Propose a project
› Write documentation
› Contribute use cases

› Analyze requirements
› Define tests / processes
› Review and submit code patches
› Build upstream relationships
› Contribute upstream code

› Provide feedback through VSFG
› Host and staff a community lab
› Answer questions
› Give a talk / training
› Create a demo
› Evangelize LFE and its projects
Use Case: Automotive

Zhuming Zhang (Xinhong)
Use Case: Manufacturing/Industrial

Sriram Rupanagunta (Aarna Networks)
5G Enables Industry 4.0

**5G Attributes**

- **URLLC**
  - 5ms e2e latency
  - 99.999% reliability

- **mMTC**
  - 1M devices/km²
  - Energy efficiency

- **Network Slicing**
  - Multiple slices each with a different attribute

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INDUSTRY 4.0
Industry 4.0 Requires a Set of 5G/Edge Capabilities

**Reliable Connectivity**
- Ethernet is too expensive and hard to maintain
- Wifi does not provide the reliability, low latency, support for edge apps, or end device management

**Edge IoT Frameworks**
- Edge IoT frameworks needed to communicate with and to manage end devices
  - Examples: AWS IoT Greengrass, Azure IoT Edge, EdgeXFoundry

**Edge AI/ML**
- Edge AI/ML inference engines required for use cases such as QA, machine analytics, video surveillance, and more
  - AI/ML algorithms may be dynamic

**Edge Applications**
- Arbitrary cloud native applications such as Augmented Reality for proactive maintenance, drone control, V2X for autonomous vehicles, and more
Industry 4.0 Application Management Problem

- I need reliable 5G management in all my factories
  - Zero touch provisioning
  - Network slicing
  - Ongoing optimization
  - Automatic corrective action (service assurance)
- I need to manage my edge computing apps
  - Initial orchestration and config based on business intent
  - Ongoing lifecycle management and service assurance
  - Termination upon completion
- I need the process to be fully automated, one-click
  - Training my team on 100s/1000s of vendor tools and/or writing ad-hoc scripts for each application is not scalable
Aarna Networks Solution

- Lightweight
- Cloud native
- CI/CD release process
- Vendor agnostic wrt. CNF or K8s provider
- Access technology agnostic (5G, LTE, WiFi)
- Support for K8s NFVI clouds
- Uses projects from open source LFN ONAP

AarnaStream™ (e.g. Network Slicing, NRTRIC, NWDAF, SON)

- Proprietary value-add

Design Time
Intent Based Orchestration
Lifecycle Mgmt.
Closed Loop Automation

100% Pure Play open source

Installer

Aarna Networks Edge Orchestrator

- Easy to install & manage
- Hardening

THE LINUX FOUNDATION
• **Cluster Registration Controller** registers clusters by cluster owners
• **Distributed Application Scheduler** provides simplified, and extensible placement
• **Hardware Platform Aware Controller** enables scheduling with auto-discovery of platform features/capabilities
• **Distributed Cloud Manager** presents a single logical cloud from multiple edges
• **Secure Mesh Controller** auto-configures both service mesh (ISTIO) and security policy (NAT, firewall)
• **Secure WAN Controller** automates secure overlays across edge groups
• **Monitoring** covers distributed application performance, and accesses
Current PoC#1: Private LTE/5G with MEC

For more info: https://wiki.akraino.org/pages/viewpage.action?pageId=28967182
Current PoC#2: Cloud Native 5G + ONAP

For more info: https://wiki.opnfv.org/pages/viewpage.action?pageId=52790056
5G POC Technology Partners
Thank You

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Use Case: Telco

Yanjun Chen (China Mobile)
Use Case: Transportation and Logistics

Eric Aquaronne (IBM)
Naeem Altaf (IBM)
Panel: Meeting at the Edge - Cross community collaboration to define Telecom Edge Reference Architectures

Ahmad ElSwaf (Saudi Telecom)
Beth Cohn (Verizon)
Sukhdev Kapur (Juniper)
Thank You!

Join us for the second session at Edge Computing World on October 20!