Global engineering:
Enabling a Connected Transport future

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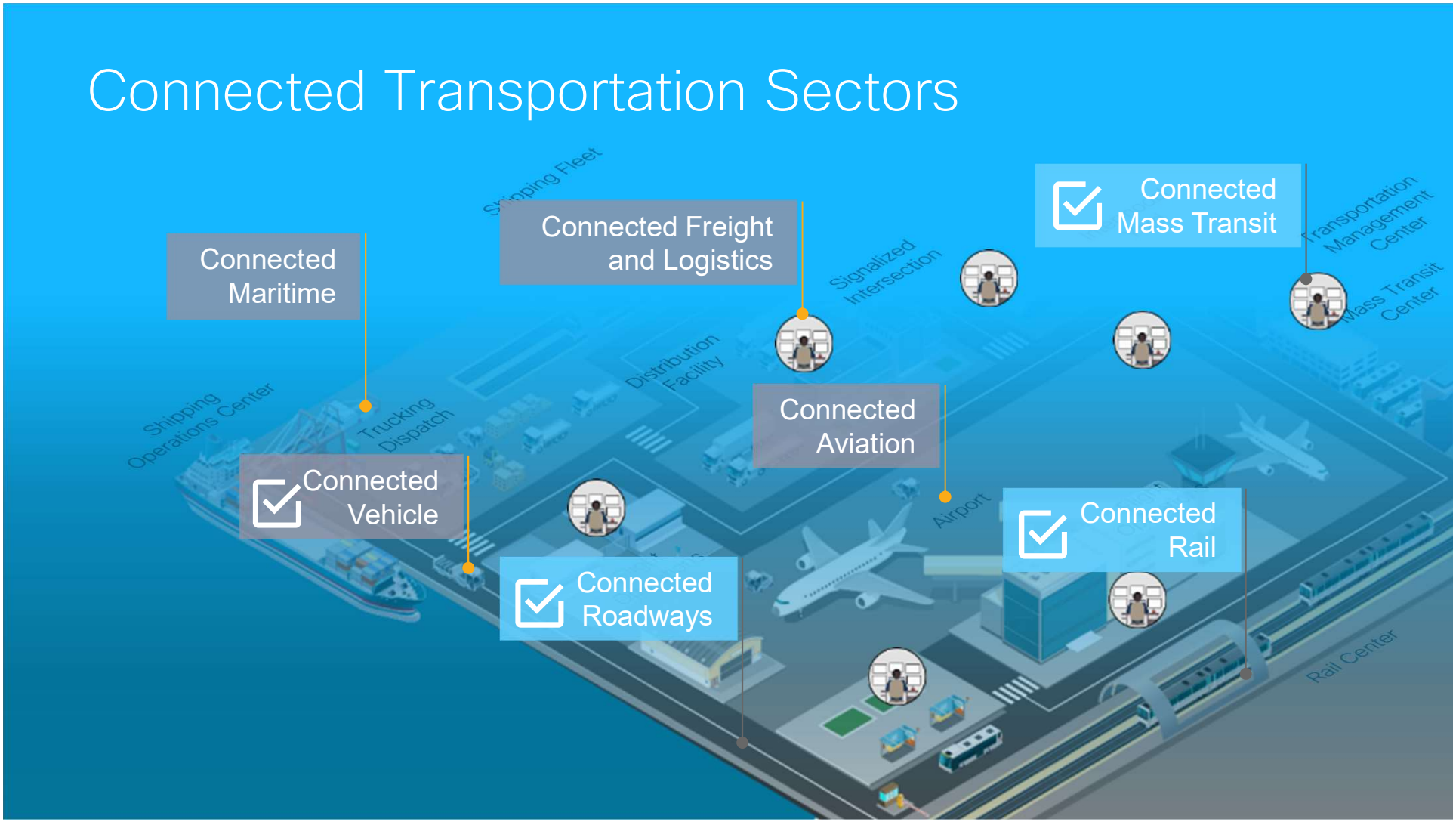
Chief Technology & Architect's Office

