Autonomous Vehicles – The Storage Challenges of Edge Computing

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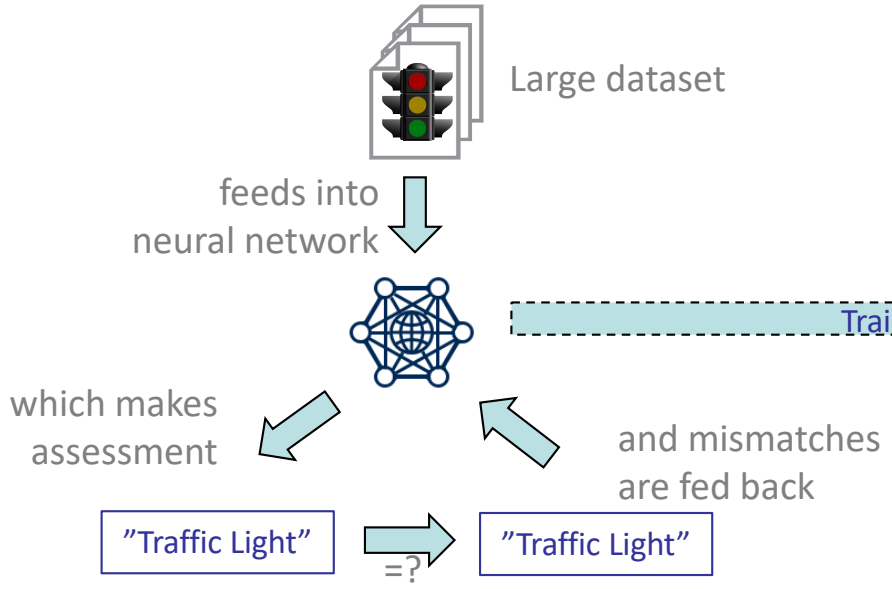
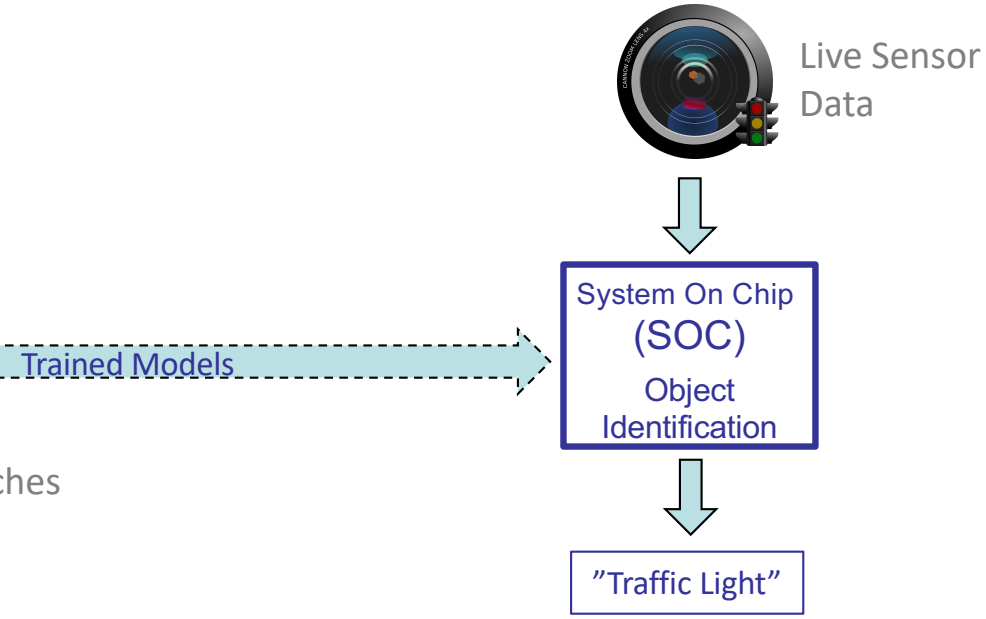
Microchip Technology Inc.

