ENABLING CONNECTED INTELLIGENT VEHICLES WITH THE FUSION PROJECT
MACHINE LEARNING-BASED DATA LIFECYCLE

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M A R C H  2 0 2 1
**CONNECTED VEHICLE USE CASES**

**Information Sharing**
- Vehicle and occupant safety services
- Application services (Hulu, Spotify)
- Location-based services (Fuel, Dining)

**Monitoring / Analytics**
- Vehicle health monitoring
- Vehicle fleet monitoring
- Usage-based insurance (UBI)
- Usage and feature analytics

**Advanced Analytics / Machine Learning**
- Predictive maintenance
- Advanced vehicle diagnostics
- Advanced driver assistance systems (ADAS)
- Autonomous driving (AD)
- Electric Vehicles (EVs)
Vehicle data-driven insights used to improve algorithms and machine learning models deployed via Over-the-Air (OTA) updates through the life of vehicles.
CONNECTED DATA LIFECYCLE CHALLENGES

Industry Needs to Support Vehicle Development with a Viable Path to Production

Unoptimized Edge Hardware Solutions
- Power-efficient processing
- Networking data bandwidth limitations
- Insufficient safety and security support

Fragmented Data Management Lifecycle
- Limited real-time, heterogeneous data ingestion
- Limited integration between data management, business intelligence (BI) and ML platforms
- Limited ability to provide end-to-end data security, governance and lineage

Limited Intelligent Edge Capabilities
- Limited access to vehicle-wide data
- Insufficient ML model accuracy and reliability
- Data transfer latency >10s of milliseconds

Static Software and ML Models
- Lack of dynamic OTA update capabilities for:
  - Vehicle software across ECUs
  - On-board analytics (ML) modules
LIMITATIONS OF TODAY’S MACHINE LEARNING-BASED DATA LIFECYCLE APPROACHES

Silo's

Buy Black-Box

Brute Force

Collect and Wait
To Create a Complete Data Lifecycle
All Components Must Seamlessly Integrate

Data lifecycle design is based on the following principles:

• Edge-to-cloud data transfer built on data ingestion with data reduction from a service-oriented gateway with the necessary speed, bandwidth, security and connectivity

• Machine Learning (ML) platform designed with the scalability to ingest, process, and create/update ML from streaming, widely ranging data sources

• Ability to deploy new or updated ML models to vehicles that exceed data fidelity and model accuracy expectations via OTA software updates

• Embedded intelligent edge computing
• Secure and reliable embedded edge operating system
• Dynamic over-the-air software updates
• Enterprise-level advanced analytics and machine learning platform
THE CONNECTED VEHICLE MACHINE LEARNING LIFECYCLE

CLOUD PLATFORM

SOFTWARE PLATFORM

HARDWARE PLATFORM

THE CONNECTED VEHICLE

INTELLIGENT EDGE

DATA SOURCES
• CAMERA
• RADAR
• LiDAR
• GPS
• IMU
• OTHER SENSORS

TERABYTES OF DATA/VEHICLE/DAY

IN-VEHICLE PROCESSING UNIT

THE CLOUD

RELEVANT AND WIDE-RANGING DATA

DATA STREAM FROM VEHICLE

OTA SOFTWARE UPDATE

MILLISECONDS LATENCY

THE CONNECTED VEHICLE MACHINE LEARNING LIFECYCLE

THE CLOUD

1 ENRICH, ANALYZE, STORE

2 MASSIVELY SCALABLE STORAGE AND COMPUTE

3 CONTINUOUSLY DEVELOP AND UPDATE ML MODELS

4 DEPLOY

INTELLIGENT EDGE

DATA SOURCES
• CAMERA
• RADAR
• LiDAR
• GPS
• IMU
• OTHER SENSORS
A multi-party automotive industry technology collaboration to define a data lifecycle platform for enabling and optimizing future connected and autonomous vehicle systems.

The Fusion Project
INITIAL USE CASE: INTELLIGENT VEHICLE LANE CHANGE DETECTION

Use Case Goals

- Lower data transmission and storage volumes
- Continuously updated ML models for higher accuracy
- Faster machine learning

Raw Sensor Data → Lane Change Detection → to train

for better Accurate Lane Keeping → to make Safe Lane Overtaking

ADAS L2/3 → for Path Planning → to get to Autonomous Driving

AD L4
**INITIAL USE CASE: IMPLEMENTATION**

**Intelligent Vehicle Lane Change Detection**

1. High-speed vehicle sensor data is collected and processed in the vehicle.

2. Edge AI software is configured by the customer to select the Lane Change events to be ingested by the cloud ML platform.

