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AI Virtual Tech Talks Series

The Smart City in Motion

Edge/AI in intelligent transportation

Clever Devices NXP Arcturus empower embedded

Philip Bockrath, Markus Levy, David Steele

November 17, 2020

AI Virtual Tech Talks Series

Date	Title	Host
November 17, 2020	The Smart City in Motion - AI in intelligent transportation	Clever Devices, NXP, Arcturus
December 8th, 2020	Bringing Spatial AI to embedded devices	SLAMCore

Visit: developer.arm.com/solutions/machine-learning-on-arm/ai-virtual-tech-talks

Agenda

The Smart City in Motion – Edge/AI in intelligent transportation

- **Introduction**
  - What is the Smart City
  - How does transportation play a role
- **Intelligent Transportation Systems (ITS)**
  - Philip Bockrath - Clever Devices
- **Enabling Intelligence at the Edge**
  - Markus Levy - NXP Semiconductor
- **Developing Systems**
  - David Steele - Arcturus
- **Demos**

What is the Smart City?

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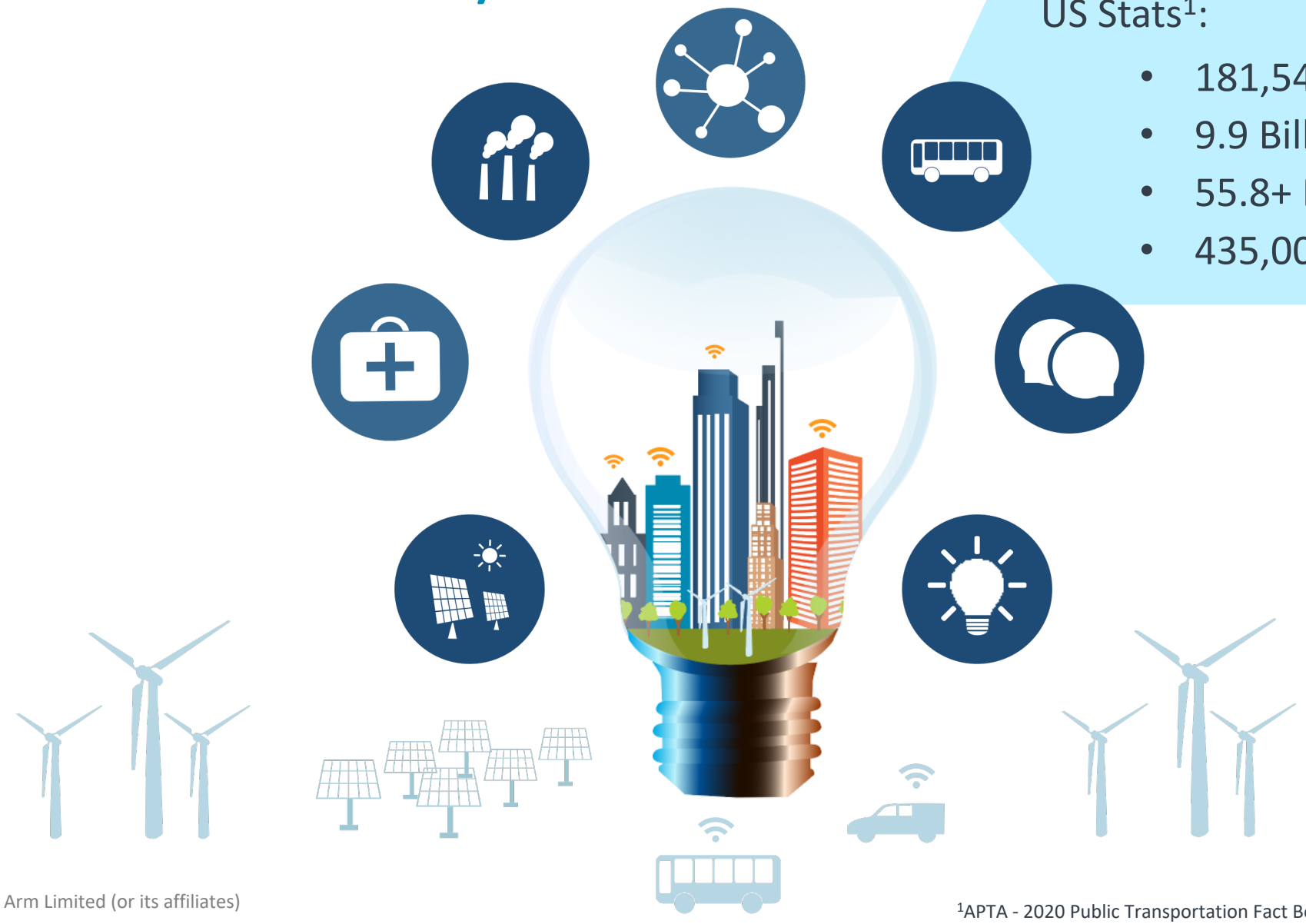
What is the Smart City?



US Stats[1]:

- 181,541 vehicles
- 9.9 Billion trips
- 55.8+ Billion miles
- 435,000+ jobs

[1]APTA - 2020 Public Transportation Fact Book

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Intelligent Transportation Systems (ITS)

Presenter

- Philip Bockrath- VP Wireless Communications
  - 26 years in the wireless communications and transit industry

Clever Devices

It’s Just a Bus

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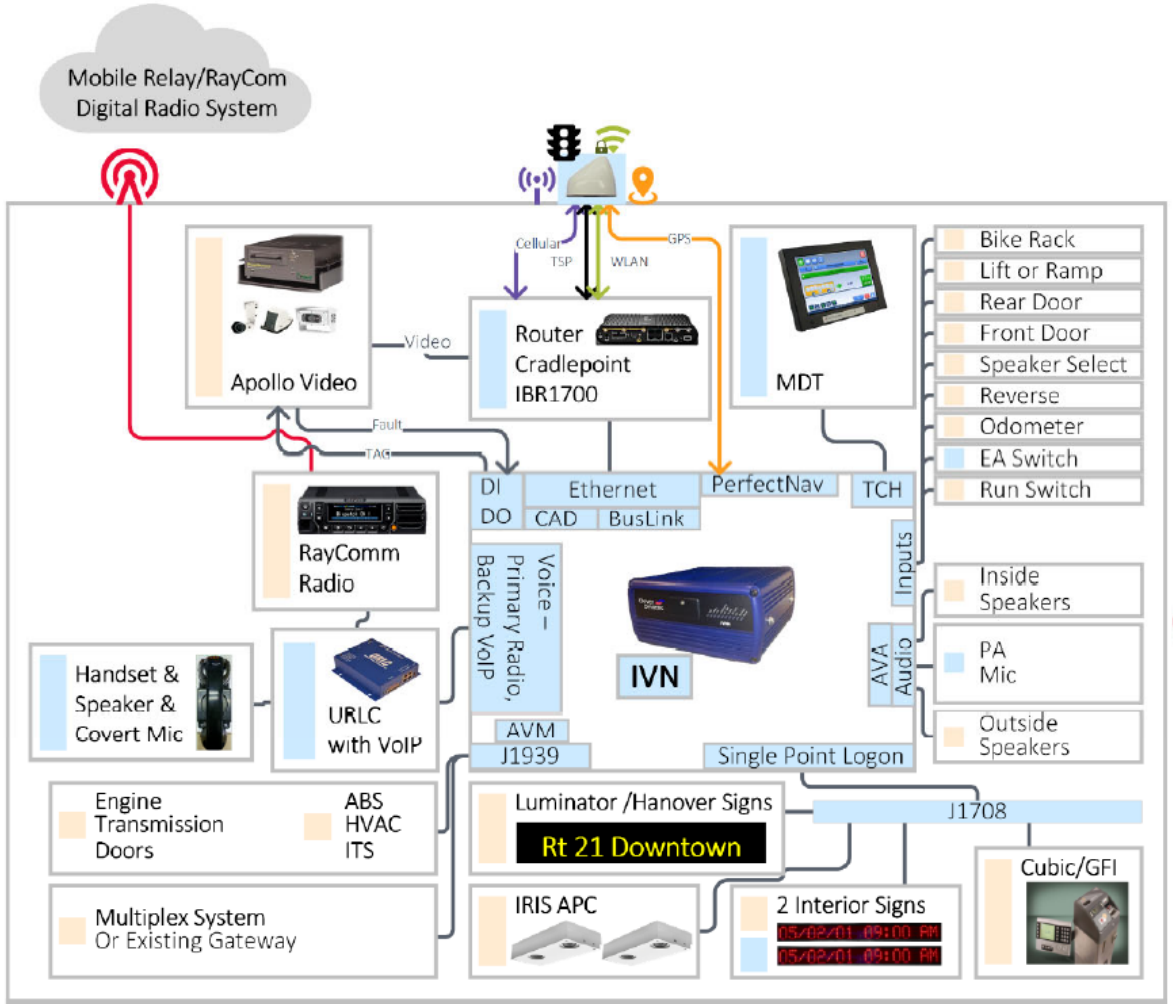
ITS Just a Bus



ITS Just a Bus

- **APC**- Automatic Passenger Counters
- **Fare Collections-** with real-time validation and fraud detection
- **Video Surveillance**
- **HR/Workforce Management-** Who gets paid based on work performed
- **AVM-**Automatic Vehicle Monitoring-Engine, Transmission, HVAC, Braking, ABS….
- **Secure Bus Access**
- **AVL/RSA-** Automatic Vehicle Location/ Route Schedule Adherence
- **Voice Communications-** Land Mobile Radio and VoIP
- **Mobile Environmental Sensors**
- **AVA-** Automatic Voice Annunciation and Stop Display for ADA compliance
- **Broadband Communications/ Passenger WiFi**

Infrastructure

- **Centralized CAD/AVL and On Time Performance Monitoring**
- **RTPI-** Real-time Prediction Indication to ridership
- **Video Surveillance-** Monitor Emergencies remotely, dispatch correct personnel, reduce response time.
- **Secure Bus Access-** Deescalate thefts, hostage situations and terrorist activities
- **AVM-** Interface to Work Order System, Fix things before there is a breakdown.
- **Disruption Management-** Real time route and schedule updates based on detours, Construction parades, or the unexpected.
- **Voice Communications-** LMR/VoIP and Autonomous Switching
- **Garage-** Precise Parked Vehicle Location
- **Mobile Environmental Sensors-** Temperature, Biological, Nuclear, Hazardous Materials

AVM

- **What if you had a brilliant mechanic on every bus?**
  - 17,000 Unique Fault and Data Points- Not CEL, Actionable Data.
- Reduce Road Calls by 40%
- 90% Reduction in catastrophic engine failures
- Reduce negative social media posts & angry customer service calls

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AVM-Use Cases

Use Case 1

Problem: Complaints about air conditioning in buses in summer. Vehicles in question not creating faults so agency couldn't easily identify which vehicles were not cooling properly. Customers upset and creating angry social media posts.

Solution: Create a report that identifies outliers to desired temperatures on all vehicles. Repair only those vehicles that fall outside desired temperatures. Tie to work order management system.

Results: No need to analyze every vehicle saving time/money. Improved customer satisfaction.

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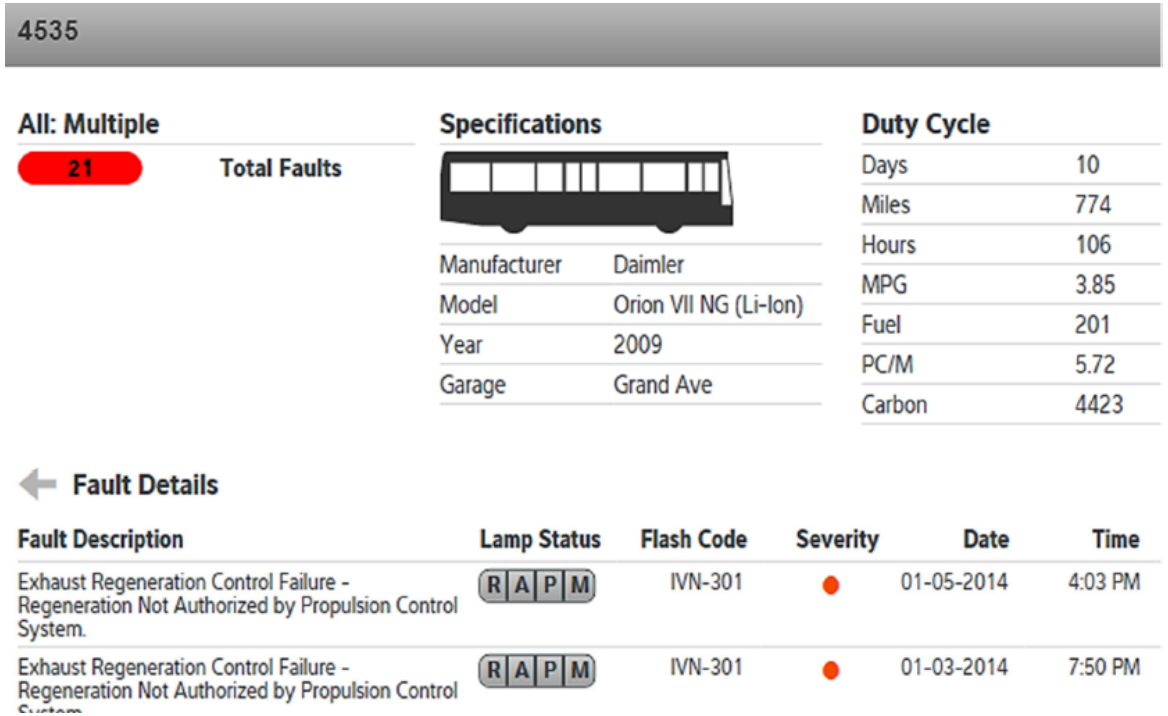
AVM-Use Cases

Use Case 2:

Problem: Agency spending significant sums on catastrophic engine failures.

