ENABLING A CONNECTED EV MANAGEMENT SYSTEM WITH NXP GOLDBOX/GREENBOX PLATFORMS AND AWS CLOUD SERVICES

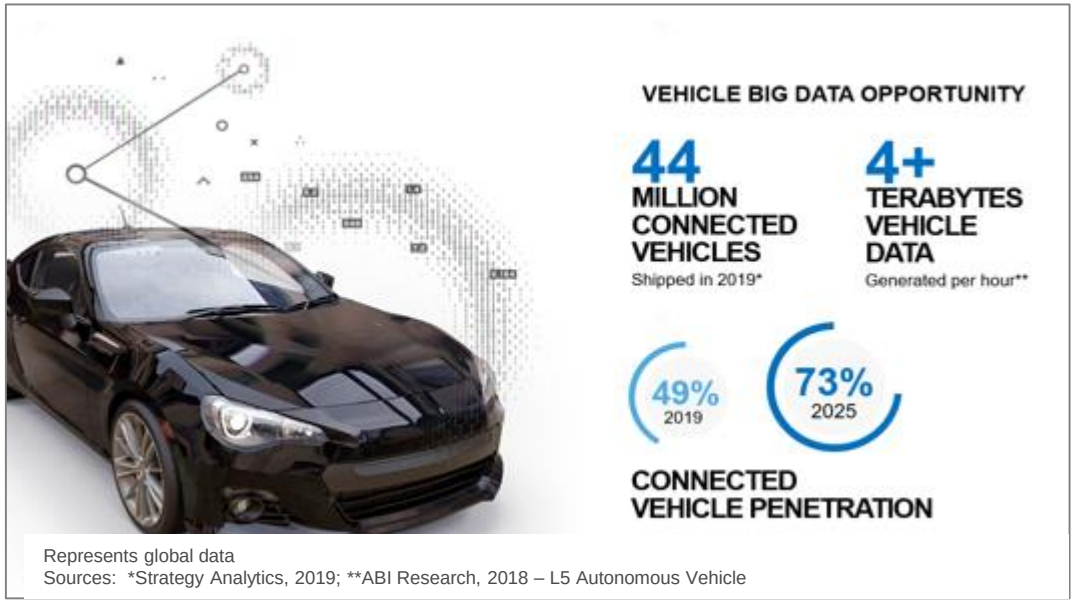
Brian Carlson
Director, Global Product and Solutions Marketing
NXP Automotive - Vehicle Control and Networking Solutions PL

MARCH 2021

SECURE CONNECTIONS FOR A SMARTER WORLD

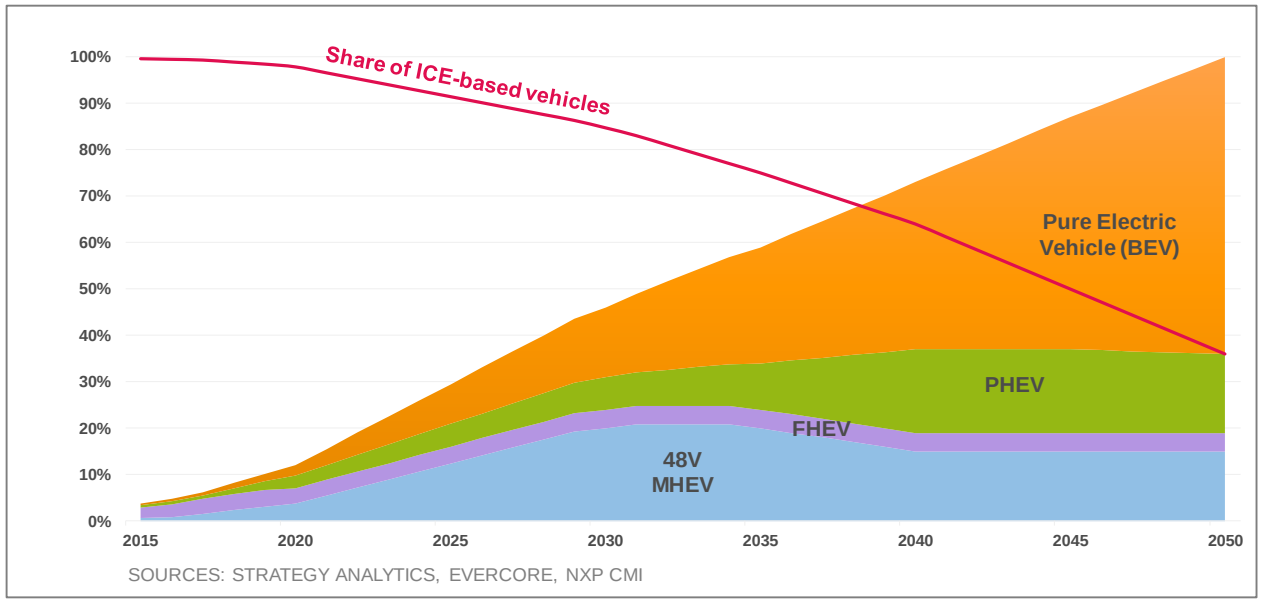
THE GROWTH OF CONNECTED AND ELECTRIC VEHICLES

Connected Vehicle Growth



Represents global data
Sources: *Strategy Analytics, 2019; **ABI Research, 2018 – L5 Autonomous Vehicle

Electric Vehicle Growth



SOURCES: STRATEGY ANALYTICS, EVERCORE, NXP CMI

- The automotive industry is transforming at a rapid pace:
  - Connecting vehicles to the cloud
  - Moving to electric propulsion systems
- Automakers have aggressive plans and are making massive investments to introduce many new electric vehicle models within the next few years
  - E.g., GM is investing $27 billion to launch 30 EVs by e/o 2025; Volvo plans to be all-electric by 2030

CONNECTED VEHICLE ENABLES AUTONOMY AND ELECTRIFICATION IMPROVEMENTS

CONNECTED

Vehicle data-driven insights used to improve algorithms and machine learning models deployed via Over-the-Air (OTA) updates through the life of vehicles

