Edge Cloud-Native Cluster

THE LINUX FOUNDATION

Edge Cloud-Native Cluster

- Introduction
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  - Location: Hyderabad, India
  - University: International Institute of Information Technology, Hyderabad
  - Mentor: Wenjing Chu
  - OPNFV Project: Edge Cloud and Clover Project

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- Project Overview

  To implement a kubernetes-based edge cluster supporting cloud-native framework and develop exemplar microservice-oriented applications for the edge as well as the edge-cloud paradigm of the future.

- Frameworks/Tools/Languages Used

  Ansible, Docker, Kubernetes, UV4L, YOLOv3, Python, Bash scripting

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- Project Objectives: The project had 3 major components-
  - Obj 1: Creation of a Raspberry Pi-based kubernetes edge cluster.
  - Obj 2: Implementation of a low-latency real-time microservice-based video streaming app for this edge cluster.
  - Obj 3: Edge of Tomorrow: Implementation of an Edge-Cloud based real-time object detection app employing collaborative machine learning.

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- Project Deliverables
  - Deliverable 1: A versatile Ansible script that can form a k8s cluster with 2 or more Raspberry Pis.
  - Deliverable 2: Containerized bash script employing UV4L along with a k8s deployment yaml.
  - Deliverable 3: Collaborative ML paradigm for Edge-Cloud, YOLOv3 based object detection containers for edge & GKE and respective k8s deployments. (Let's check out this topic in detail followed by a demo!)

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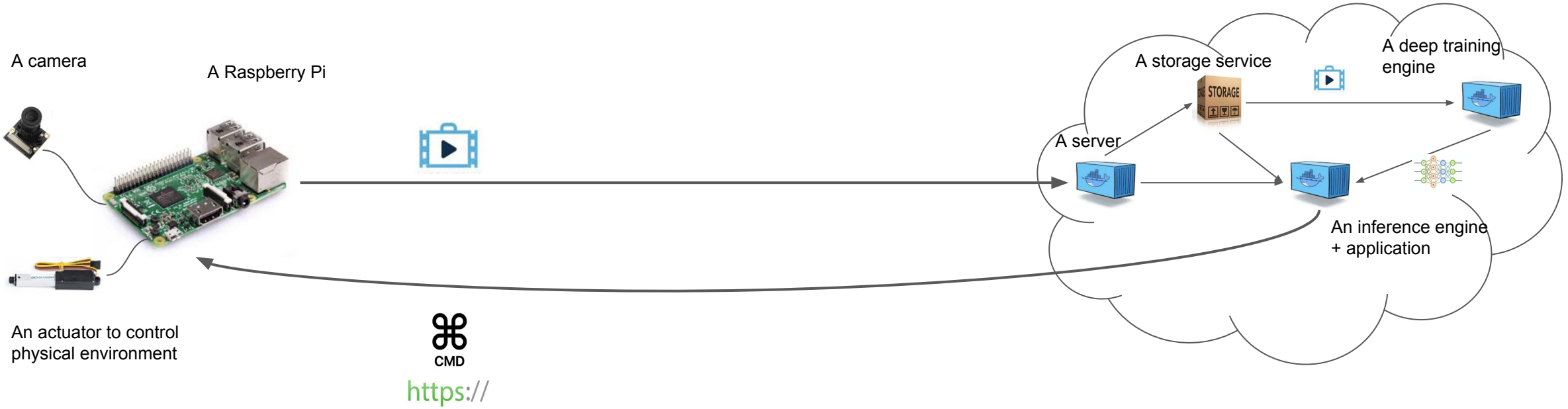
- Edge of Tomorrow
  - AI delivered through a cloud today



