THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Gavin Adams
Senior Solutions Architect, IoT
Amazon Web Services

Gavin is a Senior Solutions Architect with Amazon Web Services (AWS), specializing in helping customers deploying IoT solutions. In his journey to his current role at AWS, Gavin began his technology career supporting nuclear energy testing missions in the Nevada desert. Since then, he has been involved in other aspects of information technology including software development, security, system automation, system architecture and design, and since 2012, focusing primarily on cloud-native solutions for customers. He now focuses on delivery of edge compute solutions, putting him back in physical world with

SLIDES

The laws of the edge

- **Law of Physics**: Light (data) can only travel so fast
- **Law of Economics**: Networks extend communication —at a cost
- **Law of the Land**: Data sovereignty laws to ensure data is secure and kept local

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here...

NEW QUESTION

SLIDES

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

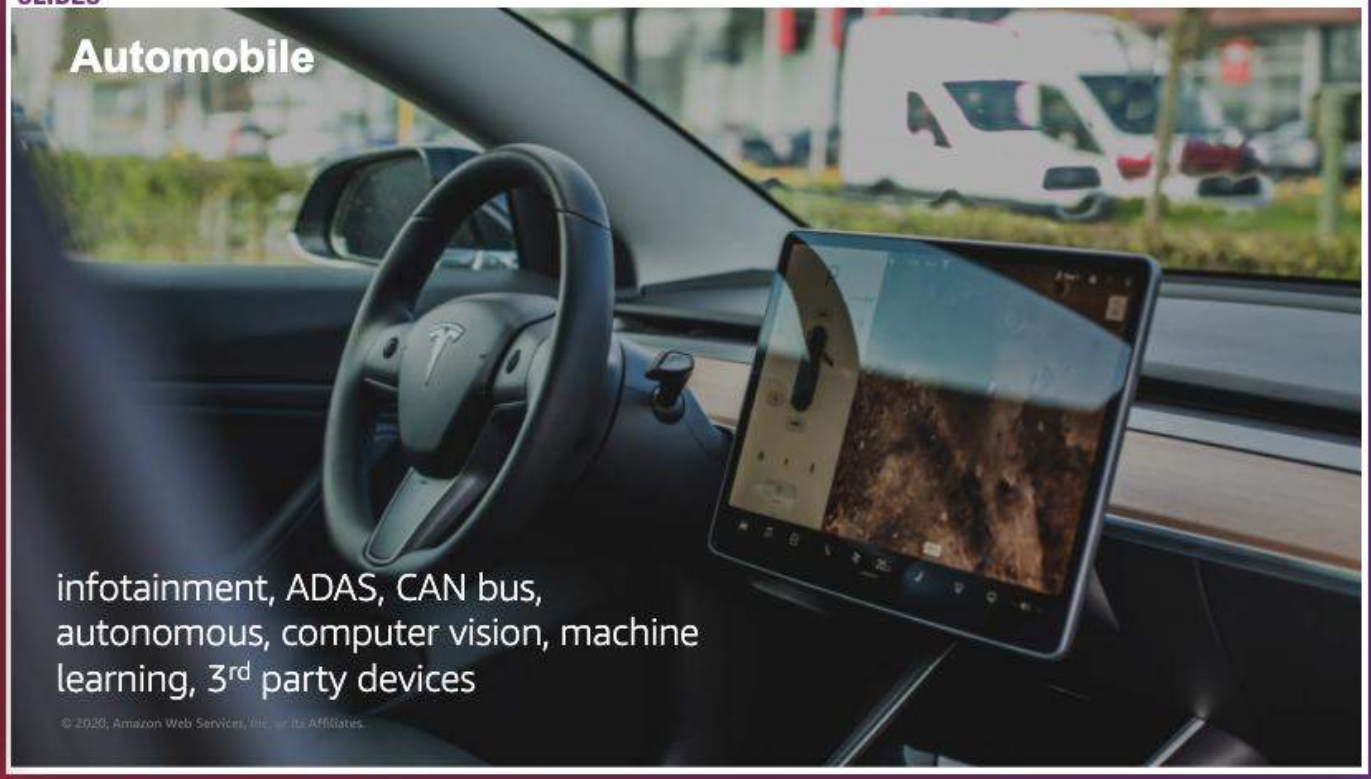
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here...

