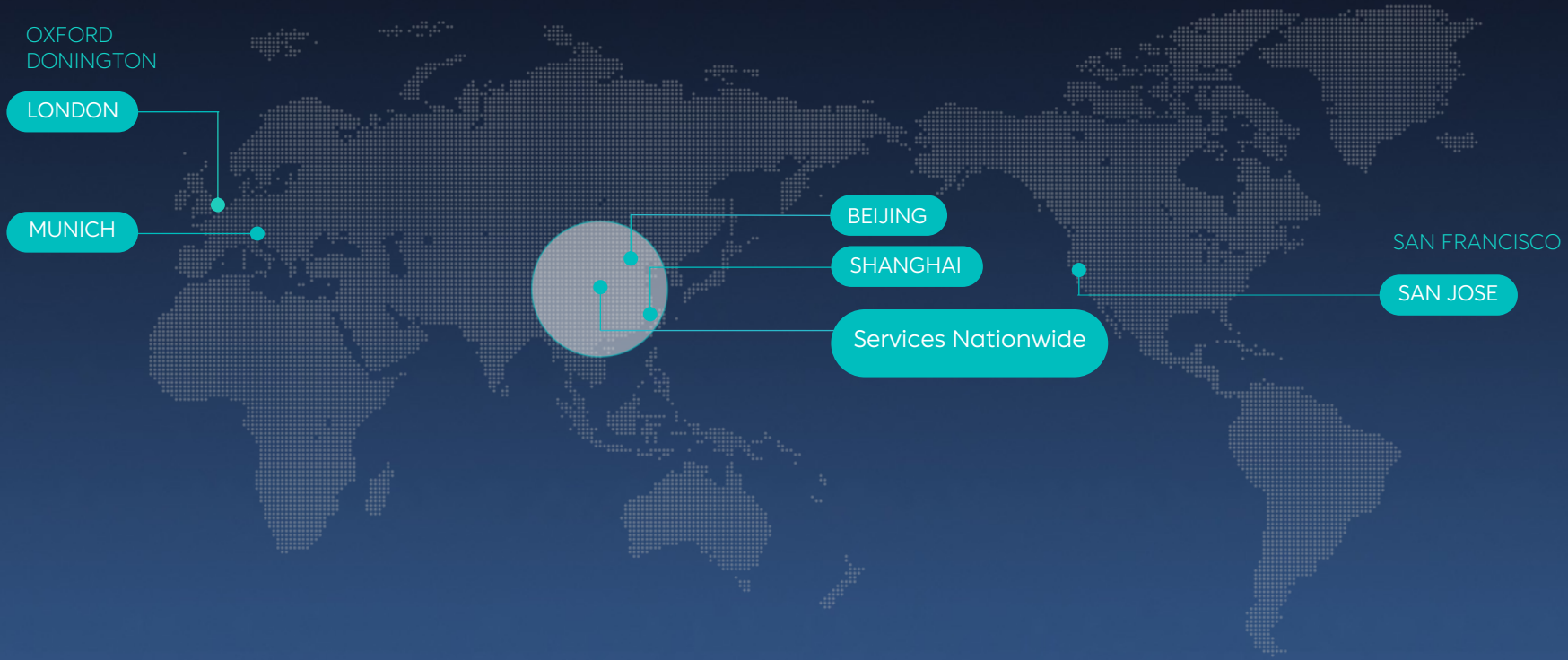
Safety in Software Systems

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

FE Racing Car

EP9

EVE

ES8

ES6


EP9
One of the Fastest Electric Cars in the World
From Track to Road

Vision Car NIO EVE

The Second Living Space

NIO ES8 Flagship SUV

High-Performance Electric SUV

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

NIO App

Moments

Activities

Friends

Surprises

Power Home

Plug in and charge

Power Swap

Battery swap in minutes

Power Mobile

Ten minutes of charging for 100km of range

One Click for Power

Worry-free power services
powered by the internet


NIO House
A Living Space for NIO'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

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)