Classic Machine Learning

Training

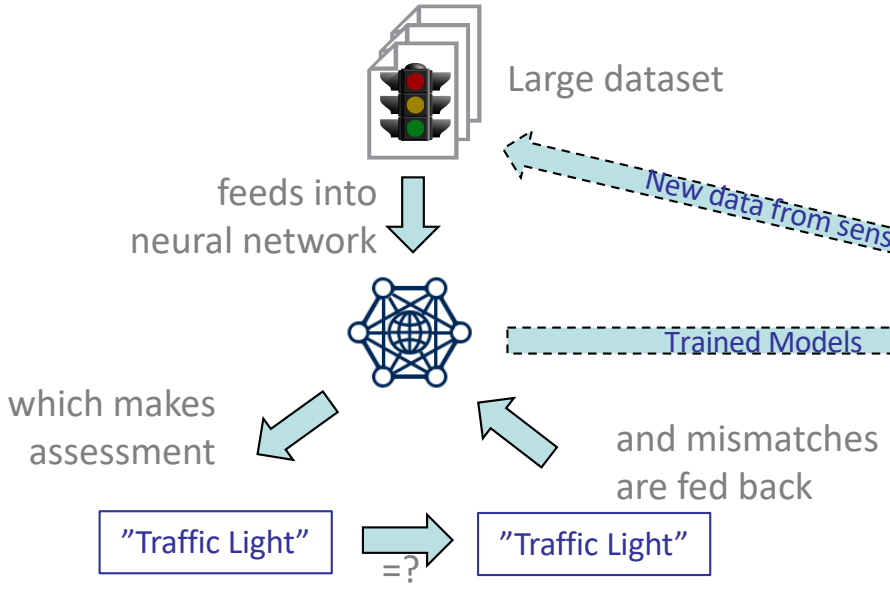


Inference

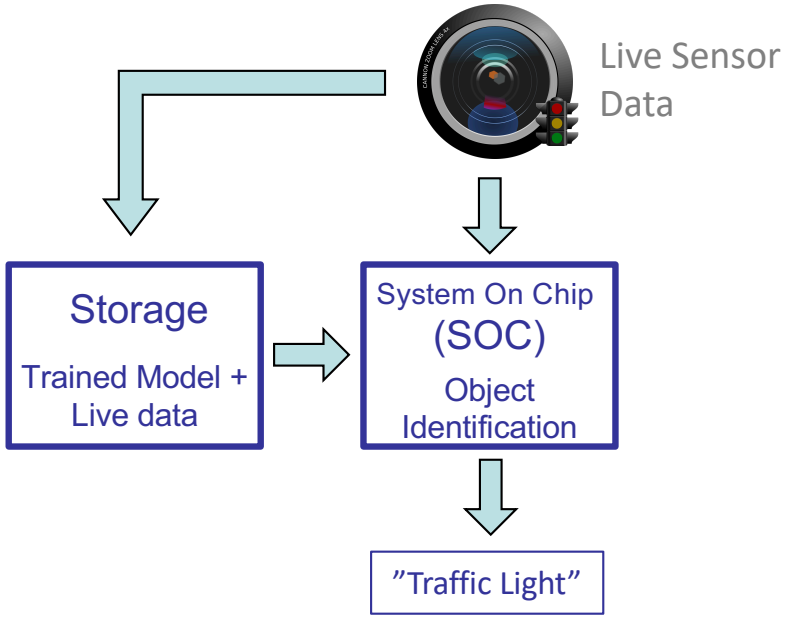


Automotive Machine Learning

Training



Inference



Flash Memory Summit

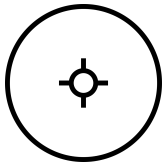
Data *Fuels* Autonomous Vehicles

- Multiple sensors collecting data *every* driving second

Sonar

Cameras

Radar


GPS

Lidar

- Intel® reports that autonomous vehicles collect 4,000GB of data *per day … each day*

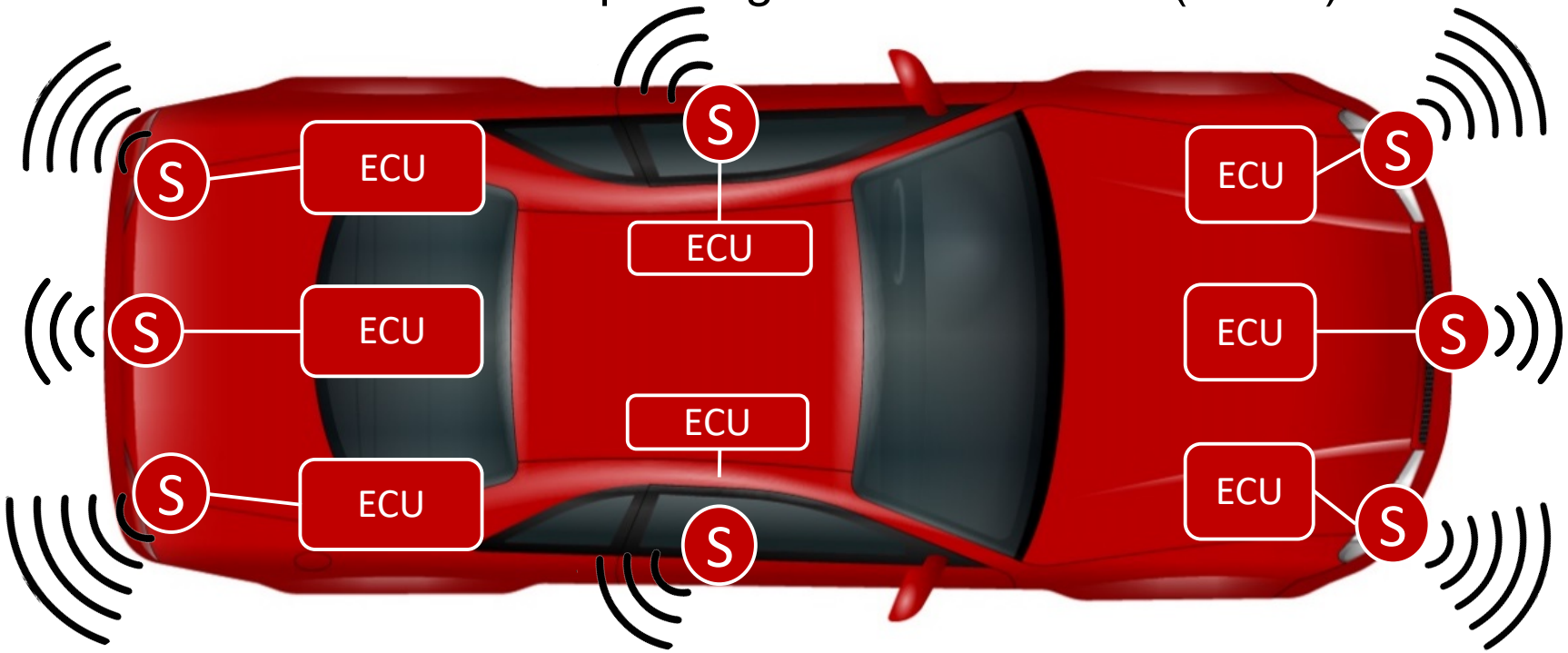
Data sourced from Intel: https://intel.ly/2fueVli

Flash Memory Summit

Where Does All the Data Go?

Sensors
- Machine Vision
- LIDAR
- RADAR
- SONAR

Vehicles have multiple Engine Control Units (ECUs)



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Where Does All the Data Go?

