



# **Industry standards for advanced vehicle data**

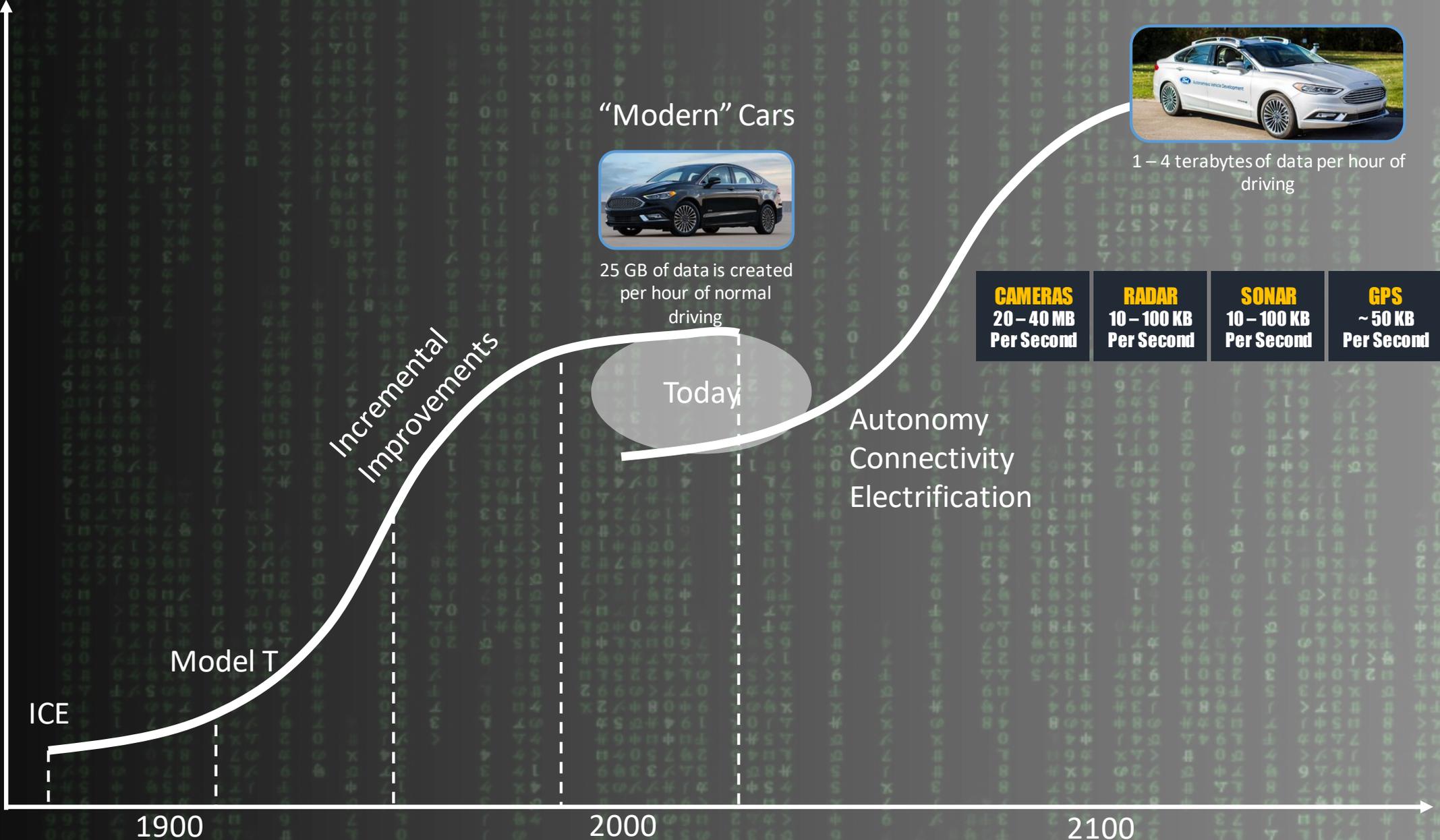
# Industry Trends

It's amazing how much data is out there. The question is how do we put it in a form that's usable?

