Blueprint: KubeEdge Edge Service Family
(Type 1: ML Inference Offloading)

Futurewei, China Mobile, Arm, Signalogic
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General Blueprint Introduction

- The KubeEdge Edge Service blueprint family introduces Edge Services built on KubeEdge for various applications in edge environment. The service is to enable application developers reach optimal latency/energy/performance/cost via balancing computation loads among device/edge/central DC(Cloud).

- Type I of KubeEdge Edge Service family focuses on ML Inference Offloading.

- Future types of this blueprint family will provide variations of end-to-end solution components around KubeEdge. E.g. hardware platform, Linaro Software Reference Platform, additional service stack on top of KubeEdge,
### Type I: ML Inference Offloading Blueprint Criteria

<table>
<thead>
<tr>
<th>Case Attributes</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Type</strong></td>
<td>New</td>
</tr>
<tr>
<td><strong>Blueprint Family</strong></td>
<td>KubeEdge Edge Service</td>
</tr>
<tr>
<td><strong>Use Case</strong></td>
<td>Facial expression task offloading to edge node</td>
</tr>
<tr>
<td><strong>Blueprint proposed Name</strong></td>
<td>ML Inference Offloading</td>
</tr>
<tr>
<td><strong>Initial POD Cost (capex)</strong></td>
<td>Less than 100KUSD</td>
</tr>
<tr>
<td><strong>Scale &amp; Type</strong></td>
<td>Up to 1 servers, x86 server With Nvidia Tesla P4/T4 GPUs</td>
</tr>
<tr>
<td><strong>Applications</strong></td>
<td>Deep learning models (facial expression) offload from mobile device to Edge/Cloud</td>
</tr>
<tr>
<td><strong>Power Restrictions</strong></td>
<td>Less than 10Kw</td>
</tr>
</tbody>
</table>
| **Infrastructure orchestration**| Docker 18.09  
OS – Ubuntu18.04  
Python 3.5 ~3.7  
CUDA>10.1  
GPU driver release 19.03 |
| **PaaS**                         | KubeEdge                                                                   |
| **SDN**                          |                                                                             |
| **Workload Type**                | Containers                                                                 |
| **Additional Details**           |                                                                             |
Project Background

1. KubeEdge is a CNCF sandbox project led by Futurewei, targeting at cloud/edge computing and networking.

2. Akraino is a LF Edge open source project promoting end-to-end solutions via blueprint projects. Akraino API sub-committee releases API whitepaper to market edge stacks introduced through blueprints.

3. ML offloading service:
   - Resource limited device needs to offload AI processing
   - Typical offloading approach is offloading inference to edge and training to central DC/Cloud
   - A device/edge/cloud collaboration framework is essential to ML offloading. KubeEdge provides underline software platform.
Upstream Project: KubeEdge Infrastructure

- **Cloud/Edge Nodes Unified management**
- **Device and Edge Application Unified Management**
- **Simplified development**: Developers can write applications, containerize them, and run them anywhere - either at the Edge or in the Cloud - whichever is more appropriate.
- **Cloud-Native, Kubernetes-native support**: Users can orchestrate apps, manage devices and monitor app and device status on Edge nodes just like a traditional Kubernetes cluster in the Cloud. Locations of edge nodes are transparent to customers. Extend K8s To Edge.
KubeEdge Status

- 2019 Mar entered CNCF Sandbox
- 5 minor(feature) releases, v1.2 released 2020.2
- 2.1k+ Star, 500+ Fork on Github, 1k+ wechat members
- 250+ Contributors (90 submitted code);
- 10 Approvers (1 Infoblox, 1 HP, 1 Microsoft)
- 14 Reviewers (1 China Unicom, 1 ARM, 1 Infoblox, 1 Inovex, 1 HP, 1 Microsoft)
- Over 40% PR made by non-huawei contributors in 2019
Device/Edge/Cloud Collaborated
ML Offloading architecture. It consists of Device(SDK), Edge offloading Service and Central management service.

Edge platform agnostic
The Edge offloading service can be deployed in any container based platforms. There is no dependency on special services from platforms. It can leverage partner services for advanced features. However those are not offloading core functions.