Source: McKinsey, IEA, Statistica

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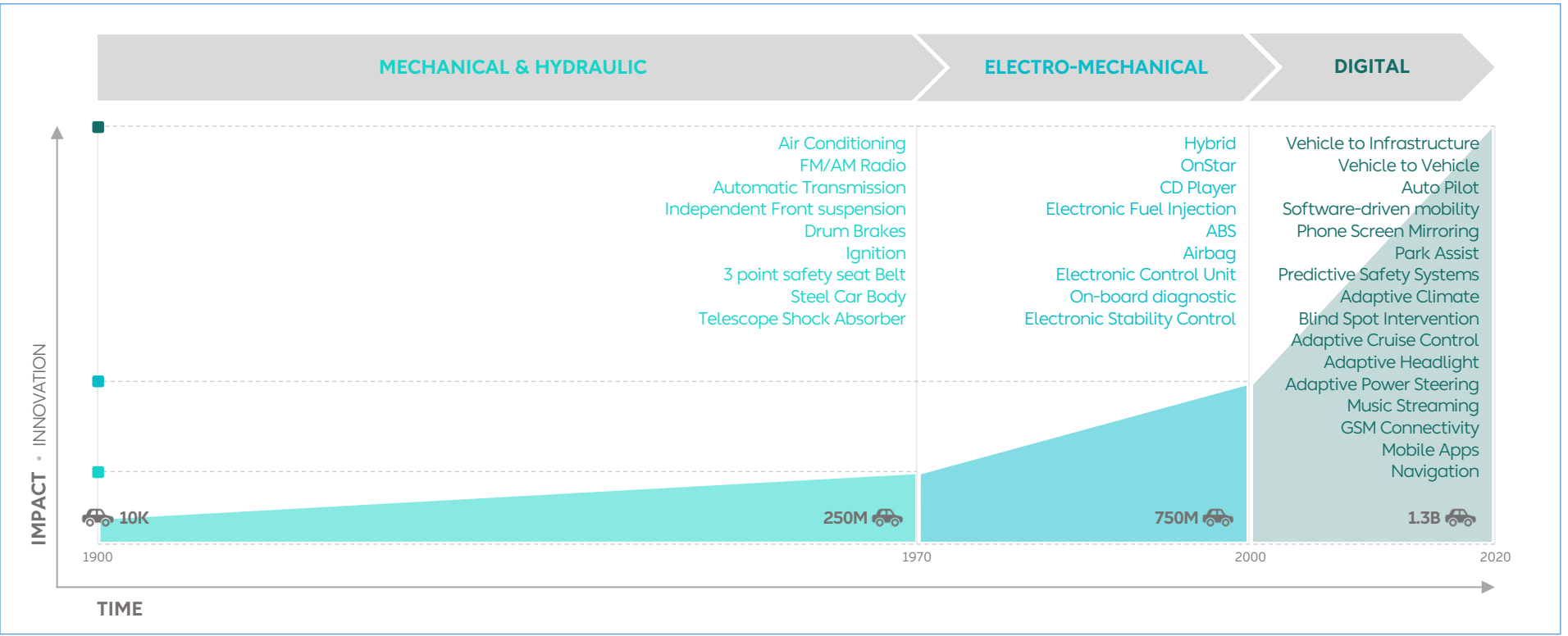
SAFETY
in Software Systems
es8

AUTOMOTIVE INDUSTRY

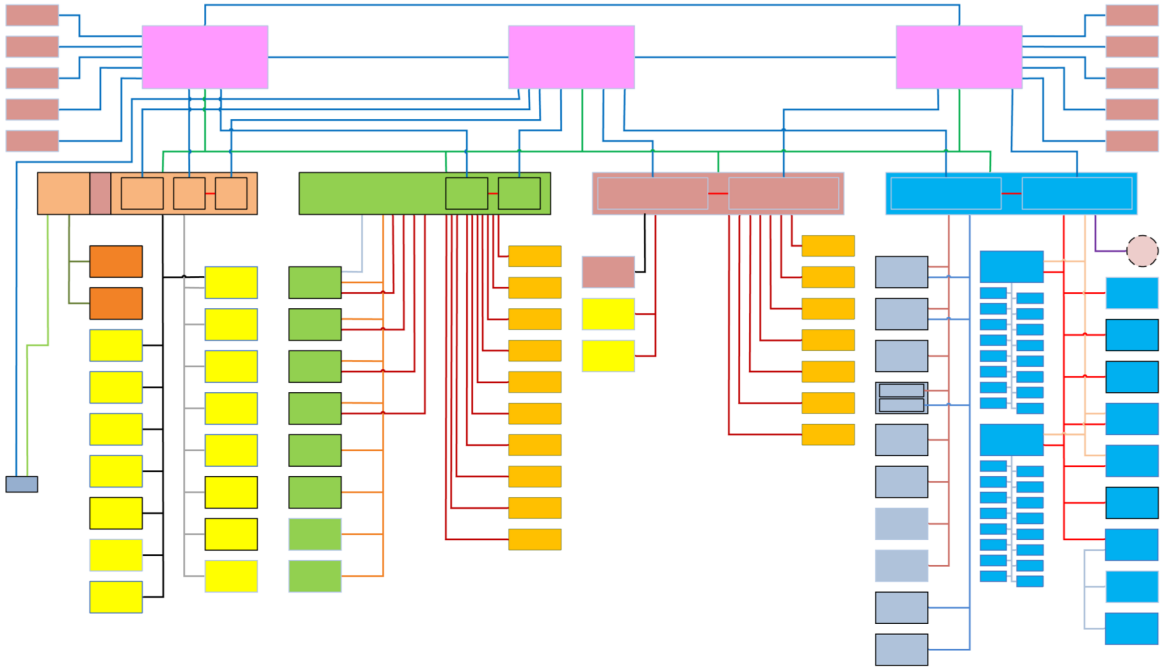
Shorter time for disruption with higher impact