~Bill Ford



Growth



“Modern” Cars



25 GB of data is created per hour of normal driving

Autonomous Car



1 – 4 terabytes of data per hour of driving

Today

Autonomy  
Connectivity  
Electrification

ICE

Model T

Incremental  
Improvements

1900

2000

2100

Time



# What Do We Consider Advanced?

**In Vehicle**

**Video Streams**

**Labeled Video**

**Signal Aggregations**

**DTC's with Context**

**Histograms**

**Audio Streams**

**Predictive Signals**

**High Frequency Time Series**

# With Proper Design, Legacy Vehicle Networks Can Handle Complex Data

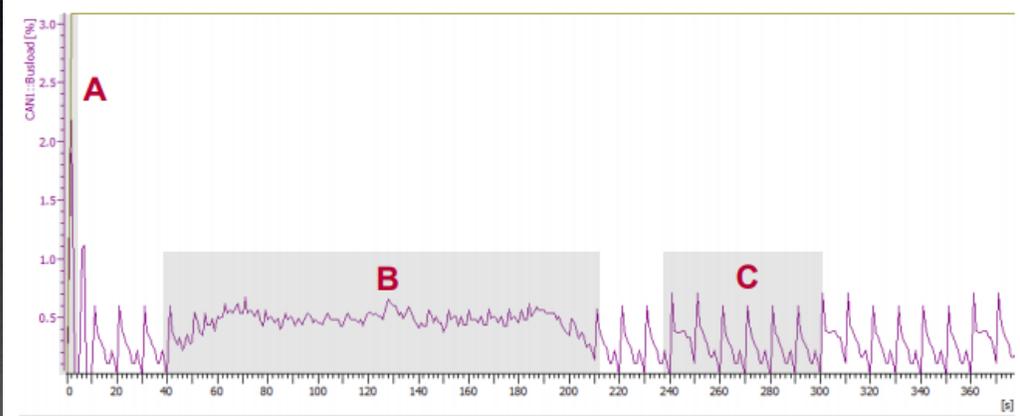
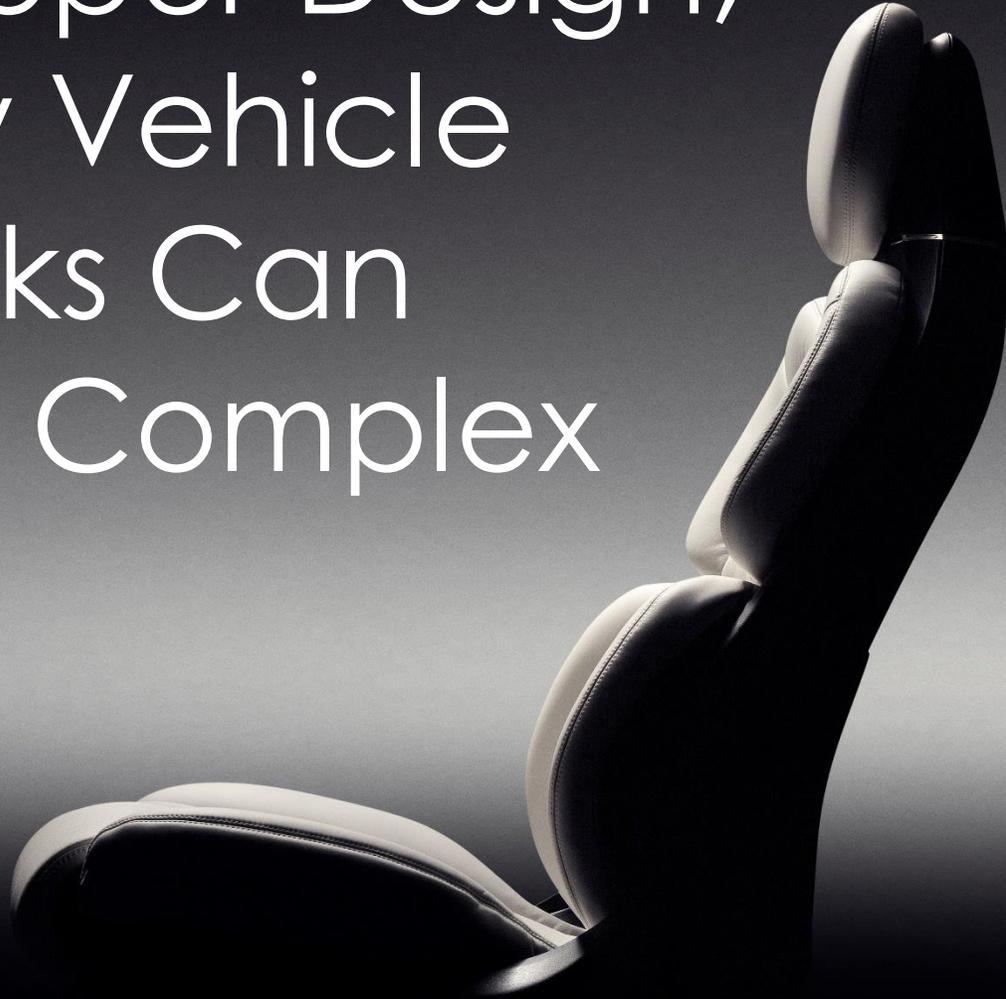
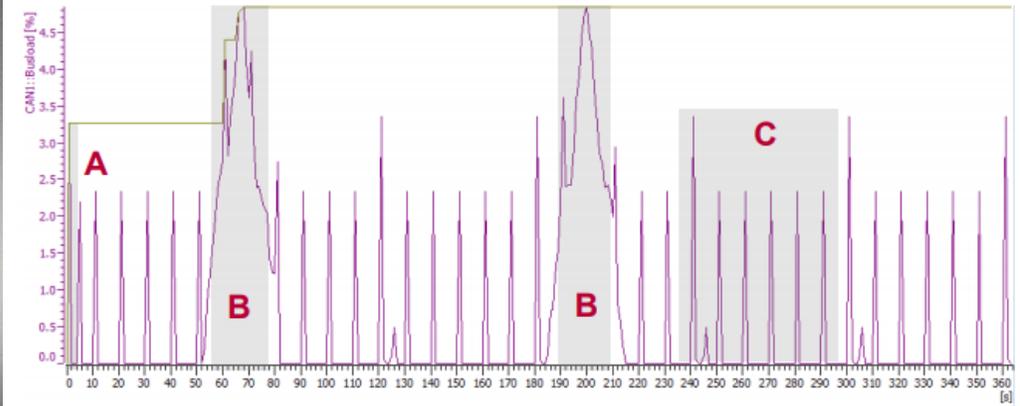
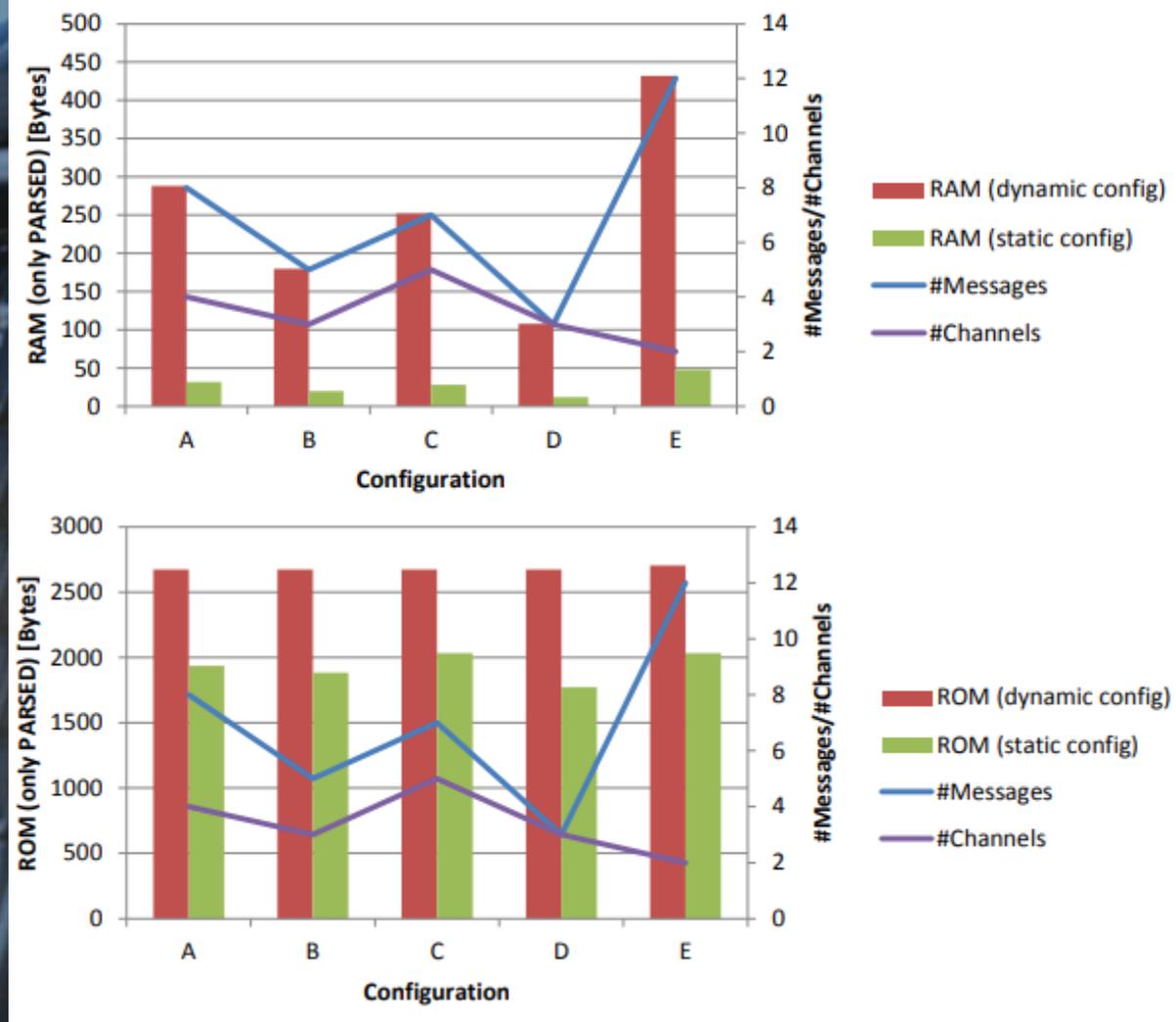


Figure 4-1 PARSED Busload for 20 ECUs with STmin=1000ms.



