TATA

TATA ELXSI

Increasing Complexity of Software in Automotive Industry

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Tata Elxsi | An Introduction

Design, Engineering and Solutions Focus

- Established in 1989, Independent public company, listed on NSE and BSE
- Integrated capability for software, hardware and systems - over 25 years of experience
- ‘Consumer Insights” led design and UX – studios in London, Bangalore, Pune
- IP and solution accelerators, automation tools and process frameworks to enable customers

Right Scale + Relevant Experience

- 5000+ engineers and growing
- Experience in aligned industry verticals – CE, Broadcast, Communications, Medical
- Flexible engagement models – ODC, CoE, Program based, Fixed Bid, T&M, SA

Assured offshore capability and processes

- Over 80% of projects completely delivered through offshore engineering teams
- ASPICE and SEI CMMi Level 5 certified processes
- Consulting & deployment of DevOps, Agile, Cloud Development Environments

Financial Stability and Performance

- $ 1B market cap, zero debt, large reserves
- Growth leader for Product Engineering Services
- TATA backing and financial strength

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Services & Industry Verticals

Technology consulting, R&D, Product Engineering, System Integration and Testing + licensable software components & IP to enable time-to-market

Consumer Electronics	Automotive	Communications	Medical Electronics
Smart TVs & Gateways, Smart Phones, Tablets, Consumer AV equipment, Broadcast devices and interactive applications	Infotainment, Telematics, ADAS, Safety & Security, Body, Chassis, Hybrids and Powertrain	3G and 4G wireless, Unified Communications, Internet Of Things (IOT), WiFi, Bluetooth, IP based voice and video	Wearable devices, Imaging and Graphics, Mobility, Compliance

Product Design & UI

Mechanical Packaging, HMI and User Experience

Application Software

Middleware, protocol stacks, applications

System Software

BSP, Drivers and Firmware, OS porting and optimization

Silicon & Hardware

SoC development, custom board and hardware design

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Key Stories from CES 2016

- **Toyota brings connected vehicle services to mainstream with its own big data centre and SmartDeviceLink**
- **Mercedes-Benz “It’s all about me” user experience**
- **Audi is fully connected, piloted and electrified**
- **Bosch to offer retrofitted eCall solution**
- **Subaru names Magellan as Cloud navigation partner**
- **VW shows BUDD-e van and e-Golf with connectivity**
- **Visteon develops cockpit ECU controller for carmaker**
- **Panasonic unveils in-car content delivery platform**
- **BMW shows AirTouch contactless touchscreen**
- **Nissan Europe selects Microsoft Azure for telematics system**
- **Harman: Connected services, drones, ADAS, active safety, Office 365 and Life-Enhancing Intelligent Vehicle Solution (LIVS)**
- **Magna teases affordable Level 2 autonomous technology in Cadillac ATS concept**
- **Subaru adds Liberty Mutual’s UBI app RightTrack to StarLink infotainment system**
- **QNX releases new software platforms for ADAS, automated driving and in-car acoustics**
- **Faraday Future reveals 1000HP intelligent electric concept car FFZERO1**
- **FCA’s 4th generation UConnect infotainment supports CarPlay and Android Auto**
- **AT&T expands 4G/LTE connected car agreement with Ford & BMW in Americas**
- **Kia’s sub-brand DRIVE WISE will work on intelligent autonomous vehicles**
- **Ford revs up development of autonomous vehicles, home automation and smart mobility**
- **Volvo and Ericsson collaborate to bring streaming content for autonomous cars**
- **Nuance powers BMW’s conversational in-car infotainment system with Dragon Drive**

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Key Automotive Industry Trends

- Connected Car
  - Connected Infotainment
  - Telematics
  - Apps
- Automation of Vehicle Functions
  - DAS
  - AEB
  - Steer By Wire
- Efficiencies
  - Lightweight
  - EV/HEV
  - Fuel Alternatives

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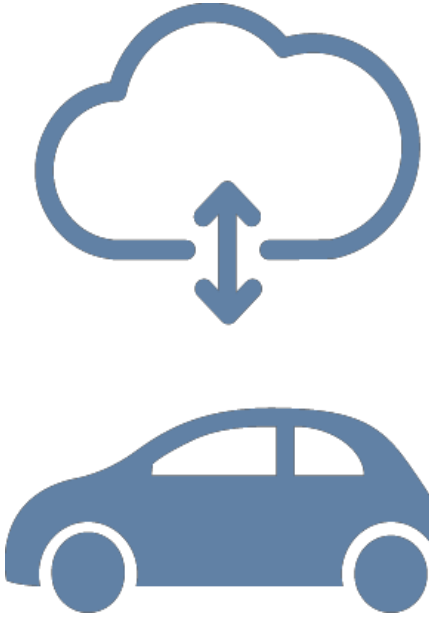
The “digital” car

Fighter planes	:	20 M lines of code
High end cars	:	100 M lines of code
Electronics SW	:	< 20% of car cost in 2005
Electronics SW	:	Almost 40% today
Innovation Spend	:	90% in Electronic Systems
Spend on innovation	:	US$ 105 B in 2014, 4% of revenue
SOC market	:	USD 31B, 7.5% growth



OEMs increasing Model choices but decreasing number of Vehicle Architectures

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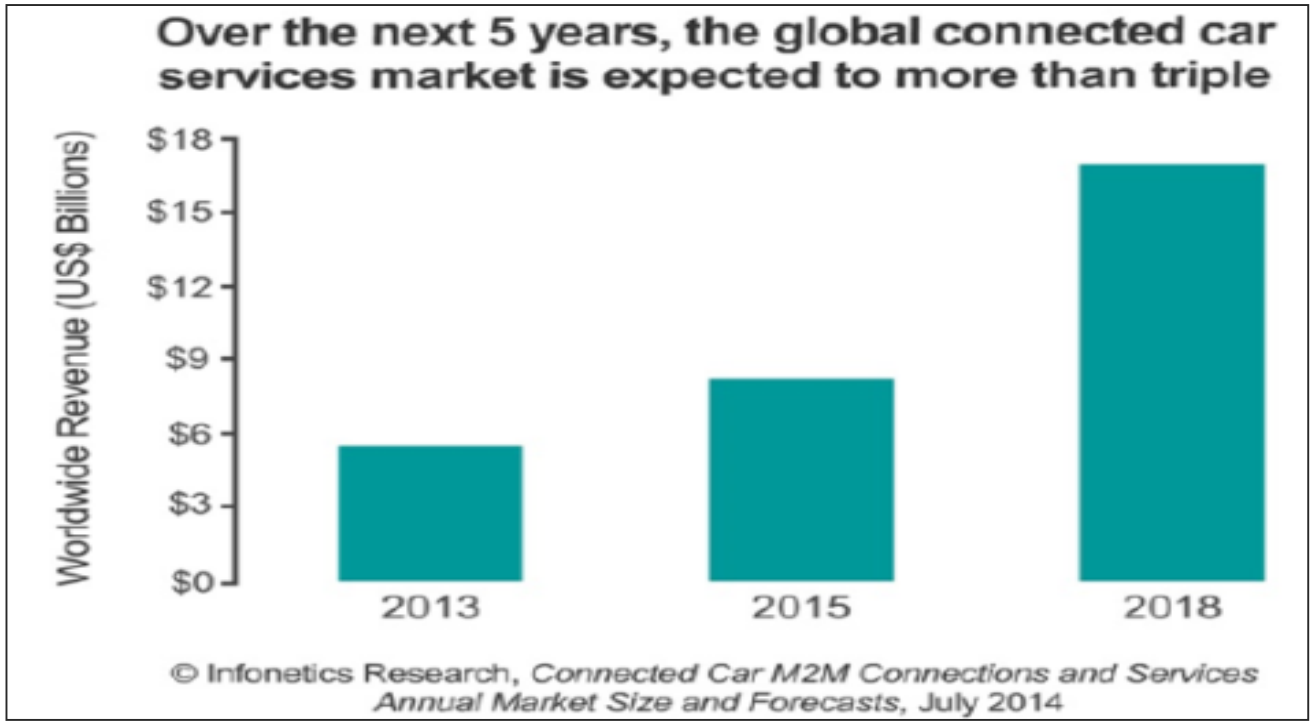
Connected Car trends