E/E ARCHITECTURE

Domain Zonal Architectures

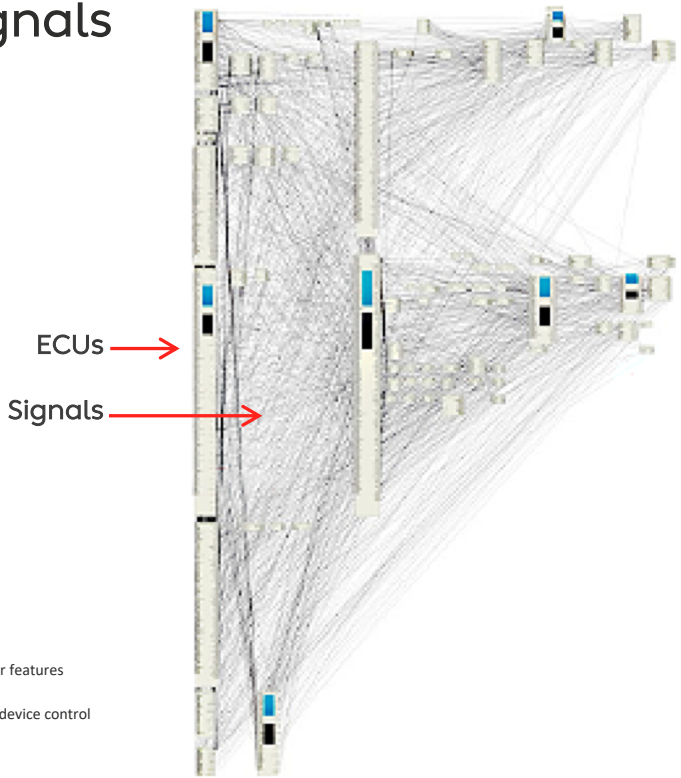
Ethernet Backbone



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

COMPLEXITY

ECUs & Signals