Courtesy: Vector Informatik GmbH

# Without significantly impacting RAM and ROM Size Constraints for Limited Compute Modules.



# ECU Consolidation

Into a distributed central compute platform



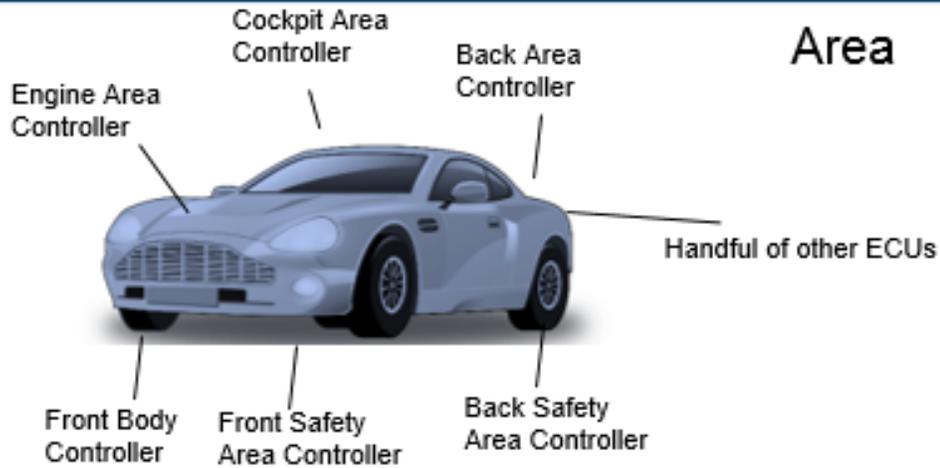
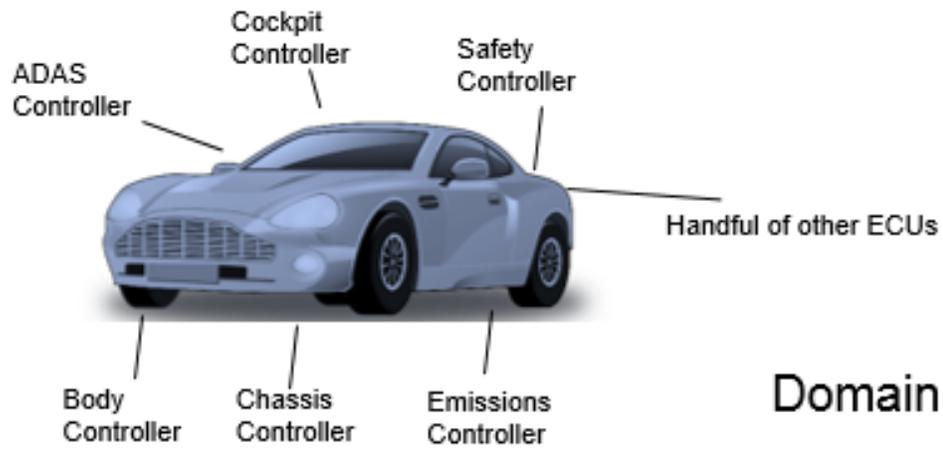
## TODAY

- 60-100 ECUs
- 6-8 operating systems
- Isolated operations
- Increasing cost & complexity

Courtesy: QNX



Combined with improved compute performance through module consolidation



## TOMORROW

Courtesy: QNX

- 6-10 Domain/Area Mega-controllers
- Consolidated software system
- Coordinated operations
- Reduced weight, cost, & complexity



The compute capability of Domain Consolidation Opens New Opportunities for Advanced Data Collection



What Should Those Data Structures Look Like?

How do you scale them across industry?

How do we share insights with our supply base?