AUTONOMY

ZERO ACCIDENTS

ELECTRIFICATION

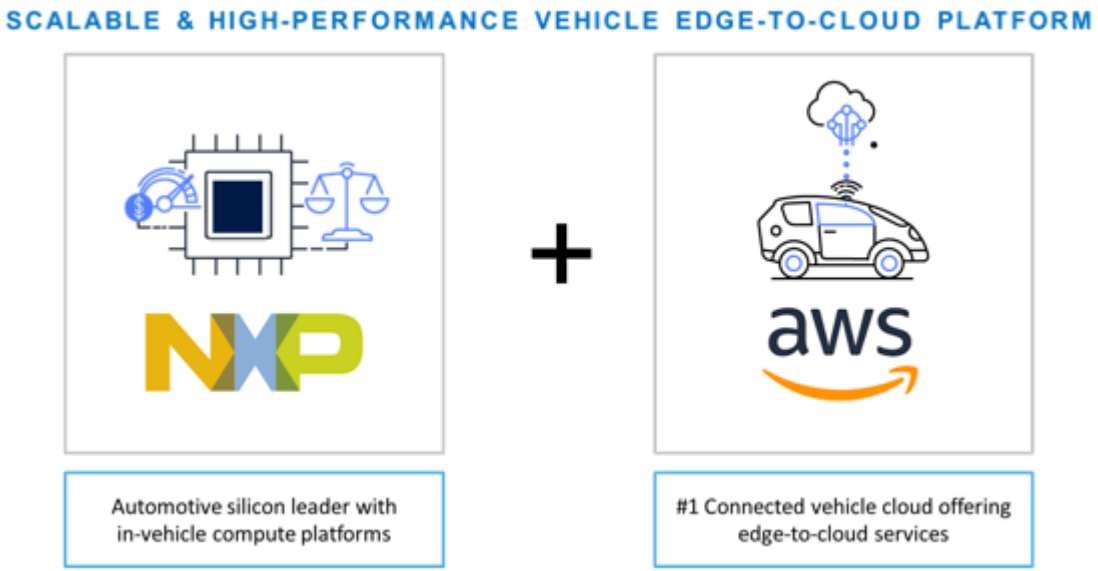
ZERO EMISSIONS

NXP – AWS CONNECTED VEHICLE COLLABORATION

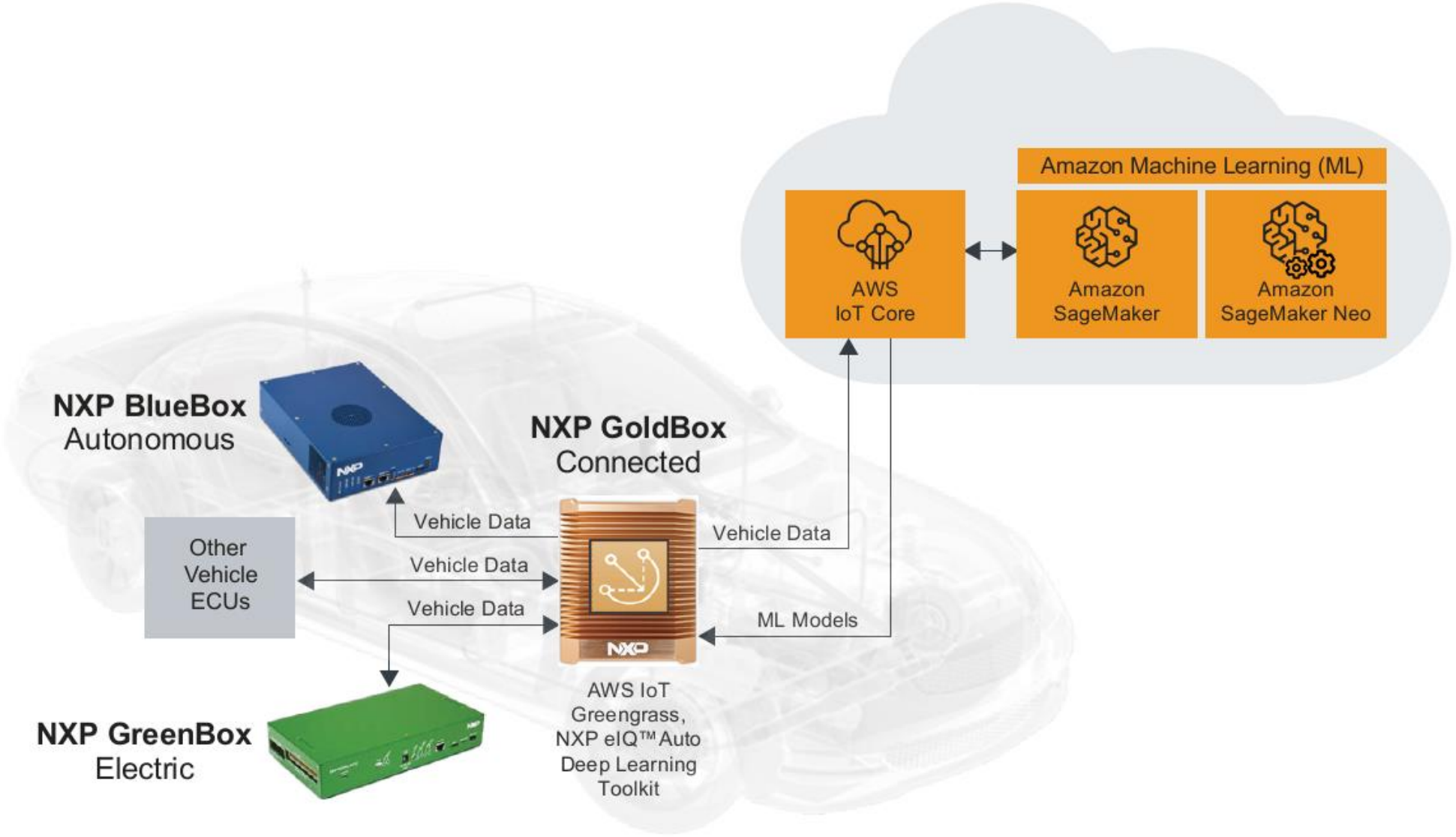
NXP Collaborates with Amazon Web Services (AWS) to Extend Connected Vehicle Opportunities

November 17, 2020 at 2:00 AM EST

- Vehicle edge-to-cloud compute solution aims to enable new automotive industry revenue opportunities
- Sets foundation for data-driven services and enhancements that offer differentiation and cost reduction such as predictive maintenance
- Expands access to vehicle Big Data and streamlines machine learning life cycle to accelerate vehicle development and post-sale vehicle enhancements



NXP AND AWS OFFER SECURE VEHICLE-TO-CLOUD SUPPORT TO LEVERAGE VEHICLE DATA



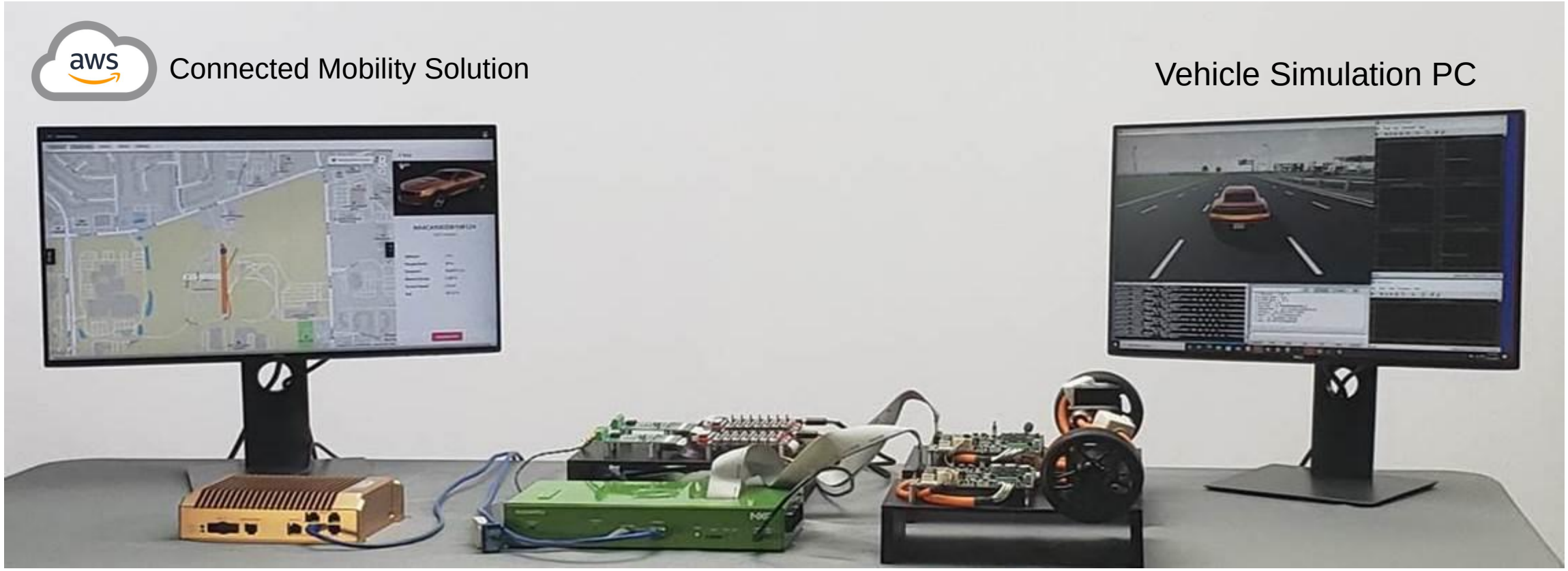
NXP AND AWS CONNECTED EV MANAGEMENT SYSTEM

- The solution incorporates the following:
  - **NXP Electrified** – xEV Powertrain Domain Control for efficient and safe vehicle propulsion using the S32S GreenBox II Electrification Development Platform
  - **NXP Connected** – Services-Oriented Gateway using the S32G GoldBox to enable vehicle wide secure connectivity and cloud connectivity
  - **AWS IoT Greengrass and Connected Mobility Solution** – bringing the power of the data center to the vehicle edge; unlocking the value of vehicle data to enable new use cases

CONNECTED EV MANAGEMENT SYSTEM: USING VEHICLE EDGE-TO-CLOUD PROCESSING

- **Value Propositions**
  - Optimize energy usage
  - Extend vehicle range
  - Continual EV improvements
- **Solution Components**
  - NXP GreenBox II for powertrain domain control
  - NXP GoldBox for vehicle edge services and secure cloud connectivity
  - AWS IoT Greengrass and Connected Mobility Solution
- **Use Cases**
  - Predictive maintenance
  - Advanced vehicle diagnostics
  - Telematics and fleet management
  - The system can support future use cases
    - Usage-Based Insurance (UBI) – coming soon