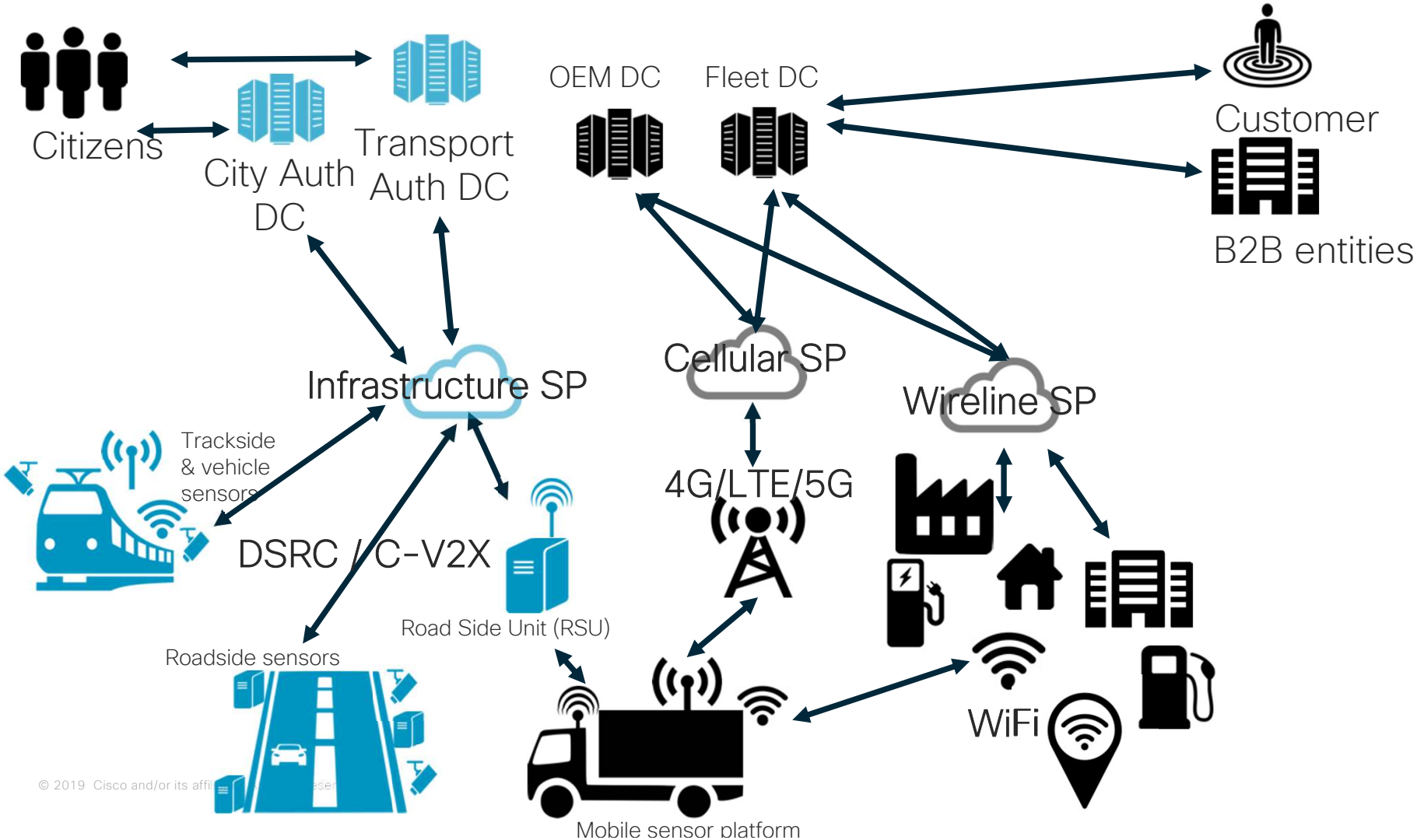
Connected Transportation Sectors



The Automotive sector is changing

- Changing engagement models with customers, partners and suppliers
- Mobility as a Service
- Shared ownership
- Electrification
- ‘Softwareification’ of the vehicle
- Unprecedented data volume challenges

Changes occurring in every market across the globe


Citizens
City Auth DC
Transport Auth DC
OEM DC
Fleet DC
Customer
B2B entities
Infrastructure SP
Cellular SP
Wireline SP
Trackside & vehicle sensors
DSRC / C-V2X
4G/LTE/5G
Road Side Unit (RSU)
Roadside sensors
WiFi
Mobile sensor platform