Sensors
- Machine Vision
- LIDAR
- RADAR
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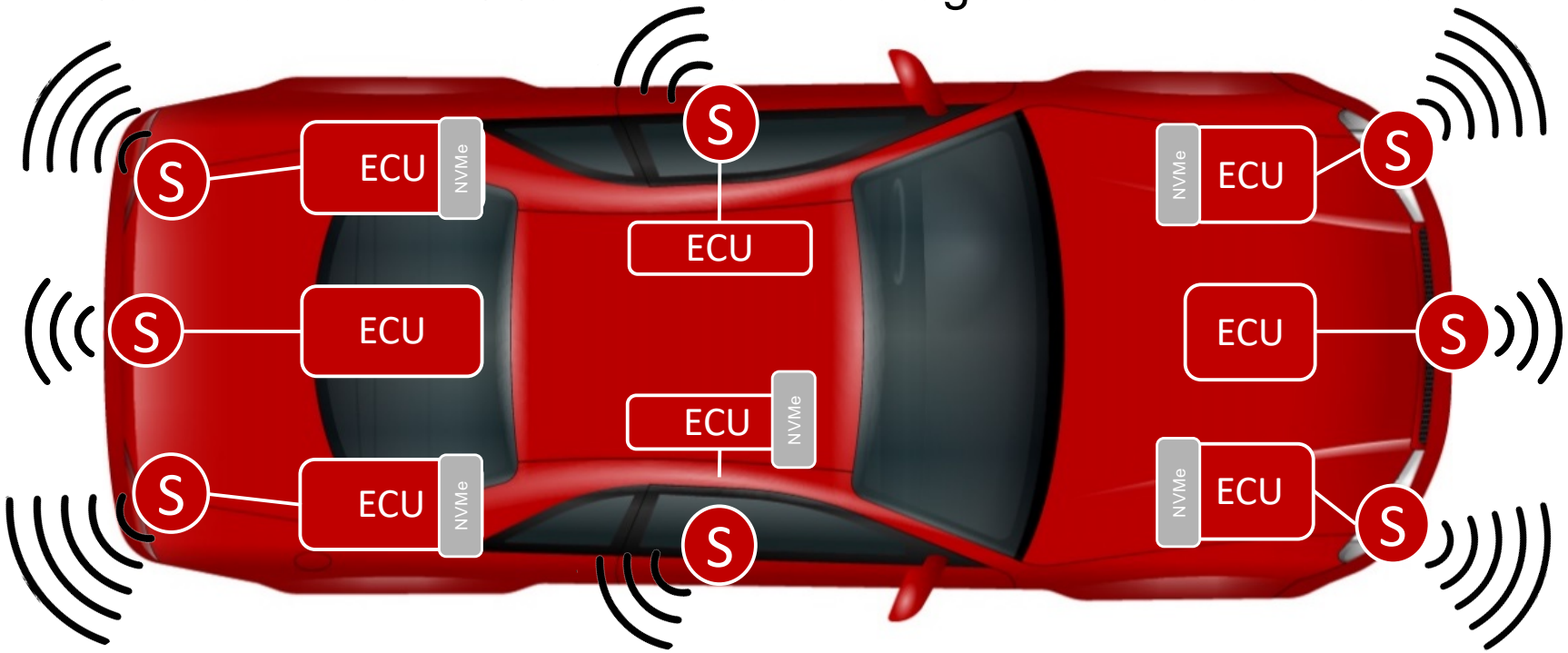
Some of these ECUs have local storage but it is scattered.



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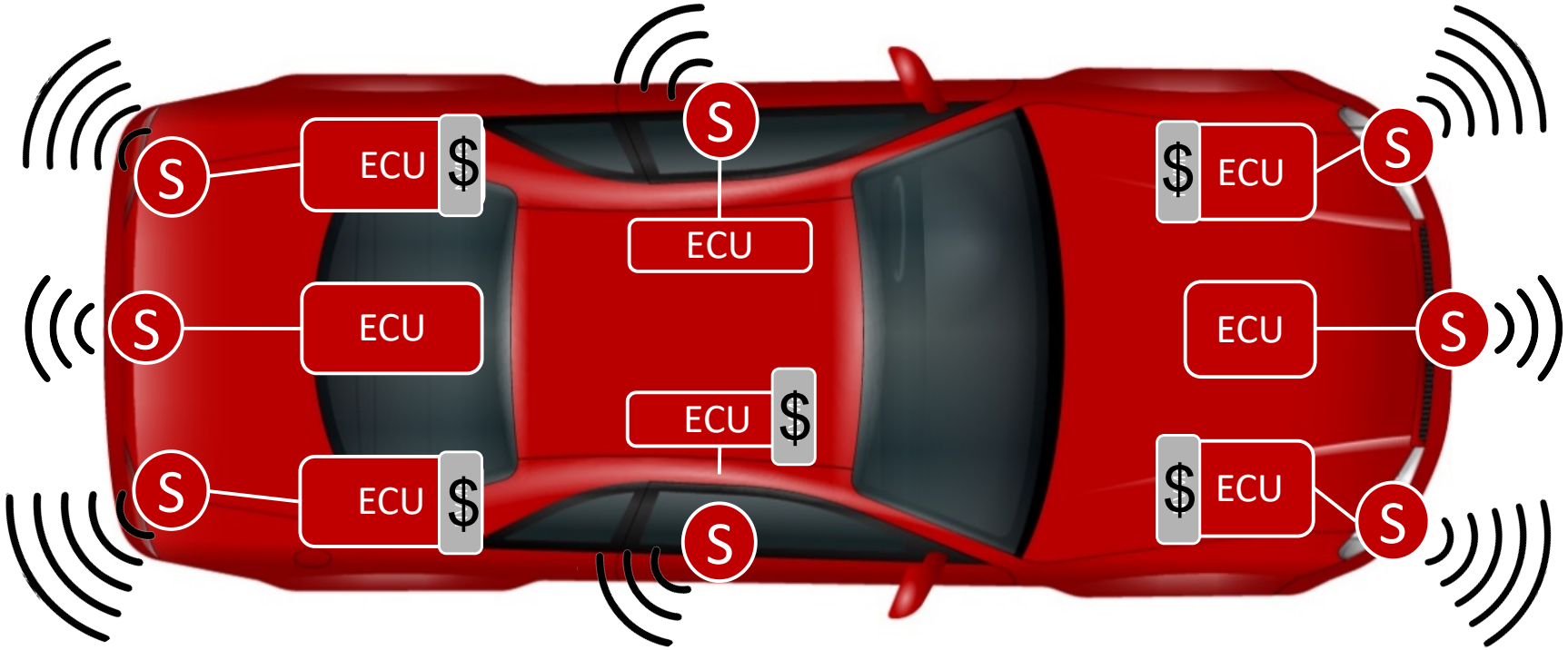
Edge Computing is Cost Sensitive