NEW QUESTION

SLIDES



THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

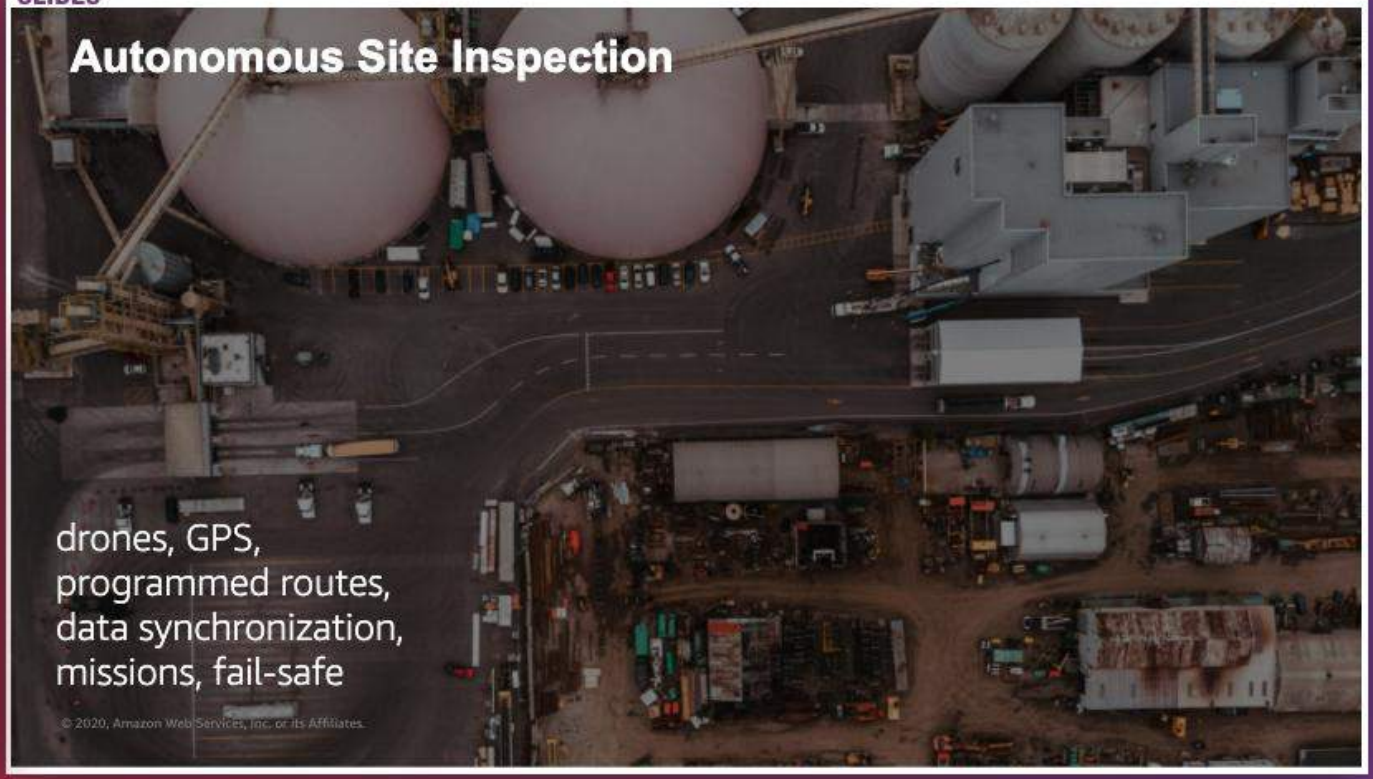
Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES



THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Constraints for use cases

	Physics	Economics	Law
Wind Turbine	Vibration detection	Telemetry via cellular	Critical infrastructure
Automobile	MobileEye (ADAS)	ML training data	-
Drone Site Inspection	Path and data collection	-	Corporate security

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here...

NEW QUESTION

SLIDES

Edge implementation patterns

Abstracted compute, ML, etc.

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

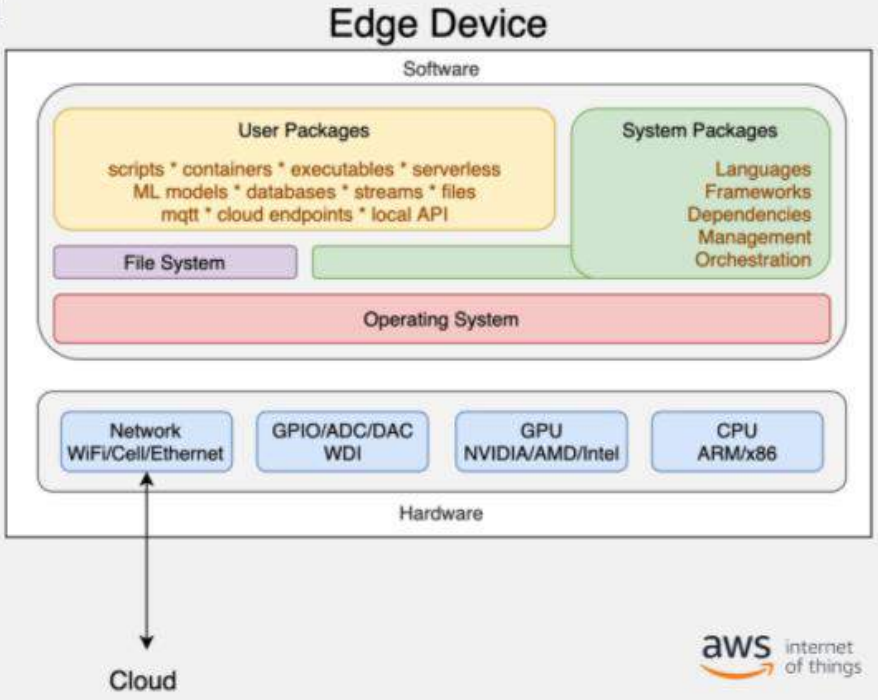
Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Operating system