CONNECTED EV MANAGEMENT SYSTEM



Secure Edge-to-Cloud Processing

xEV Powertrain Domain Control

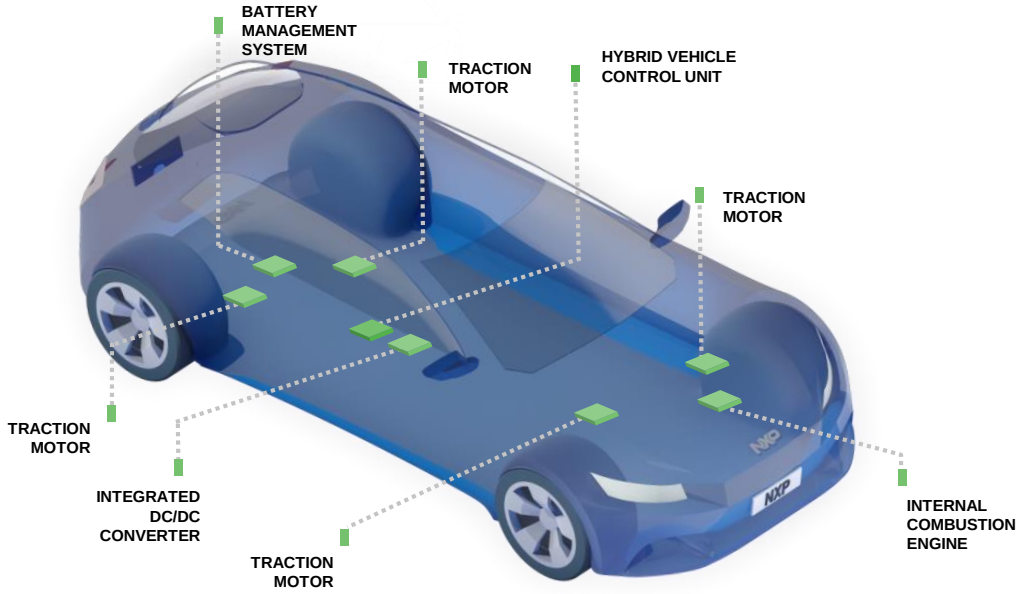
Dual Motors

GreenBox II Electrification Development Platform

SECURE CONNECTIONS
FOR A SMARTER WORLD

NXP GREENBOX II VEHICLE ELECTRIFICATION DEVELOPMENT PLATFORM

- **Development platform for NXP S32S247TV, an Arm® Cortex® R52** safe and secure SoC
- High-performance ASIL D compute with 4 x Arm® Cortex®-R52 cores with Neon SIMD running in lockstep and operating at up to 800 MHz
- Peripheral control using complex timers, filters and analog modules to support Hybrid Electric Vehicle (HEV) or motor control applications
- Numerous automotive communication interfaces: Ethernet, CAN FD, LIN, UART, JTAG, SDHC, PSI5, SENT
- Hypervisor support for virtual machines and task isolation
- Easy to use out of the box experience with S32 Design Studio IDE and sample software for advanced control applications



GREENBOX II EV POWERTRAIN DOMAIN CONTROL (PDC) COMPONENTS

Hardware

- GreenBox II with S32S247TV
  - Comms peripherals (SJA1105 Ethernet switch, TJA1048T CAN FD PHY)
- Battery Management System (BMS) SPI-to-TPL (MC33664TL)
- BMS battery 6-cell monitors (MC33772)
- Dual 3-phase electric motor drive (MC33937, upgrade possible to GD3100)

Software Libraries & Tools

- MathWorks® Simulink® HEV model, Simulink Coder
- NXP Model Based Design Toolbox for S32S
- NXP Automotive Math and Motor Control Library (AMMCL)
- NXP S32S Software Development Kit (SDK)
- OpenSynergy Hypervisor (COQOS Micro)

Algorithms

- MathWorks HEV Energy Management System (Adaptive ECMS)
- NXP BMS (Extended Kalman Filter)
- NXP Dual Motor Control (Field-Oriented Control)