Storage is expensive and per ECU storage is inefficient.



NVMe Sharing Technology

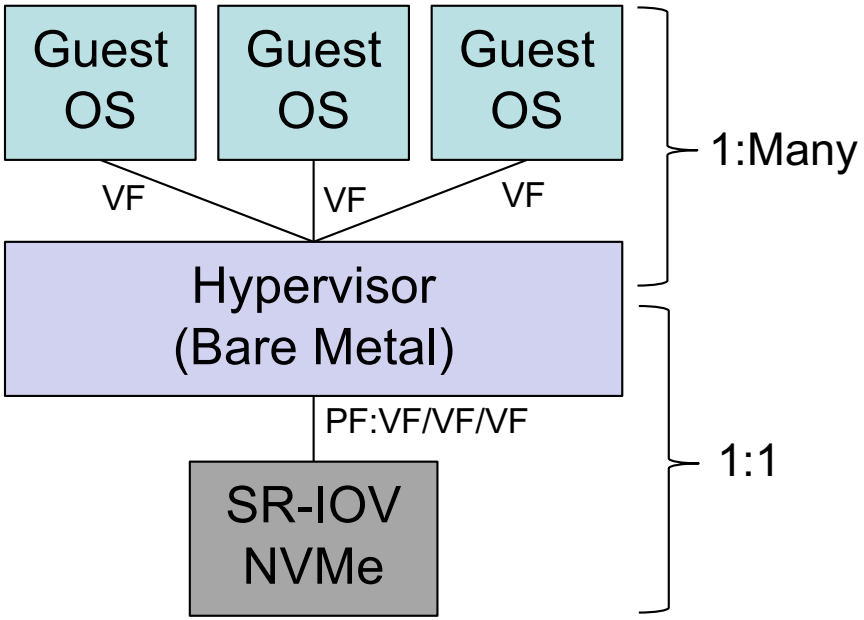
Single Root I/O Virtualization (SR-IOV)

- Originally invented to allow for single endpoints to be exposed as multiple virtual endpoints in a virtual machine environment
- The endpoint is exposed on the PCIe® topology as a single physical function (PF) with multiple virtual functions (VF)