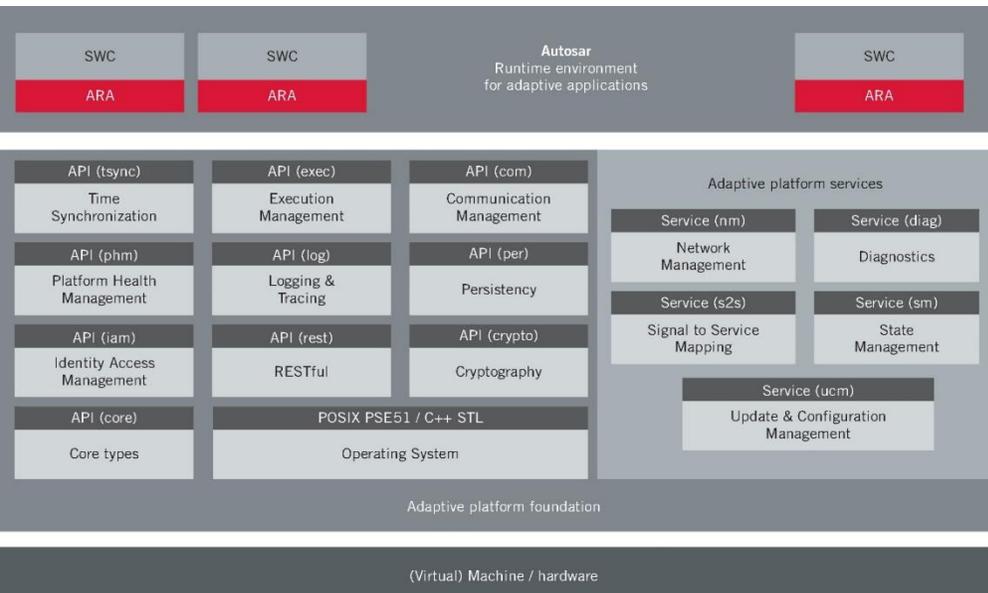
```
object ▶ Signal ▶ children ▶ ADAS ▶
└─ object {3}
  └─ Attribute {3}
  └─ Signal {3}
    └─ description : All signals that can dynamically be updated by the vehicle
    └─ type : branch
    └─ children {7}
      └─ Body {3}
      └─ Drivetrain {3}
      └─ OBD {3}
      └─ ADAS {3}
      └─ Chassis {3}
      └─ Vehicle {3}
      └─ Cabin {3}
    └─ Private {3}
      └─ description : Uncontrolled branch where non-public signals can be defined.
      └─ type : branch
      └─ children {0}
        └─ (empty object)
```

Courtesy: GENIVI

# How do we scale into lower level modules?

# How do we incorporate them across OEM's?

# Current Standards stop at basic Integer/float definitions





What Scripting tools and capabilities should we be using as an industry in an embedded environment?

- Python?
- Lua?
- Scala?

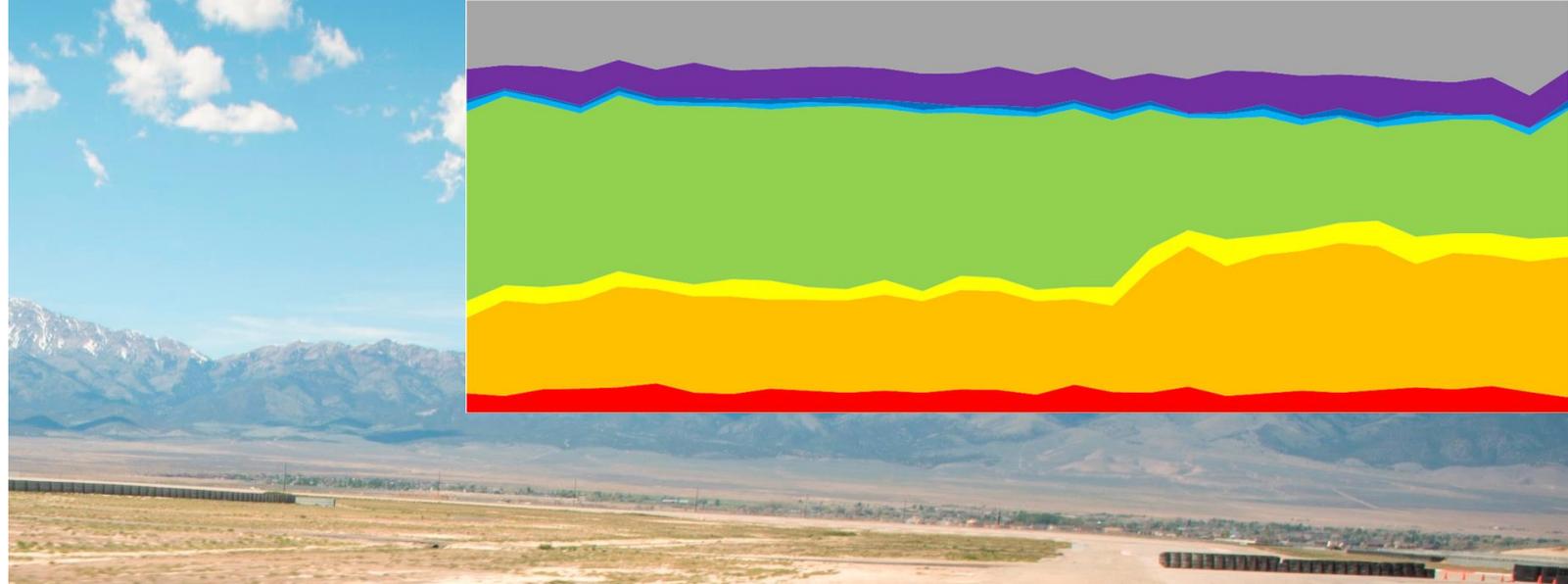
How do we manage safety and privacy regulations with scripting?