Solution: Predictive analysis enables agency to address concerns before they require a completely new engine.

Results: Reduce the number of failures dramatically by addressing problems before they require complete engine overhauls. Saved over $5.5M(US) by reducing blanket manufacturer contracts from $6M (US) to $.5M (US) per year.



4535

All: Multiple

21 **Total Faults**

Specifications

Manufacturer	Daimler
Model	Orion VII NG (Li-Ion)
Year	2009
Garage	Grand Ave

Duty Cycle

Days	10
Miles	774
Hours	106
MPG	3.85
Fuel	201
PC/M	5.72
Carbon	4423

Fault Details

Fault Description	Lamp Status	Flash Code	Severity	Date	Time
Exhaust Regeneration Control Failure - Regeneration Not Authorized by Propulsion Control System.	R A P M	IVN-301		01-05-2014	4:03 PM
Exhaust Regeneration Control Failure - Regeneration Not Authorized by Propulsion Control	R A P M	IVN-301		01-03-2014	7:50 PM

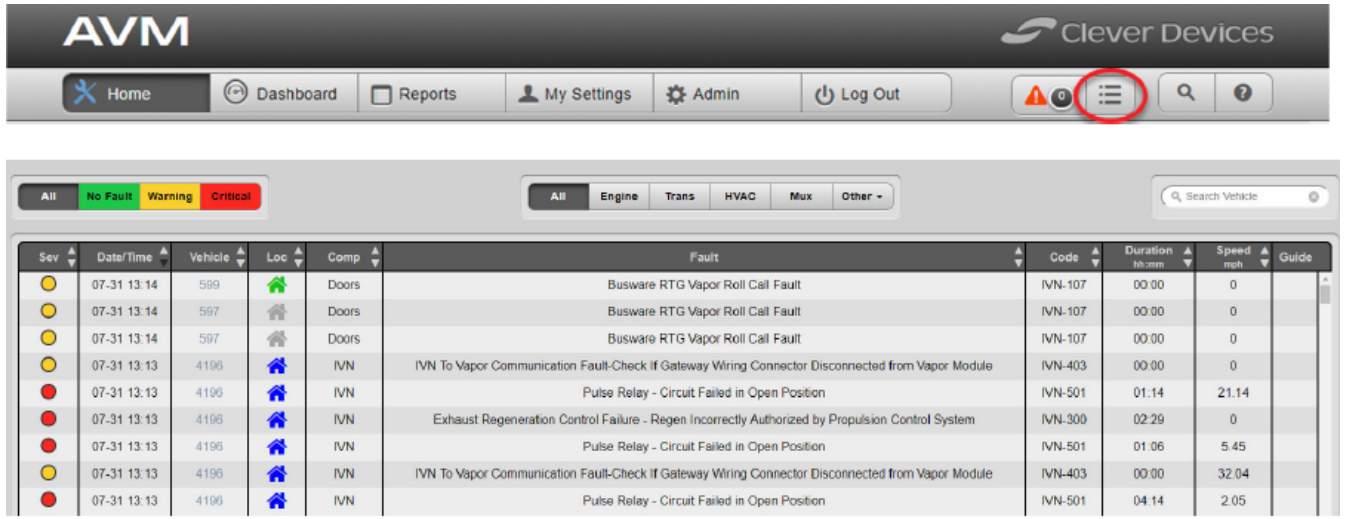
AVM-Use Cases

Use Case 3

Problem: Vehicles with undiagnosed maintenance issues not addressed until following day leading to increasing road calls.

Solution: MAN (Maintenance Action Necessary) audio announcement made upon pull-in triggering crew that repair required.

Results: Vehicle is repaired and already on the road before morning report even generated reducing likelihood of road call/frustrated customer.



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Secure Bus Access

Use Case 4:

Problems:

- Theft/Unauthorized Access
- Hi-Jacking with the intent to cause harm to those onboard or on the street
- Malicious actions of a disgruntled employee
- Joyriders

Solutions:

- Secure Operator Log In with PIN to start engine
- Seat Vacancy Triggers- automatically log off the system if driver leaves seat rendering the bus immovable.
- Remote vehicle shut off brings vehicle to a safe stop
- Speed threshold breach locks out the transmission

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- Seat Vacancy Triggers
- Left/Right Signals Alternate
- Alert Message displayed on the interior destination signage
- On-board announcement can be made
- Headlamps and hazard lights will flash

SYSTEM LOG ON

- Secure Operator Pin required to start engine
- Pin matched to employee ID
- If validation fails, transmission with not engage
- Multiple failed attempts must call dispatch to verify pin

DISABLE

- Brake Lights Illuminate as bus de-celerarates
- Door Opens when bus stops
- Stop Engine and Brake Indicators Flash
- Brake and Accelerator interlocks are engaged and signal sent to ABS Module
- Transmission placed in neutral
- Headlights and hazards flash

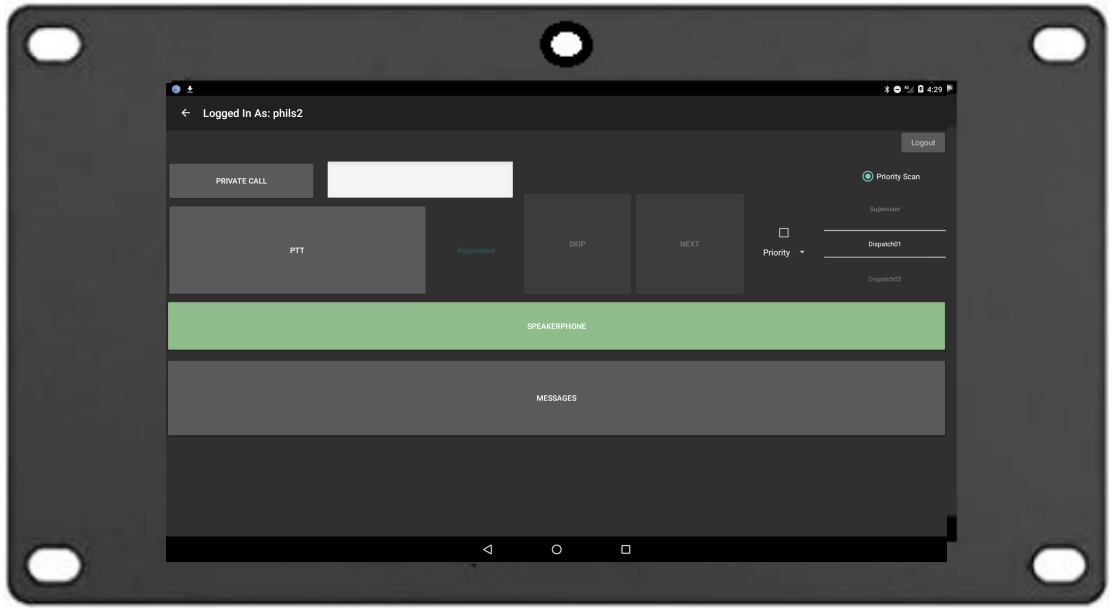
Secure Access-Continued

Use Case 4:

Add Facial Recognition Discussion

Process

- **User Selects Traditional log in or Facial Recognition**
- **Silhouette is shown that allows user to move correct distance from camera.**
- **User image is validated**
- **User is logged on to application**



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AI Virtual Tech Talks Series

Enabling Intelligence at the Edge

Presenter

Markus Levy

- Director of Machine Learning Technologies,
- NXP Semiconductor

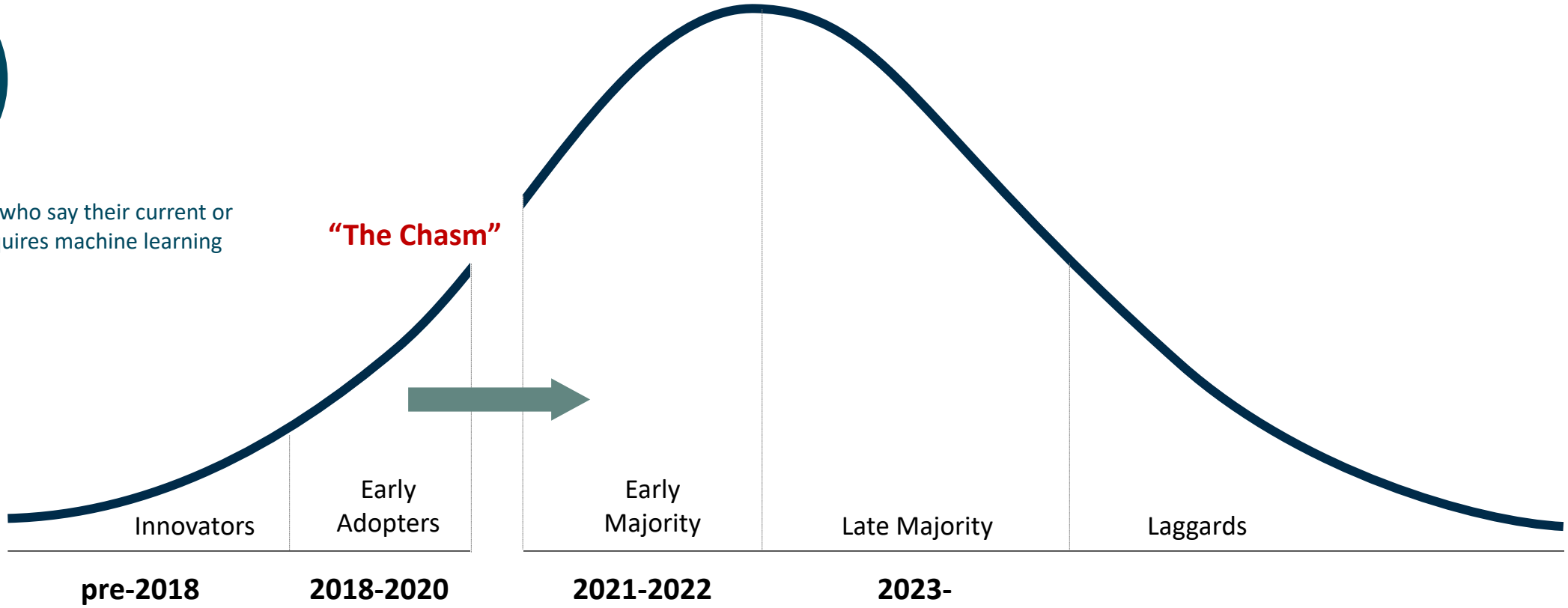
Enabling Edge Intelligence

Markus Levy - Director of ML Technologies, NXP

Machine Learning Adoption Life Cycle – The Big Wave is Coming!

55%

of developers* who say their current or future work requires machine learning

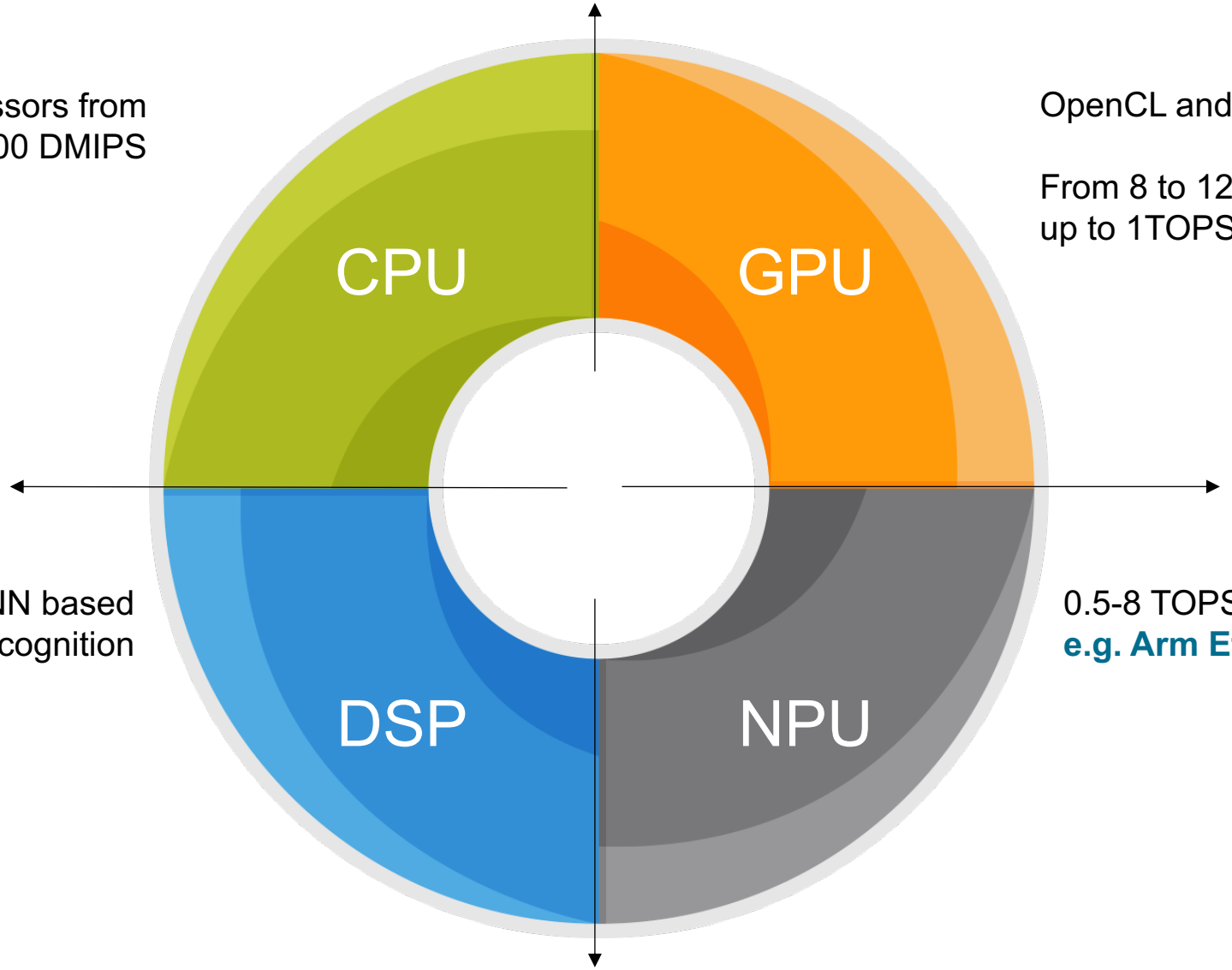


"MACHINE LEARNING FOR **ALL**, NOT JUST A SELECT FEW"