	Total Cars	Connected Cars
2014	1.05 B	8%
2015	1.09 B	10%
2017	1.18 B	14%
2020	1.32 B	20%



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Connected Car - Convergence of Technologies

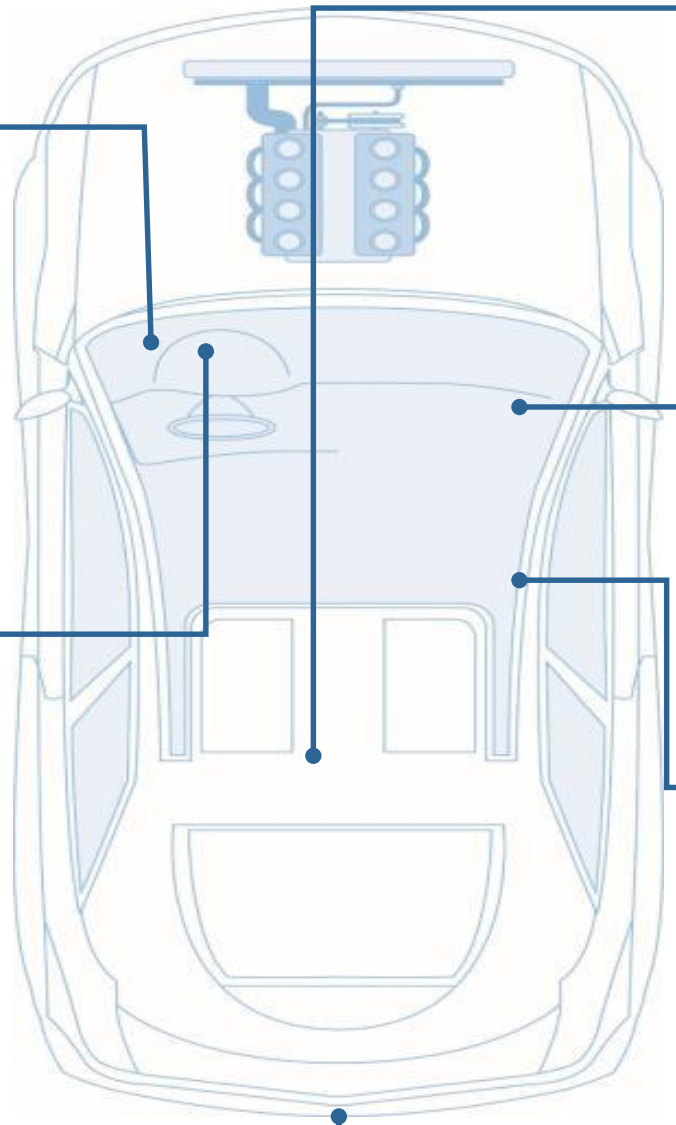
Telematics

- Turn – By – Turn Navigation
- Road Side Assistance
- Location Based Services

Remote Services

- Stolen Vehicle Detection
- Vehicle Health Report
- Geo Fencing
- Diagnostics

ADAS



Rear Seat Entertainment

- Smart Phone Integration
- Security
- Location Based Services

Connectivity

- 3G, 4G
- Car as a Hotspot
- OTA Updates

Connected Infotainment

- Content on the go
- Hands Free Calling / Bluetooth/Voice/ Gesture

Auto Industry capabilities

Non Auto capabilities

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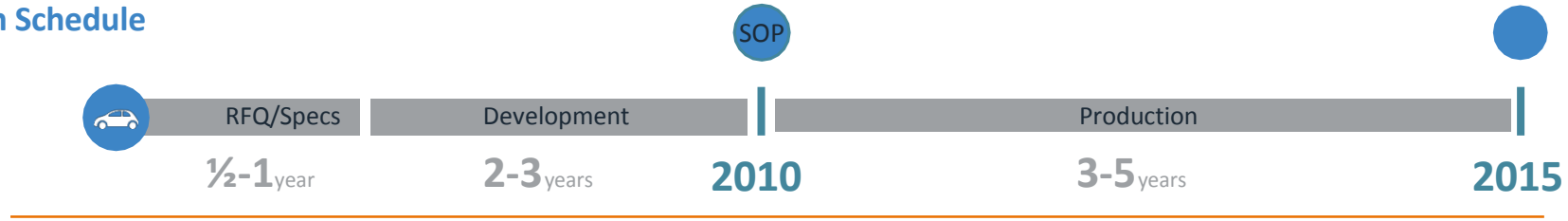
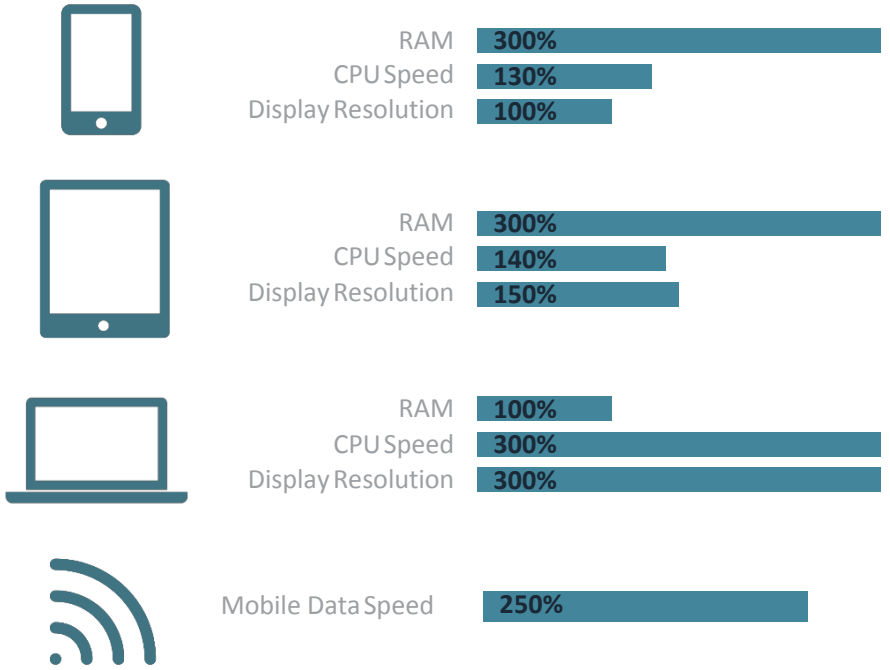
Challenges : "Clock Speed" delta between Car & CE

A Typical **Program Schedule**



But In 3 years,

Look how things change in the CE world…



As a result of this dynamic, **85%** of consumers would be willing to pay an additional **$150** just to have the **option to upgrade** their vehicle electronics

Vehicle development cycles are 3-4 years vs. typical consumer electronics development times of 18 months (or significantly less)