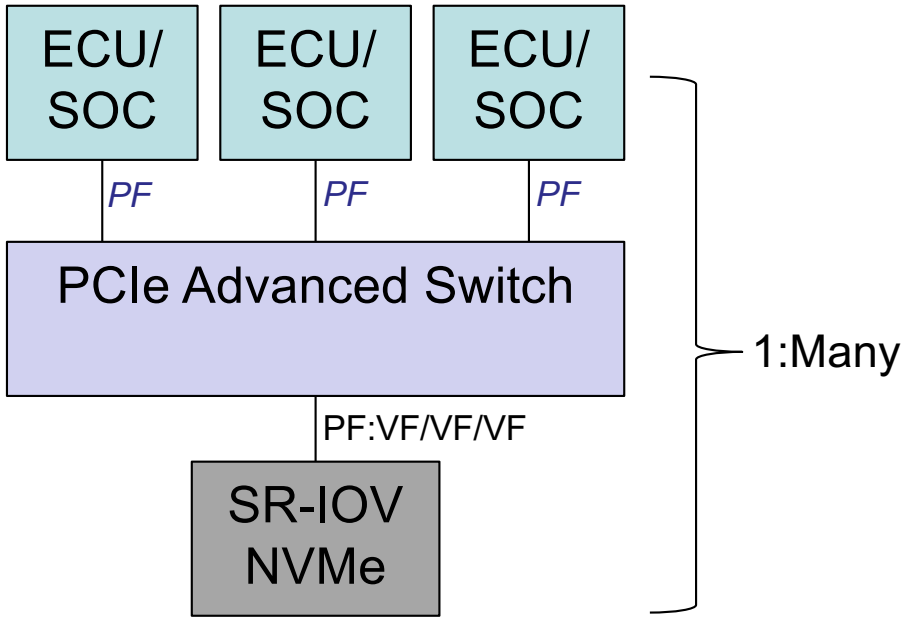
NVMe SR-IOV

- A fully featured NVMe™ controller is exposed on each VF as well as on the PF

From Hypervisor to PCIe Shared



Classic NVMe SR-IOV



Automotive NVMe SR-IOV

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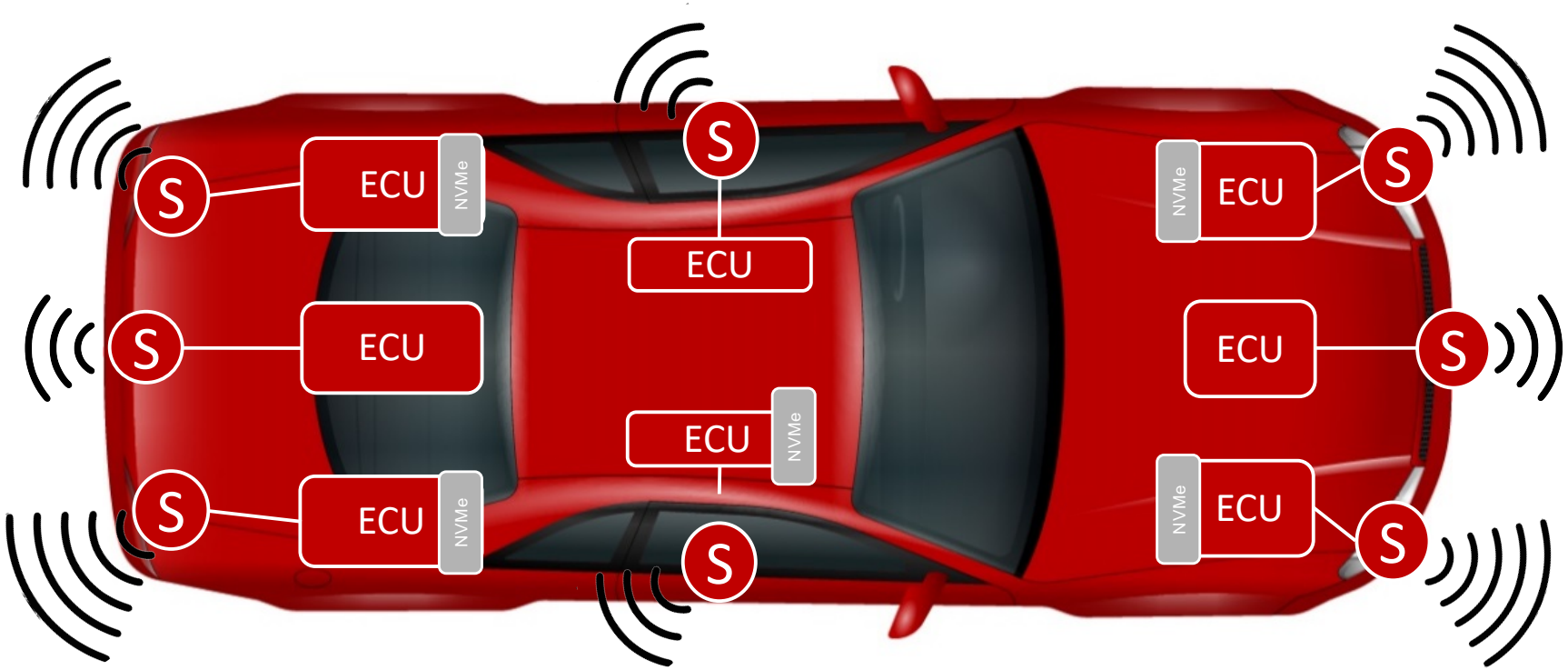
Remember This Picture?