- **Linux**
- **General purpose**
  - Ubuntu
  - Raspberry Pi OS
- **Embedded**
  - Yocto/ OpenEmbedded
  - Buildroot
- **Others**
  - Busybox
  - Alpine
  - BalenaOS



aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

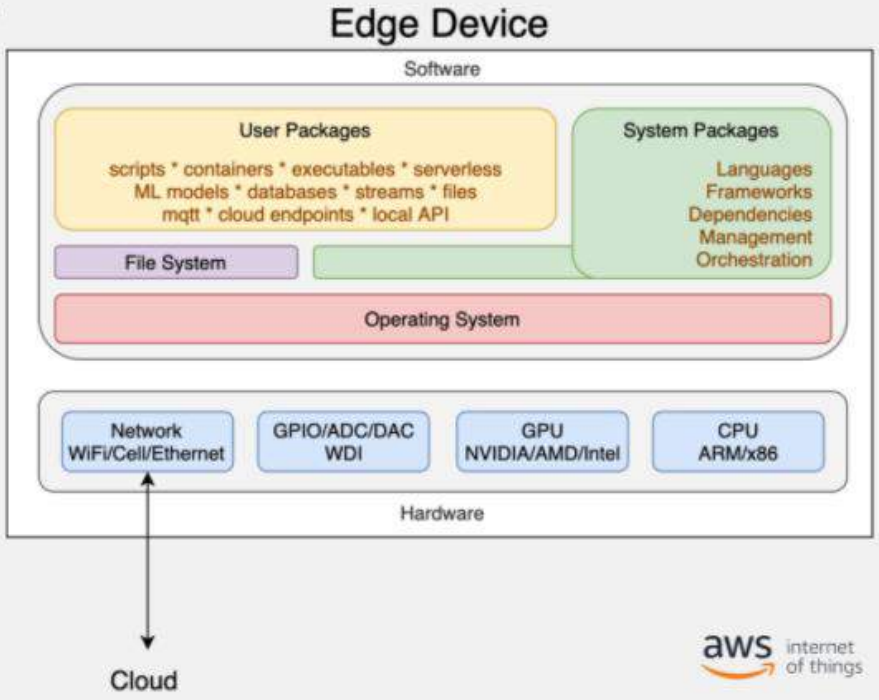
Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

System packages

- **Language specific**
  - Python 2.x, 3.x
  - Java, NodeJS
- **Dependencies**
  - .so (GLIBC)
  - Numpy
  - Gstreamer
- **ML/DCNN Frameworks**
  - MXNet
  - TensorFlow Lite/RT
  - Neo-Ai-DLR
- **Management**
  - Tunneling
  - OTA updates
- **Edge Frameworks**
  - K3s, K8s
  - EdgeX
  - AWS IoT Greengrass



Take a break! Enjoy our Experiences + Fun & Games!

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

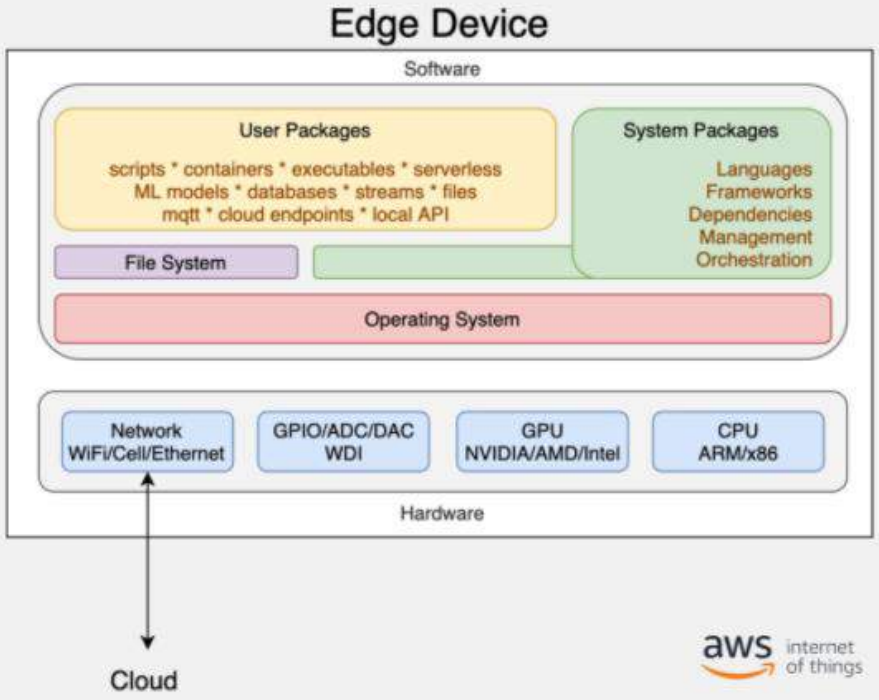
Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

User packages

- **Native**
  - Scripts
  - Processes
  - Daemons
- **Containers**
  - OCI/Docker
- **Edge Framework**
  - Functions
  - Containers
  - Services
  - Queues
- **Local Device Interop**
  - APIs
  - Endpoints
- **ML Models**
  - Inference
  - Retraining
  - Drift



THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

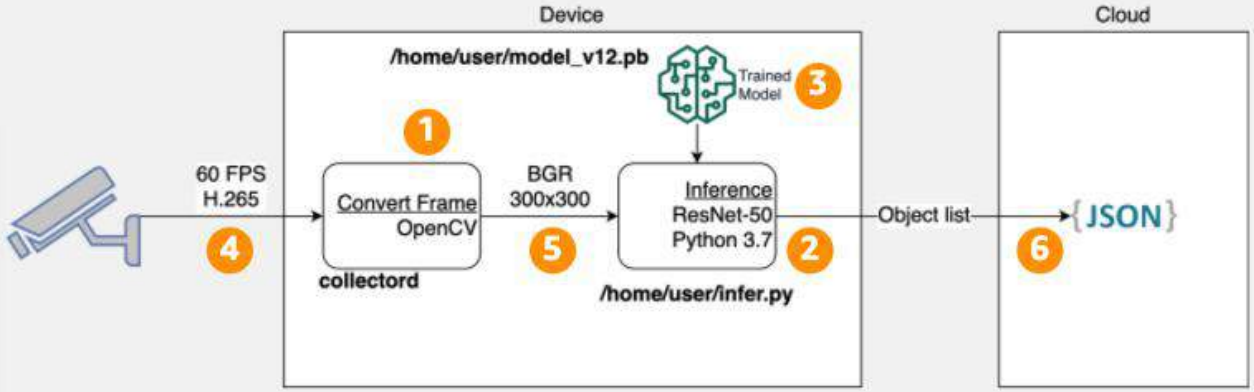
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Edge computer vision (basic)



aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

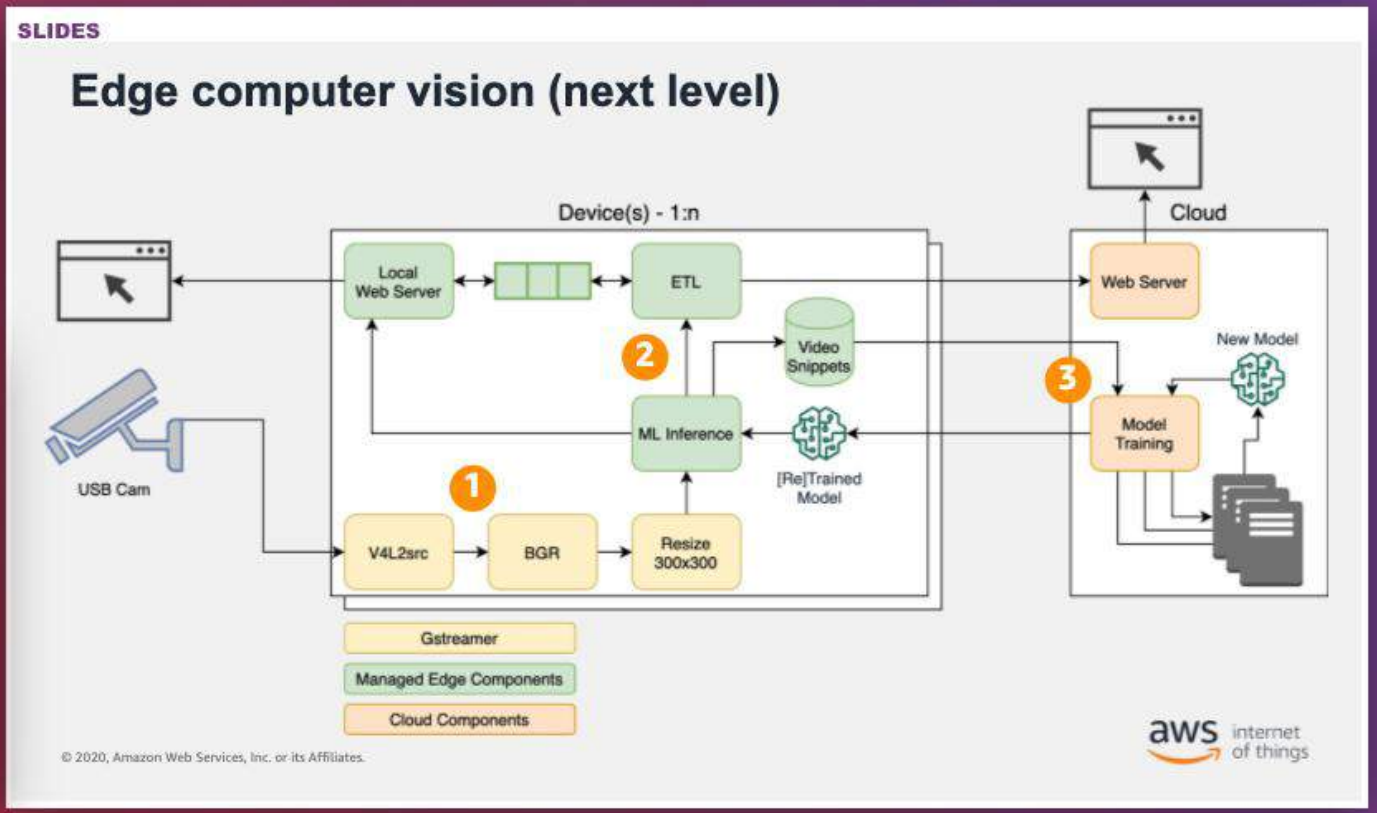
Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES



THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

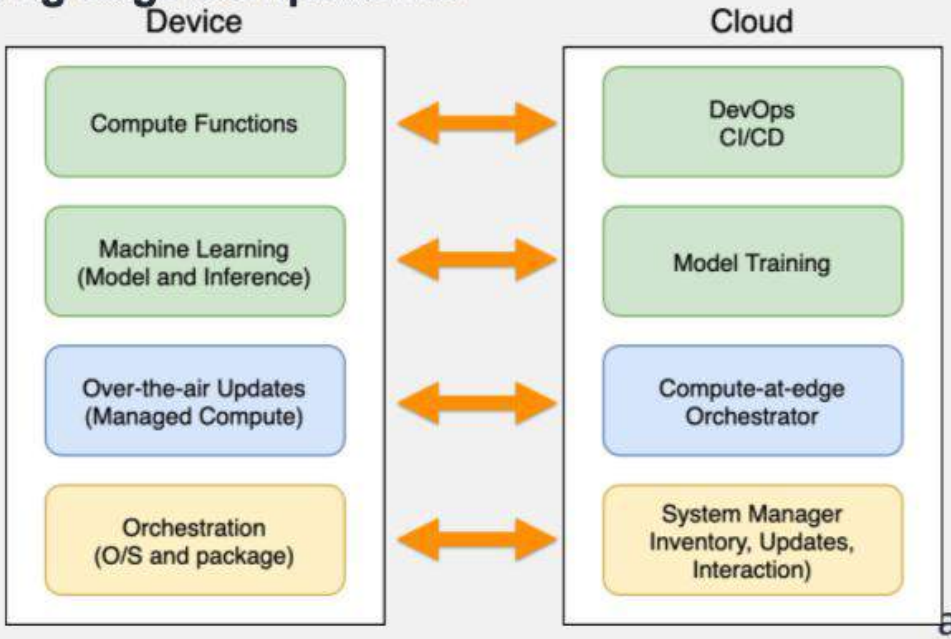
Q&A WITH SPEAKER SPEAKER BIO

Enter question here...

NEW QUESTION

SLIDES

Managing edge components



aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

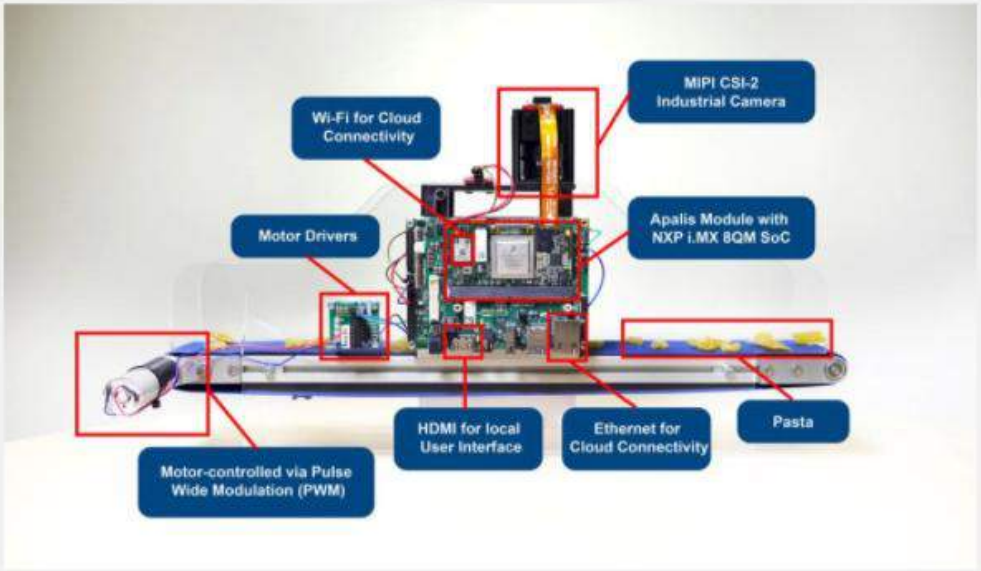
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