* Aspencore 2019 Embedded Markets Study by EE Times

Inference Processing at the Edge – NXP's Compute engines

Applications processors from
1000 DMIPS to 120,000 DMIPS



OpenCL and OpenVX support

From 8 to 128 GFLOPS (FP32, training),
up to 1TOPS (INT8, inference)

Voice & Audio with NN based
Automatic Speech Recognition

0.5-8 TOPS
e.g. Arm Ethos-U55 and Ethos-U65

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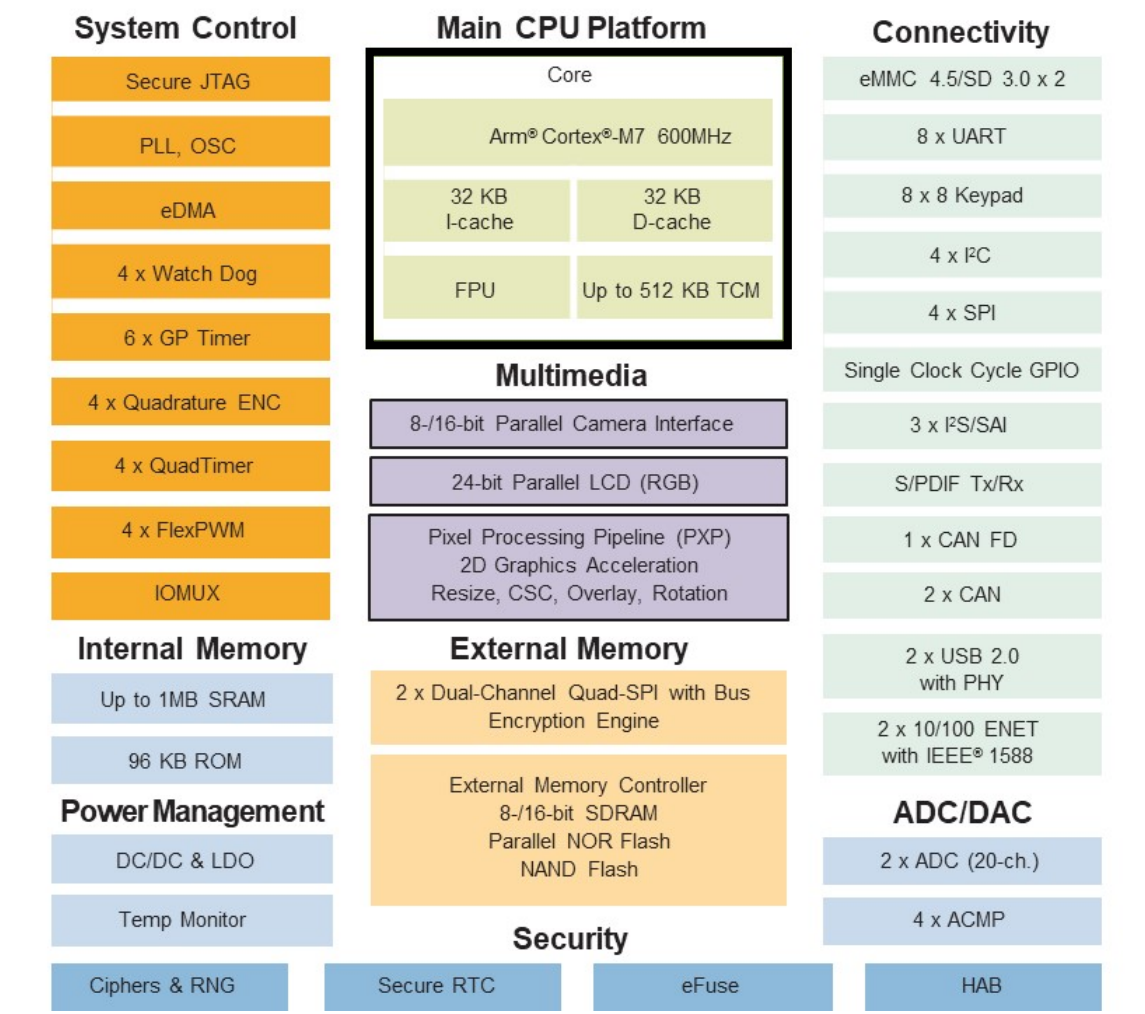
i.MX RT MCUs

- 600 MHz Arm Cortex-M7 core
- 1 MB of SRAM
- 8-/16-bit Parallel camera interface including PXP

i.MX RT1060

- Next generation 1000 MHz Arm Cortex-M7 + 400 MHz Cortex-M4 cores
- 2 MB SRAM with 512 kB of TCM
- PXP and MIPI-CSI

i.MX RT1170



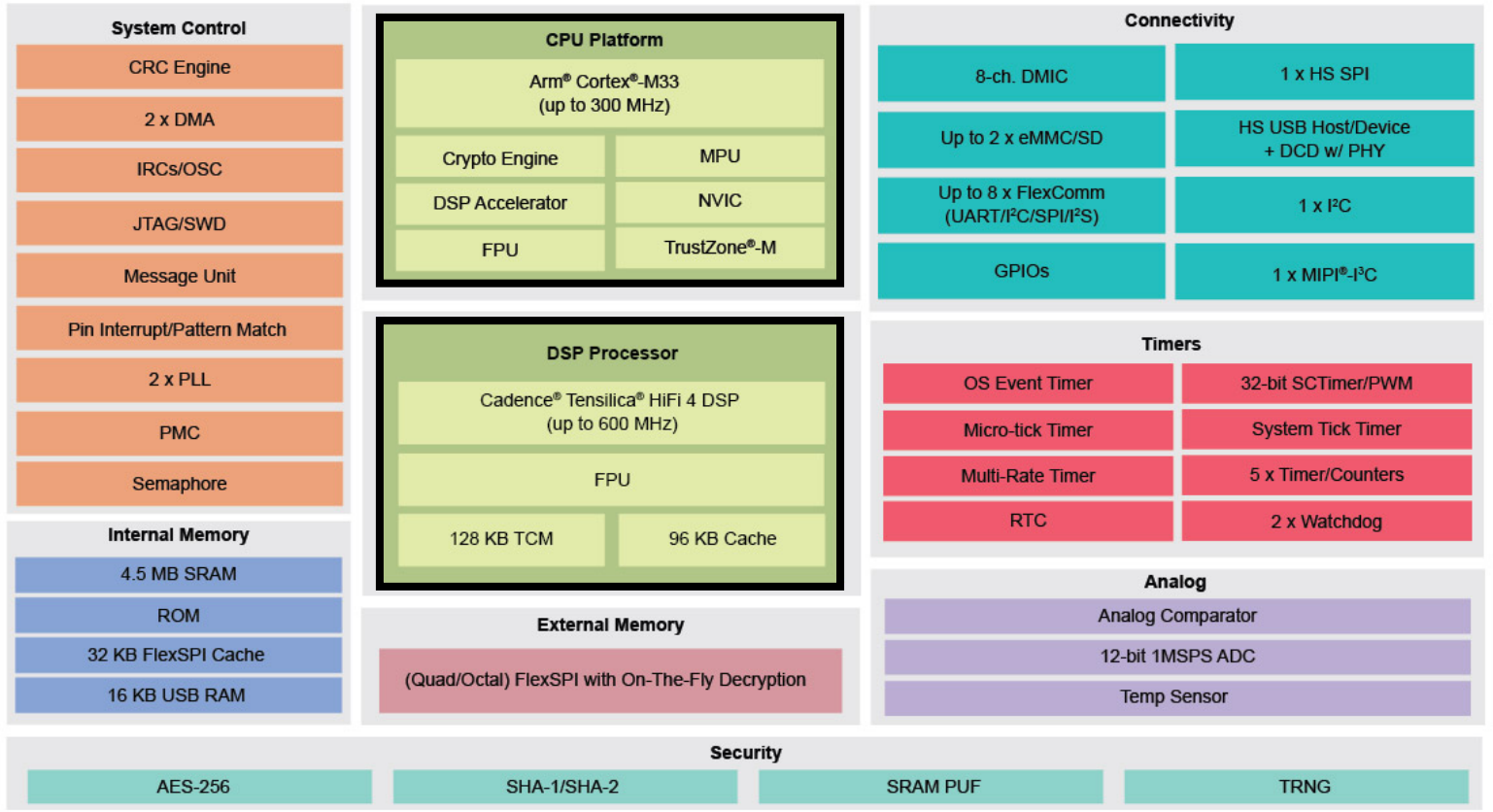
i.MX RT600 MCUs

- 300 MHz Arm Cortex-M33 core
- 600 MHz DSP
- 4.5 MB of SRAM
- Audio and sensor processing

NXP

i.MX RT685

i.MX RT600 CROSSOVER MCU FAMILY BLOCK DIAGRAM



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i.MX 8M Plus Machine Learning Compute Engines

Machine Learning Accelerator (1GHz)

- Primary Use: Multi-camera classification/detection

Quad Arm® Cortex-A53 (1.8GHz)

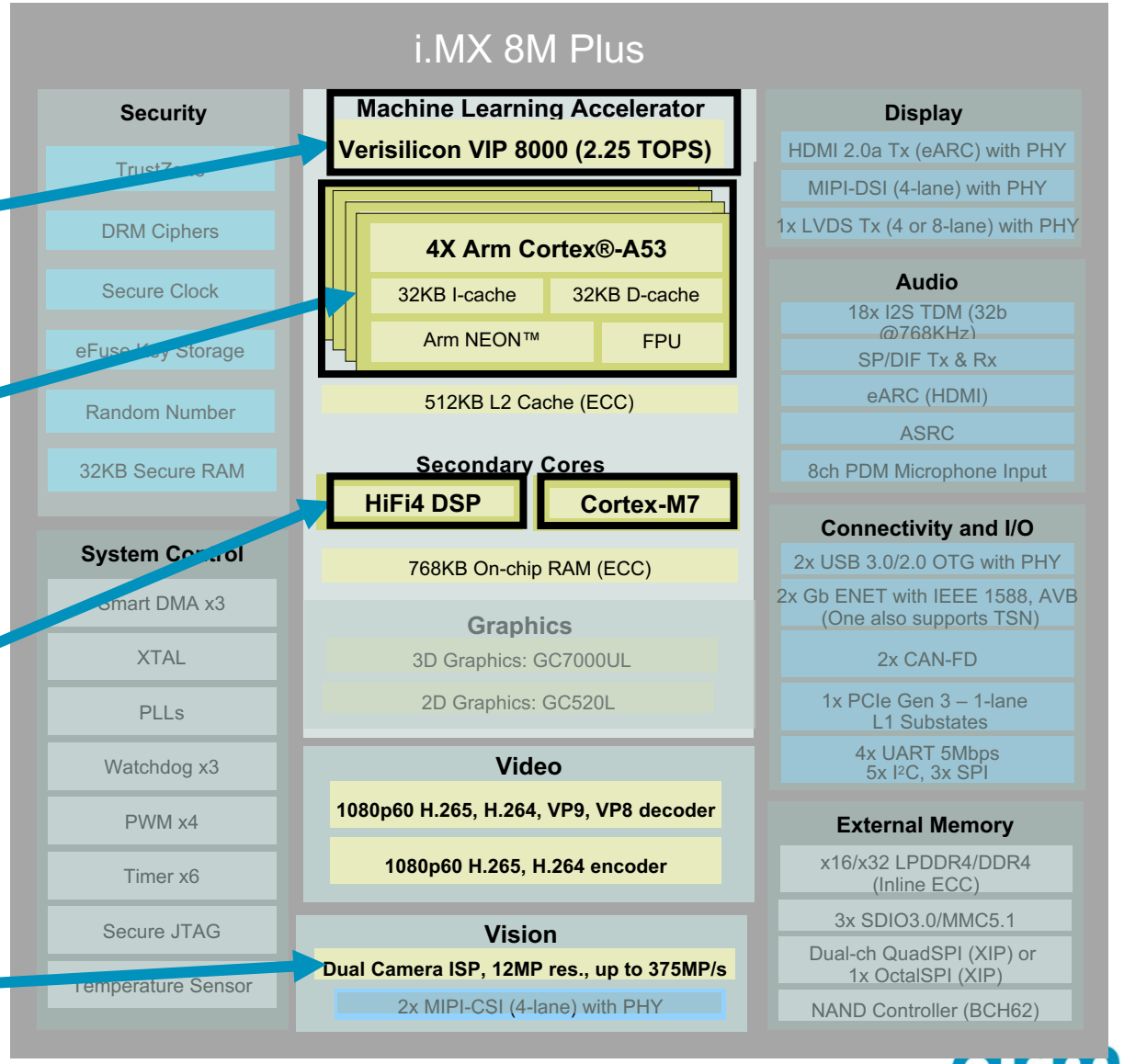
- Primary Use: Speech command recognition, object detect/classification