GoldBox Service-Oriented Gateway

SECURE CONNECTIONS
FOR A SMARTER WORLD

S32G IS A NEW TYPE OF AUTOMOTIVE PROCESSOR: VEHICLE NETWORK PROCESSOR

PROCESSING

Lockstep Arm Cortex-M7 Microcontrollers

Cluster Lockstep Cortex-A53 Microprocessors

Automotive Networks Acceleration

Ethernet Packet Acceleration

NETWORKING

20 x CAN/CAN FD Interfaces

LIN and FlexRay™ Interfaces

4 x Gigabit Ethernet Interfaces

PCI Express Gen 3 Interfaces

SAFE ASSURE by NXP

SAFETY & SECURITY

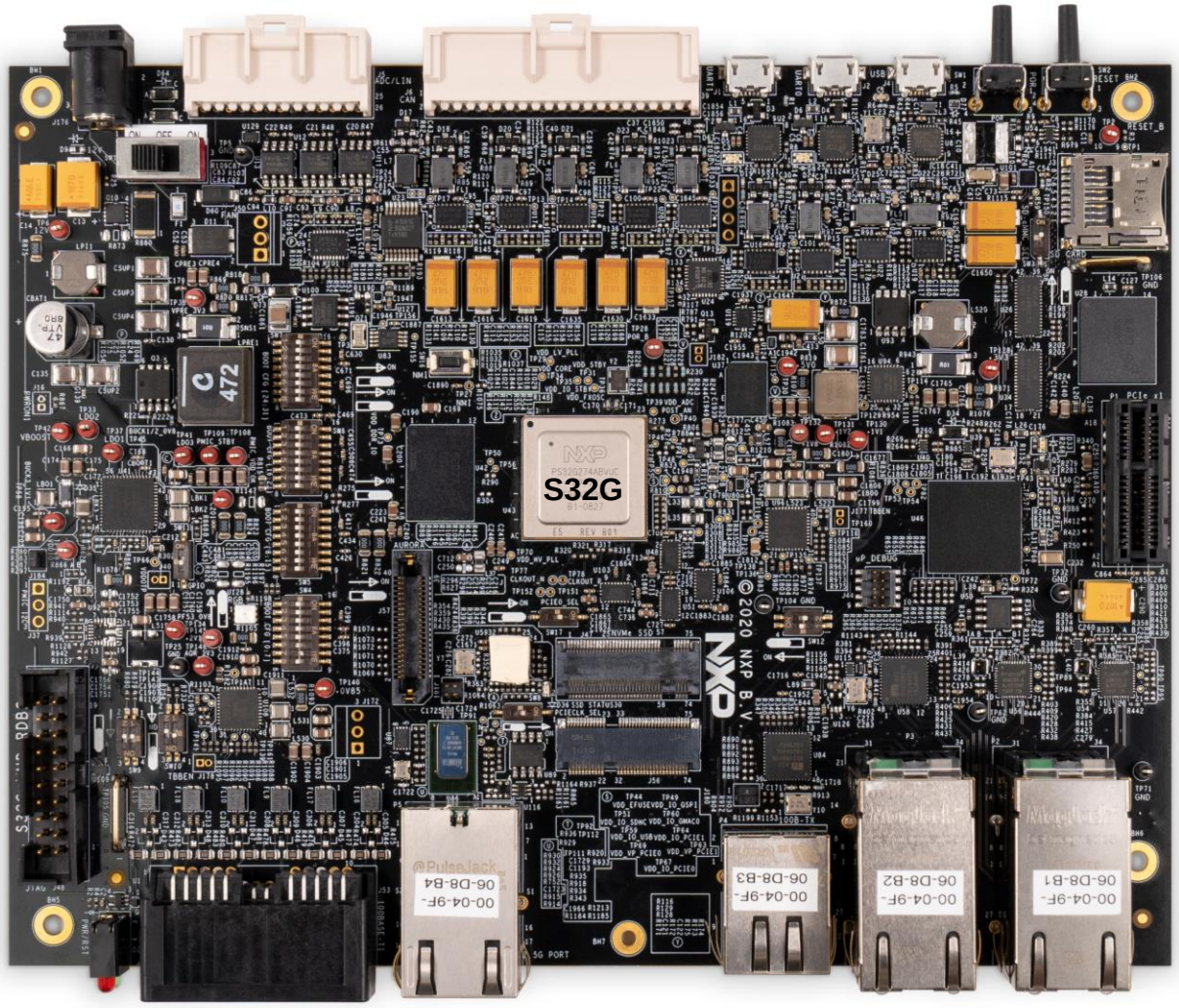
ASIL D Functional Safety Support

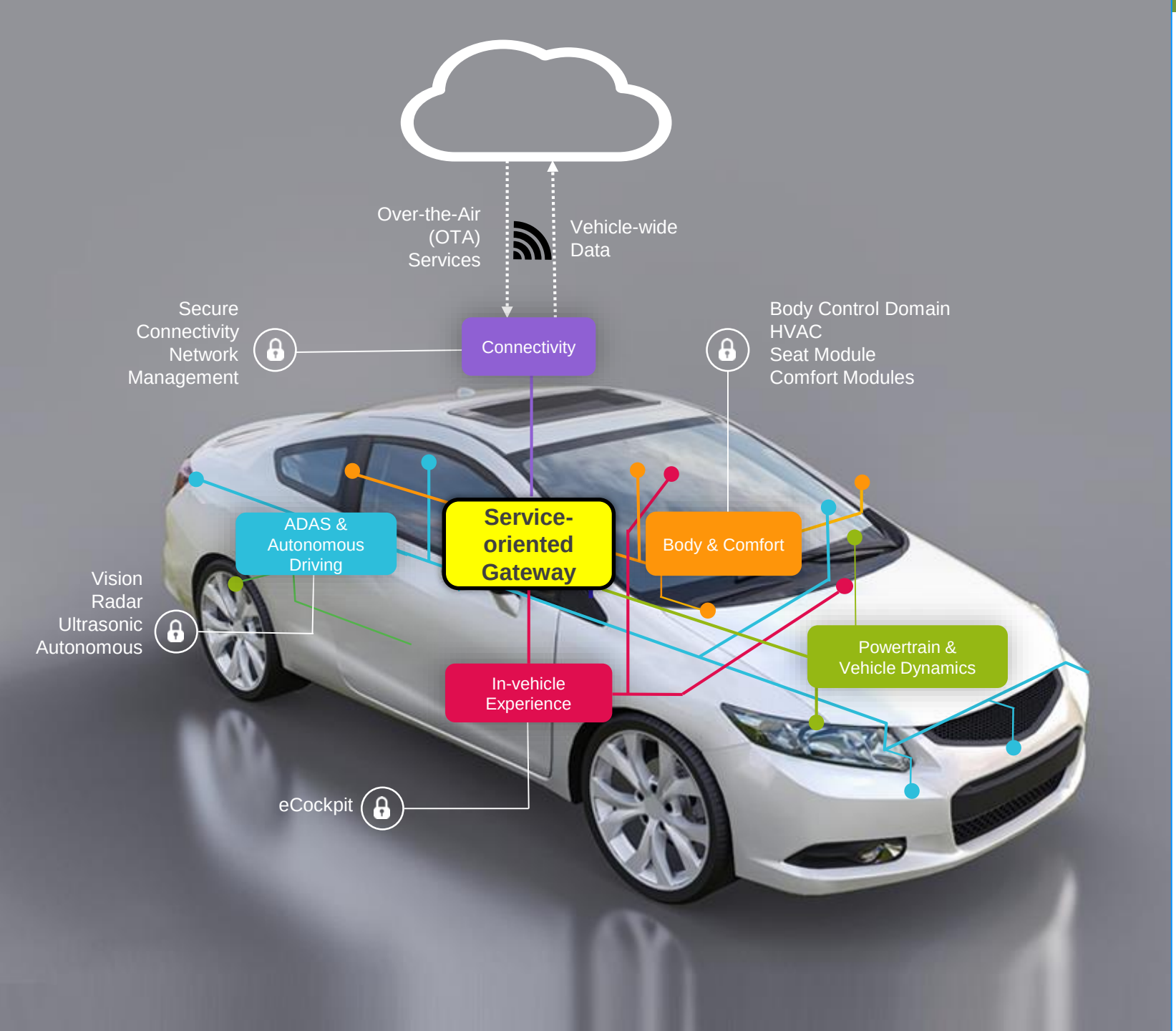
Advanced Hardware Security Engine

EDGELOCK™ ASSURANCE by NXP

S32G GOLDBOX SERVICE-ORIENTED GATEWAY OVERVIEW

- Service-oriented Gateway reference design based on S32G
- NXP service-oriented gateway extends EV management and optimization capabilities with vehicle-to-cloud processing.
- 12x Ethernet, 18x CAN FD, 5x LIN, 1x FlexRay interfaces
- PCI Express x1 slot for system expansion and USB 2.0 OTG connector
- M.2 slots for SSD storage and AI/ML acceleration modules
- JTAG debug and Aurora trace support
- Rugged enclosure with integrated thermal management





SERVICE-ORIENTED GATEWAY

Central gateway provides secure networking across vehicle domains

Extends gateway with services based on Service-oriented Architecture (SoA)

Lowers cost to develop and deploy vehicle services

Supports upgradable vehicle with vehicle-wide Over-the-Air (OTA) updates

Provides vehicle data edge processing and support for cloud services

In the Connected EV Management Solution demo, the Gateway runs the AWS IoT Greengrass edge software

S32G: BRINGING TOGETHER AUTOMOTIVE AND ENTERPRISE WORLDS TO ENABLE DISRUPTIVE OPPORTUNITIES

Technology Convergence

Automotive Networking →

- CAN/LIN/FlexRay™ Networks | Gigabit Ethernet Networks with Hardware Acceleration
- Real-time Processing | High-level OS / Virtualization
- Safe and Secure Gateway | Applications/Services

← **Enterprise Networking**

Vehicle-to-Cloud Processing

Vehicle Insights and Sensor Data ↔ Service-oriented Gateway Processing ↔ 

↔ ☁

New Opportunities

- Vehicle Health
- Usage-Based Insurance
- Over-the-Air Upgradeable Vehicles
- Other Monetization Opportunities

VEHICLE EDGE-TO-CLOUD PROCESSING PARTITIONING AND INTERACTION

VEHICLE SERVICE-ORIENTED GATEWAY

- Vehicle Services
- Vehicle Data Filtering
- Edge Analytics / ML Inferencing
- Data Reduction
- Edge Storage
- Data Transmission

- Vehicle Data
- Edge Results

Secure Connection

- OTA Updates
- ML Models
- Vehicle Management

- Data Ingestion
- Data Enrichment
- Data Analysis
- Machine Learning / Deployment
- Cloud Services
- Cloud Storage (Data Lake)

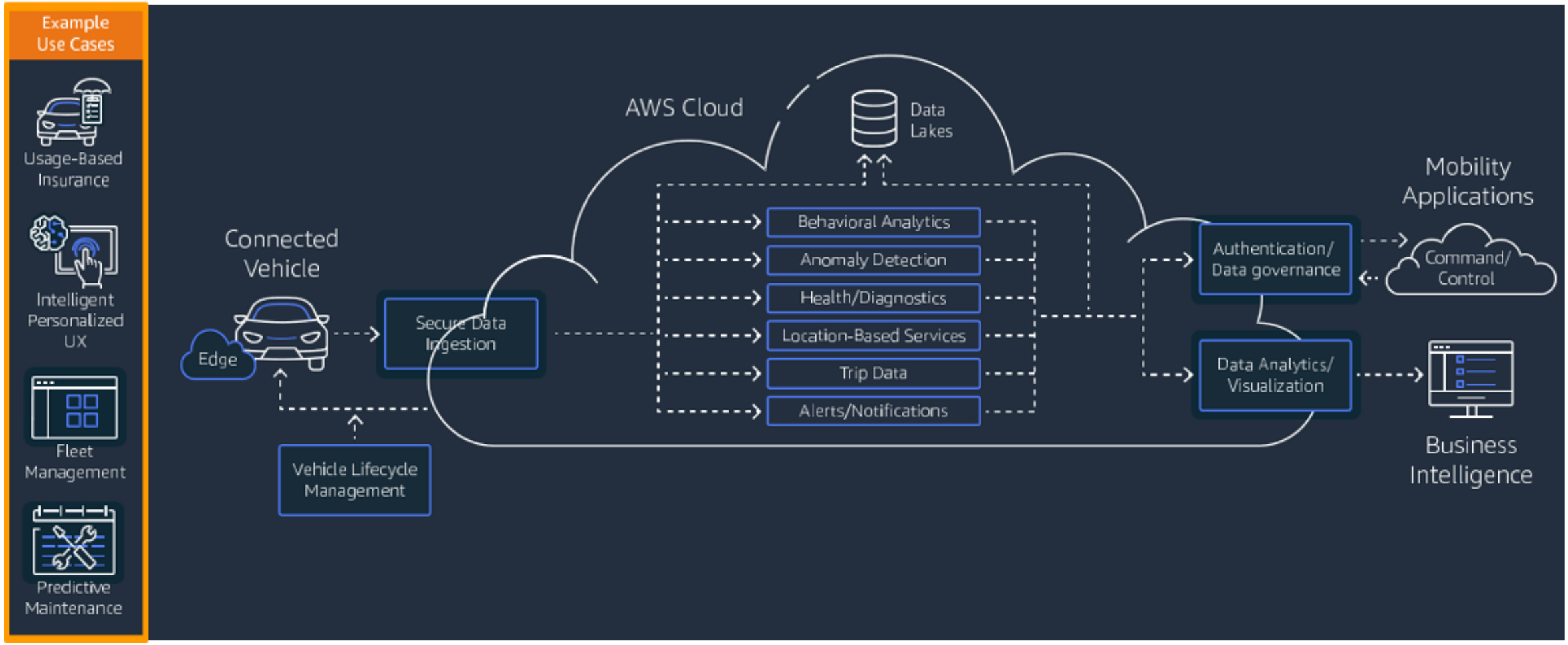
- NXP edge processing + AWS cloud processing brings the automotive and IT worlds together to enable new use cases
- Edge and Cloud collaborate to unlock the full potential of vehicle data and enable new services and business models
- Streamlined infrastructure and enablement is key to successful proliferation