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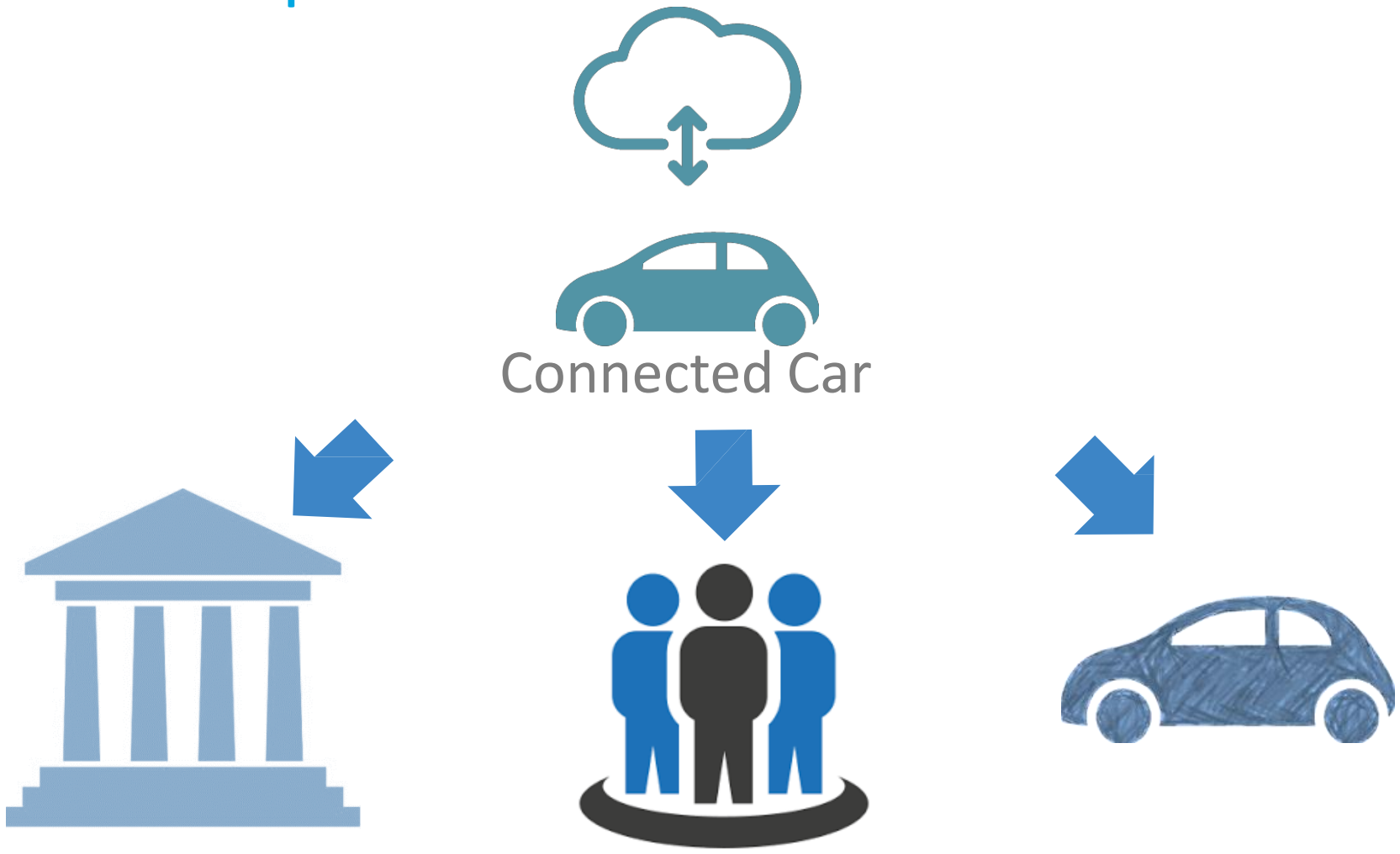
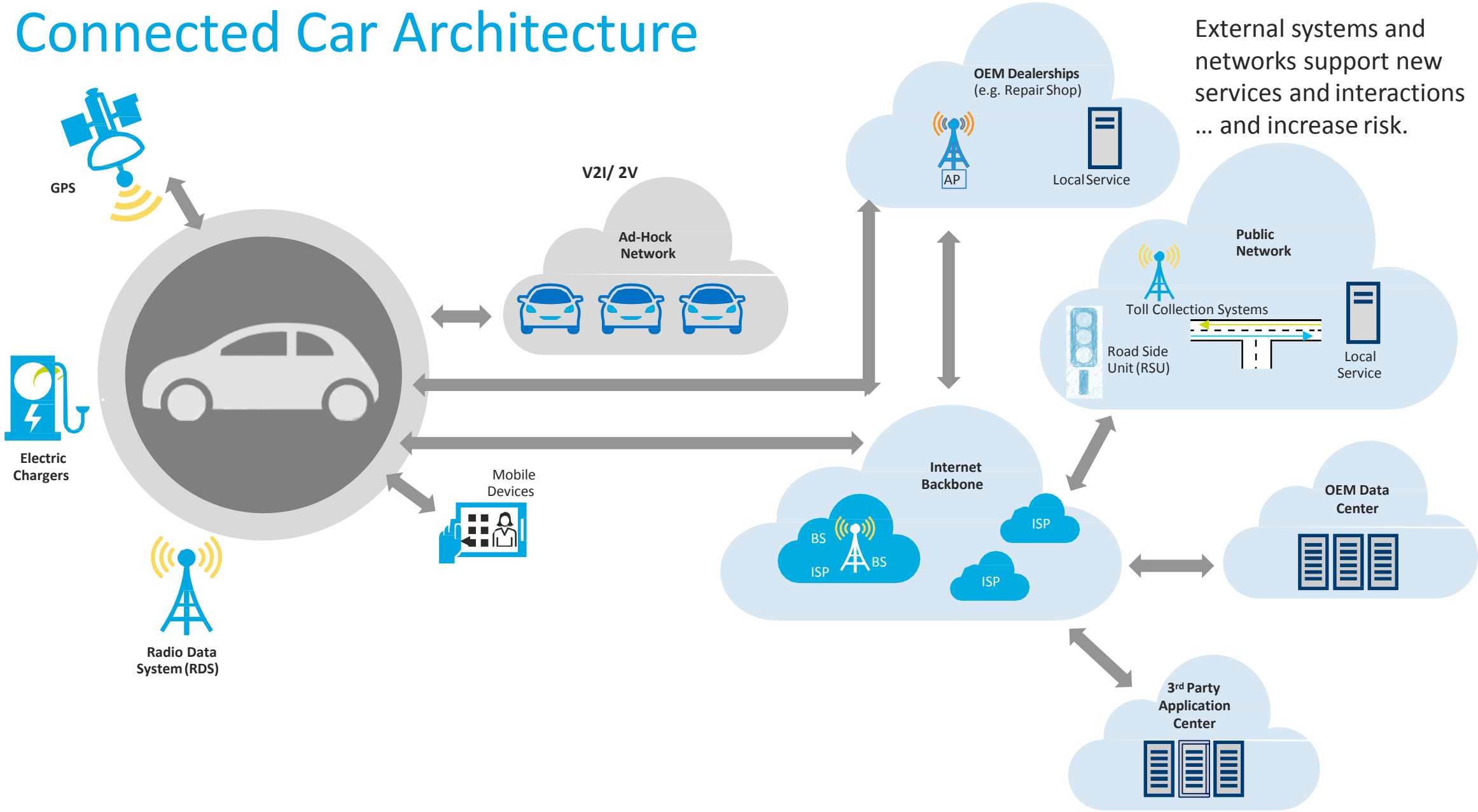
Connected Car Adoption



Connected Car Architecture

External systems and networks support new services and interactions … and increase risk.