We aren't waiting for a full industry consensus to derive value today.



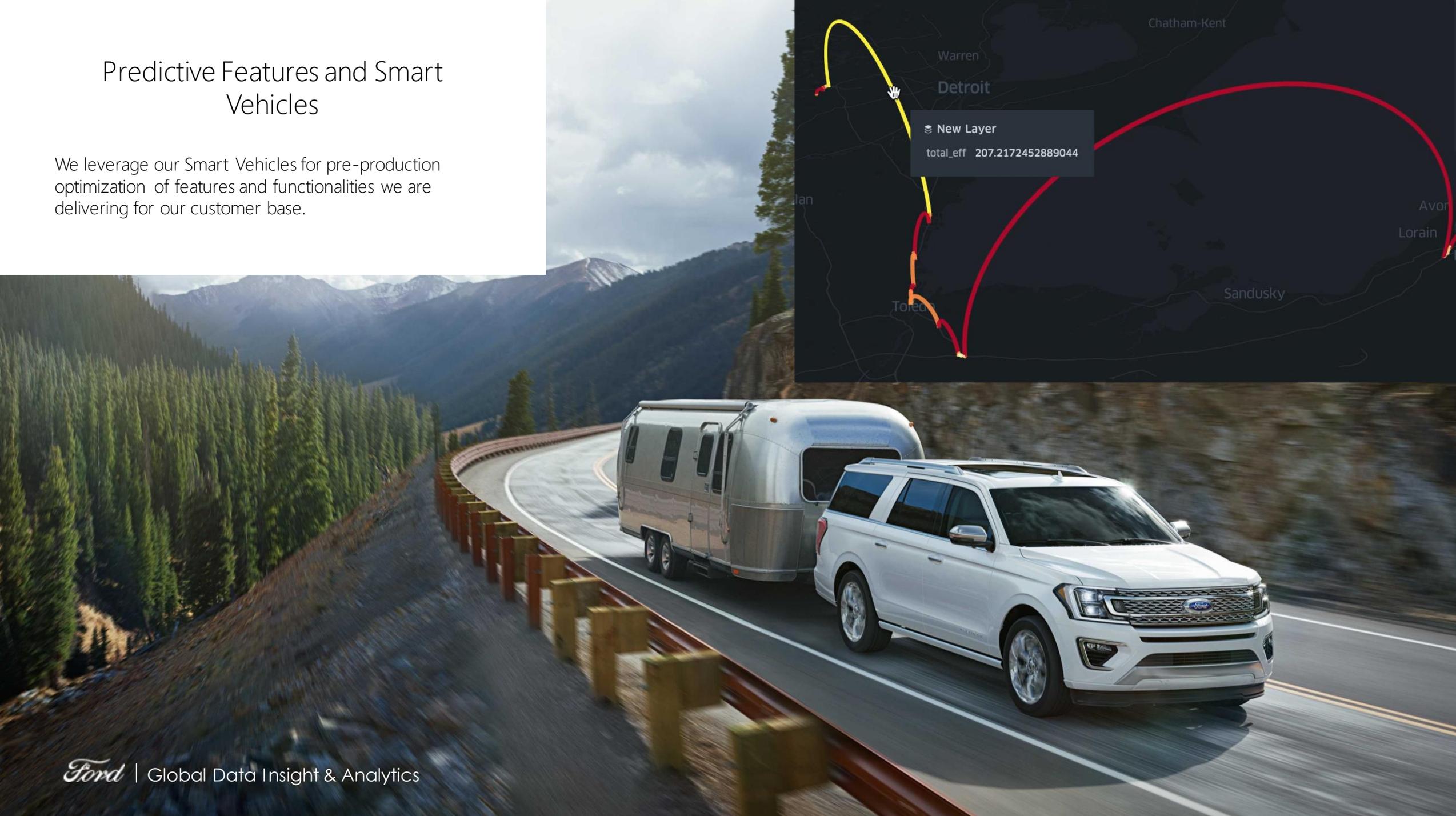
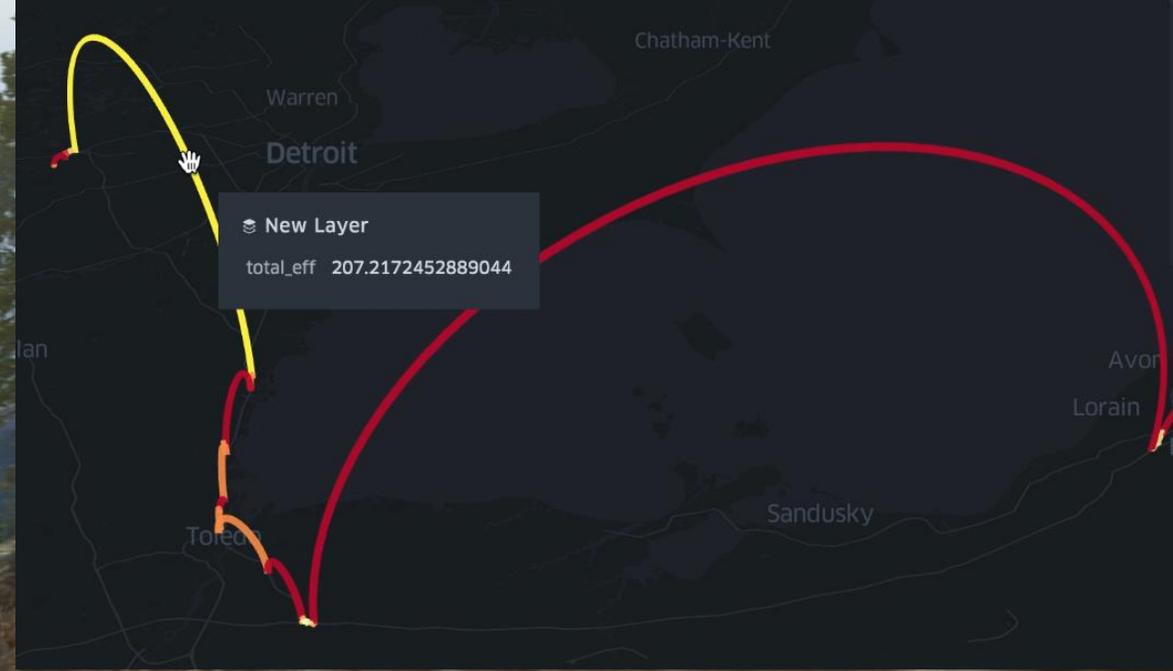
## Customer Listening Habits Drive Feature Development