AWS Vehicle Edge and Cloud Services

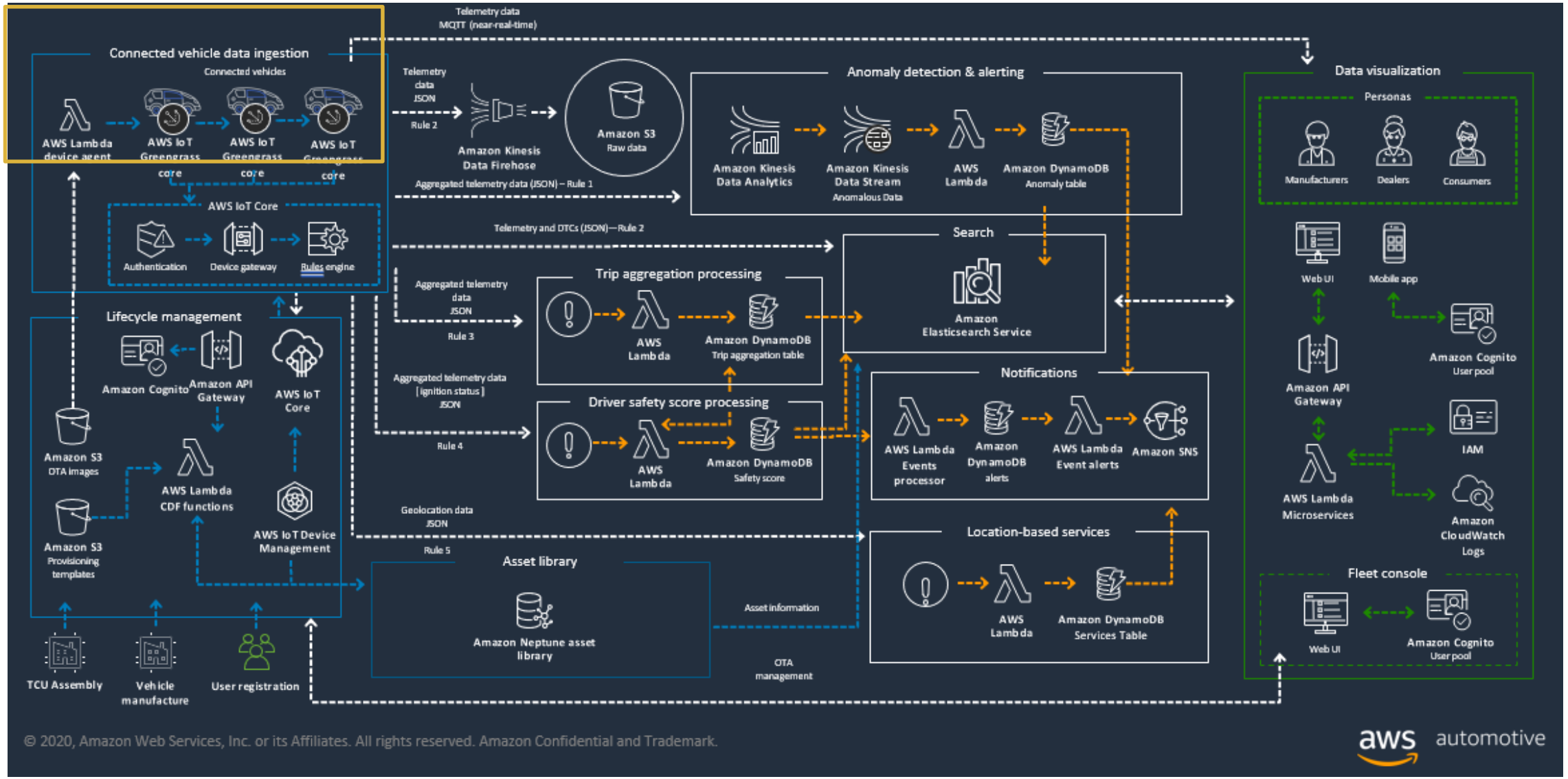
SECURE CONNECTIONS
FOR A SMARTER WORLD

AWS CONNECTED MOBILITY SOLUTION (CMS) OVERVIEW

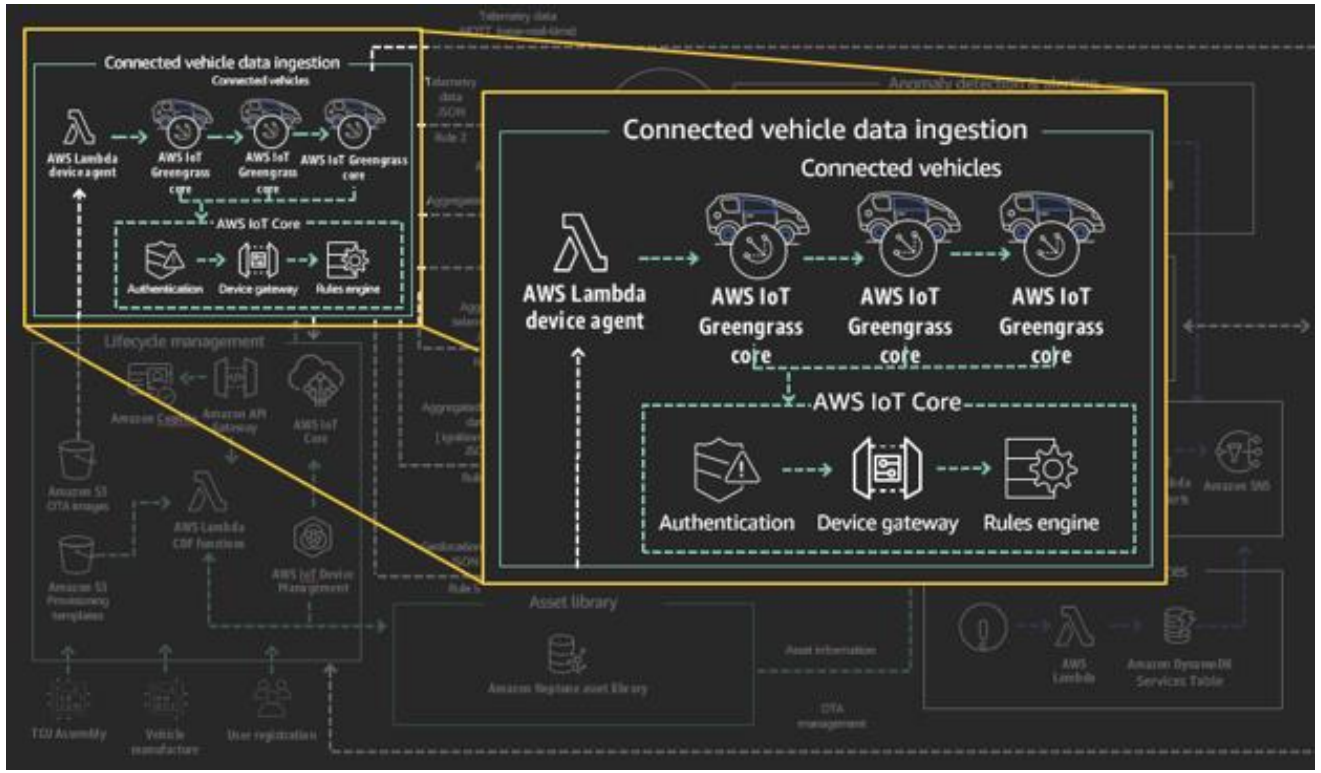
The AWS Connected Mobility Solution allows you to easily and securely connect your vehicles and build innovative new mobility features and applications that run at the edge and in the cloud at global scale



AWS CONNECTED MOBILITY SOLUTION REFERENCE ARCHITECTURE



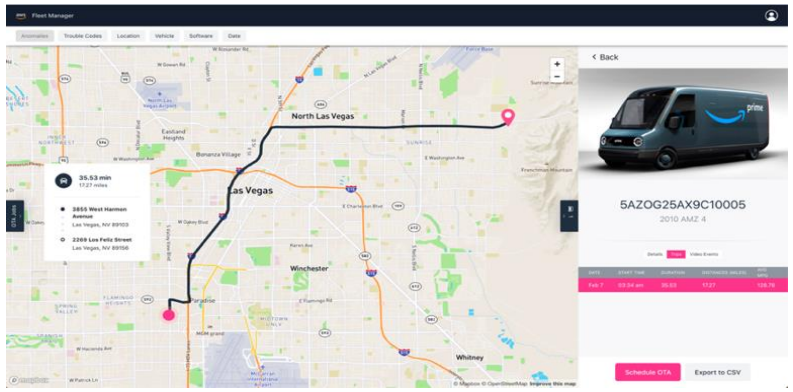
CONNECTED VEHICLE DATA INGESTION FROM AWS IOT GREENGRASS