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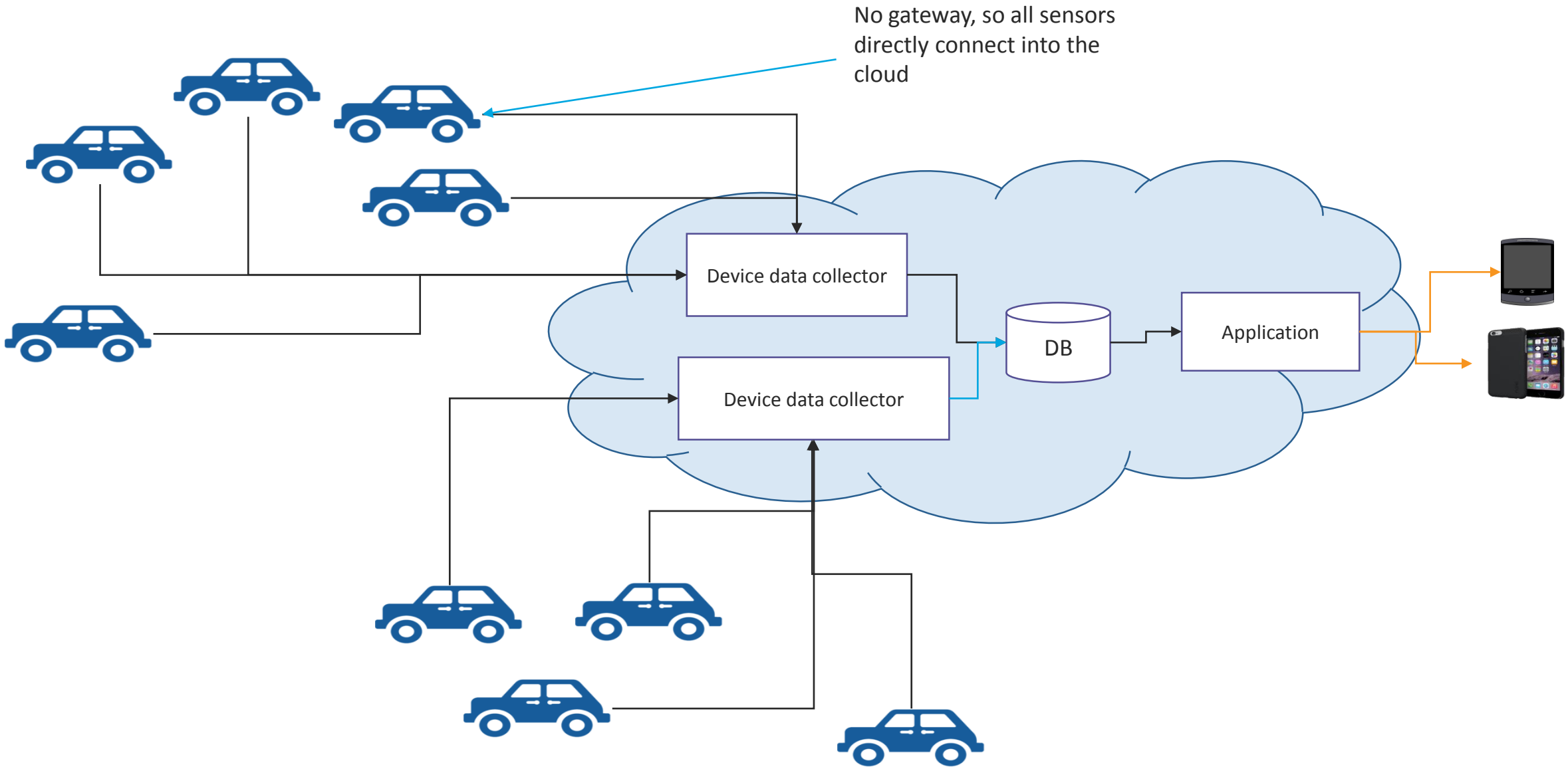
Connected Car Bird's Eye View



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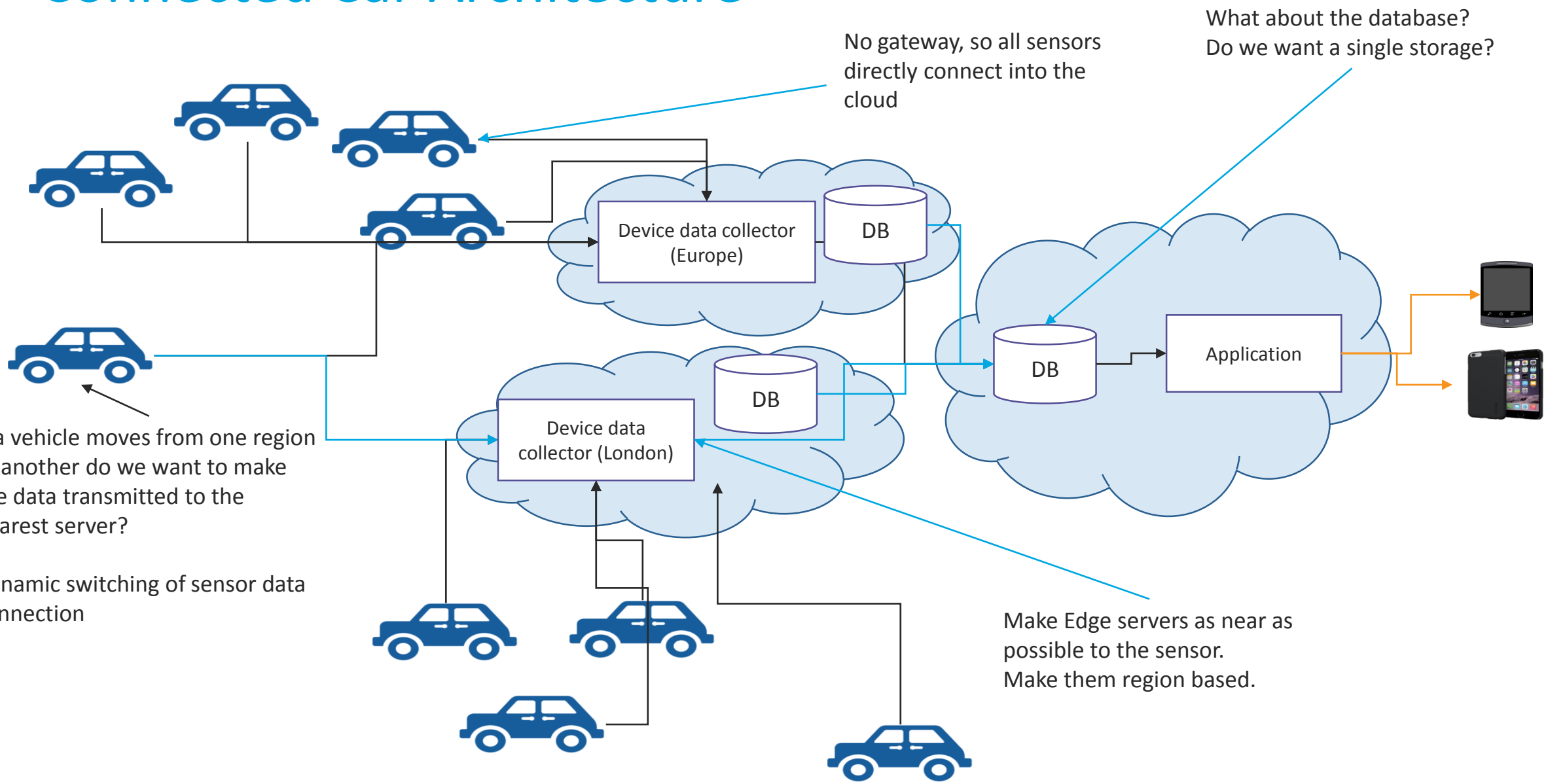
Connected Car Architecture



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Data Volume: 50GB+/per hour/per car