Less than 2% of smart vehicle customers were using the Front Disc (CD Player) technology in 2018 when we decided to remove the feature from the vehicle. Our understanding of our customer's feature utilization, benchmarked against third party market research confirmed we made the right decision.



# Predictive Features and Smart Vehicles

We leverage our Smart Vehicles for pre-production optimization of features and functionalities we are delivering for our customer base.

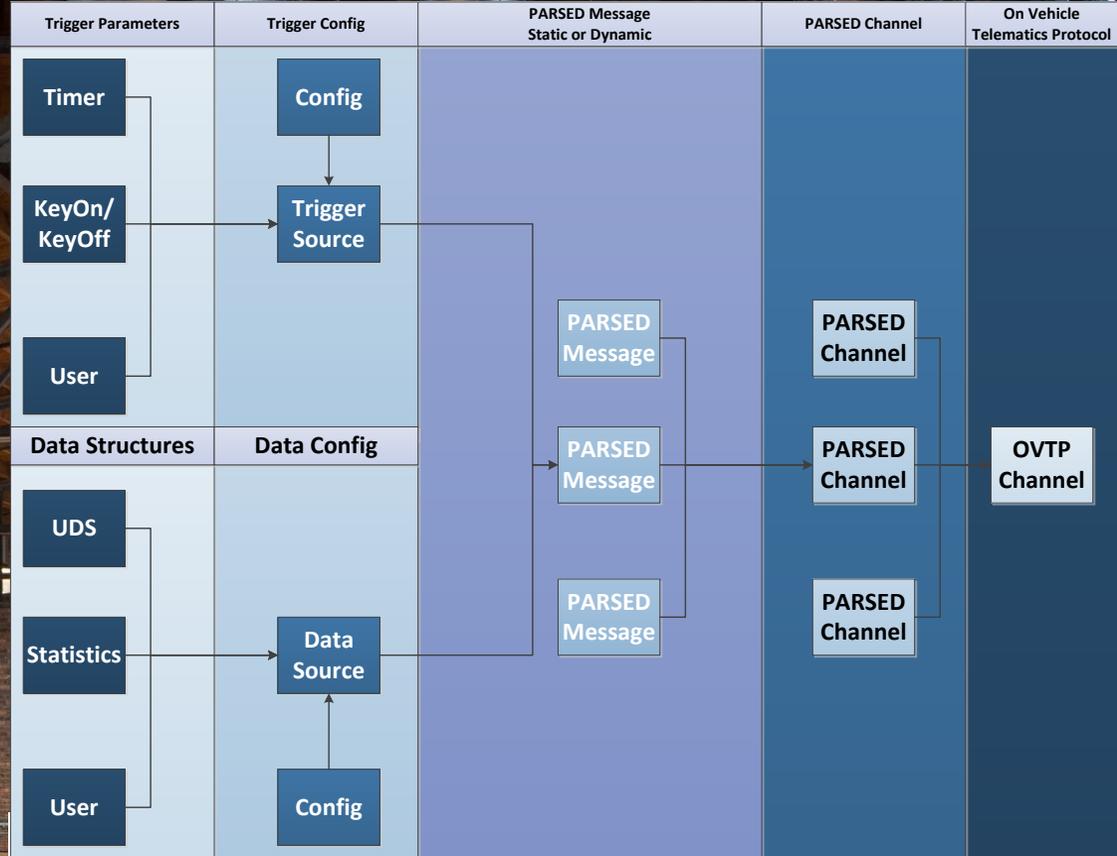




## Smart Vehicles at Scale

Our mandate for 100% connectivity is unlocking new opportunities for our customers. The density of data our smart vehicles generate is staggering.

It allows us to have a new agility around insights on what products we want to provide for each region, new opportunities for efficient logistics, and a re-Imagination of the relationship between a customer and its vehicle.