Cortex-M7+HiFi4 DSP (800MHz)

- Primary Use: Keyword detection, sensor fusion

Bonus: 2 channel Image Signal Processor (ISP)

- Primary Use: Scaling, dewarping, image enhancement



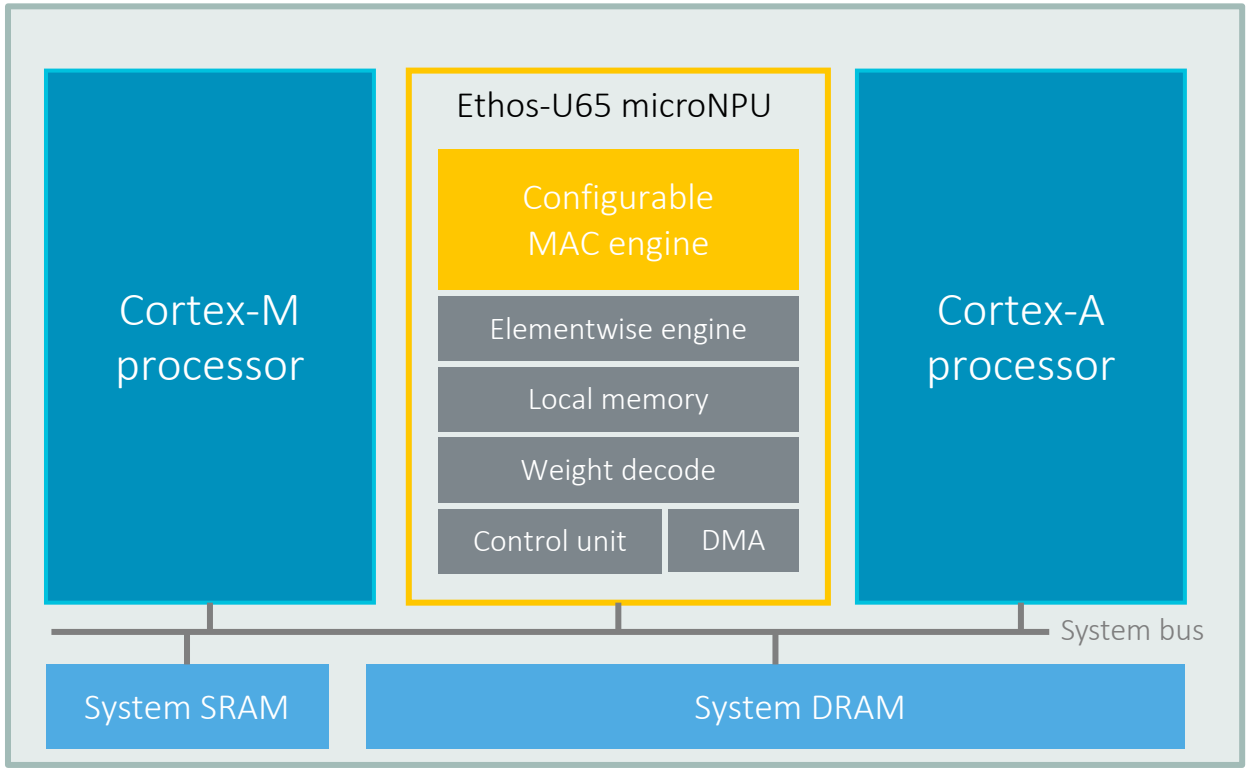
Next Gen A-class Based System with Arm® Ethos-U65

HW acceleration for high compute NN + Cortex-M for other operations

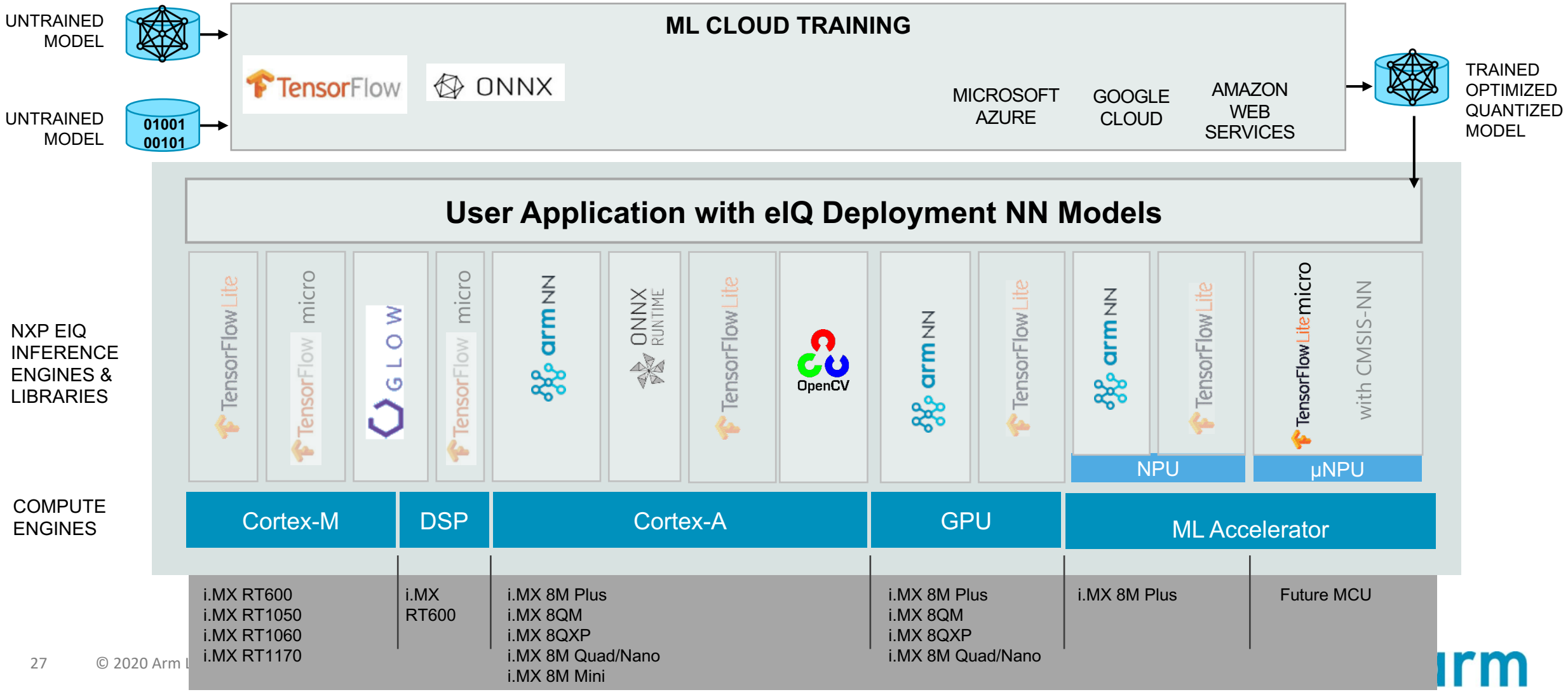
Multiple configurations 256/512 MACs/cycle