- Data accuracy vs data size
  - Eg., collect GPS data of vehicle
    - Latitude (8) + Longitude (8) + number of satellites (4) + direction (4) + altitude (4) = 28 bytes per collection per vehicle
  - Collect every 5s
    - 12 points every minute = 28 * 12 * 60 * 24 = 483,840 per day
    - i.e., 14, 515, 200 = approximately 15MB per month per vehicle
  - Collect every 1s
    - 60 points every minute = 28 * 60 * 60 * 24 = 2,419,200 per day
    - i.e., 72, 576, 000 = approximately 72MB per month per vehicle
  - Data size increased 4.8 times when we increase frequency
  - But accuracy is lost when we reduce frequency
- Accuracy required depends on data
  - Eg., For Vehicle tracking system,
    - If real-time route tracking is a requirement, location needs to be collected at a high frequency in seconds
    - While velocity of the vehicle can be tracked at a frequency of minutes maybe every 5 minutes
- Trade-off between accuracy and volume

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Database Choice: The Data Type

- Is Data geospatial?
  - For eg., Vehicle Management
    - Location of vehicles is location based
    - Need to know relations of vehicles w.r.t each other
  - Need geospatial representation of data
  - Geospatial query of data
- Is Data temporal in nature?
  - For Vehicle Management
    - Where was the vehicle at 12:00 and where is it now?
  - Need time-series databases
- Need both in the same database

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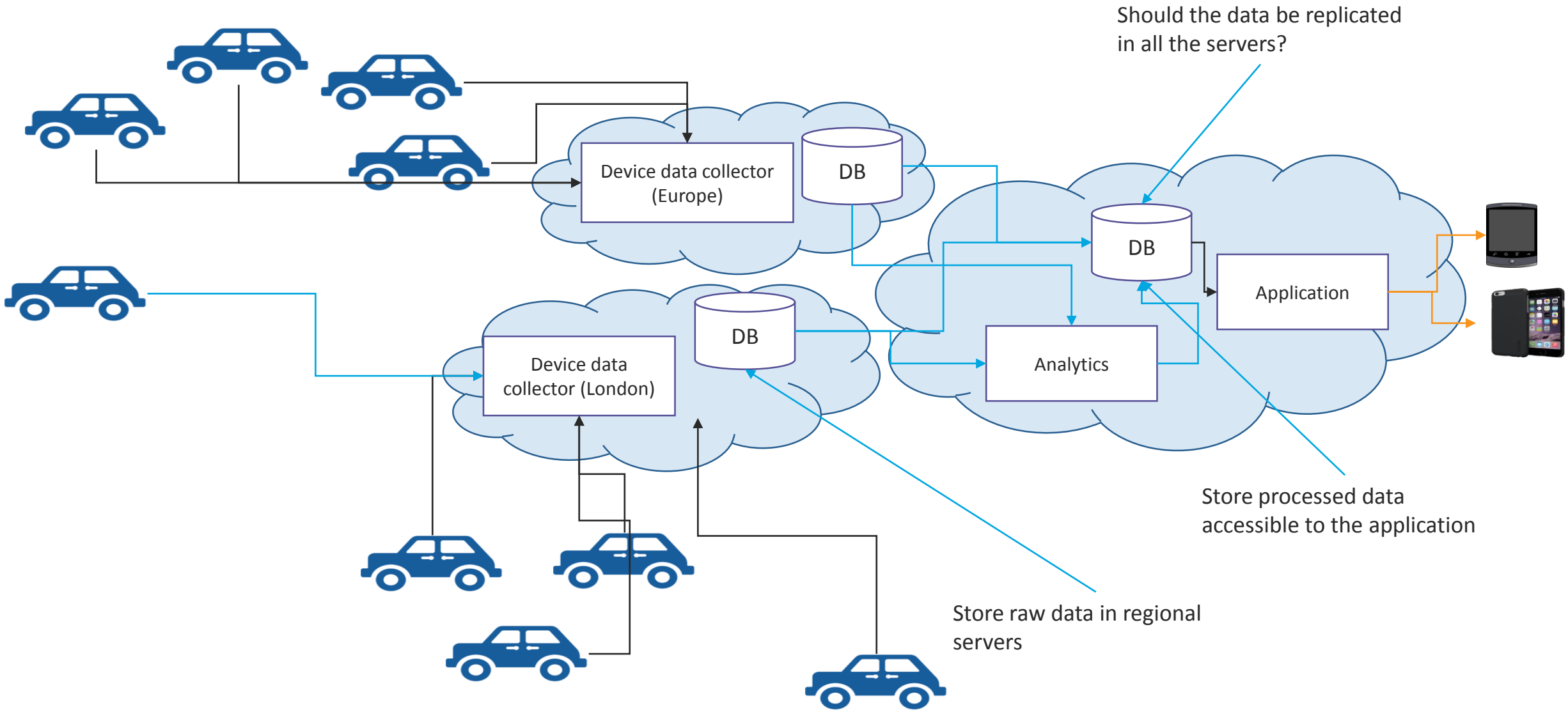
Data Volume impact on Architecture



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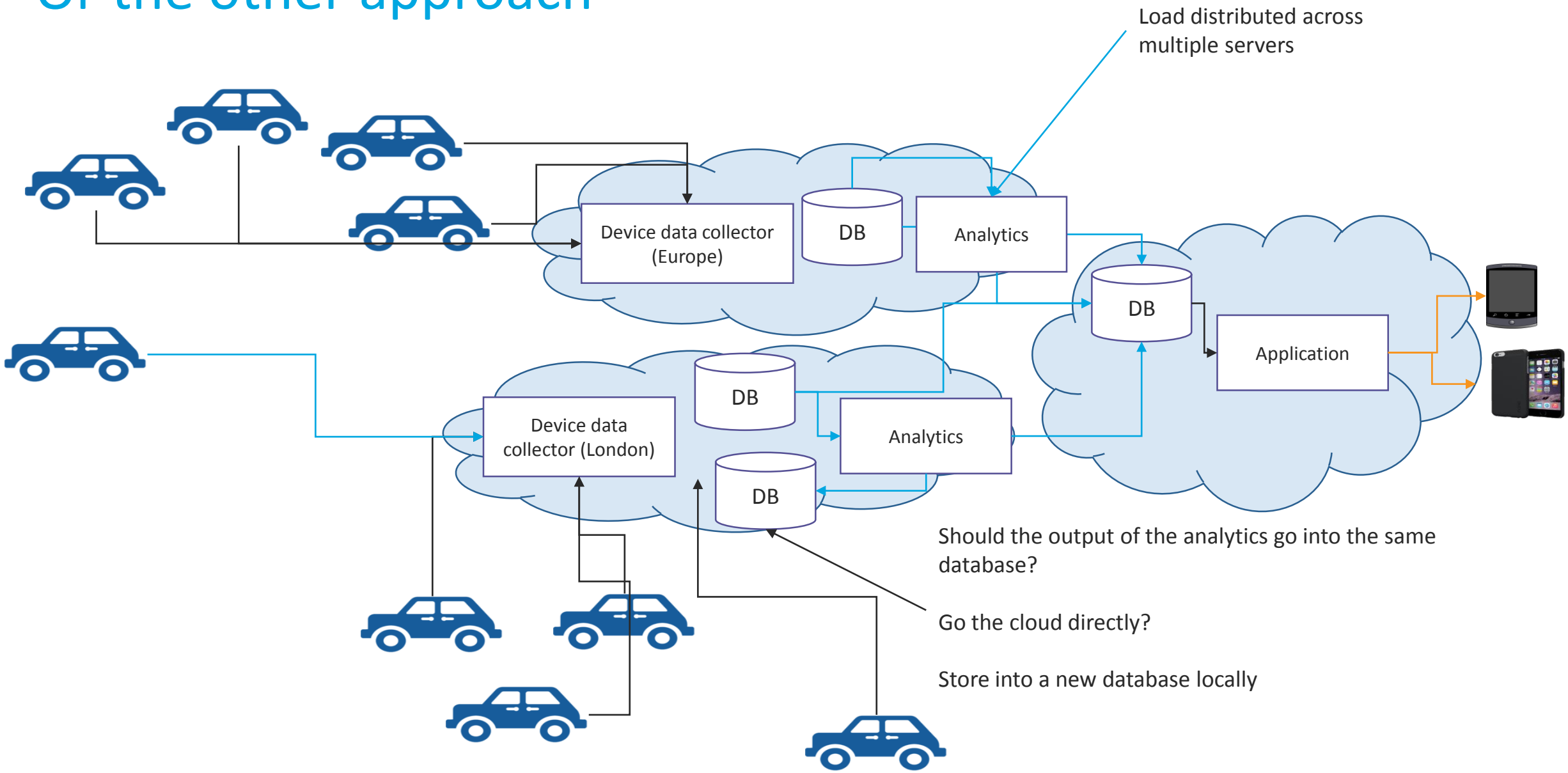
Or the other approach