3. Processed, AI-relevant vehicle data is transmitted to the cloud for additional analytics, machine learning, reporting and storage.

4. Customers can configure information to be ingested from their fleet to train specific AI-models. This significantly accelerates the training of customers’ AI-models.

5. Analytics Modules are automatically updated with new ML models.

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**THE INTELLIGENT EDGE**

1. 
   - **EDGE HARDWARE** (NXP)
   - NXP BlueBox AD Platform and S32G GoldBox Gateway

2. 
   - **EDGE AI** (TERAKI)
   - Edge Collection, Analytics, Processing, Compression

3. 
   - **EDGE TO CLOUD** (CLOUDERA)

4. 
   - **AI TOOLING** (TERAKI)

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**THE CLOUD**

1. 
   - **EDGE MODEL** (AUTOMAKER)
   - (97% ACCURACY)

2. 
   - **EMBEDDED EDGE SYSTEMS** (WIND RIVER)
   - Embedded OS Systems

3. 
   - **UP TO 99% MODEL ACCURACY**

4. 
   - **ML TRAINING & RETRAINING** (CLOUDERA)

5. 
   - **VEHICLE SENSOR DATA**

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**DEPLOY**

- **OVER-THE-AIR (OTA) UPDATE** (AIRBIQUITY)
INITIAL USE CASE: INTELLIGENT VEHICLE LANE CHANGE DETECTION – ON-ROAD TESTING

Cameras

Inertial Motion
High-performance vehicle processing platforms and service-oriented gateway architectures (SoA) with:

- External and internal connectivity (Ethernet and CAN)
- Real-time ECU consolidation for vehicle-wide data access
- Network hardware accelerators that optimize System-oriented Architecture (SoA) data traffic
- Offload processor cores that focus on valued services

Direct SoA Data Traffic to Optimal Host/Virtual Machine

Advanced Data Filtering and Firewalling Based on Traffic Fields (e.g., SOME/IP Header Fields)

Hardware Isolation Technology to Isolate System Memory and Peripherals (Trusted/Untrusted, Safety/Non-Safety Critical)
NXP S32G GOLDBOX SERVICE-ORIENTED GATEWAY

- 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
NXP Layerscape LX2 + S32G BlueBox 3.0

- **Designed for Automated Drive**
  Designed, architected and built for existing and future workloads

- **Enhanced Performance**
  Based on high performance Layerscape2 Auto, S32G Gateway and 3rd party accelerator (Kalray Coolidge) expansion

- **True Embedded Platform**
  True automotive embedded platform featuring end-to-end auto grade system-on-chip ICs

- **Modular Scalable Open Platform**
  Flexible architecture supporting multi configurations to prototype various L2+ use cases

- **Flexible ASIL-B / ASIL-D Safety Decomposition**
  System level safety implementation with the device level safety collaterals

Increase the speed of development
INCREASE Performance

Embedded Architecture
Flexible and easy of prototyping

Protect your customers
Safety
NXP – THE FUSION PROJECT COLLABORATION SUMMARY

NXP is a leading automotive semiconductor provider that offers automotive processing solutions across multiple vehicle application domains. The NXP S32 Automotive Platform is a scalable computing platform that balances performance and power efficiency with microcontrollers and processors optimized for each vehicle domain. They’re designed to address current and future connectivity, security, and safety challenges.

S32G VEHICLE NETWORK PROCESSORS
NXP’s S32G Vehicle Network Processors are a combination of safe and secure, real-time and application processing, with embedded hardware security, network acceleration and heterogeneous vehicle network interfaces. The S32G processors enable modern service-oriented gateways for rapid deployment of new vehicle capabilities and advanced edge-to-cloud analytics to unlock the value of vehicle data.

S32G GOLDBOX
The NXP GoldBox is a compact, highly optimized and integrated reference design featuring the S32G vehicle network processor. With its high-performance safe and secure computing capacity and rich networking interfaces, the GoldBox can support several automotive applications such as service-oriented gateways, vehicle central compute, domain controllers, safety processors and block boxes. Carmakers, suppliers and software ecosystem partners can directly use the GoldBox to help accelerate development for shorter time-to-market.