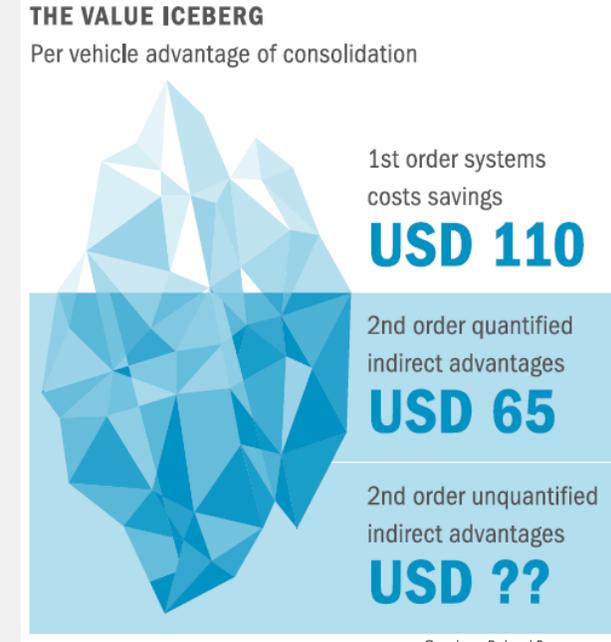


## Advanced Data Schema Design

We've gone as far as defining our own embedded data sets and data schemas to accelerate the utilization of data for scalable decision making around feature utilization, warranty cost improvement, and better customer experience

We recognize this only works if the data set reaches a significant market segment and economy of scale to support Tier I and Tier II needs as well.

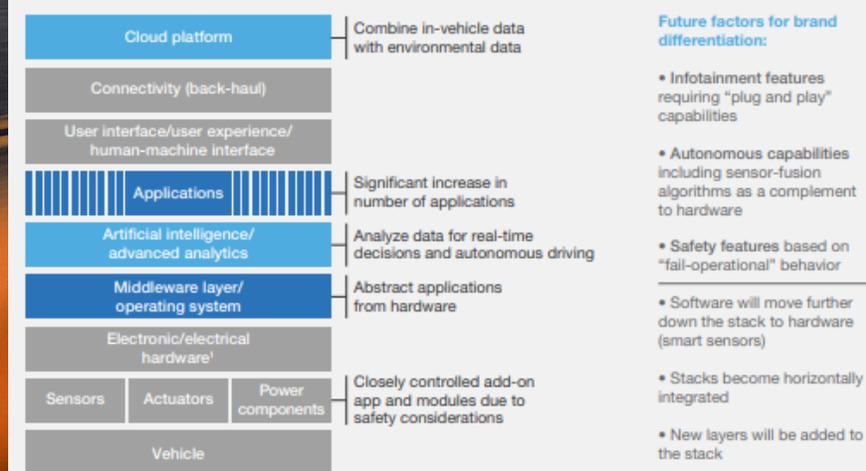
These market trends offer us the opportunity to once again rethink the relationship between a customer, their vehicle, and the connected world around them.



Architecture will become service oriented, with new factors for differentiation.

#### Future layered in-vehicle and back-end architecture

■ Existing layer ■ Modified layer ■ New layer



<sup>1</sup>Including operating system in status quo.

# Thank You

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