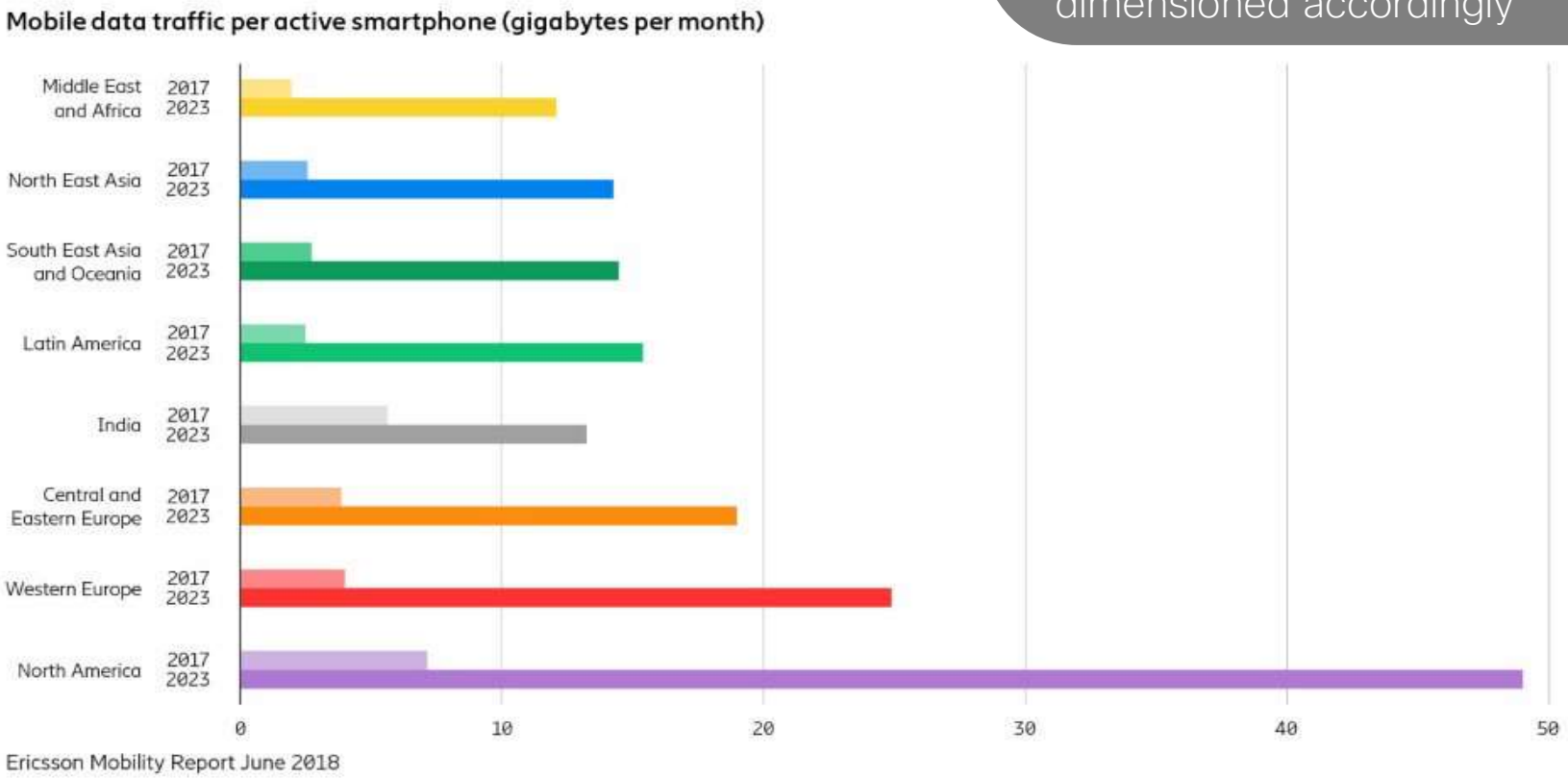
It’s all about the data

“Each autonomous vehicle will be generating approximately 4,000 GB – or 4 terabytes – of data a day”