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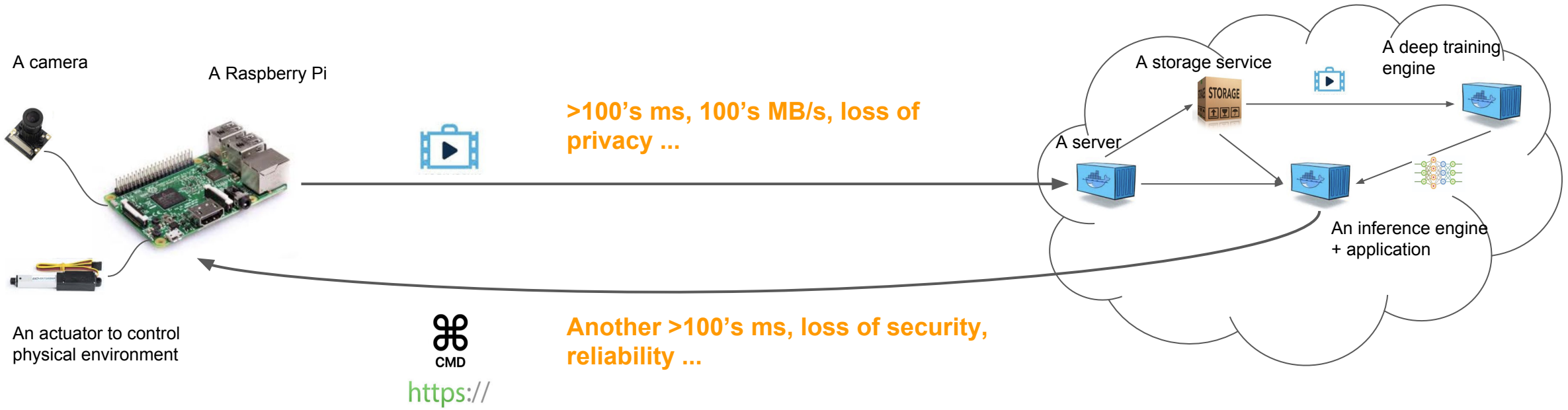
- Edge of Tomorrow
  - Disadvantages of the current system?



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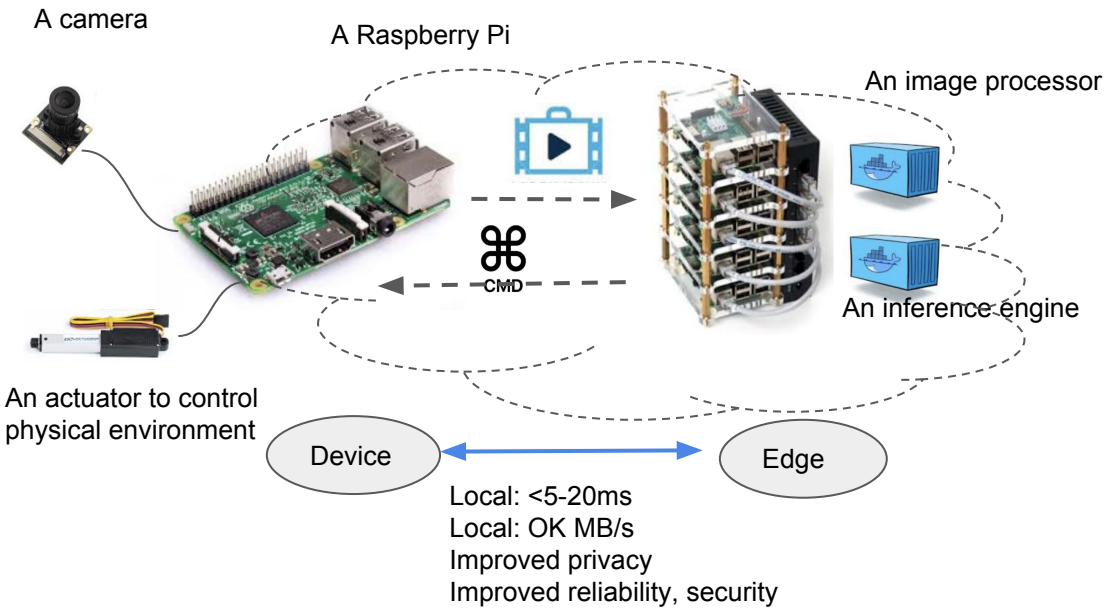
- Edge of Tomorrow
  - AI delivered through an Edge-Cloud of tomorrow