Sensors
- Machine Vision
- LIDAR
- RADAR
- SONAR



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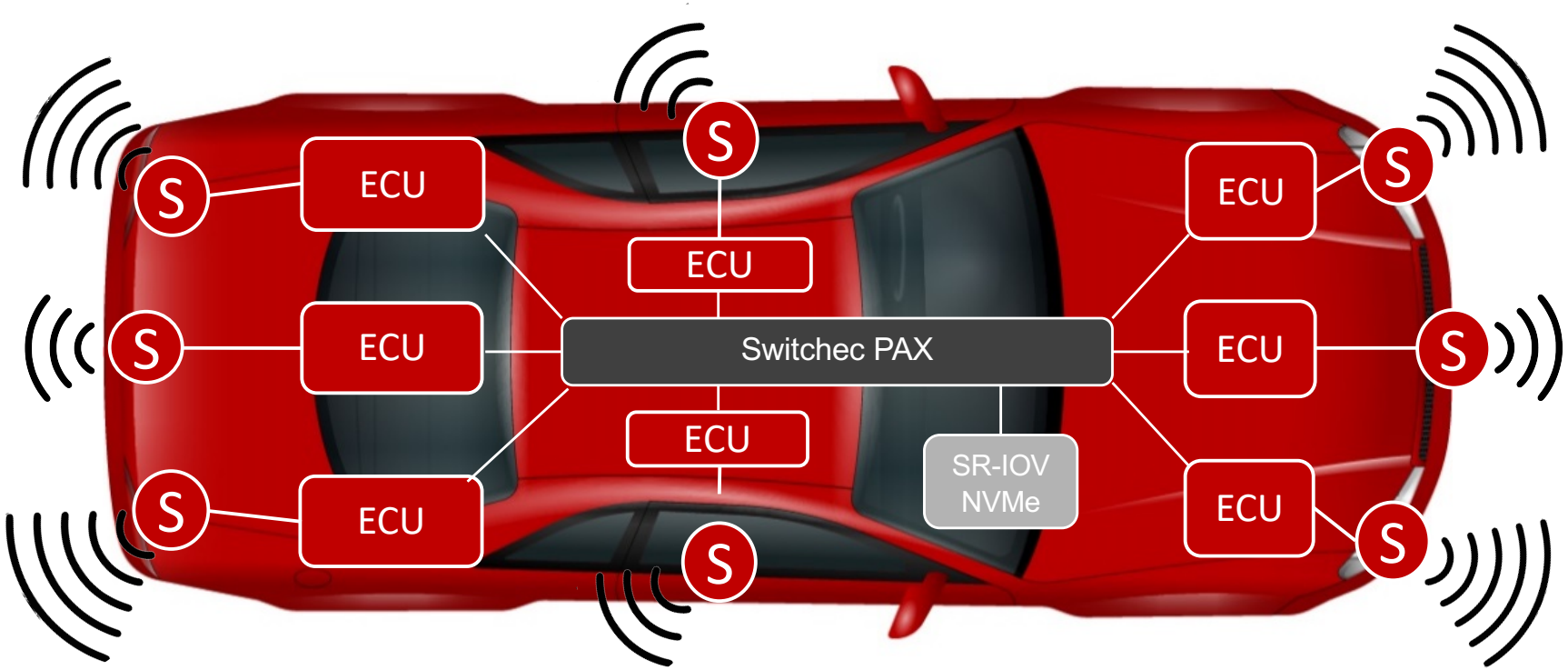
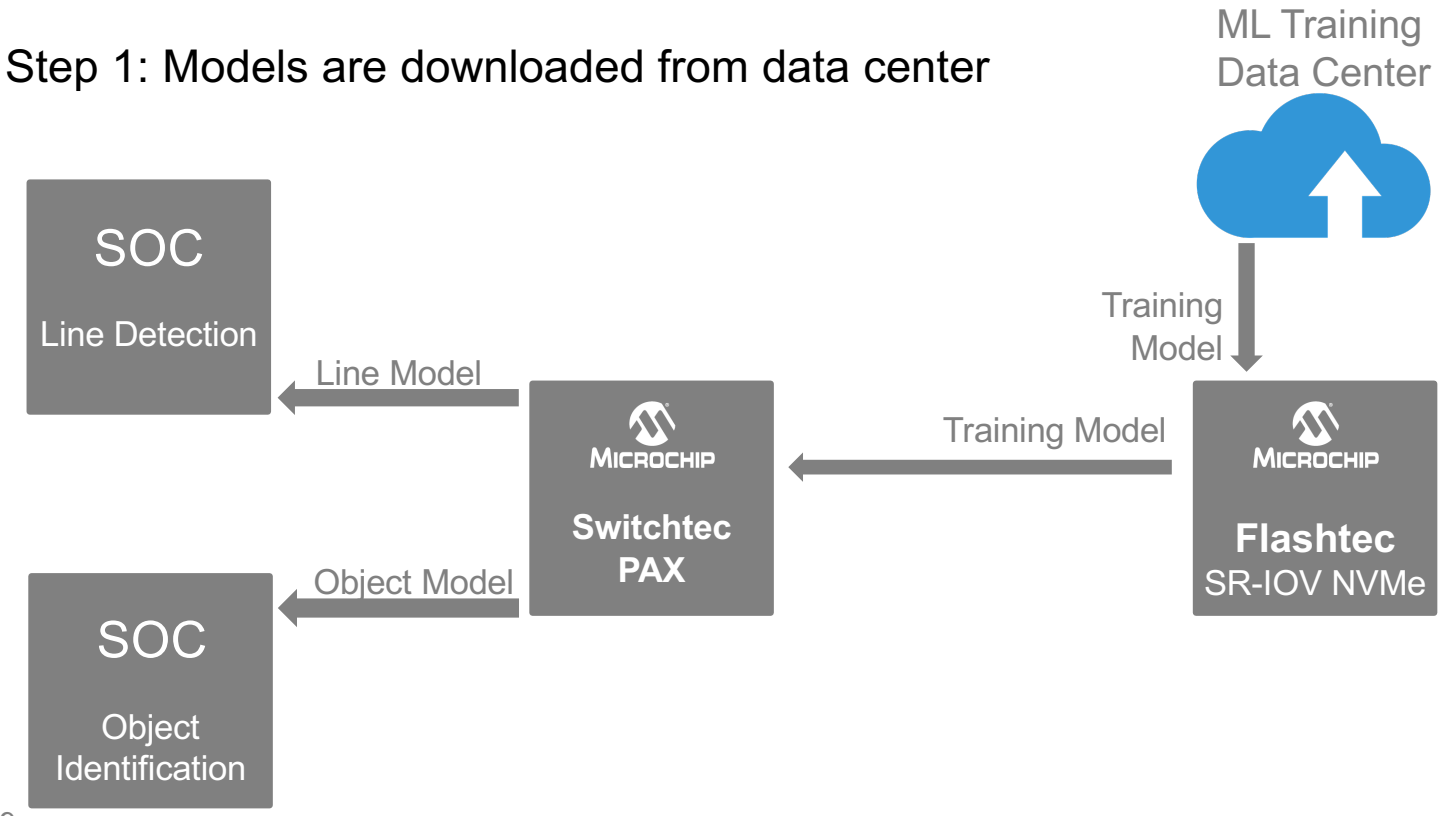
SR-IOV NVMe Sharing with PAX