Model compression and on-the-fly weight decompression

Optimization strategies for DRAM and SRAM

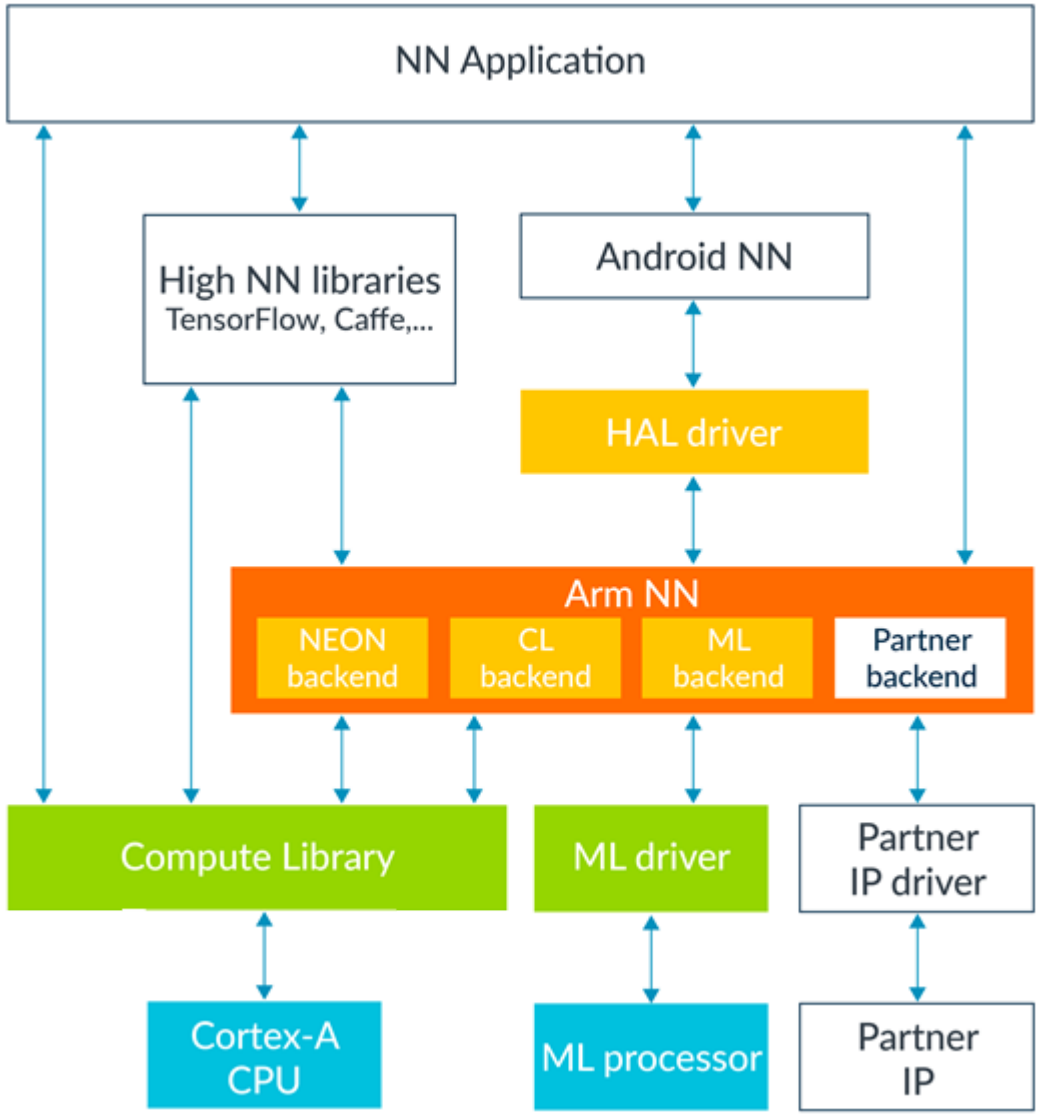


Flavors of NXP eIQ™ Machine Learning Development Environment

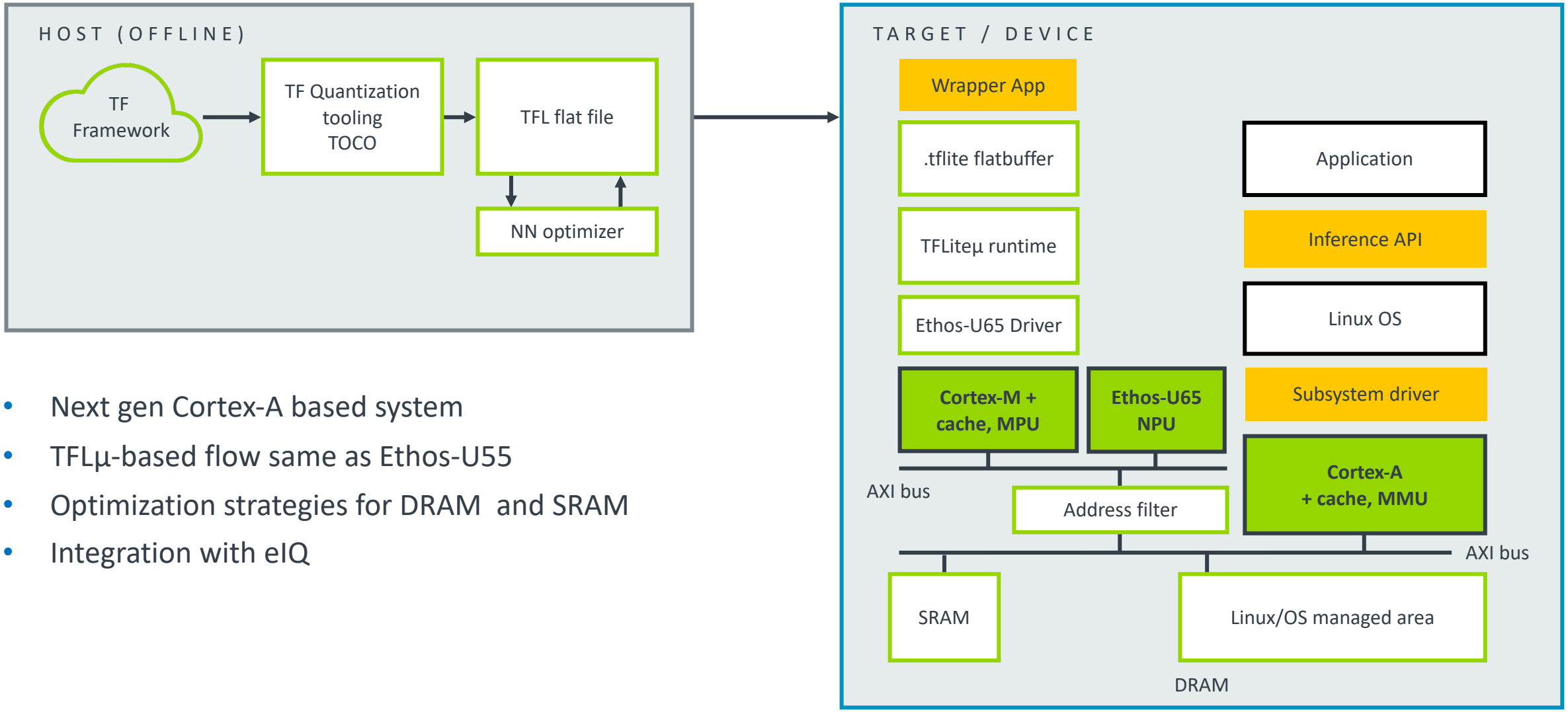


eIQ - Arm NN

- Inference engine connecting high-level libraries with underlying CPUs, GPUs, and other IP
- NN format parsing support: TensorFlow, TF-Lite, Caffe, ONNX
- A backend maps a graph's layers to the hardware (i.e. driver responsible for executing the compute)



Ethos-U65 Software Flow



- Next gen Cortex-A based system
- TFLμ-based flow same as Ethos-U55
- Optimization strategies for DRAM and SRAM
- Integration with eIQ

Enhanced eIQ™ ML Development Environment

Upcoming

Embedded Developers

Data Scientists

ML Experts

Intuitive GUI

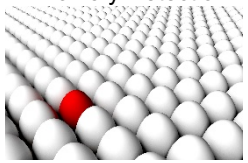
Command Line Interface

DeepView™ **Bring Your Own Data** Workflow

DeepView™ **Bring Your Own Model** Workflow

PyTorch ONNX Caffe2

Anomaly Detection



Voice Recognition

Face Recognition

Multi-Object Classification

Complex Diagnosis

Applications

TFLite | GLOW | eIQ-Deepview Run-Time → Cortex-M

TFLite | ArmNN | ONNX Run-Time | eIQ-Deepview Run-Time → Cortex-A, GPU, NPU, microNPU

Enabled through an investment-based exclusive strategic partnership with Au-Zone Technologies.
Available Q1/2021

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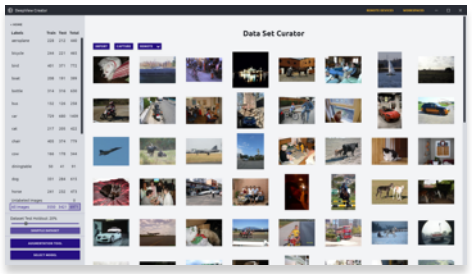
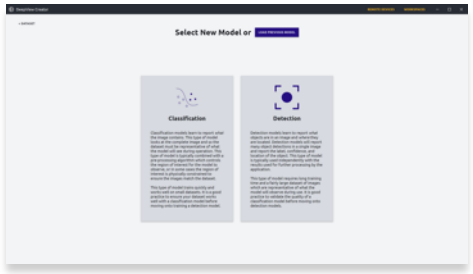
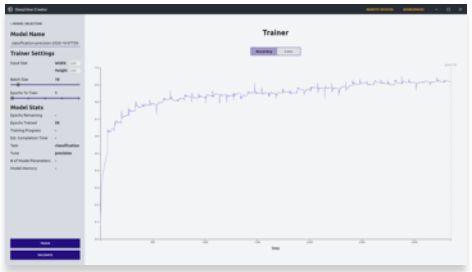
DeepView™ **Bring Your Own Data** Workflow



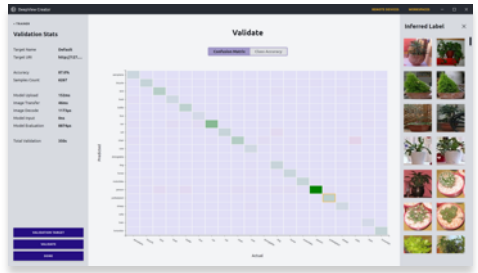
Data Curation



Model Selection



Model Training, Optimization, Quantization



Model Validation

DeepView™ **Bring Your Own Model** Workflow

PyTorch

ONNX

Caffe2

Public or Proprietary Model

Model Conversion, Optimization, Quantization

On Target Profiling and Production

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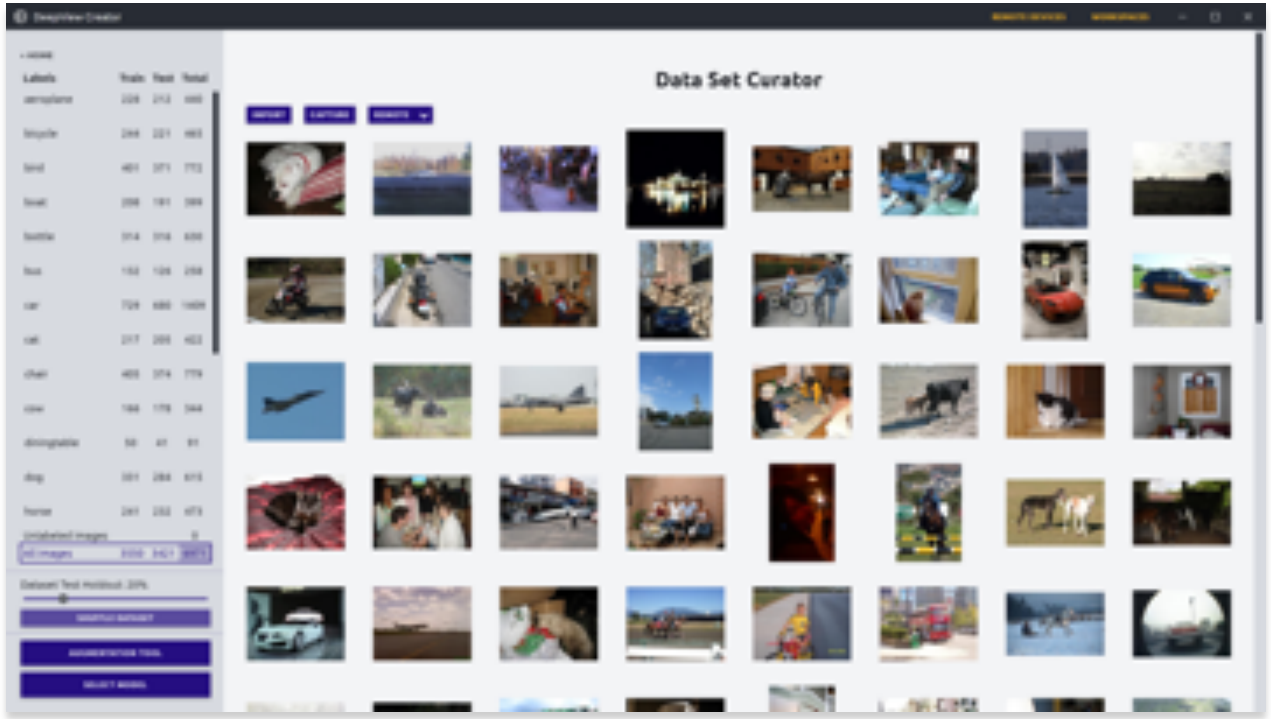
Data Set Curator

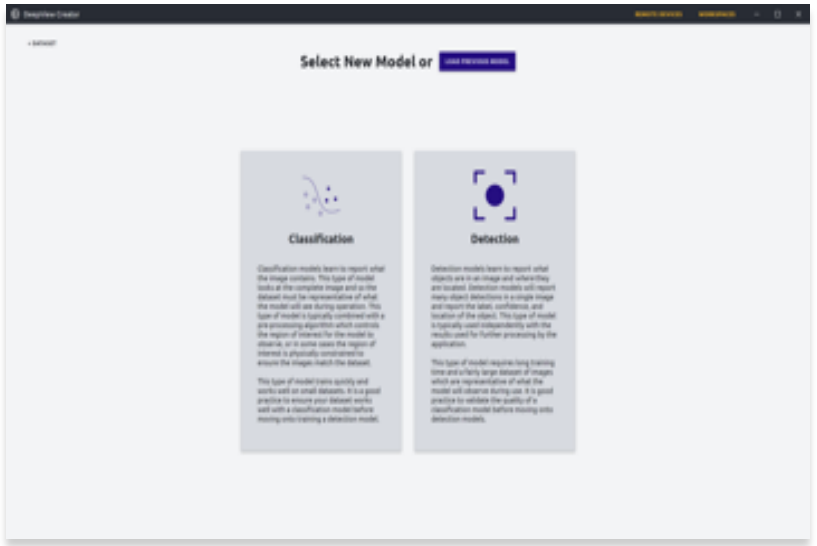
- Image import/capture
  - Label, Annotation
- Augmentation tool
  - Horizontal & vertical flip
  - Random cropping
  - Random image height/weight expansion
  - Random rotation
  - Random Shear
  - Contrast, brightness, saturation
- Shuffler for training and test set

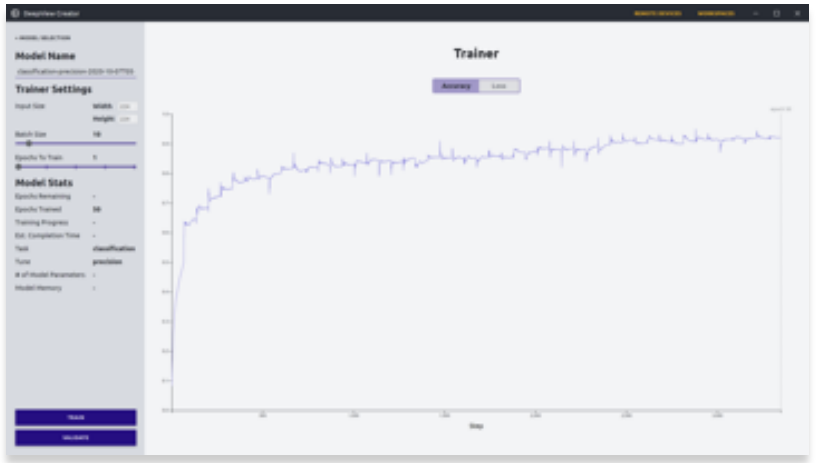


Model selection and training

- Classification Models
- Detection Models
- Model tuner
  - Performance
  - Balanced
  - Precision

- Model Training, Optimization, Conversion, Quantization & Deployment





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AI Virtual Tech Talks Series

Developing Systems

Presenter

David Steele

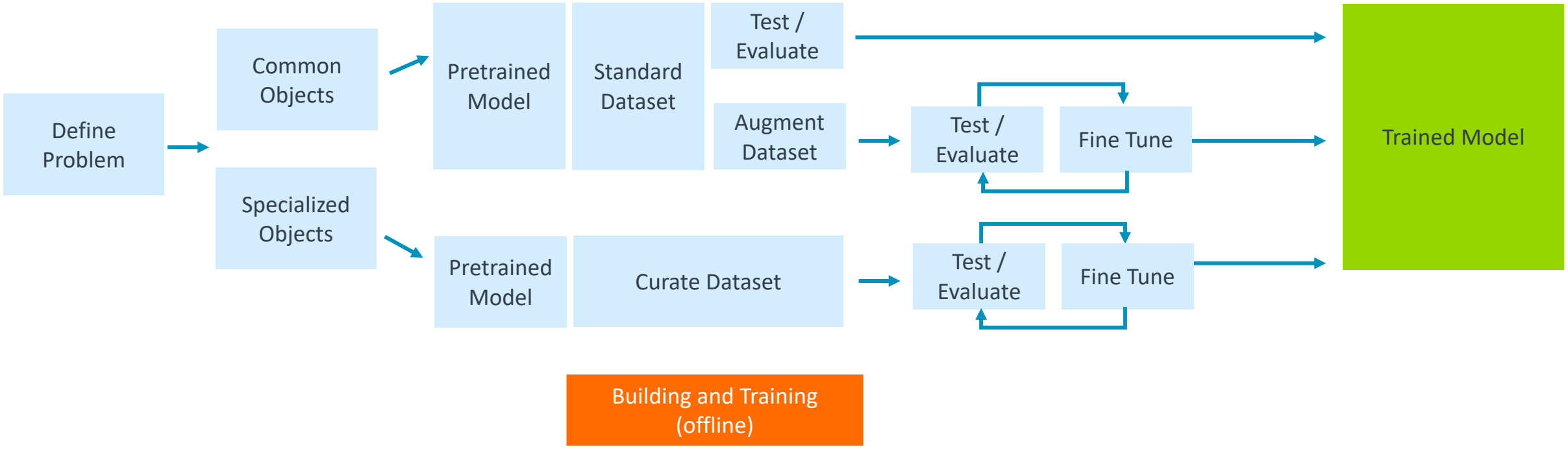
- Director of Innovation, Arcturus
- 20 years experience with edge systems and enablement