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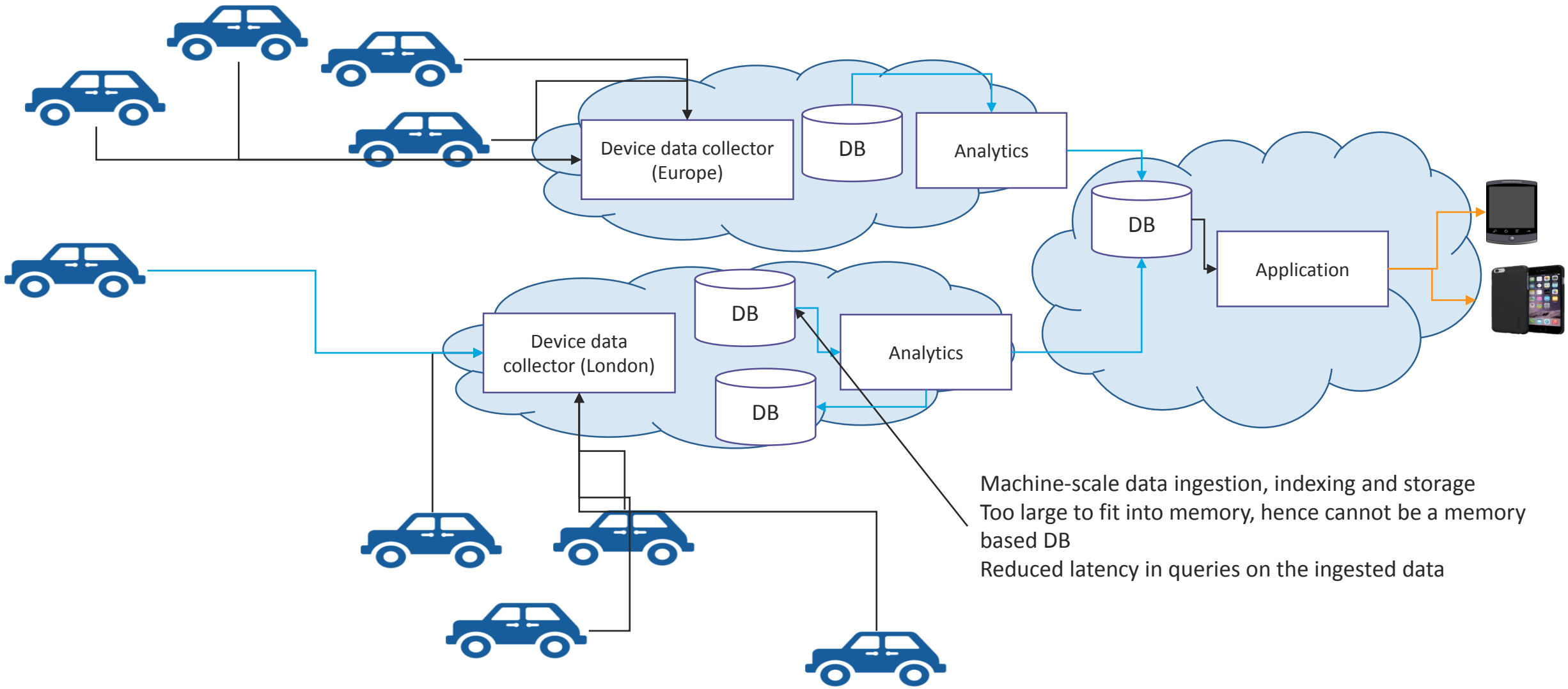
Database Choice: Data ingestion rate



Machine-scale data ingestion, indexing and storage
Too large to fit into memory, hence cannot be a memory based DB
Reduced latency in queries on the ingested data

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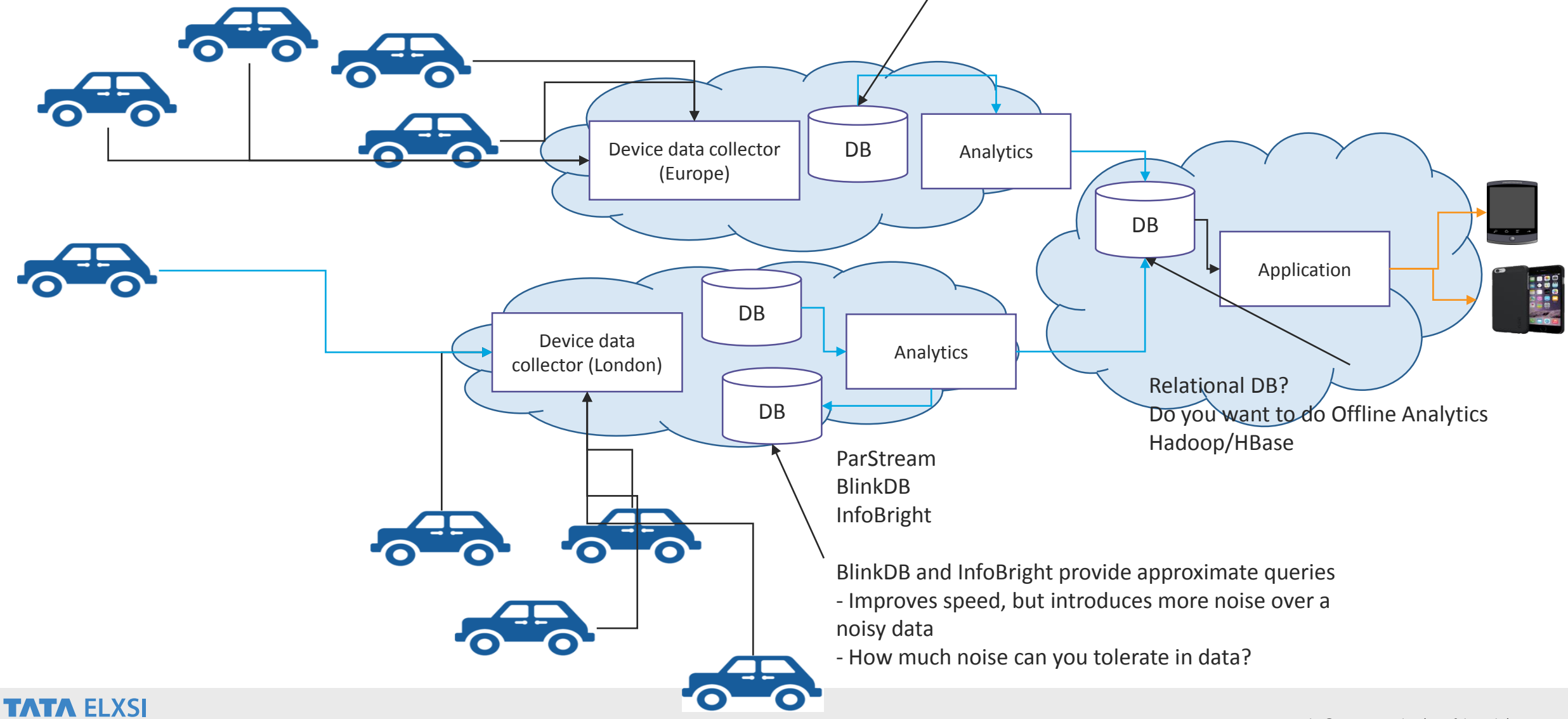
Database Choices