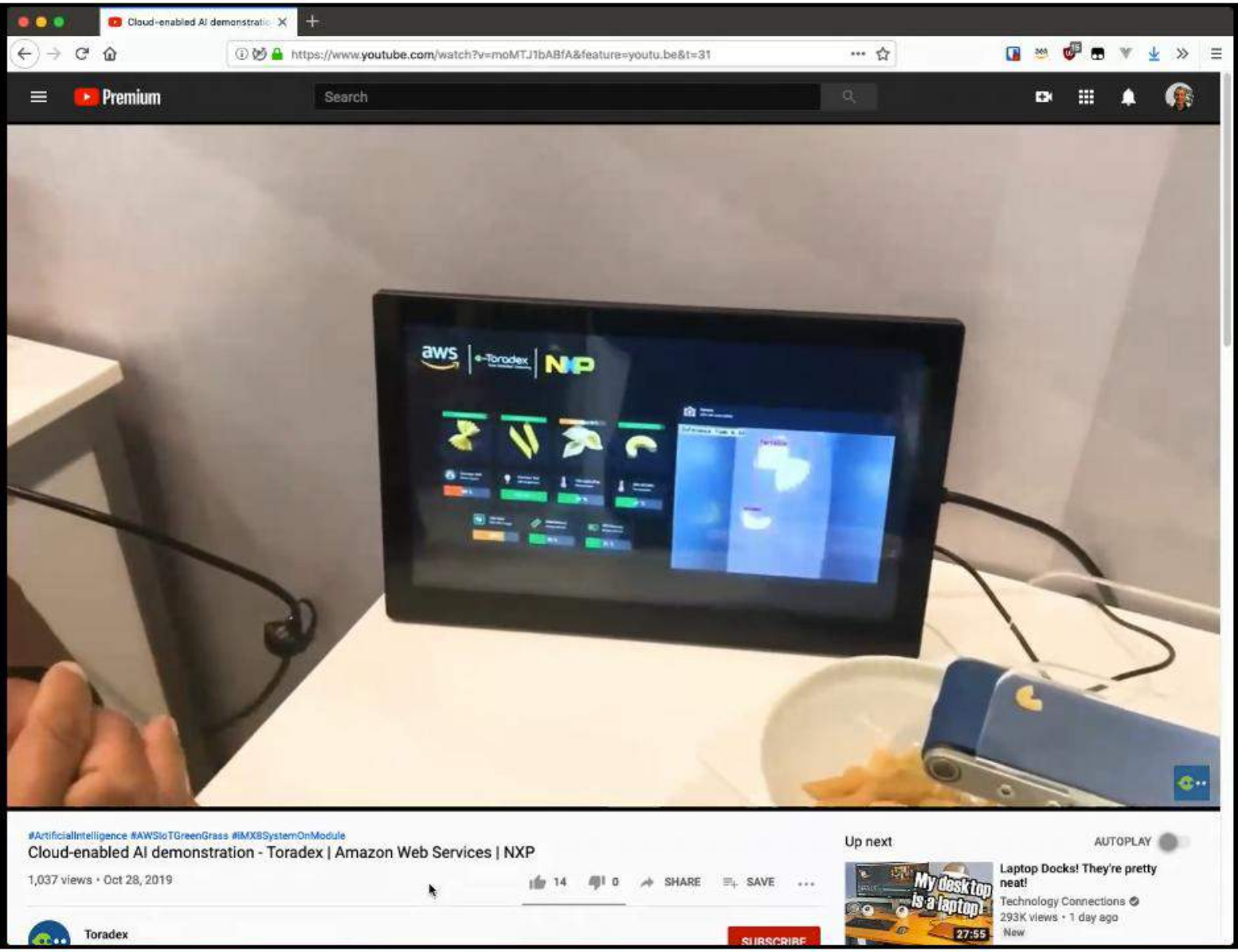
Toradex Demo Hardware



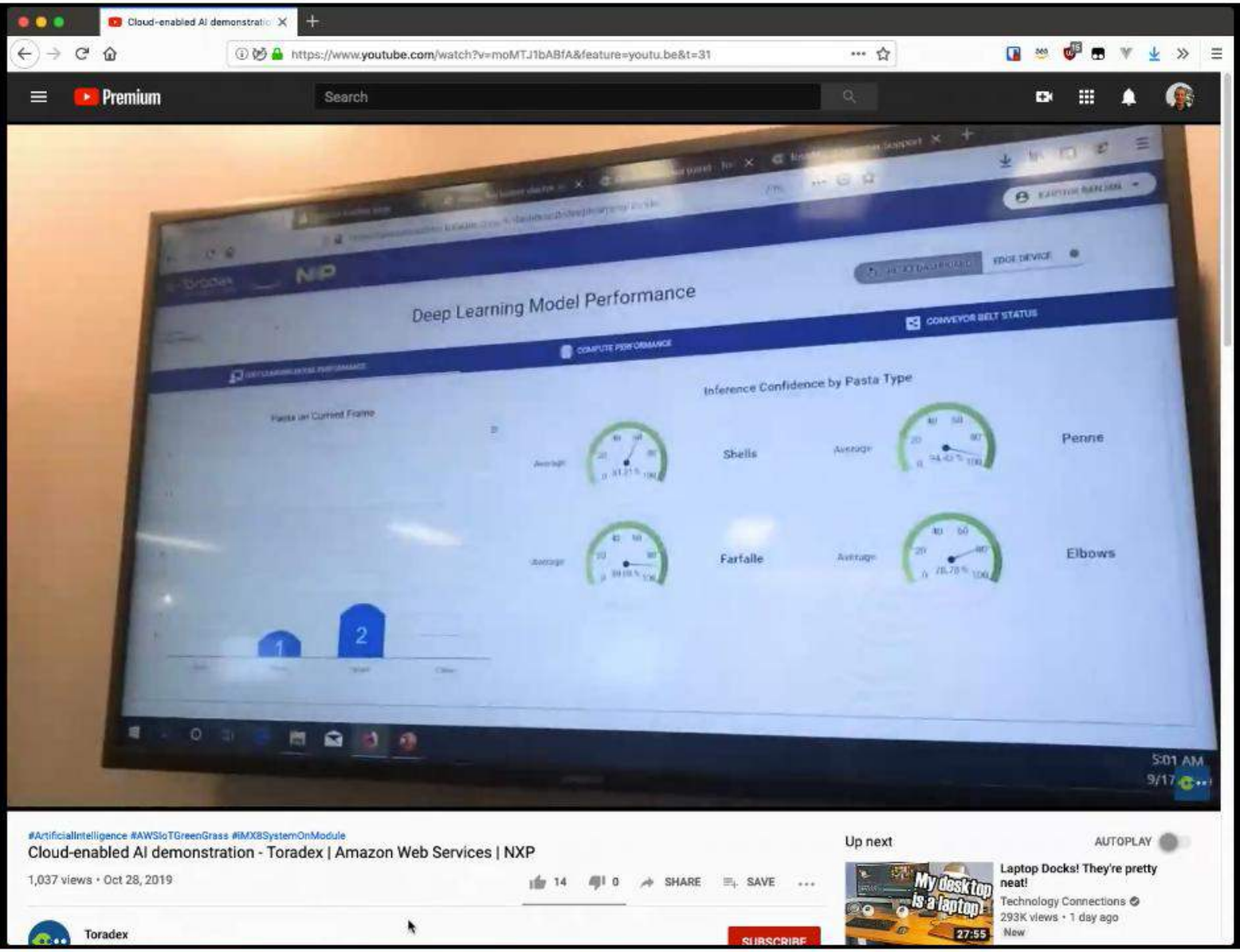
aws internet of things

SCREEN SHARE

SCREEN SHARE



SCREEN SHARE



THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

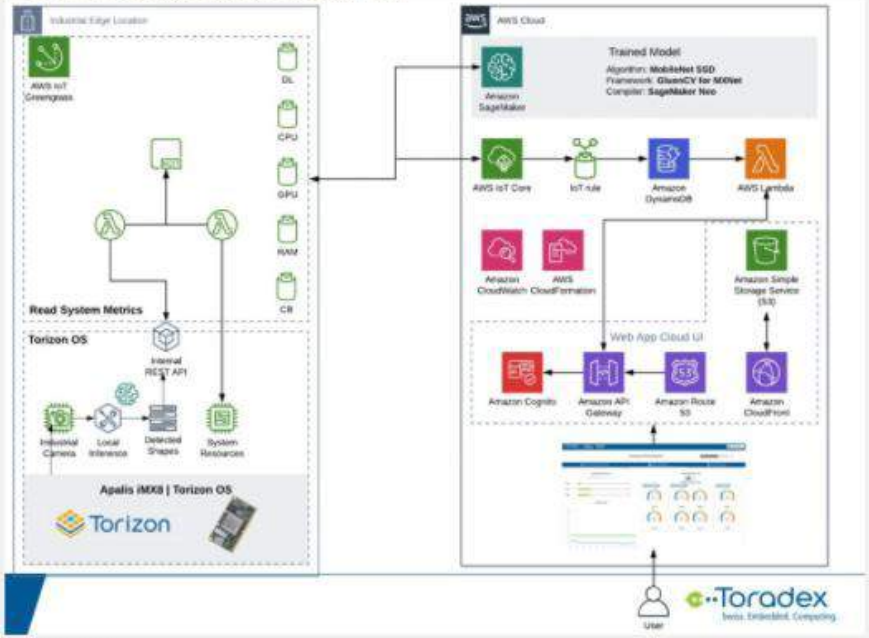
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Toradex Demo Architecture



aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Hey! Wait! Don't pick up the ph{#`%${%&`+'${`%&NO CARRIER"

When things go horribly, horribly wrong

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

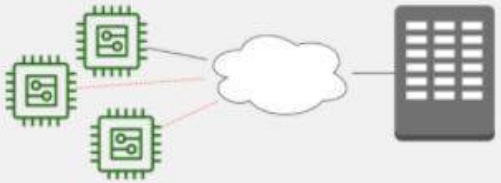
Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Intermittent connectivity

- Everything fails, all the time
- Design for failure
- Address state and operation
  - Online->offline
  - Offline->online
  - Minutes, hours, …, years



aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Security constraints

Ports: 80, 443, 8443, 8883, 53
tcp, udp, ipv4, ipv6

52.11.19.0/22

44.226.17.39/32