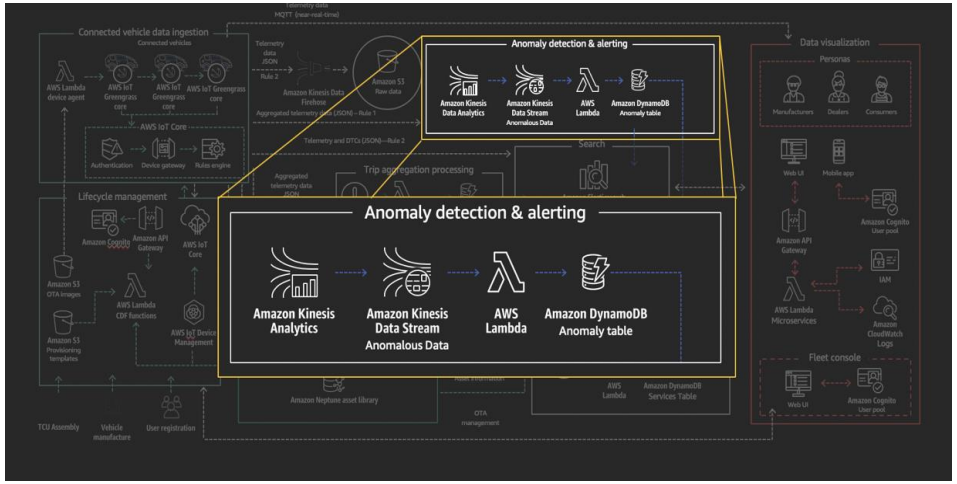


AWS IoT Greengrass

- Edge compute software
- Machine Learning (ML) models
- Location-based services
- Secure connectivity to AWS IoT Core running in cloud
- Secure, signed OTA software updates

AWS CMS HELPS ORGANIZE DATA AND DRIVE HIGHER OPERATIONAL EFFICIENCY ACROSS VEHICLE FLEET AND ENTERPRISE

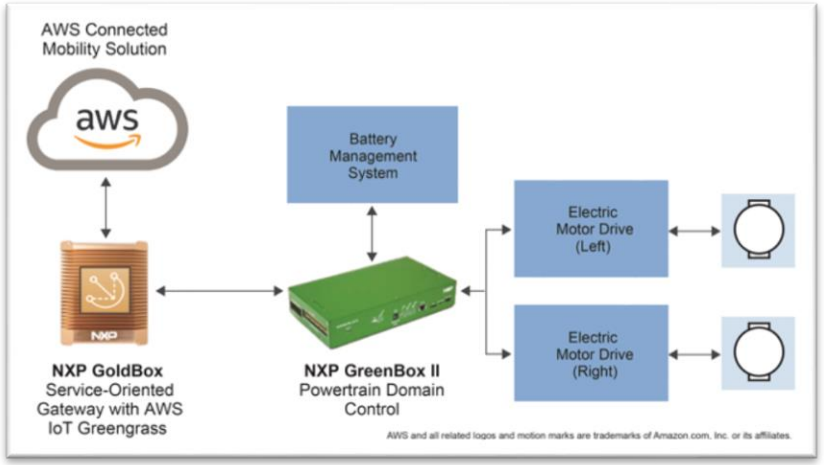




AWS Connected Mobility Solution (CMS)

- Diagnostic Trouble Code (DTC) detection and alerting
- Anomaly detection in the data stream
- Create drive safety scores
- Leverage location-based services
- Fleet monitoring interface
- APIs for mobility services partners