MongoDB (Allows for geo-spatial queries)
SpaceCurve (Spatial organization of data)
DataStax (Cassandra for IoT)
OpenTSDB (Time series)



Relational DB?
Do you want to do Offline Analytics
Hadoop/HBase

ParStream
BlinkDB
InfoBright

BlinkDB and InfoBright provide approximate queries
- Improves speed, but introduces more noise over a noisy data
- How much noise can you tolerate in data?

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The Data Variety

- Data from different sources have to be related to each other
- Different frequencies how tie data together to make meaning out of it?
- Applications have to be built on co-related data
- For vehicle management
  - Current location of the vehicle collected from GPS
  - Current velocity of the vehicle collected from OBD
  - Data collected at different frequencies.
  - Co-related to determine if speed limits are being violated

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Data Reliability

- Will the sensor give back the same data point given
  - Under the same set of environmental conditions?
  - Impact of noise on the sensor

- How dependable are the data point collected?
  - Can it directly be used to provide application features?
    - E.g., Single data point temperature collected is 29.5C
    - Comfortable temperature set at 30C
    - Should the AC be turned on or off?
    - e.g., Latitude/Longitude collected is 12.967816 / 77.510983
    - Is it same as 12.967241, 77.511101?
    - Need a nearby function and not direct comparison?

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Data Types and Data Integrity

- Impact of Customization
  - Different devices provide the same data
    - Data formats are different from different devices
    - Data from all these devices have to be mapped to a common schema
  - Different customers require different features
    - Data collected depends on features
    - Data co-relation and analytics depends on features
    - Have to be customizable what data can and need not be collected

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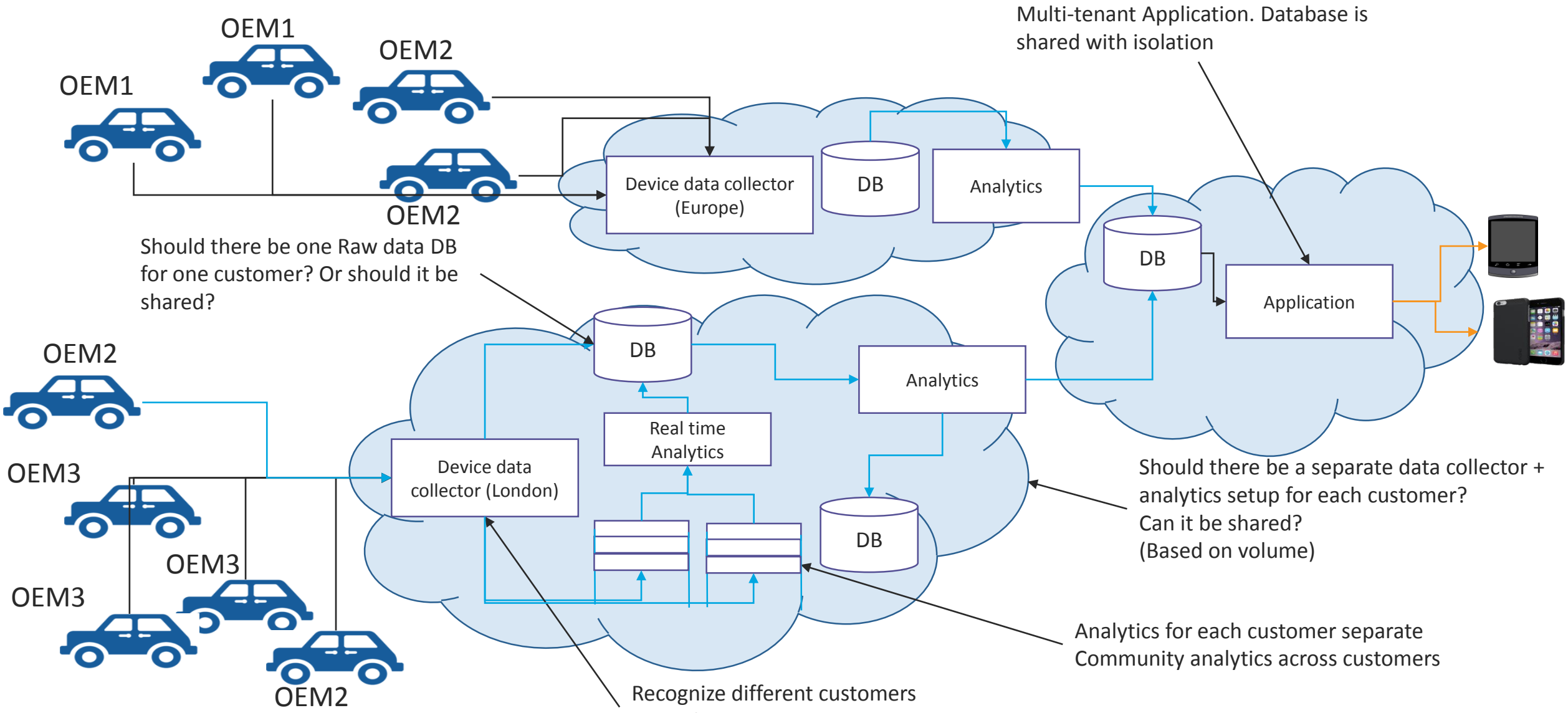
Data Analytics