- 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

SOFTWARE COMPLEXITY

- 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

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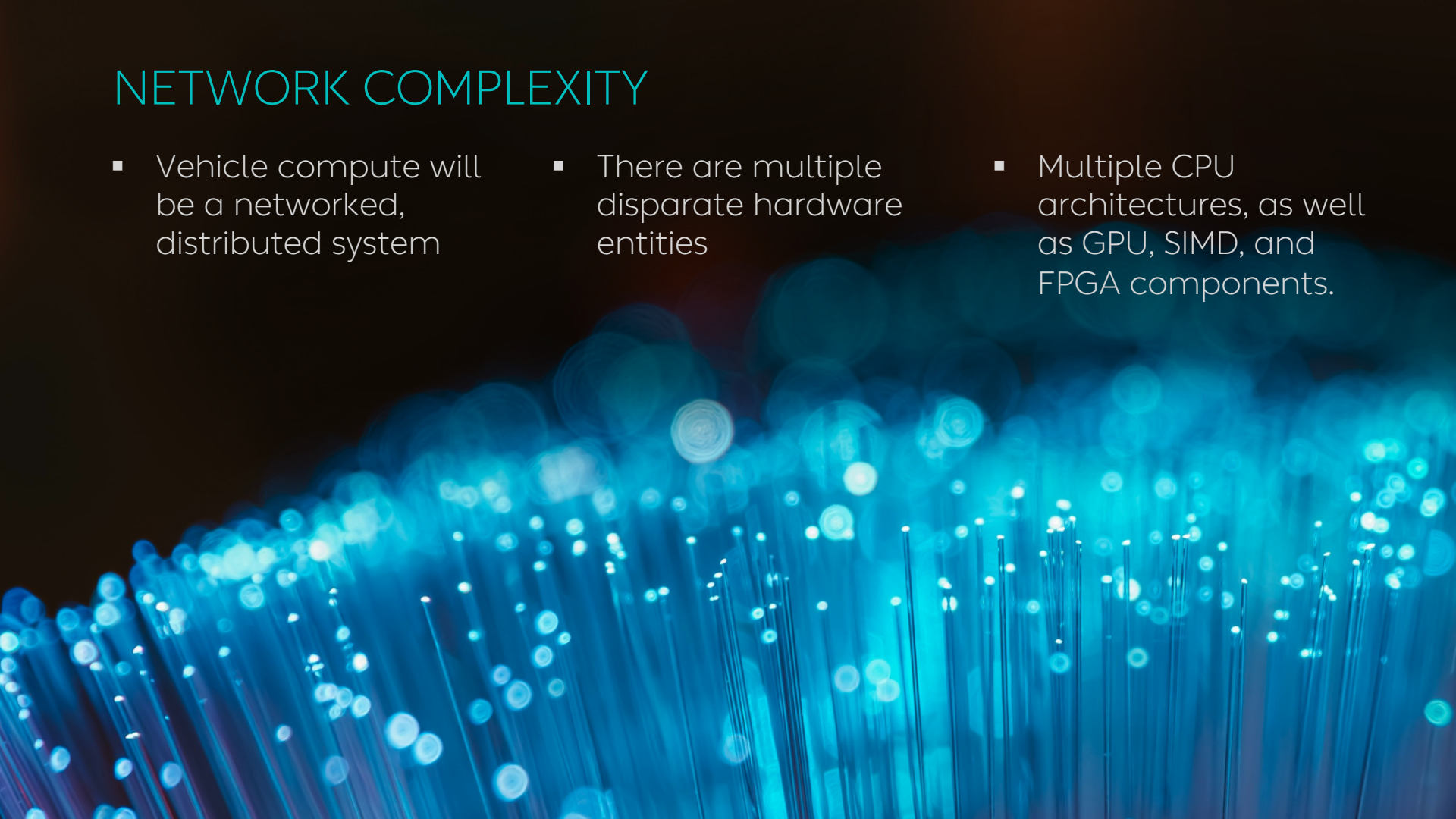