Looking at a Use case

Key Objectives

- Identify people
- Provide localization
- Identify packages
- Report analytics / situational awareness

Model Selection and Training



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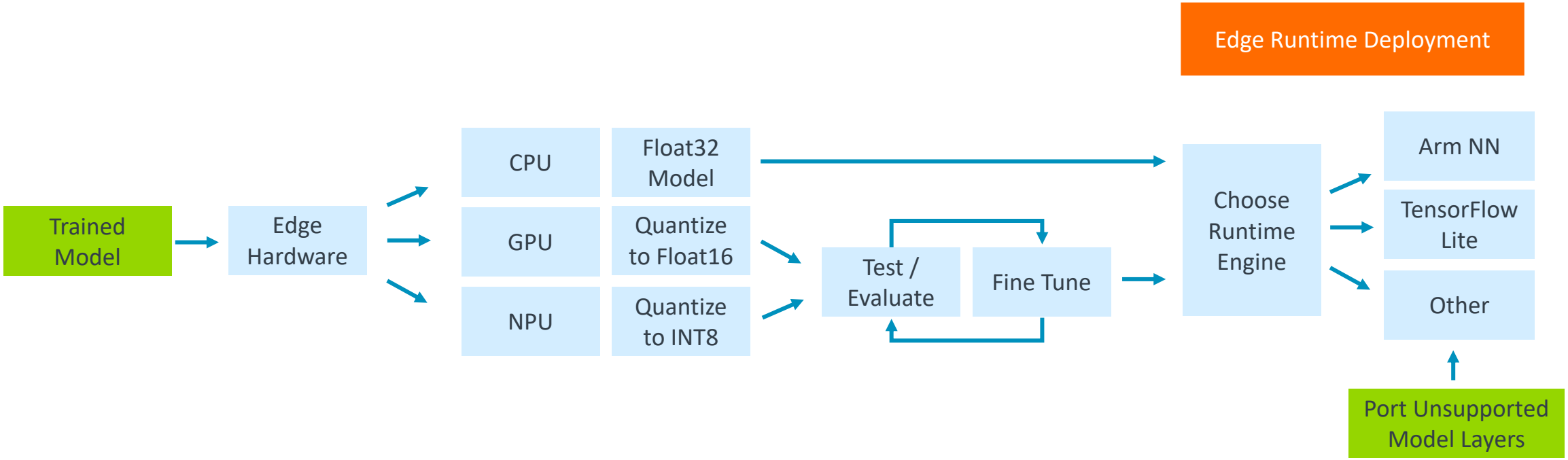
Edge Runtime Optimization



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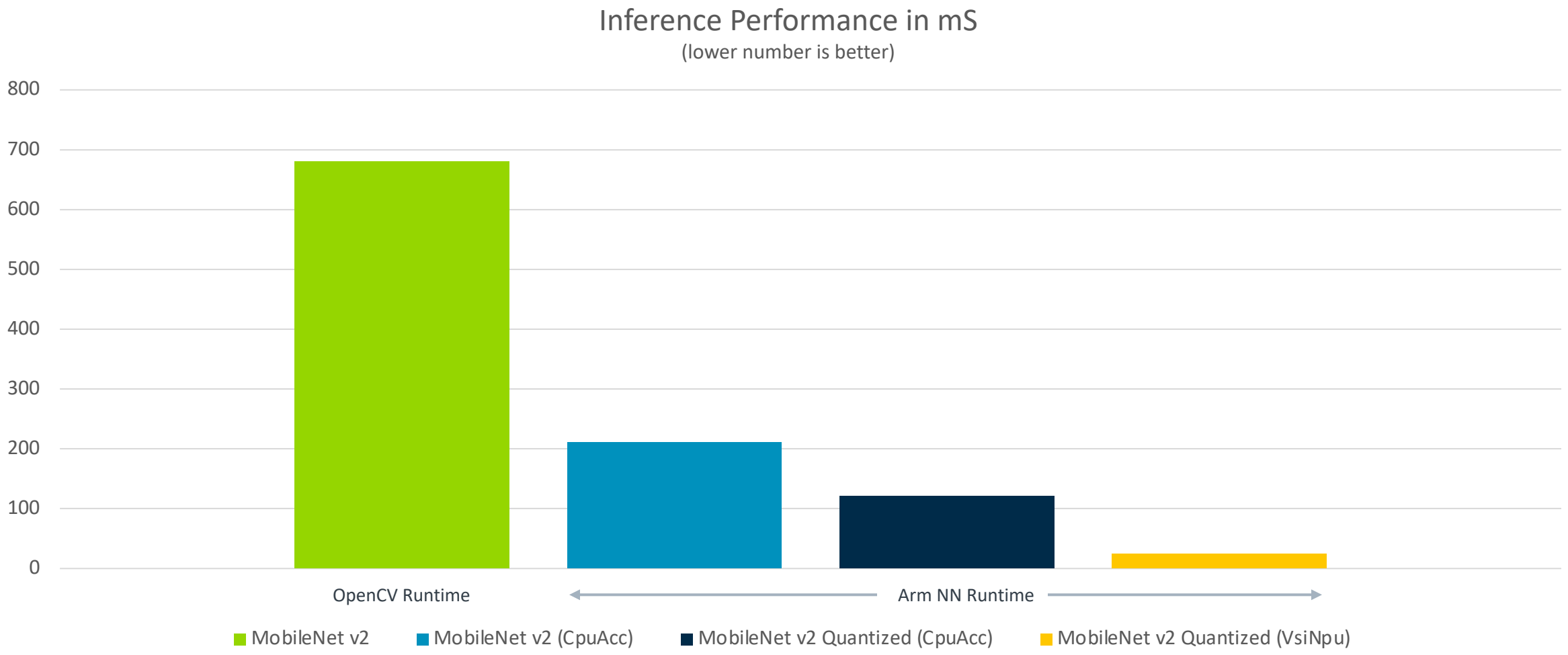
Model Acceleration



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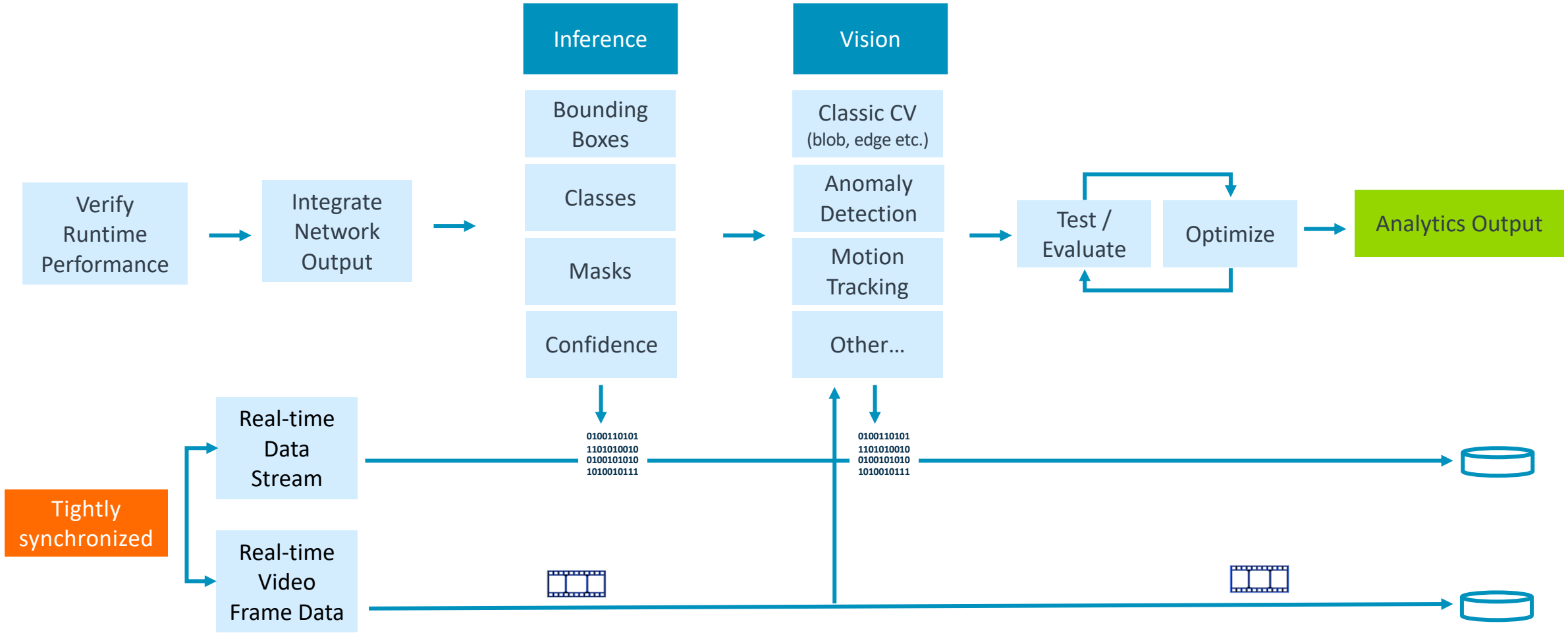
Inference and Vision



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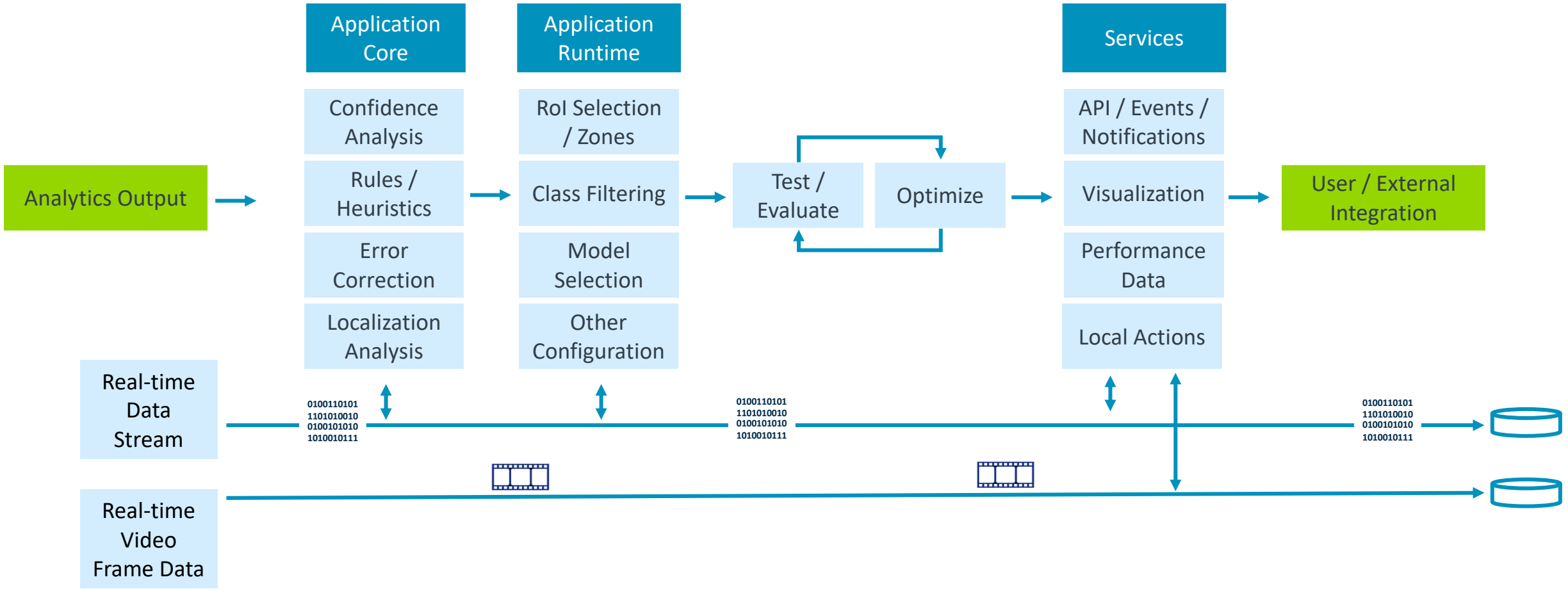
Application and Services