my-service-name.it.example.com

*.mgmt.it.example.com

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

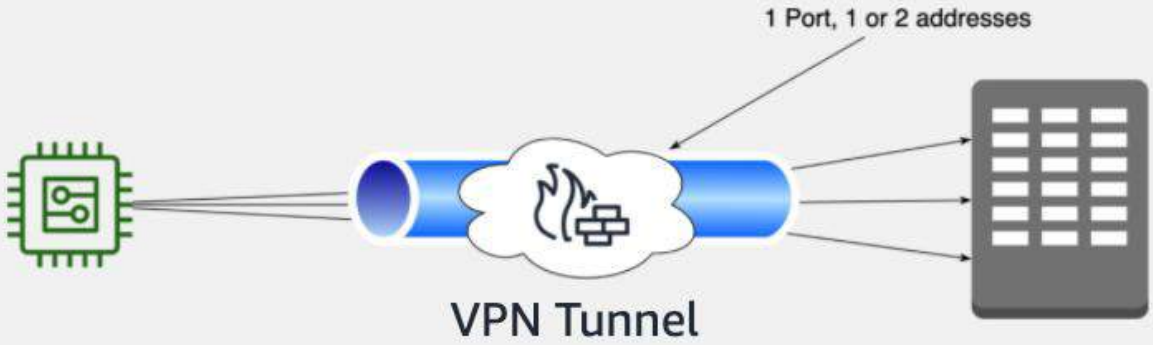
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Reduce access surface area



aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Other design considerations

- **Dependencies for functions**
  - Python 2.7 vs 3.6 vs 3.x
  - Common vs packaged per-entity
- **Fail-fast and rollback (don't brick the device)**
  - Watchdog or supervisor
  - Atomic operations
- **Varying environment**
  - Connectivity: hard-wired vs WiFi vs cellular vs LPWAN
  - Off-device resources: file shares, sensors, etc.
- **Secure and rotate credentials**

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Designs that align

When IT ain't happy, ain't nobody happy*

*Paraphrased from Tracy Bryd

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

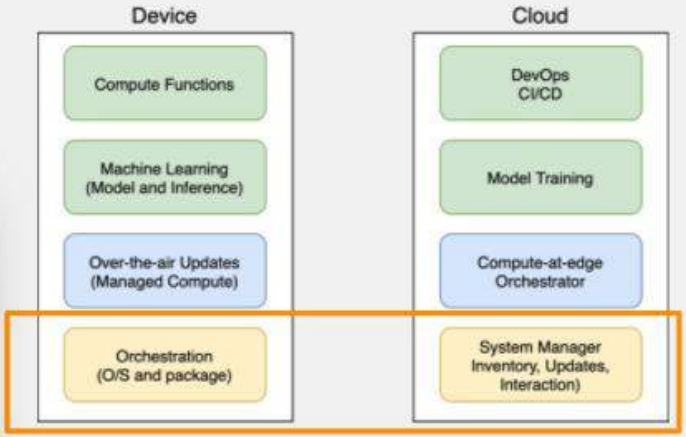
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Managing edge components – Operating System