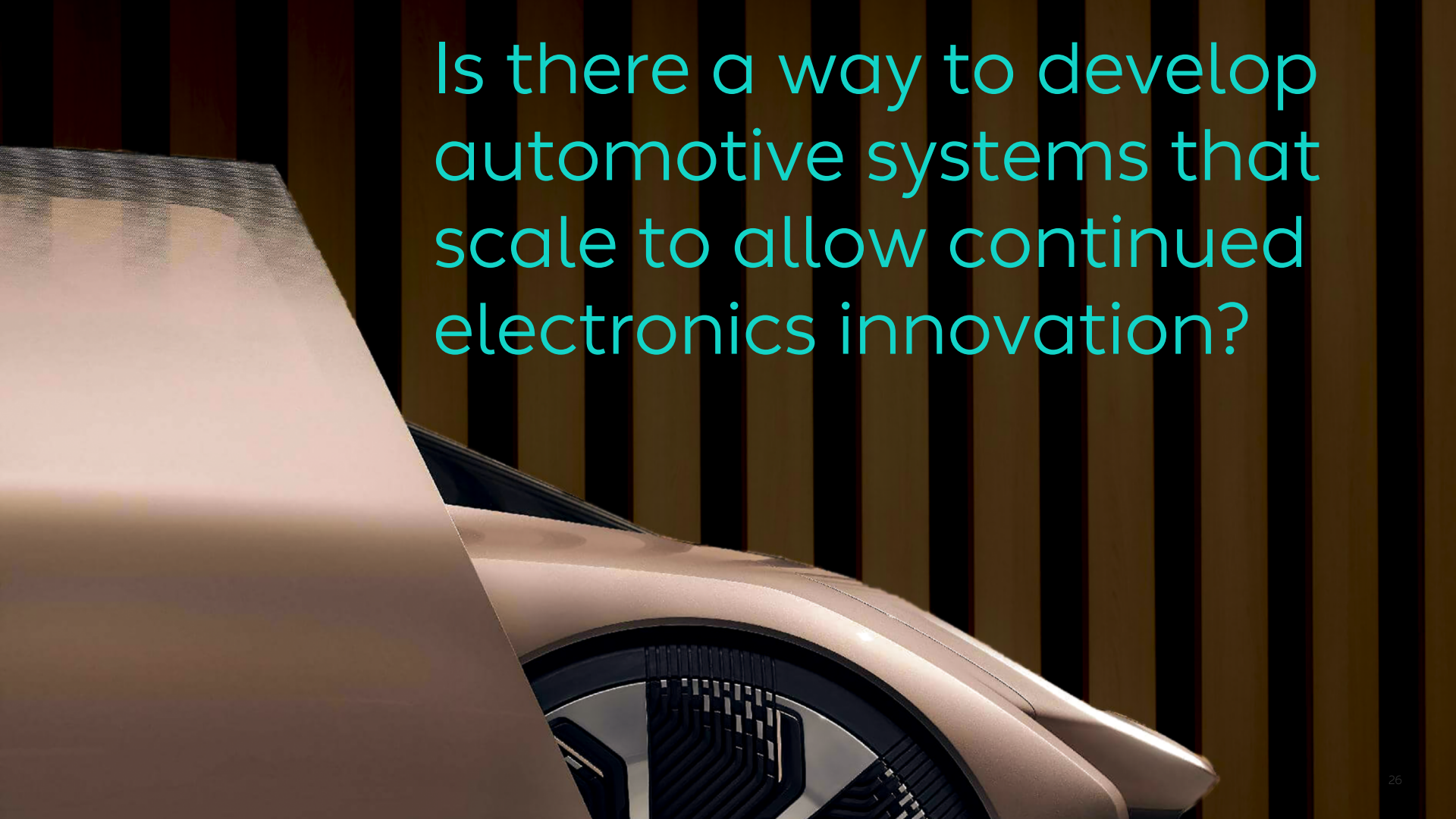
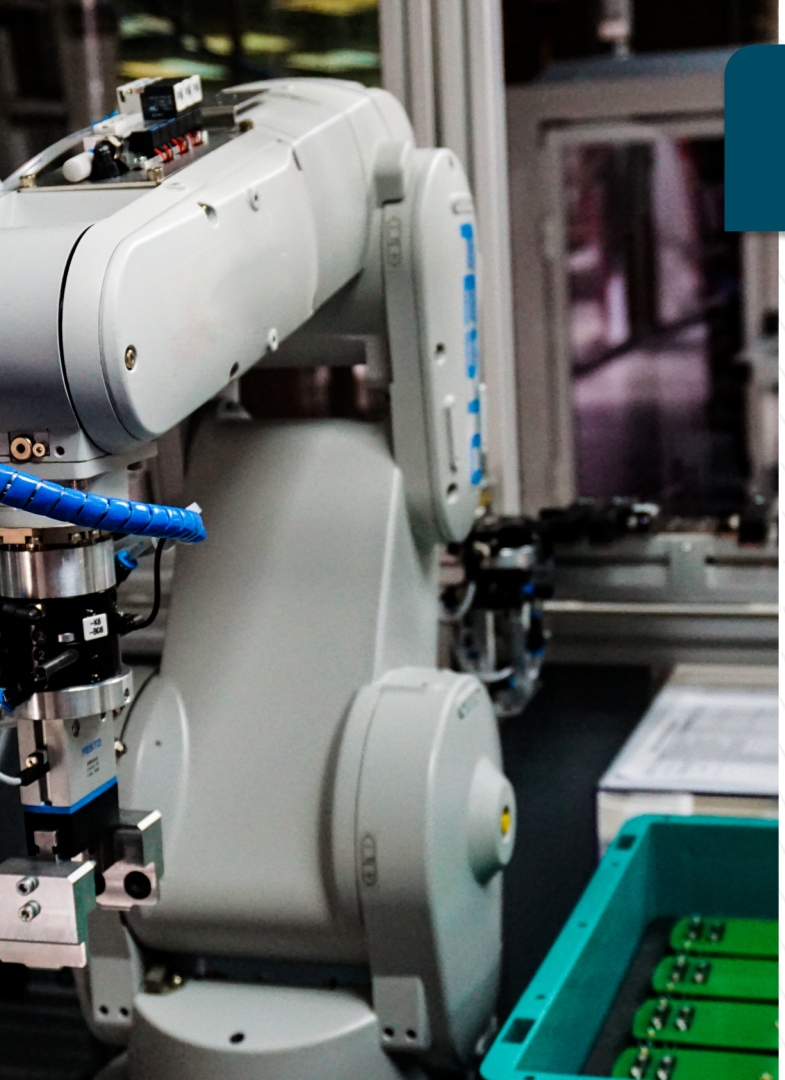


Tools exist for each domain, independently...


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

Thank you