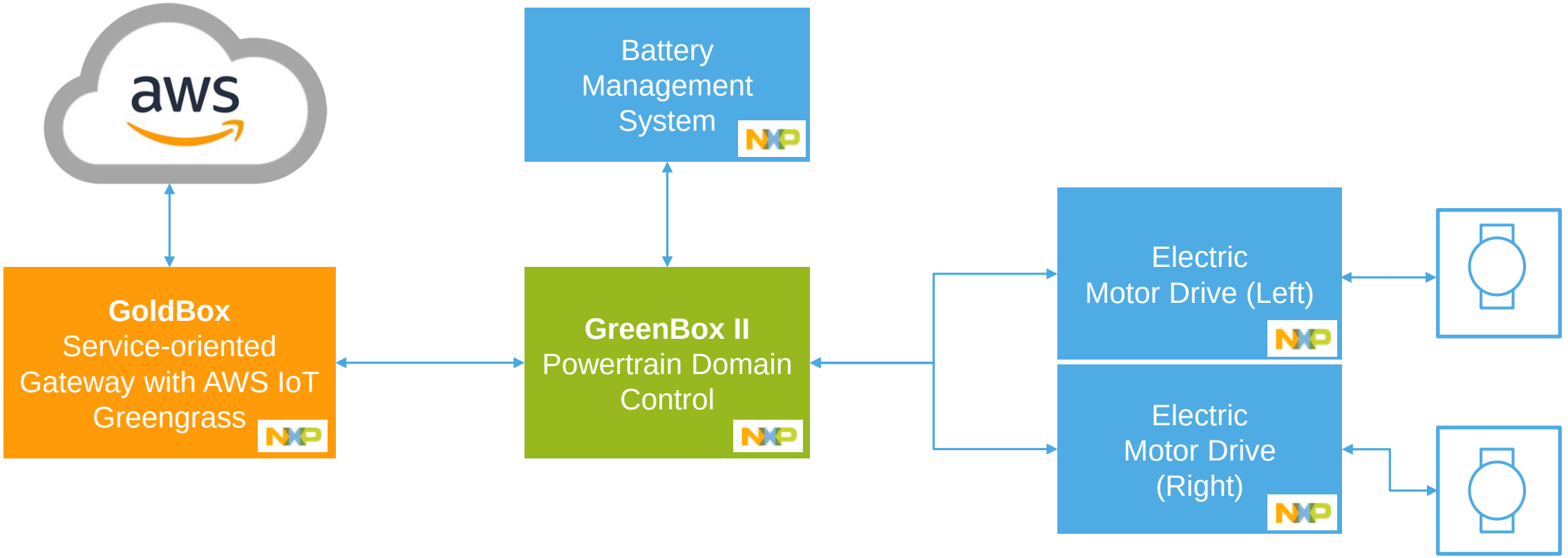
System Operation



SECURE CONNECTIONS FOR A SMARTER WORLD

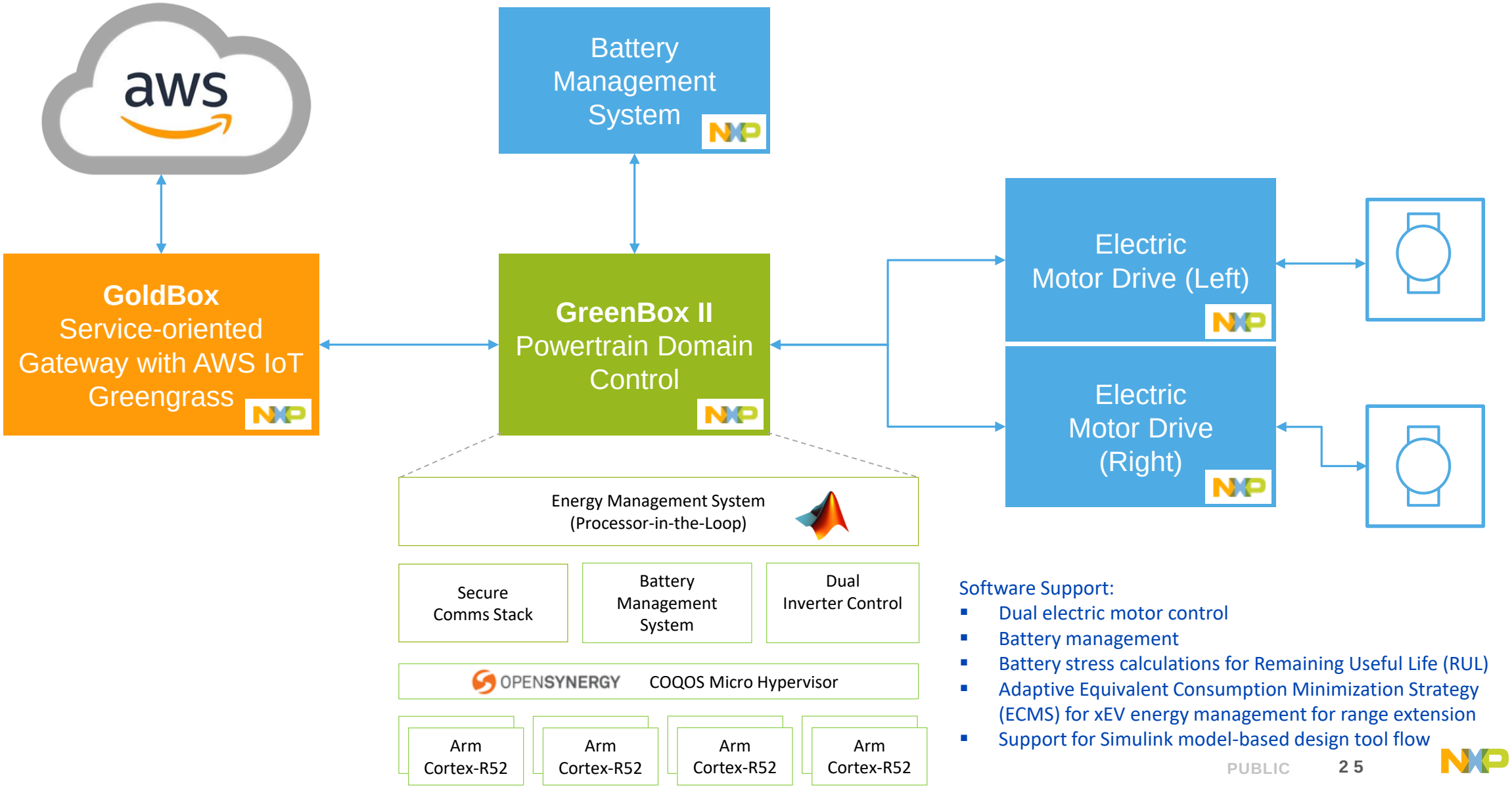
CONNECTED EV MANAGEMENT SOLUTION DEMO

AWS Connected Mobility Solution



CONNECTED EV MANAGEMENT SOLUTION DEMO

AWS Connected Mobility Solution

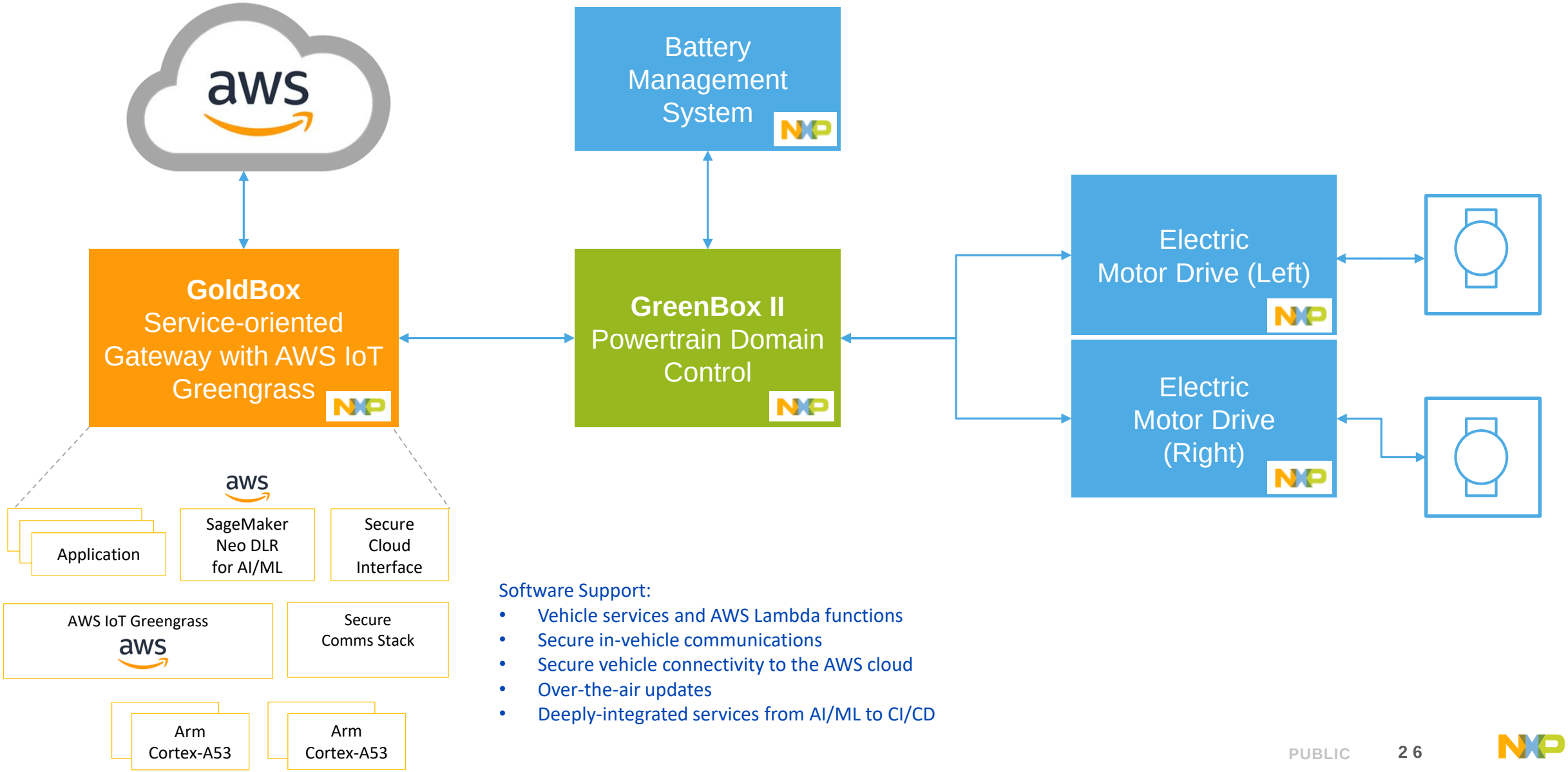


Software Support:

- Dual electric motor control
- Battery management
- Battery stress calculations for Remaining Useful Life (RUL)
- Adaptive Equivalent Consumption Minimization Strategy (ECMS) for xEV energy management for range extension
- Support for Simulink model-based design tool flow