NXP BLUEBOX
The NXP BlueBox is an Automotive High-Performance Compute (AHPC) development platform that provides the required performance, functional safety and automotive reliability for engineers to develop ADAS applications, self-driving cars, and innovate with new vehicle networking architectures and safety concepts. The BlueBox combines automotive-grade embedded compute, safety and networking processors with expansive I/O connectivity and an integrated Software Development Environment (SDE) enabling safe, reliable and scalable AHPC solutions.

https://www.nxp.com/Automotive

Brian Carlson
Director, Global Product and Solutions Marketing

“NXP is securely connecting our vehicle-wide S32 automotive edge processing platforms with the cloud to empower new data-driven services and business opportunities. This vehicle edge processing is critical to reduce the amount of data sent to the cloud for economic feasibility, as well as support vehicle-wide over-the-air updates and machine learning model deployment to drive the future of upgradable vehicles.”
INTELLIGENT SYSTEMS PLATFORM SOFTWARE

WNDRvR

Secure, reliable, open-source embedded edge operating system solutions:

• Embedded Linux for the Intelligent Edge
• Robust, secure, and reliable operating system environment
• Long-term support, maintenance, and security vulnerability monitoring
• Development, deployment, and operation lifecycle
Embedded AI applied on edge data is built upon:

- Deterministic reduction technology with an intelligent selection information (events, objects, situations) that are relevant to a given application
- Architecture that overcomes both on-board power limitations; lowers application latency and enables low-level sensor fusion
- Intelligently pre-process sensor data and increase the application (AI-models) accuracy

By 2023, more than 50% of enterprise-generated data will be created and processed outside the data center or cloud, up from less than 10% in 2019.

Source: Gartner
DATA LIFECYCLE SOLUTION FROM THE EDGE TO AI

CLOUDERA

Enterprise-class advanced analytics and machine learning solutions:

- Data management platform enabling real-time analytics on streaming data to effectively ingest, store, and process data in real time or near-real time
- Instantly delivers updated ML models to the vehicle through OTA technologies

Ingest and Deploy Real Time Vehicle Data
Combine All Data Types and Schemas Required to Build Accurate Machine Learning Models
Fully Integrated Data Management, BI, and ML Platform, Eliminating Point Solution Challenges
Data Security and Governance Across the ML Lifecycle from Ingestion to Deployment
OVER-THE-AIR (OTA) SOFTWARE AND DATA MANAGEMENT

Cloud-based orchestration and automation of over-the-air software updates and data management:

• Efficient OTA service delivery capability to overcome the increasing complexity of multi-ECU software and data campaigns
• Edge analytics framework supporting upgradable data analytics modules and Uptane-based multi-layer cybersecurity protection
• Efficiently planned and executed software update and data management campaigns using cloud-based back-end management tools
The Fusion Project Video
THE FUSION PROJECT OVERVIEW VIDEO
DEMONSTRATION HIGH-LEVEL ARCHITECTURE TO TRAIN AND RUN BETTER ML MODELS
CLOUD TOOLS DASHBOARD – VIEW CAPTURED VIDEO EVENTS AND PERFORMANCE METRICS
CLOUD TOOLS ANALYTICS – VIEW VEHICLE SIGNALS OF INTEREST AND DATA TRANSMISSION VOLUME
CLOUD TOOLS OTA SETTINGS

Enter VIN

JF123DEF1FGFF1000

Make
Mythos

Model
Poseidon

Trim
DX

Year
2013

VIN
JF123DEF1FGFF1000

Current Subscription Status
Subscribed

Most Recent Vehicle Configuration (Reported on Feb 23, 2021 5:30:43 AM)

- SDK_Primary_ECU_01
- SDK_Primary_Base_Pkg 1.0
- SDK_Secondary_ECU_01
- Teraki v3.1 update 3.1
THE INTELLIGENT CONNECTED VEHICLE FUTURE

• By creating a capable data lifecycle platform, The Fusion Project has opened the door for advanced intelligent vehicle use cases
  - From data ingestion through OTA machine learning deployments

• Fully-integrated hardware, software and cloud platforms for automotive customers to choose and train their own ML models

• Enables models to be trained 10x quickly and improve them over vehicle lifetimes as more data is collected in different situations

• IP and future developments are owned by the OEM – giving flexibility and technology flexibility and ownership
The Fusion Project
Data Lifecycle Platform Performance

- Up to 99+% Model Accuracy
- Up to 98% Data Reduction
- 10x Faster ML Training Time

Train Connected Vehicle AI/ML Models Faster with Higher Accuracy and Lower Cost
FOR MORE INFORMATION ON THE FUSION PROJECT

Visit The Fusion Project website to view video and eBook and request a demonstration.