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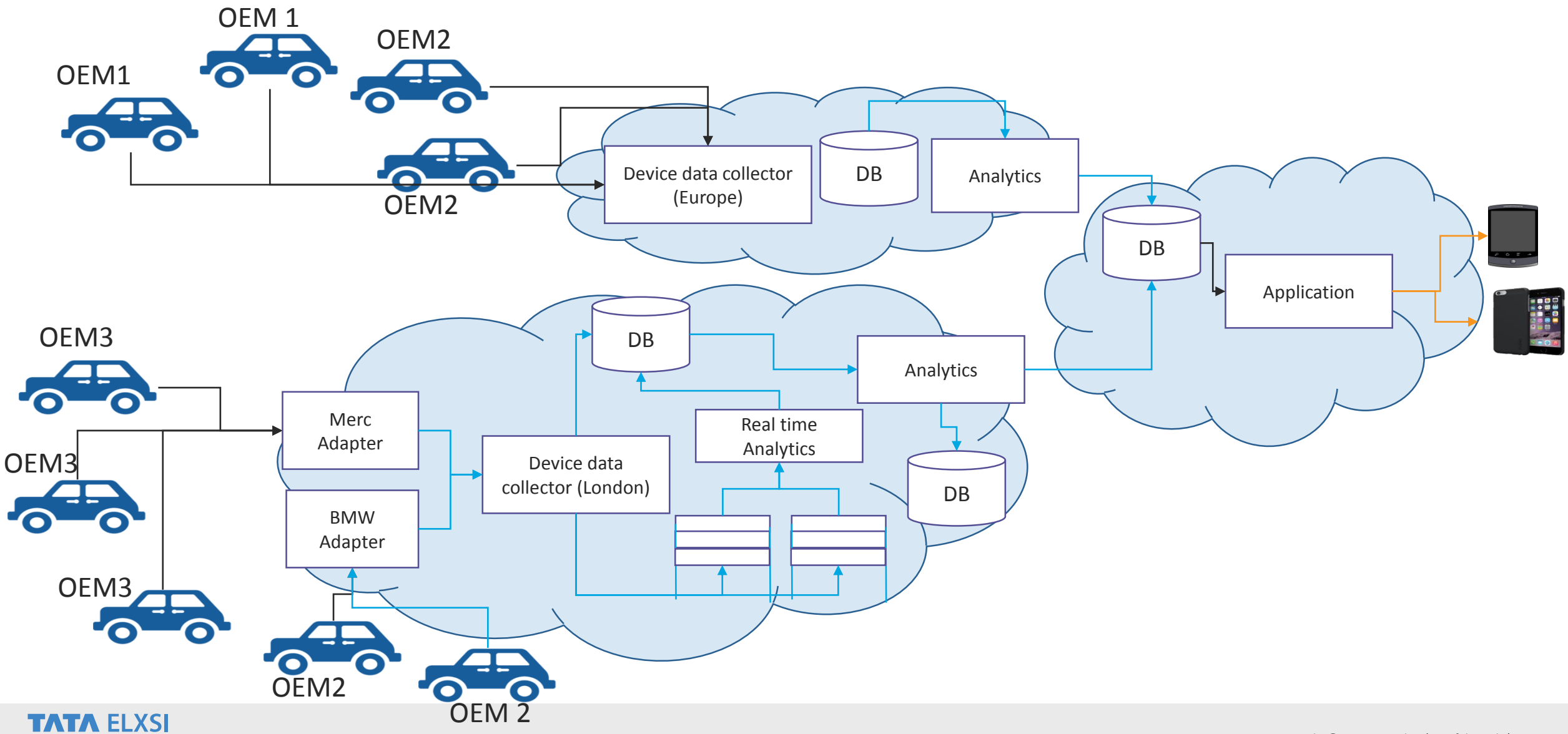
Impact of customization on the Architecture



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Scaling – Simple problem, tricky to solve

- Simple problem definition
  - As the number of devices/cars increase, the architecture should **scale up** to take the load
- Tricky to solve
  - Invest just enough for the current load, but architect to expand easily
- Standards ??
- Compliance Obligations?

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And some non technical challenges

- Who is the owner of the valuable vehicle/consumer data?
- Who will the customer trust
- Who will use my data
- Who should be allowed to use my data
- Privacy

And many more…..

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The “digital” car : Here to Stay !!

Fighter planes	:	20 M lines of code
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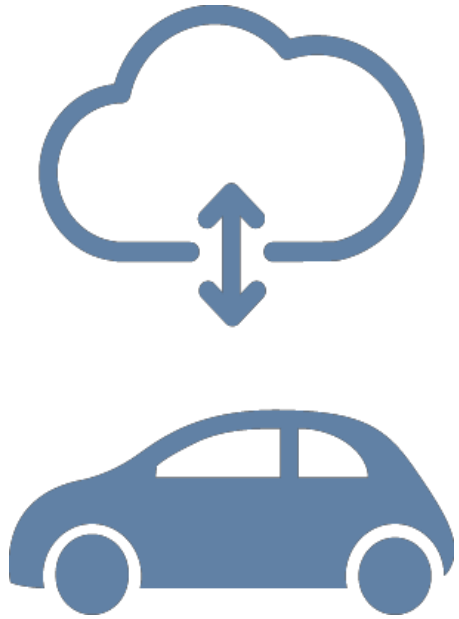

Huge, Mass of Unoptimized Lines of Code, Heterogeneous Architectures, Scalability, Reliability, Interoperability are challenges to managed simultaneously with increasing complexity of features and functionalities.

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Thank You

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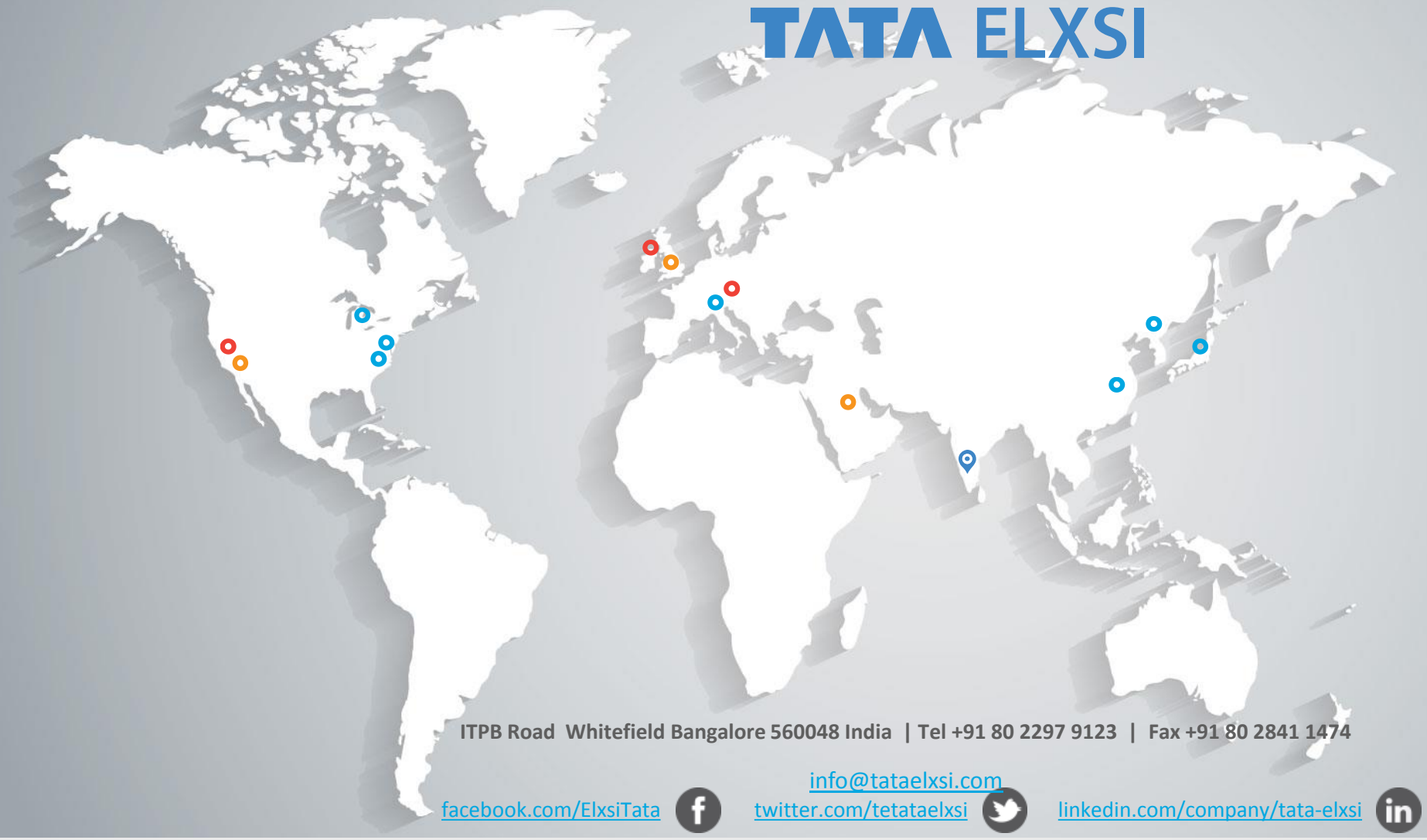

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