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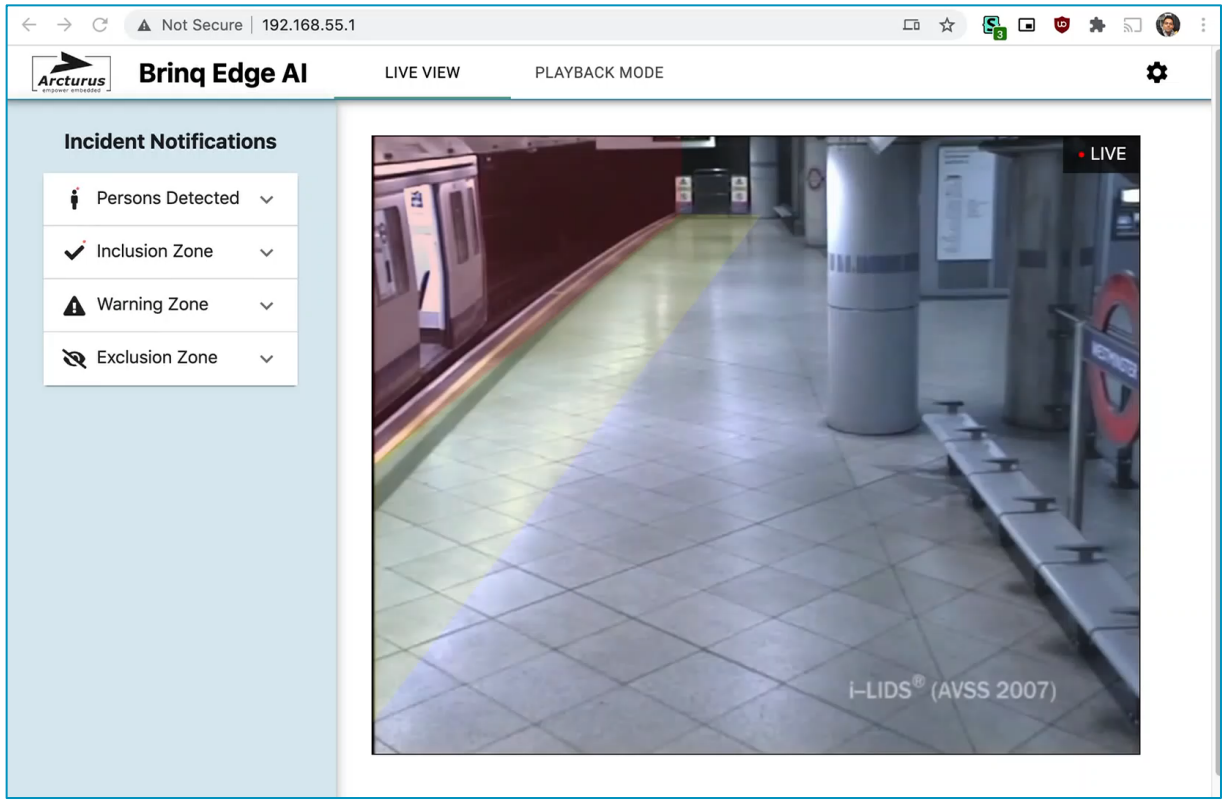
Video Demo

Boundary Crossing and Tracking



Localization is provided by using bounding box output and comparing it with predefined zones

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Tracking and Re-identification

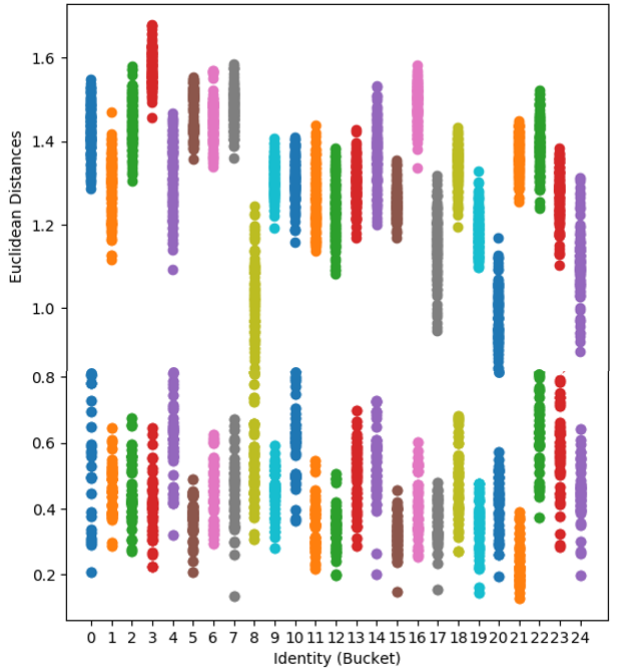
Algorithms and Data Analysis

Determining Identity and Association

Analyzing Visual Appearance

Different pairs

Same pairs



Market1501 Dataset

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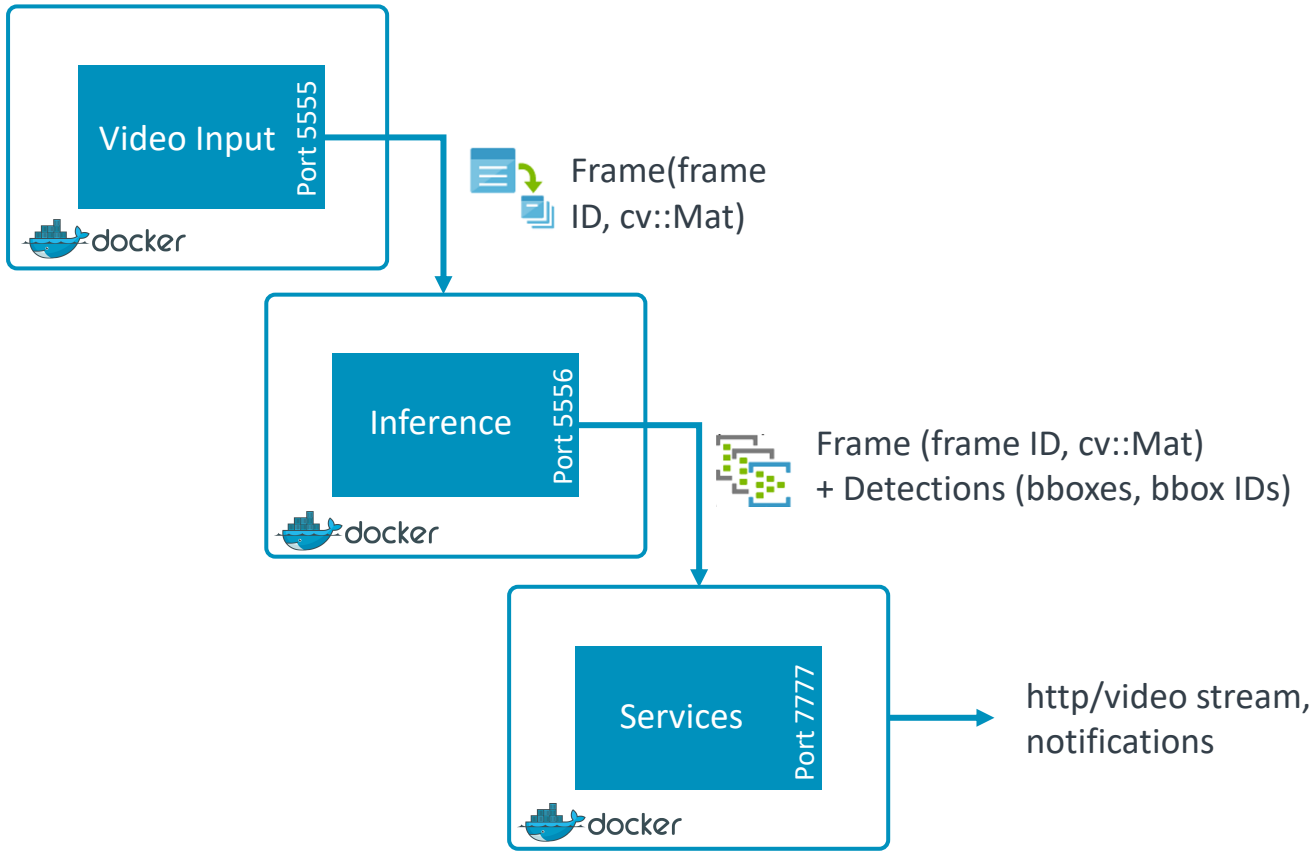
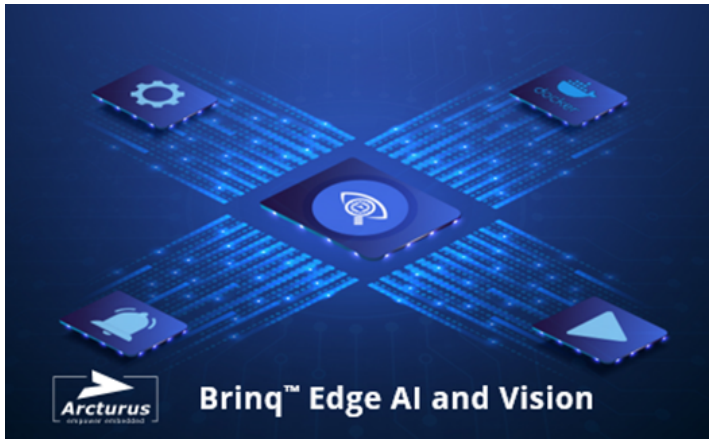
Pipeline Design

Scalability and Serviceability





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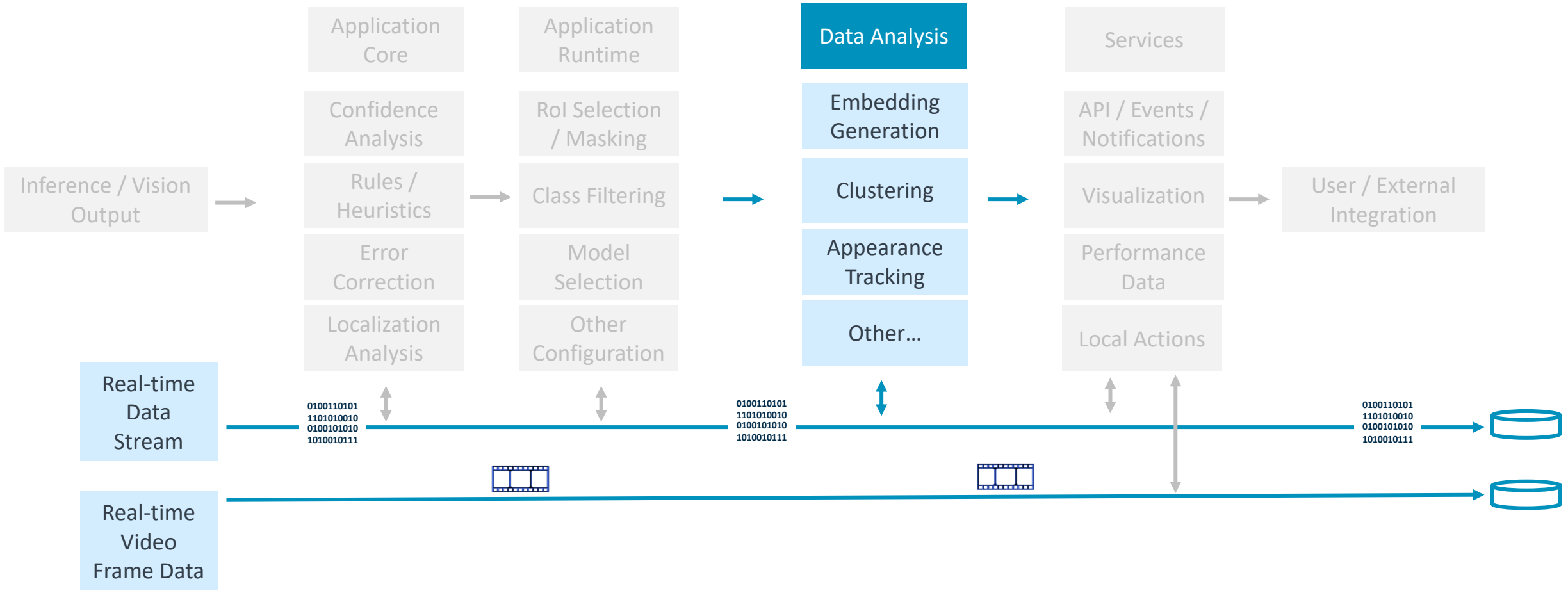
Adding in New Pipeline Node



