OpenEdge

The General Framework of Edge Computing

Leding LI
Chief architect of Baidu Cloud IoT
Member of LFEdge Technical Advisory Council
Overview
Cloud computing and Edge computing

Cloud:
- Web Services
- Storage
- Database
- ML Training

Edge:
- IoT/M2M
- Industry
- CV Security
- Smart Home

Frequency

Realtime

- Delay-sensitive
- High bandwidth consumption
- Power and connection limited
- Privacy and Policy requirements
Edge Targets

OpenEdge Target

- On-premises Micro-cluster
- Headless Box with AI chip
- Headless Box or Tablet
OpenEdge Project
OpenEdge Project

https://github.com/baidu/openedge
https://openedge.tech/

First release in Dec. 2018
Agile, monthly release
4 Releases
12 Contributors
900+ stars on github.com

Focus
Cloud Native infrastructure on Edge
Large-scale deployment of unattended equipment
Toolkits & services for creating applications

Vision
Edge Operating System
Edge Toolchain for Developers
Cloud, Edge and IoT data collaboration
Function as a Service

- OpenEdge MQTT Broker
- OpenEdge Core Queue
- OpenEdge FaaS Server
- GRPC Server & MQTT2GRPC
- Ingress | Load Balance & Fail Over
- Function Life Cycle
- OpenEdge Core RESTful API

Function Instance 1
- Runtime Image
- Runtime Config
- User Code
- User Config
- User Data

Function Instance 2
- Runtime Image
- Runtime Config
- User Code
- User Config
- User Data

Dynamic Instances

Runtime Config
- Listen Address
- Resource
- Graceful Reload

User Code
- Code Package

User Config
- Config Files

User Data
- Volume Definition
Optimization for Edge

Adaptive
- Raspberry Pi
  - Linux, macOS, Windows 10, Legacy Windows
  - x86, x86_64, armv7, aarch64, mips, mips64
- Cluster with HA

Automation
- Raw Node
  - No Root
  - No Console
  - No Remote Shell
- Activation
- Workload OTA
- Firmware OTA
- Signed Node

Unstable Network
- MQTT Client
  - Core Queue
    - Local Persistent Buffer
    - QoS Supervisor
    - Garbage Cleaner
  - Remote

IO Limited
- Core Queue
  - Sync Q
  - Cache Q
  - DB
  - Overload Q
  - Router
  - Send Q
  - ACK Q
Roadmap, Edge Operating System

OpenEdge Linux OS

Part 3: Data
  Variable Layer

Part 2: System & Last Success
  Immutable Layer
  Linux Kernel

Part 1: System & Active
  Immutable Layer
  Linux Kernel

Immutable Layer

Key part
  OpenEdge Core

OCI part
  containerd
  runc

POSIX part
  busybox cli
  musl libc

Variable Layer

Image part
  OCI images

Volume part
  Config volumes
  Data volumes

Privileged part
  Security license files
  System runtime files

Unattended Hardware

Linux initramfs

mount /dev/part3 /var
OpenEdge IDE

OpenEdge EDK
- Edge Development Kit
  - Message Kit
  - Instance Kit
  - Storage Kit
  - Queue Kit
  - Vision&ML Kit
  - Speech Kit
  - GeoLocation Kit
- Cross Build Toolchain
- LLVM Toolchain
- WASM Toolchain

OpenEdge EDK plus
- CI/CD
- DevOps
- OTA CLI
- Edge Deployment Kit
- Emergency Shell
- Local Diagnostic
- Cloud Emulator
Baidu IntelliEdge

An OpenEdge Solution for Enterprise
OpenEdge
- Remote Management
- Built-in Services
- Container Runtime
- Device Management

Infrastructure
Open Source for Developers

Baidu
IntelliEdge
- Advanced Management
- Video & ML Inference
- Time-series Data Tools
- Hardware Partners

Solutions
Commercial for Enterprise
Edge & Cloud Fusion

Edge side

- Sensor
- Camera
- Speaker
- Gateway

Baidu IntelliEdge
- AI Solution
- Data Solution
- OpenEdge
- Certified Hardware

Cloud side

Baidu IoT Platform
- IoT Hub
- Time-series DB
- Rules Engine
- Edge Console

Baidu Big Data
- Stream Compute
- Time-series Analysis

Baidu AI
- AI Training
- Model Transform

Data uplink

Knowledge downlink
AI Solution

Video Ingress Service
- USB Camera
- Ether Camera
- USB Initializer
- Ether Initializer
- Linux Video Interface
- Video decoder
- Frame sampling
- Image disk saver

ML Inference as a Service
- GRPC Server → FaaS Server
- User Model
- ML Inference Library
- OpenCL
- CUDA
- OpenVINO
- Device-Container Binding
- GPU
- GPU
- VPU

Auxiliary Services
- Time-driven Trigger
- Image disk cleaner | Shell Function
- Object Storage Uploader
- Image decorator and encoder
- Video playback
Long Term Goals

Ecology
- Community
  - Open Edge community
  - Open source

Services
- Connection
  - End2End Security
  - Protocols

- Compute
  - Unified work flow
  - DevOps
  - Serverless
  - Unified data bus

- Developers
  - IDE
  - CLI toolchain
  - C-API
  - Feature components

- Manufactures
  - Production Box
  - AI chips
  - Dev Broads
  - IoT Certification

Infrastructure
- IoT Stack
  - Lightweight App
  - MQTT, ML, Security
  - OTA Firmware
  - RTOS

- OpenEdge Linux OS
  - Cloud Native Apps
  - OpenEdge Framework
  - OCI Container
  - Linux Kernel

- ABC Cloud & Stack
  - Cloud Native Apps
  - Kubernetes
  - IaaS
  - IDC or On-premises

Compute Everywhere, Data Anywhere, Edge & Cloud Fusion
Applications
Over 60% reduction in automatic driving costs to help solve cross-regional road synergy challenges

Global optimization of a wide range of multi-base station nodes
Quality inspection by AI

Fusion Manufacturing line & AI model production line
Model deployment efficiency: 1 days → 1 minutes
Solve the problem of flexible production quality inspection
Integrated Energy Management

Electricity Meter

Edge node in factory

Capacity & Requirement Translation
Power consumption forecast

OpenEdge

Gateway

Edge node in factory

Power system

Edge node in factory

Data uplink

Knowledge downlink

Daily power load forecast for a factory within 45 days

Predictive average accuracy 91%
5% Increase in plant productivity

AI algorithm avoids the risk of power deviation assessment for more than 3,000 enterprises

http://pop.litiandata.com/
Identify the spilled situation through machine vision, Deploy the algorithm on the local smart edge to infer, instantly identify problems, and reduce bandwidth costs.
Charging pile Digital twin

Through big data Model training, the algorithm is deployed on the local intelligent edge, forming the local charging pile digital twin, providing the hand manipulator mode and the embedded mode of charging job quality detection service, real-time output operation effect.
Accurate fertilization of UAV

Through spectral analysis and machine vision to identify farmland pests and diseases, the algorithm is deployed on the local intelligent edge, for detection, plant protection UAV into one (discovery or elimination) to lay a solid foundation.