- **Operating system**
  - Distribution (Debian, RHEL, Yocto)
  - Repositories
    - Public, private, baked-in
  - Packages
    - Python, Java, .so
- **Orchestration**
  - O/S – Salt, Ansible, Puppet
  - Container – K8s/K3s, AWS IoT Greengrass
  - Serverless – OpenWhisk, OpenFaaS, AWS IoT Greengrass

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

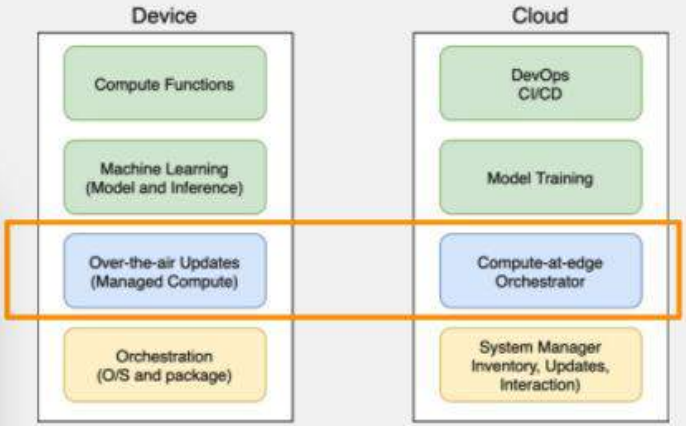
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Managing edge components – Orchestration



- **Assets**
  - Functions
  - Image and compose files
  - Machine learning models
  - O/S updates
  - Firmware
- **Asset access** – endpoints
- **Fleet management**
  - Deploy, update, report
  - Asset deployment
- **Status and reporting**
  - Dashboard
  - Device and fleet metrics
- **Device security/identity**

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

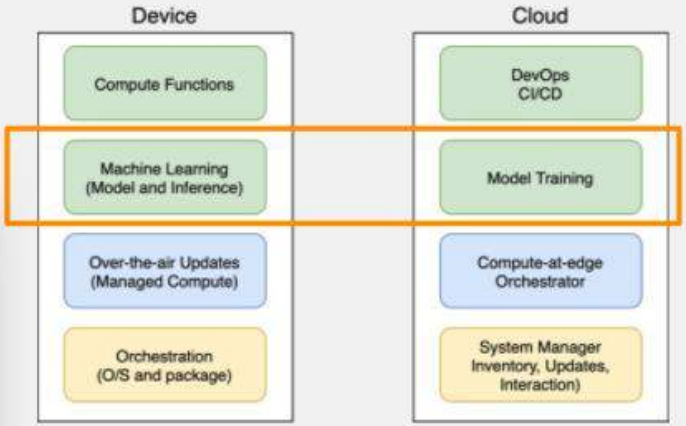
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Managing edge components – Machine Learning



- **Training**
  - Notebooks
  - Training dataset
  - Validation and test sets
  - Training resources (cloud, VM, dedicated hardware)
- **Model Output**
  - DLR, TVM, Treelite
  - Mxnet, TensorFlow, CAFFE
  - Asset storage location

aws internet of things

THE LINUX FOUNDATION OPEN SOURCE SUMMIT NORTH AMERICA

Embedded Linux Conference North America

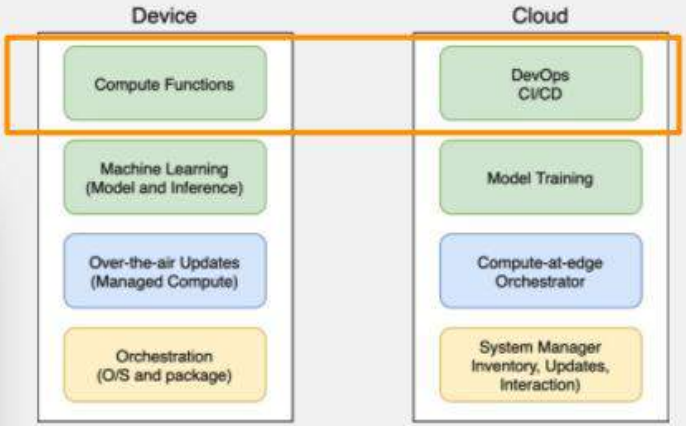
VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Managing edge components – Edge Logic



- **Development**
  - Git, IDEs, CI/CD pipeline
  - Unit and regression testing
  - Artifact location
- **Testing**
  - Unit, regression, simulated device
  - Inclusive of O/S, orchestration and ML
- **Deployment**
  - One-box (if available)
  - Blue-green
  - Fleet deployment
- **Roll-back**

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Pulling it all together

aws internet of things

THE LINUX FOUNDATION
OPEN SOURCE SUMMIT
NORTH AMERICA

Embedded Linux Conference
North America

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here...

NEW QUESTION

SLIDES

In summary

- If there is any semblance of connectivity for a device, edge compute and machine learning can be adopted
- Define or adopt patterns to build a “full-stack” edge device
- Depending upon where and how deployed, research potential “gotcha’s” and address or accept
- Leverage the hard work and tools of your IT or OT department
- Look to AWS IoT Greengrass as an example of edge compute and machine learning capabilities

aws internet of things

VIDEO

Q&A WITH SPEAKER SPEAKER BIO

Enter question here... NEW QUESTION

SLIDES

Q&A

Deep Learnings at the Edge

Gavin Adams, Specialist Solutions Architect
Amazon Web Services

aws internet of things