Problem Statement of Edge Computing beyond Access Network for Industrial IoT

draft-geng-iiot-edge-computing-problem-statement-00

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Background

• Focus on **use cases** and **problem statement**, related work in other SDOs and gap analysis.

• Create research discussion and standardization work for:
  – Protocol for east-west comm between multiple BEC gateways
  – Common API across various BEC platform.
  – User mobility: Edge to Edge
  – Edge device config/mgmt (both device-level and virtual-resource-level)
  – Light-weight virtualization technologies (container/unikernel)
  – Local edge security

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What is Beyond Edge Computing (BEC)

Cloudification
- Resource Pooling
- Clustered Computing
- Common Hardware
- Centralized Deployment

Edgification
- Real-time and low latency
- Dedicated computing
- Diversity of hardware
- Decentralized deployment

BEC takes care of the first hop where the service of a particular industrial vertical connects to the network
Capabilities of BEC(1/2)

• Heterogeneous IoT device compatibility
  Various IoT interface including Zigbee, WIFI, tens of Field Buses and etc.

• Low and deterministic service latency
  Various mission-critical services (Motion control etc.)

• Data pre-processing and traffic offloading
  Reduce WAN bandwidth and increase the effectiveness of data

• System resource isolation
  Support multi-tenancy situation – which is a norm for IoT ecosystem

• Offline processing
  Robustness even in unlikely circumstances
Capabilities of BEC(2/2)

- End-to-end security

  *Security provided right from customer premises*

- Distributed artificial intelligence

  *Making use of GPU/TPUs for AI applications (Graphic/Inferences)*

- Real-time operation

  *Real-time operating system (i.e. Industrial Linux) for spontaneous events*

- Unified API for multi-ecosystem edge application

  *API to expose Software/Hardware capabilities for application ecosystem*

- Service isolation for network slicing

  *Mapping services to specific network slice for E2E service guarantee*
Architecture

BEC Management Platform
- Application management (Lifecycle, verification, publishing, Devops etc.)
- Device-level management + System resource management
- SDN platform –control and optimization for BEC network

Interfaces
- Management interface – Lightweight interface for device configuration/monitoring and virtual resource management
- Data interface – Unified but flexible for interoperation in data plane (i.e. MQTT, OPC-UA and others)

Distributed BEC platform
- Lightweight virtualization technology for resource isolation and fast application deployment
- Heterogeneous but modularized southbound interface
- Comprehensive and unified API for capability exposure
Example of E2E BEC system

Flexible industrial access
- Industry-grade design
- 17+ industrial interfaces
- Voice, Wireless, VPN in one box

Pre-analysis of local data
- Data aggregation: industrial data analysis
- Data filtering: saving WAN traffic
- Data security: encryption

Edge and Cloud Collaboration
- Predix and apps at edge
- Edge: real-time and reliability
- Cloud: unified policies and Big Data

Flowchart:
- BEC Gateway
- Predix Machine
- App1
- App n
- Linux container
- Agtile CONTROLLER
- Predix Cloud
- RS232, RS485, CAN, FXS
- Altex
- Edge computing
- Predix and apps at edge
- Edge: real-time and reliability
- Cloud: unified policies and Big Data
Use case - Connected Elevator Testbed

**Market Segment**
- Buildings & Facilities: Elevators
- This testbed may also be applicable to other verticals such as
  - Machine Tools
  - Engineering Machines
  - Industrial Washers

**Location**
- The OpenLab in Nanjing, China
Gap Analysis in IETF

• **Multiple Virtualization Technologies Coexistence/Coordination**
  
  Interface/Model required for selection between various virtualization technologies for specific vertical use cases/requirements

• **Light weight Device-level management and virtual resource**
  
  Massive number of isolated resource pool need much lighter interface for management – Netconf+YANG for VIM?

• **Framework and APIs for multi-ecosystems**
  
  Unified and modularized APIs across multiple compiling environment for maximum flexibility and friendly ecosystem

• **Runtime Updates**
  
  Energy efficient software/firmware update without service break-down
Conclusion

• BEC methodology – Distributes as much as you can, centralized only if you must (i.e. massive computing/storage).
• Research interest – very popular topic across the industry (IIC, ECC, EdgeXFactory, OpenFog, OPENIL, RIOT and etc.)
• IETF and IRTF – Architecture and framework for RG, interface/API deliverables might be for WG (see SUIT BoF)
• Further discussion @ Bar BoF Thursday 20:00-21:30 Hullet