

Safety in Software Systems Jamie Carlson, VP of Autonomous Drive

NIO is more than a car company

Conceived and planned since 2012 and formally founded on November 28, 2014. NIO is a global company that designs, develops, and produces smart, high-performance, premium electric vehicles. Our aspiration is to shape a better life for our users through thoughtful design, amazing services, and cutting-edge technology.



NIO has over 9,500 employees and world-class research and development, design, and manufacturing centers in Shanghai, Beijing, San Jose, Munich, London and seven other locations.



NIO's Products



One of the Fastest Electric Cars in the World From Track to Road

3

Vision Car NIO EVE The Second Living Space



NIO ES8 Flagship SUV High-Performance Electric SUV

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es8

100 M

NIO ES6 High-Performance Long-Range Electric SUV

NIO officially began deliveries of the ES8 on June 28, 2018 Over 11,000 ES8s delivered in 225 cities by February 2019

NIOApp

Moments



Activities



Friends



Surprises



Power Home

Plug in and charge

Power Mobile

Ten minutes of charging for 100km of range



3



Power Swar

One Click for Powe

Worry-free power services powered by the internet

NIOHouse

A Living Space for MO's Users and Friends

Production Model:

Manufacturing Partners + Independently Produced Core Components



Global EV sales are forecast to increase from a record **1.1 million vehicles worldwide in 2017 to 11 million in 2025**

EV Sales expected to surge to **30 million vehicles** worldwide in 2030 as they become cheaper to make than internal combustion engine cars.

CHINA is #1 in VEHICLE & EV MARKET SIZE and GROWTH



China is already the largest vehicle and electric vehicle market in the world

Massive future growth opportunities in China:

- Car ownership is estimated to reach a mere 15% by 2020 (estimated 30.2M vehicles)
- Current EV penetration in vehicle market is still low at 1.5% (325k vehicles in 2016)

Over **40%** of all EVs sold globally are sold in China.

2x the amount sold in the U.S.

China accounts for **27%** of the 88.1M passenger vehicles sold in 2017

SAFETY in Software Systems

AUTOMOTIVE INDUSTRY

Shorter time for disruption with higher impact

MECHANICAL & HYDRAULIC	ELECTRO-MECHANICAL	DIGITAL
Air Conditionir FM/AM Rad Automatic Transmissic Independent Front suspensic Drum Brak Ignitic 3 point safety seat Be Steel Car Boo Telescope Shock Absorb	g Hybrid o OnStar n CD Player n Electronic Fuel Injection ss ABS n Airbag It Electronic Control Unit y On-board diagnostic er Electronic Stability Control	Vehicle to Infrastructure Vehicle to Vehicle Auto Pilot Software-driven mobility Phone Screen Mirroring Park Assist Predictive Safety Systems Adaptive Climate Blind Spot Intervention Adaptive Cruise Control Adaptive Headlight Adaptive Power Steering Music Streaming GSM Connectivity Mobile Apps
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E/E ARCHITECTURE

Domain Zonal Architectures Ethernet Backbone



One of many E/E architectures under considerations at NIO.

COMPLEXITY



- One customer function may be spread across multiple ECUs.
- Different development teams for each ECU.
- Coordinating changes across multiple ECUs/suppliers takes a lot of time and costs a lot of money.

> Technical complexity & commercial complexity

Signals and services are construction artifacts (effect) not the source of truth (design objectives).

How do you alignment and consistency through the development?

From Martin Hiller, Volvo, from Automotive Ethernet Congress, 2019-02

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- Multiple algorithm pipelines
- Scheduling constraints and conflicts
- Hardware acceleration requirements
- Massive data volume

HARDWARE COMPLEXITY

- Vehicle compute will be a networked, distributed system
- There are multiple disparate hardware entities
- Multiple CPU architectures, as well as GPU, SIMD, and FPGA components

NETWORK COMPLEXITY

- Vehicle compute will be a networked, distributed system
- There are multiple disparate hardware entities
- Multiple CPU architectures, as well as GPU, SIMD, and FPGA components.

Tools exist for each domain, independently...

Is there a way to develop automotive systems that scale to allow continued electronics innovation?



NIO'S Point of View



- Single point of truth for app, simulation, communication, validation, and production and production testing.
- Allows for complete product life cycle management.
- Auto-configuration: Extracts all appropriate communication and network services into networking components and binds time-synchronization, assured message delivery, bounded latency, fault tolerance.
- Consistent-security: Binds message integrity, device identity, communication authenticity to applications respective signals and services.

FROM MODEL TO PROVISIONED SYSTEM

- Management of ingress/egress at every port
- Requirements for redundant paths between ECUs
- Securing access to the network and the data it carries