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Characterization

Describing Appearance in Human Terms

Detection and Colour Modeling

Segmentation Output

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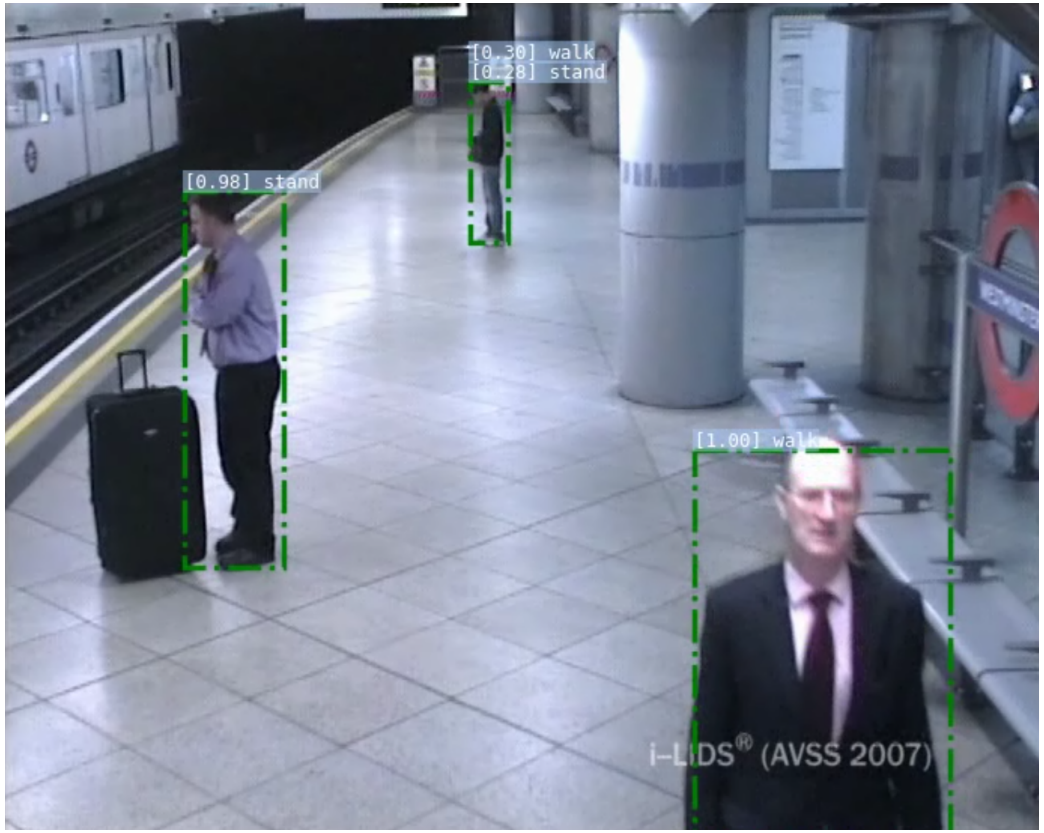
Action Recognition

Normal vs Abnormal Behaviour

Normal



Abnormal

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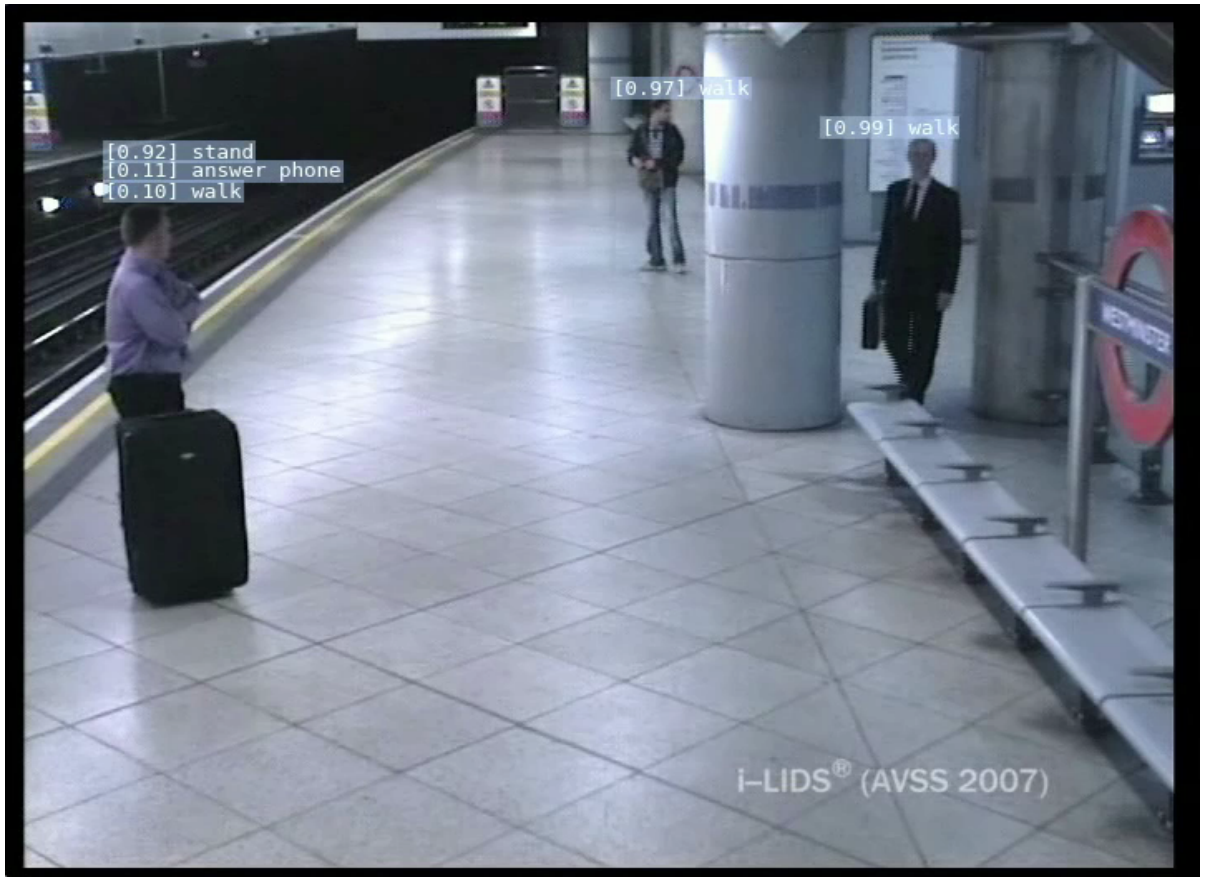
Video Demo

Action Recognition



Action recognition analyzes a sequence of frames to determine behaviour

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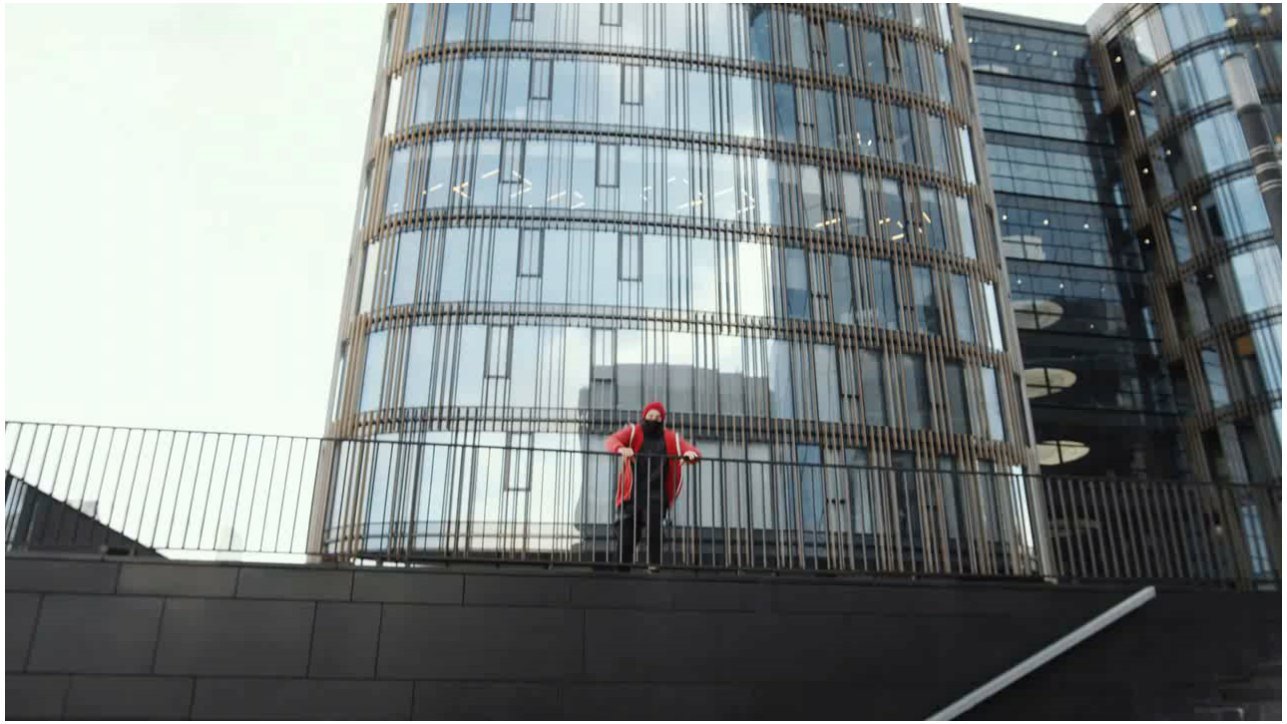
Video Demo

Action Recognition

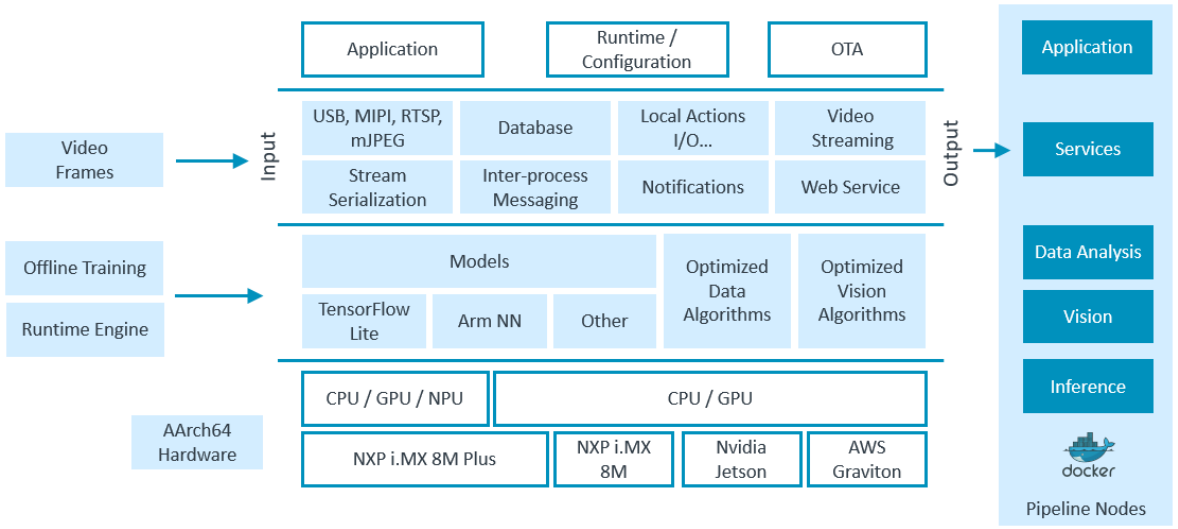


Action recognition analyzes a sequence of frames to determine behaviour

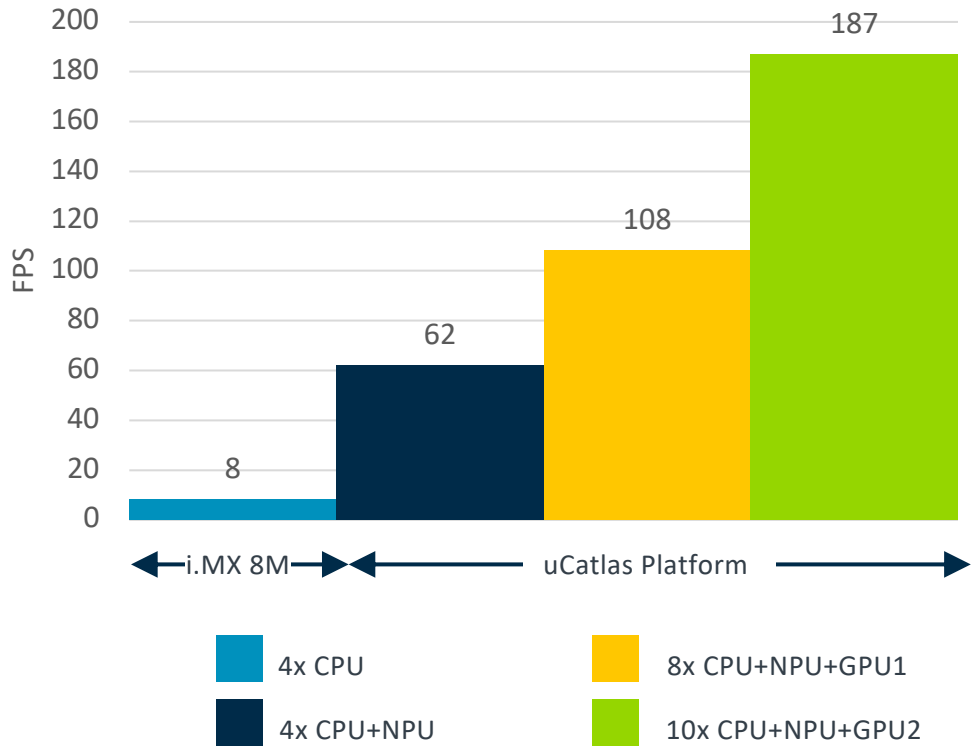
Brinq - Edge AI / Vision

Software and Hardware solutions

Solution Stack



Hardware Performance



Benchmarked using SSD_MobileNet v2, v3_small

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Thank you!

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2 - 4 December

Register today at: www.tvmconf.org

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AI Virtual Tech Talks Series

Thank You
Danke
Merci
谢谢
ありがとう
Gracias
Kiitos
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धन्यवाद
شكرًا
תודה