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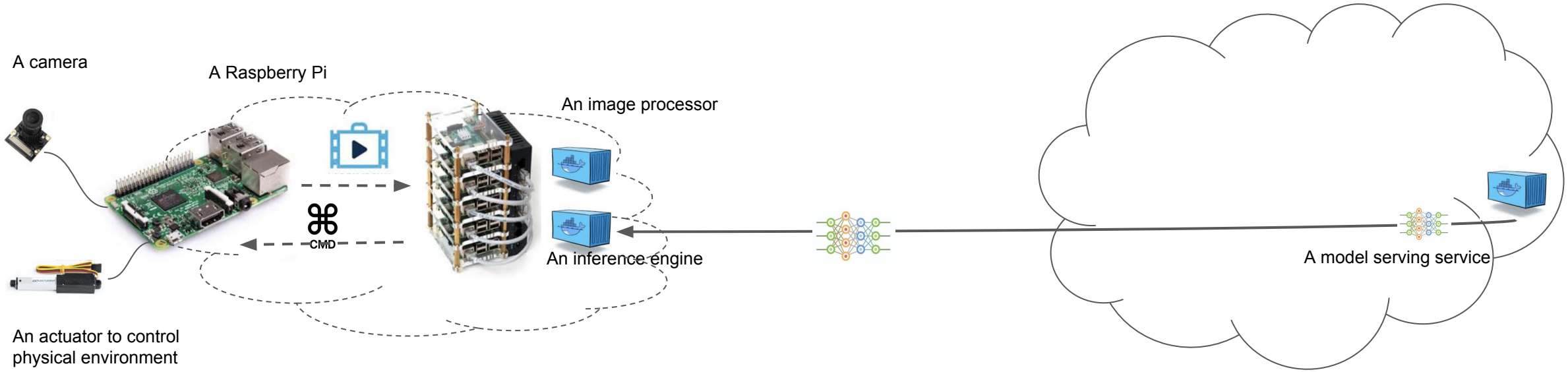

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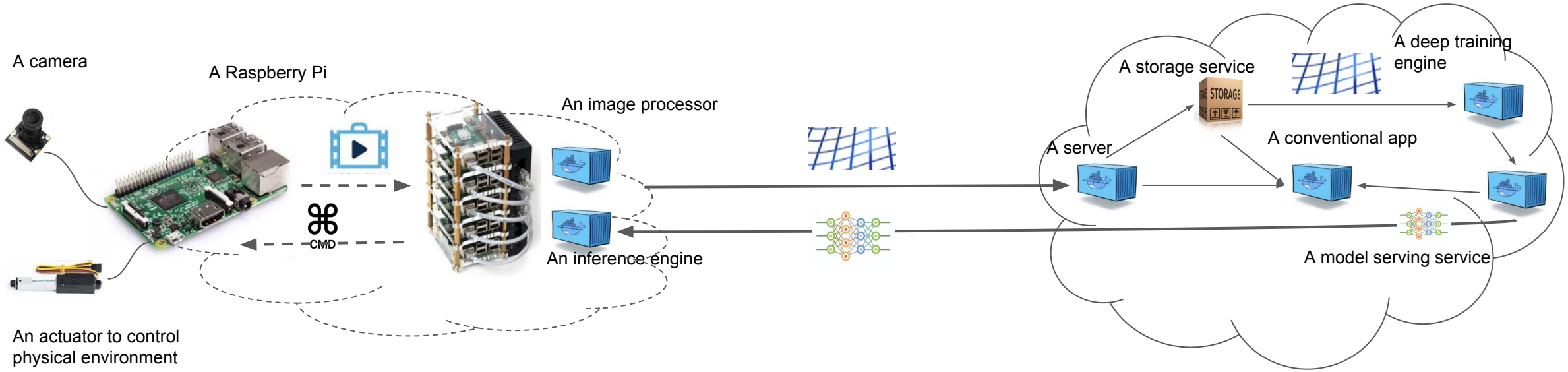

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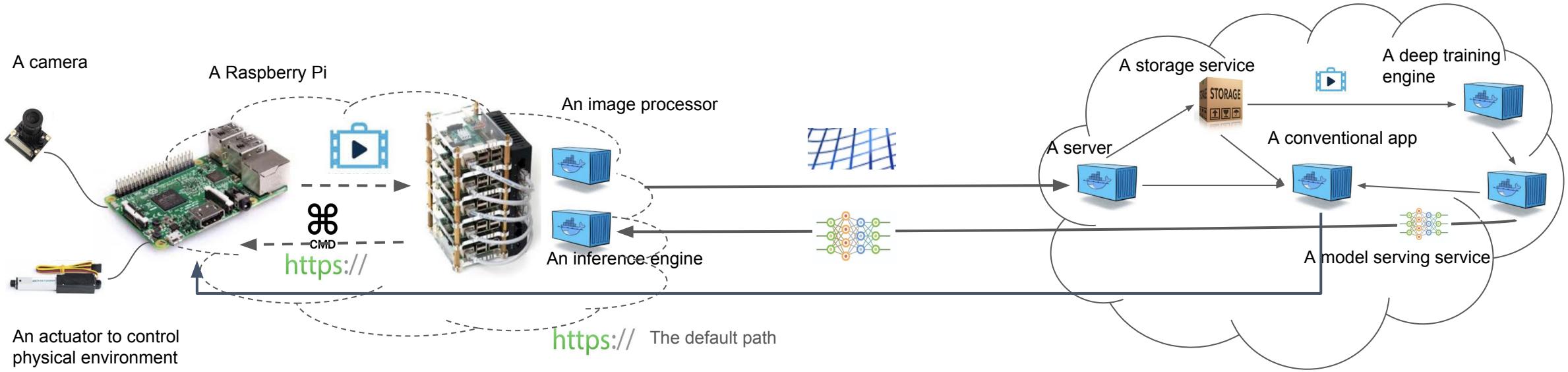