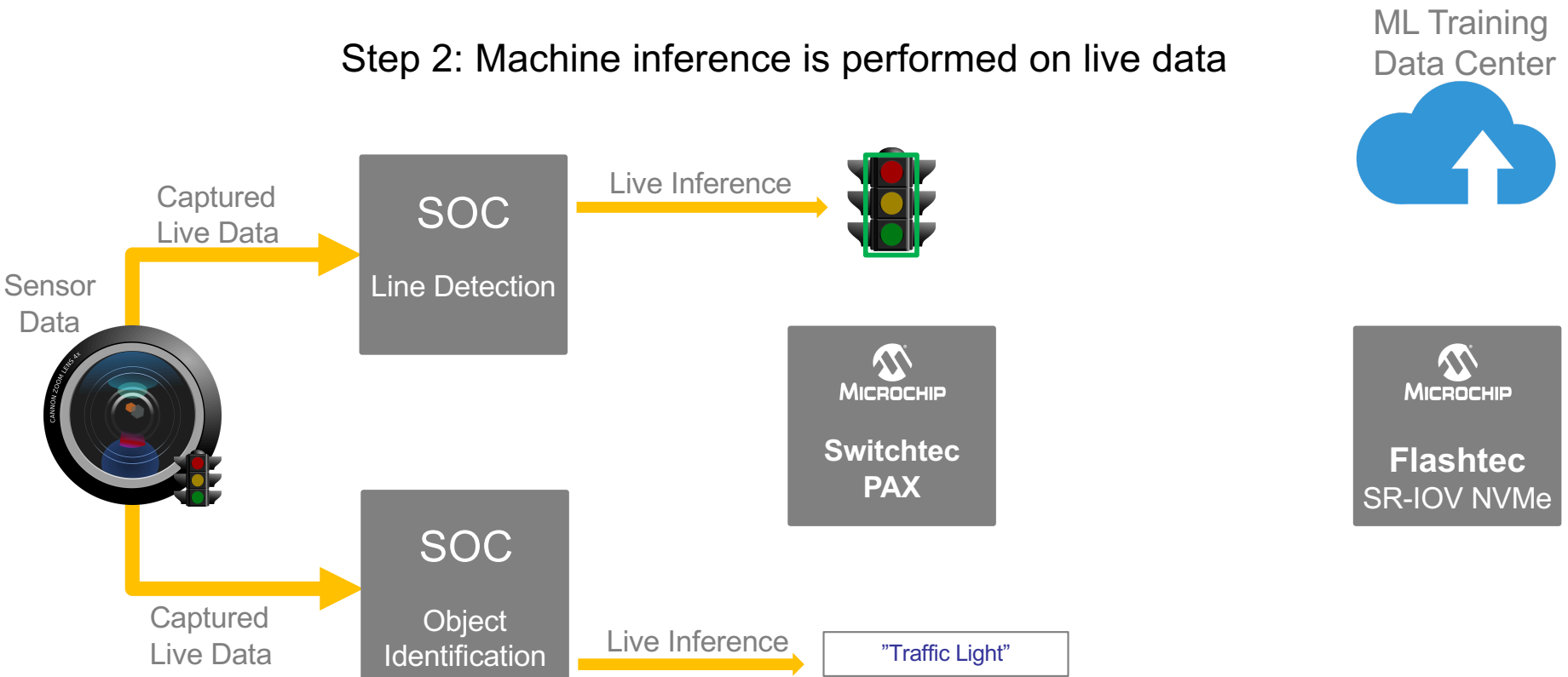
Autonomous Vehicle at Rest

Step 1: Models are downloaded from data center



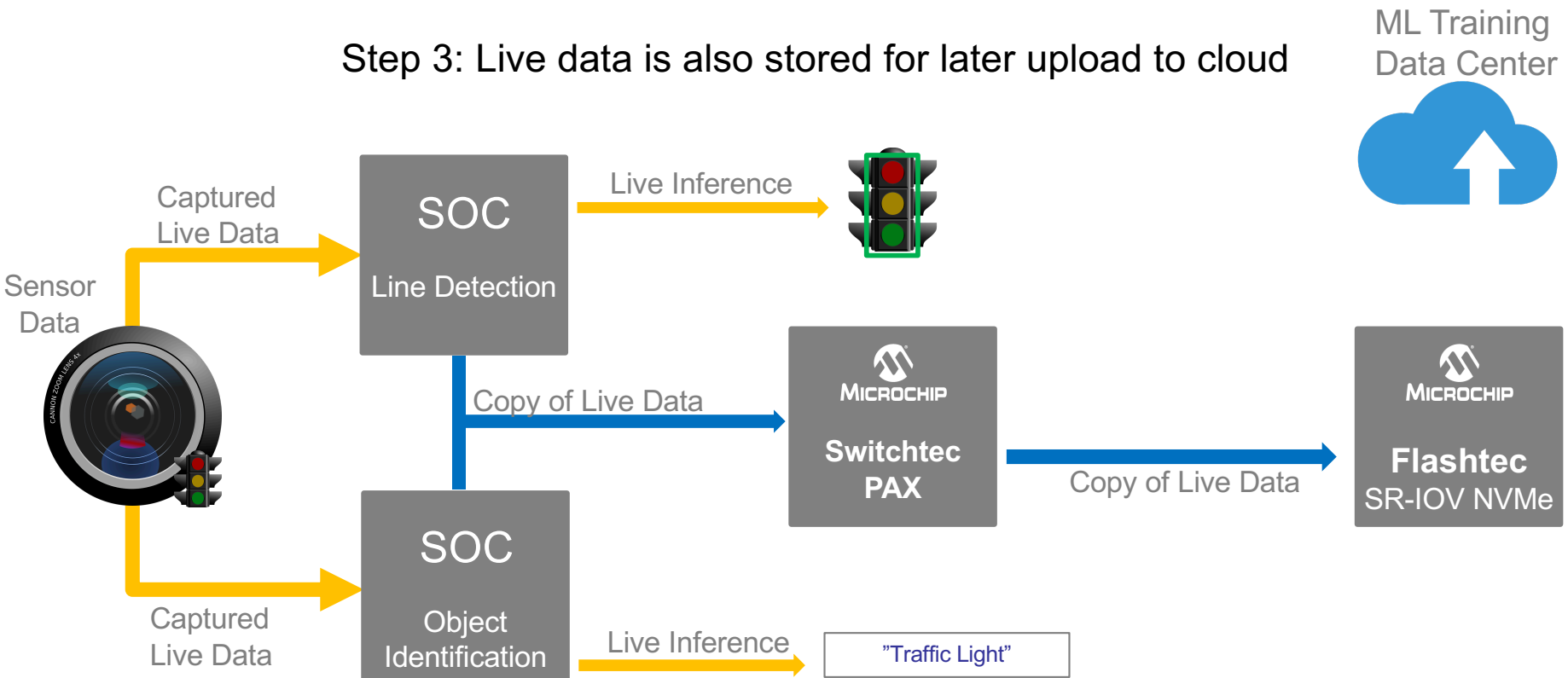
Autonomous Vehicle Active

Step 2: Machine inference is performed on live data



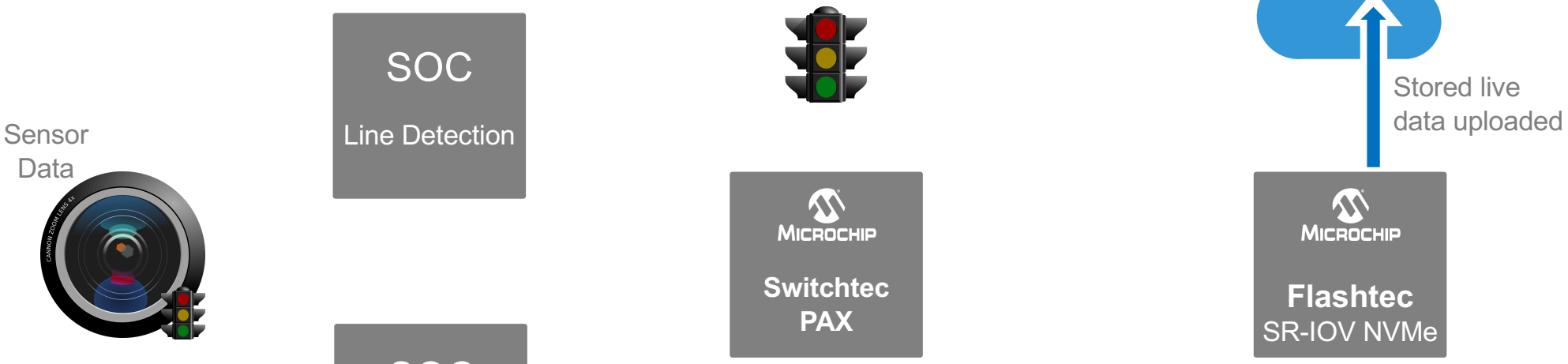
Autonomous Vehicle Active

Step 3: Live data is also stored for later upload to cloud



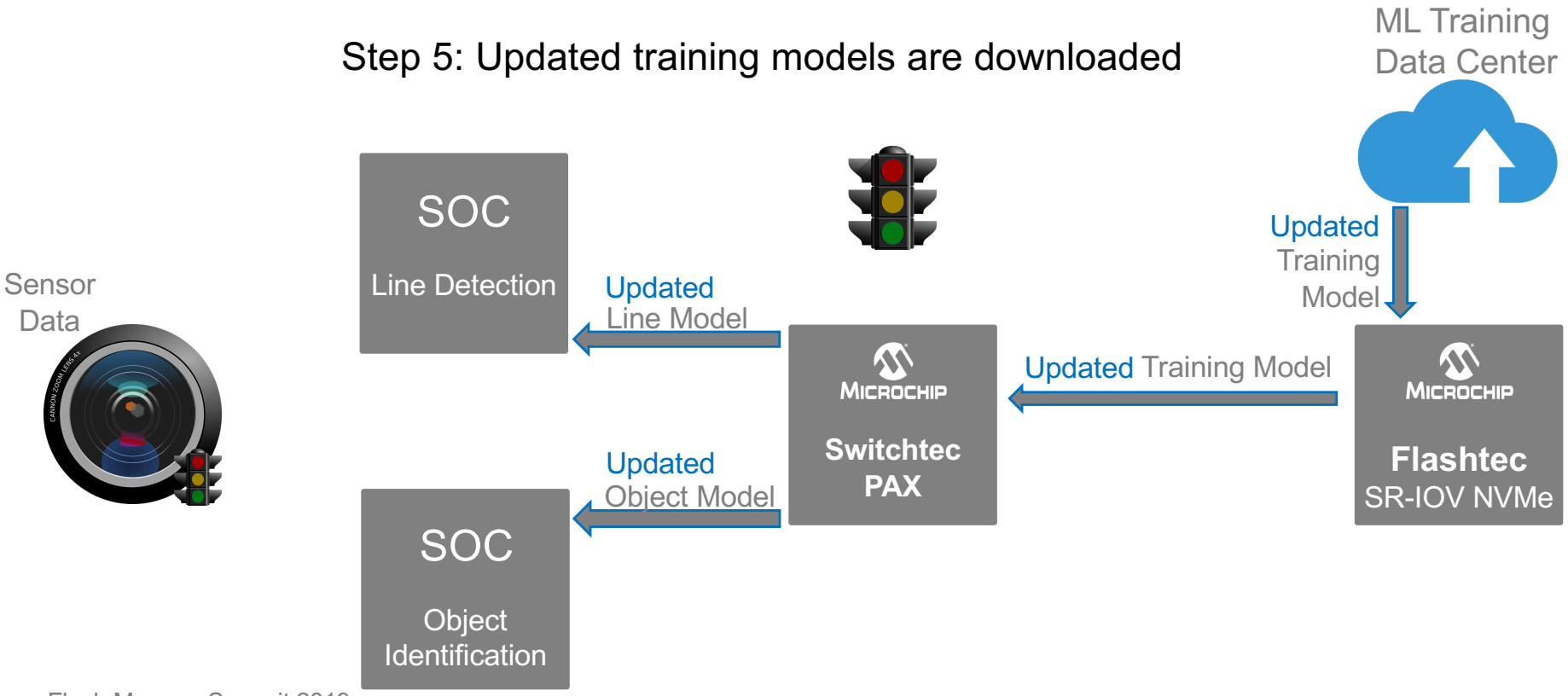
Autonomous Vehicle at Rest

Step 4: Stored raw data is uploaded for further training



Autonomous Vehicle at Rest

Step 5: Updated training models are downloaded



Summary

- Vehicles are getting more complex
- Data is fueling autonomous vehicles
  - Currently scattered over several storage elements
- SR-IOV NVMe sharing can be a cost-effective way to implement edge computing in the autonomous vehicle