CONNECTED EV MANAGEMENT SOLUTION DEMO

AWS Connected Mobility Solution

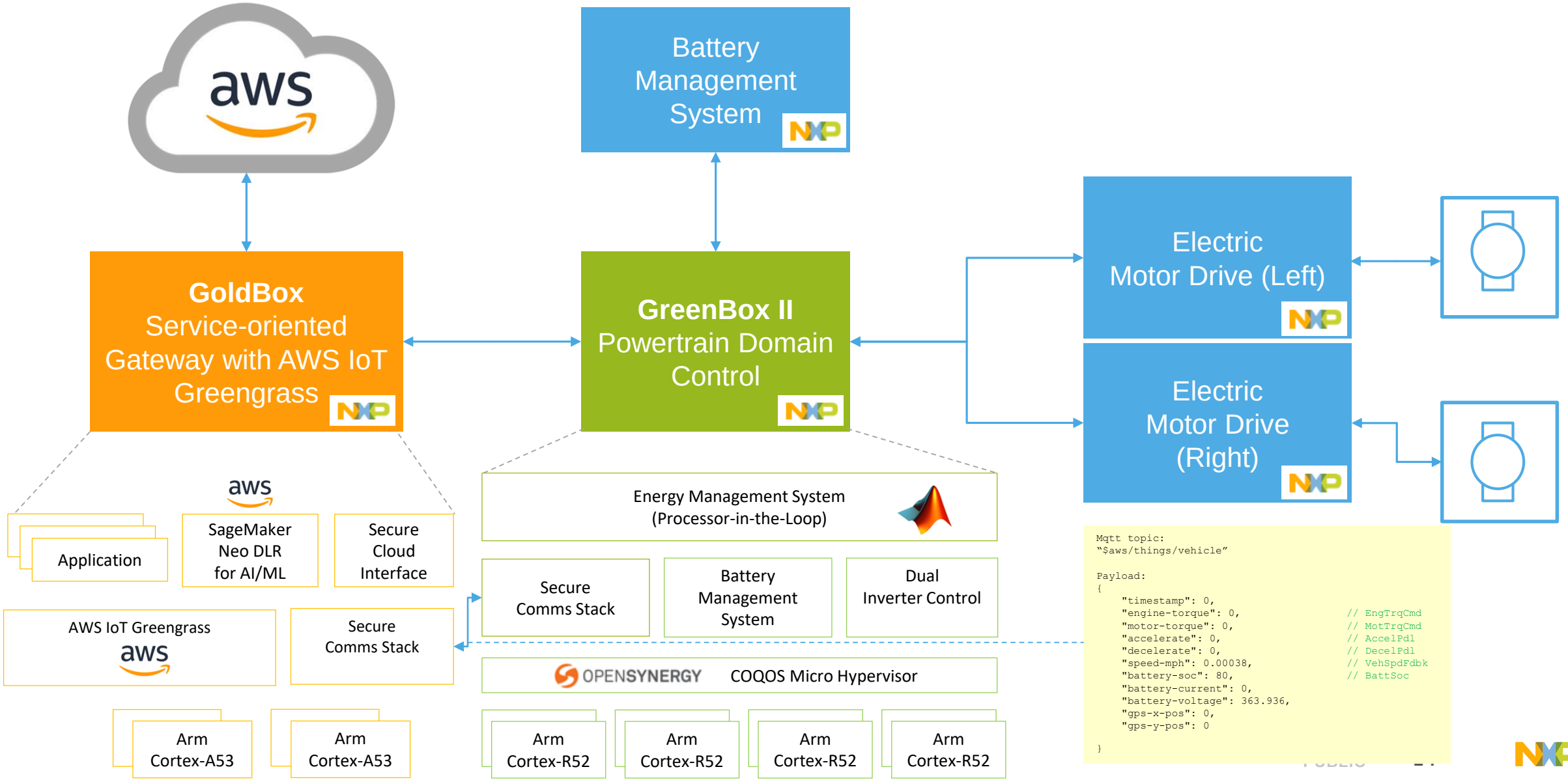


Software Support:

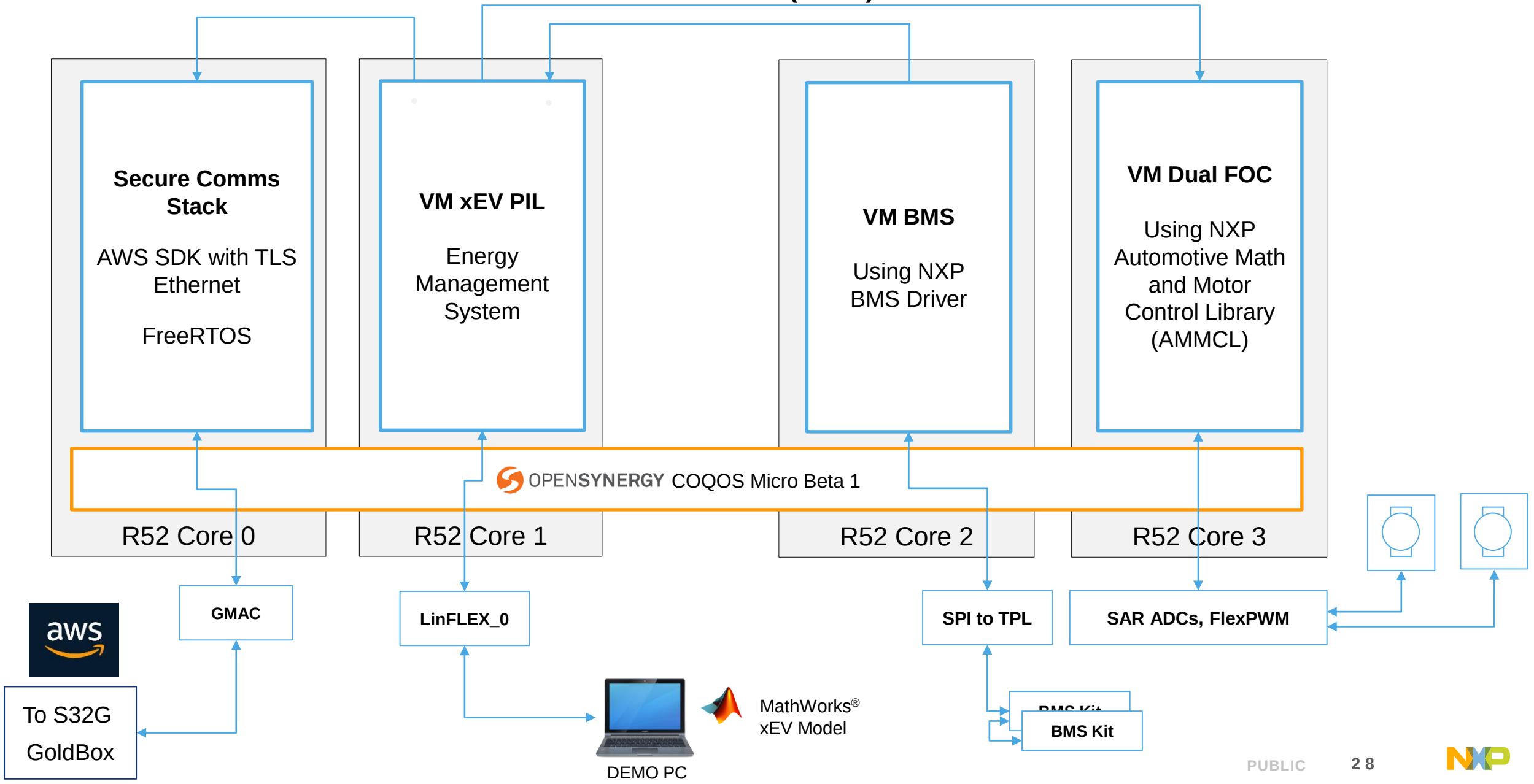
- Vehicle services and AWS Lambda functions
- Secure in-vehicle communications
- Secure vehicle connectivity to the AWS cloud
- Over-the-air updates
- Deeply-integrated services from AI/ML to CI/CD

CONNECTED EV MANAGEMENT SOLUTION DEMO

AWS Connected Mobility Solution



GREENBOX II POWERTRAIN DOMAIN CONTROL (PDC) DEMO APPLICATION SOFTWARE



SOLUTION COMPONENTS SUMMARY

- **GoldBox**
  - AWS
    - Greengrass IoT Core and IoT SDK
    - SageMaker and SageMaker Neo
    - Connected Mobility Solutions (CMS)

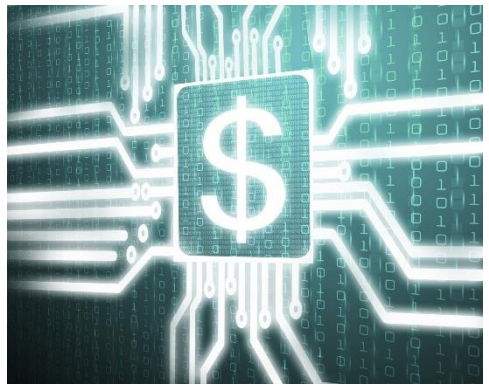
- **GreenBox**
  - **Third-party Software**
    - **OpenSynergy:** COQOS Micro Hypervisor
    - **MathWorks:** MATLAB, Simulink, Vehicle Dynamics Blockset, Powertrain Blockset
    - **Industrial Systems and Controls (ISC):** Advanced powertrain controls for energy management and battery stress minimization

- **NXP Software**
  - Automotive Math and Motor Control Library (AMMCL)
  - Model-Based Design Toolbox (MBDT) for S32S
  - S32 Design Studio IDE and SDK
  - Powertrain Domain Control demo software

Building on Top of the Connected EV Management System

SECURE CONNECTIONS
FOR A SMARTER WORLD

CREATING A TURNKEY OEM SOLUTION FOR MONETIZING VEHICLE DATA



By working together, each company leverages their strengths for connected vehicles

- NXP vehicle platforms aggregate and process vehicle data
- AWS cloud software enhances and stores data
- Aioi Insurance Services utilizes data for insurance and car fleets

MS&AD AIS MOTER LEVERAGING NXP AND AWS SOLUTION

Utilizing vehicle edge processing and cloud, MOTER conducts risk assessment in a cost-effective manner.

Edge

Gateway

GoldBox (S32G)

MS&AD AIS MOTER

AWS IoT Greengrass

aws

Cloud

AWS IoT Core

aws

Kinesis

SageMaker

Neo, Edge Manager, Ground Truth

Lambda

AWS Data Exchange

Business Services

MS&AD AIS

Other Platform Partners

Insurance Carrier

Fleet Management

Vehicle Health Management

More Information Available Soon

Demonstration Video

SECURE CONNECTIONS
FOR A SMARTER WORLD

CONNECTED EV MANAGEMENT SYSTEM DEMONSTRATION VIDEO

SUMMARY

NXP and AWS enable new connected EV opportunities

- The Connected EV Management System forms the foundation for future innovations and services
  - Based on NXP vehicle processing platforms: S32G GoldBox and S32S GreenBox
  - Leveraging AWS IoT Greengrass, AWS IoT Core and AWS Connected Mobility Solution

- Other companies can leverage the NXP + AWS solution to create new business services
  - Aioi Insurance Services is a great example offering MOTER insurance products for fleets

SECURE CONNECTIONS
FOR A SMARTER WORLD