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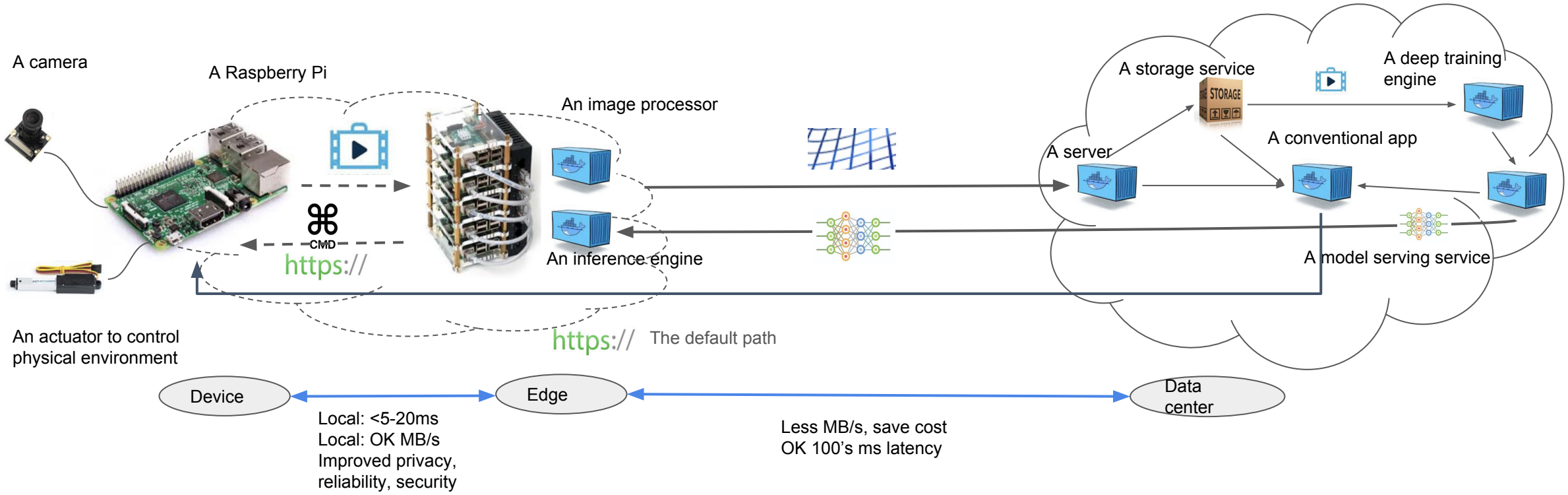