Offloading as a Service (OaaS)
OaaS can be offered to any applications which needs edge capabilities. It serves as a SaaS on top of Edge PaaS layer.

Open and Expandable Architecture
This diagram focuses on ML inference edge offloading use case. The overall architecture can be expanded to support various other ML offloading services including federated training.
Use Case 1: Device App AI model inference offloading workflow

1. Camera App
   • Image pre-process
   • Image resize
   • Convery image to pixel array

2. Convert to Pixel Array
   • Inference engine
   • Emotion recognize
   • AI service offloading API

3. gRPC Server/Session Bundle
   • Application registration
   • Emotion recognize model training
   • Model deployment

4. AI Service Engine manager

5. Tensor-RT AI Frame work

6. Model Source

- Facial expression recognition
- Smart Factory Flexible Quality Control
Use Case 2: Edge Offloading Speech Recognition in Operation Field

Edge Native Lawful Intercept
Akraino Blueprint Use Case
© Signologic 2020
Rev 1, Mar 2020

Mobile devices being intercepted have no app, by definition

Intercepted mobile devices

Telco Network

RTP audio

(1) Warrants
(2) Acquired audio

(1) Warrants Issued
(2) Lawful Intercepts

Unified conversation with transcription (diarization) for all endpoints, both network and field

(2) Audio Processing + ASR Inference

Edge Node

(3) Audio Processing
Real-time wideband audio
Background noise, overlapping conversations
Stream alignment for multiple endpoints
Merge streams into unified conversation
Calculation intensive
ASR inference and diarization, but no GPUs

(4) Advanced Inference, Training
Larger models, multiple models
Augmentation for channel or background noise / babble
New vocabulary, speakers, language

Private Central DC

(4) Advanced Inference, Training
Unrecognized / low confidence speech
Updated models

(4) Advanced Inference, Training

Akraino Edge Stack
# Appendix: Assessment Criteria

<table>
<thead>
<tr>
<th>Criteria</th>
<th>This BP</th>
<th>Criteria</th>
<th>This BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Each initial blueprint is encouraged to take on at least two committers from different companies</td>
<td>Futurewei, Arm, CMCC</td>
<td>Project contact name, company, and email are defined and documents</td>
<td><a href="mailto:Yin.ding@futurewei.com">Yin.ding@futurewei.com</a></td>
</tr>
<tr>
<td>Complete all templates outlined in this document</td>
<td>Detailed in this slide</td>
<td>Description of the project goal and its purpose are defined</td>
<td>Yes</td>
</tr>
<tr>
<td>A lab with exact configuration required by the blueprint to connect with Akraino CI and demonstrate CD. User should demonstrate either an existing lab or the funding and commitment to build the needed configuration.</td>
<td>Validation lab hosted by Futurewei</td>
<td>Scope and project plan are well defined</td>
<td>Targeting R4</td>
</tr>
<tr>
<td></td>
<td>Resource committed and available</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Blueprint is aligned with the Akraino Edge Stack Charter</td>
<td>Yes</td>
<td>Contributors identified</td>
<td>Futurewei, Arm, CMCC, Signalogic</td>
</tr>
<tr>
<td>Blueprint is code that will be developed and used with Akraino repository should use only open source software components either from upstream or Akraino projects.</td>
<td>Yes</td>
<td>Initial list of committers identified (elected/proposed by initial contributors)</td>
<td>Futurewei, Arm, CMCC, Signalogic</td>
</tr>
<tr>
<td>For new blueprints submission, the submitter should review existing blueprints and ensure it is not a duplicate blueprint and explain how the submission differs. The functional fit of an existing blueprint for a use case does not prevent an additional blueprint</td>
<td>Yes</td>
<td>Meets Akraino TSC policies</td>
<td>Yes. The project will operate in an open, collaborative and ethical manner</td>
</tr>
<tr>
<td>Name of the project is appropriate (no trademark issues etc.); Proposed repository name is all lower-case without any special characters.</td>
<td>KubeEdge Edge Services</td>
<td>Proposal has been socialized with potentially interested or affected projects and/or parties</td>
<td>Yes</td>
</tr>
<tr>
<td></td>
<td>Cross Project Dependencies</td>
<td>KubeEdge</td>
<td></td>
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