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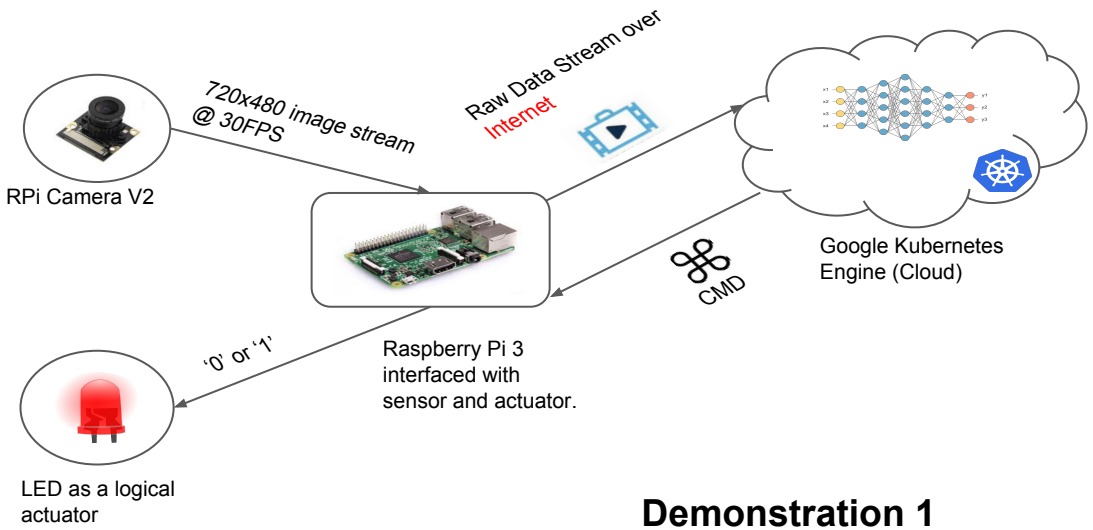
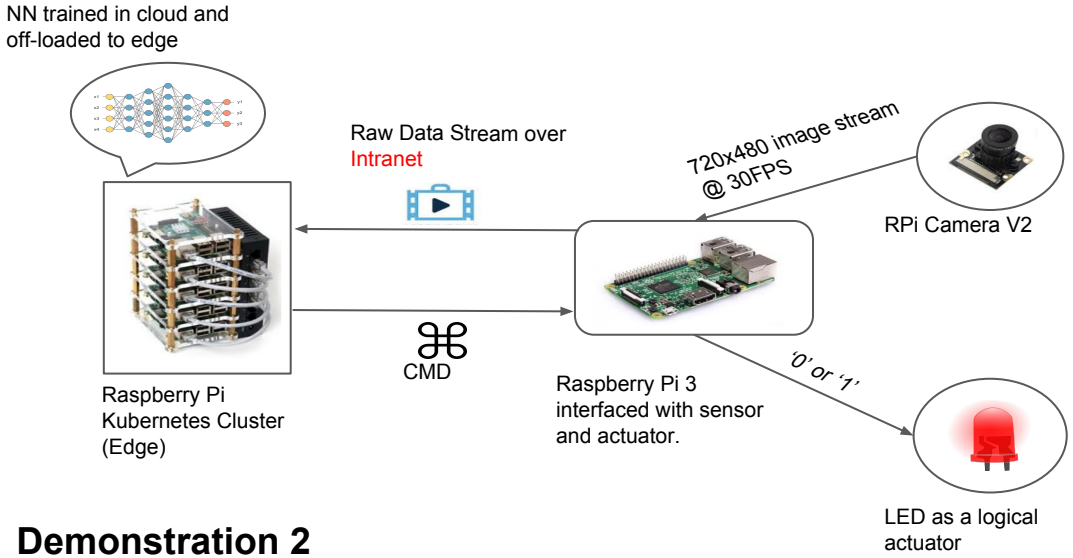
- Edge of Tomorrow
  - Demo: To trigger an action locally based on the detection of an object of interest



Demonstration 1



Demonstration 2

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- Edge of Tomorrow
  - Details of the demo
    - YOLOv3-Tiny Object Detection pod runs on Edge/GKE. Darknet compiled with NNPACK and ARM Neon on Edge and CUDA/cuDNN on GKE.
    - Source RPi has the 2 pods: (a) Video streaming and (b) CMD actuation from Edge/Cloud.
    - Edge/Cloud pod workflow: Capture image stream -> Run NN -> Send CMD.
    - Simple Socket programming used for sending/receiving CMD.
    - Latency test: Edge vs. Cloud!

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- Edge of Tomorrow
  - A not-so-professionally-recorded Demo!

- Prediction Time
  - Edge: 2 - 2.5s /Image Vs. Cloud: 0.007 - 0.01s /Image.
  - Due to high prediction time, Edge can take upto 4-5s for detection in worst case.
- Image Stream lag
  - Edge: 0.009 - 0.02s vs. Cloud: 0.5 - 1s
- CMD lag
  - Edge: Negligible vs. Cloud: ~0.5s

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- Project Execution & Accomplishments
  - All 3 objectives completed with code and documentation committed.
  - The original Obj 3 of integrating the system with Clover is still open.
  - The Edge of Tomorrow project was accepted and delivered as a lightning talk at the Open Networking Summit, Europe, 2018!

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- Recommendations for future work
  - CI/CD pipeline for Edge/Edge-Cloud.
  - Better compatibility with Docker and kubernetes for ARM devices.
  - Low-cost GPU enabled Edge devices supporting popular deep learning frameworks.
  - Framework for designing collaborative ML algorithms for Edge-Cloud with ease.

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- Questions?