Brian Krzanich, Intel, 2016

Cellphone data consumption

Cellphones receive more data then they transmit. Carrier networks are dimensioned accordingly

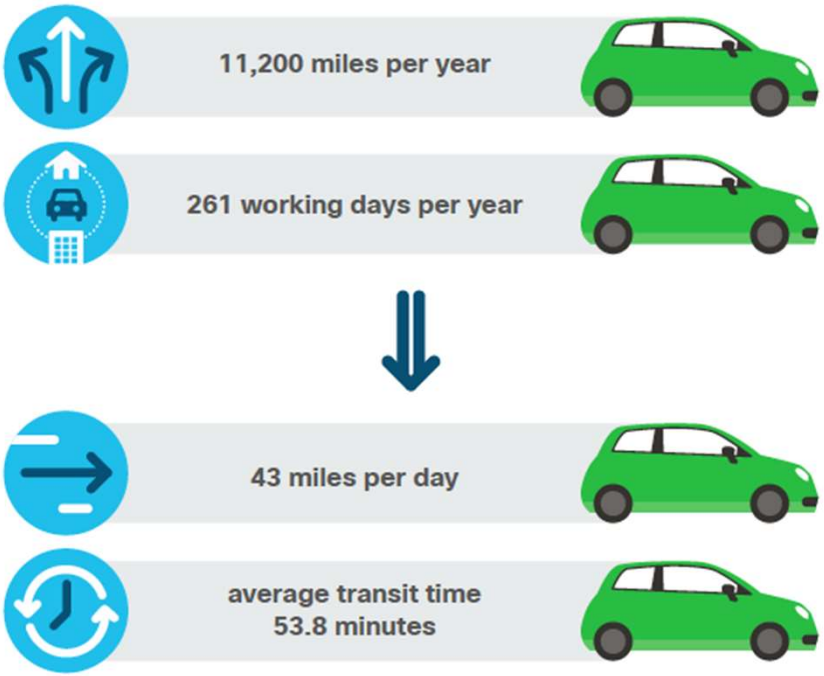


What are vehicle maker's gathering?

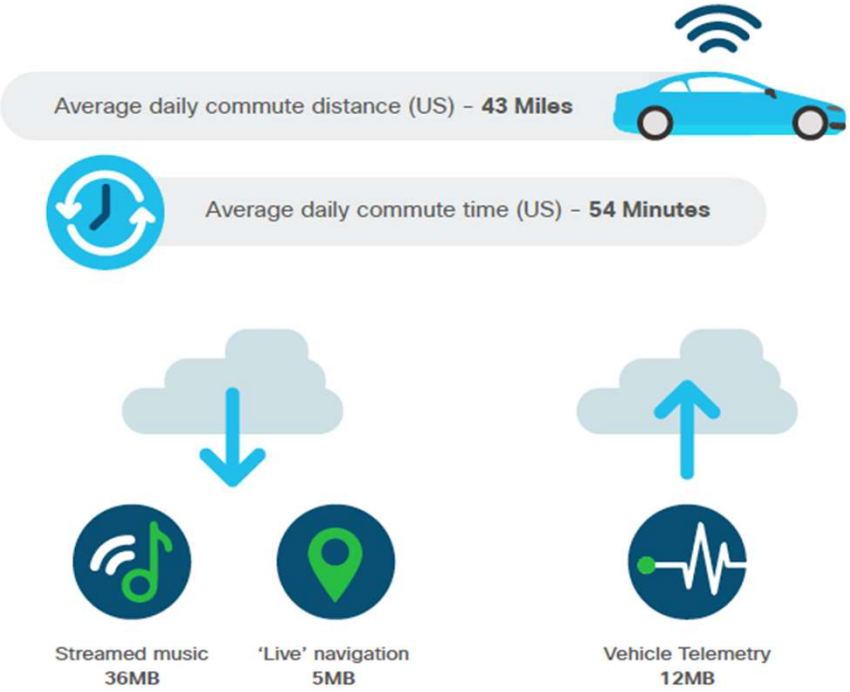
Type of data	Examples of information collected
Vehicle status	Mileage, battery voltage, door and hatch status
Position and movement	Time, position, speed
Vehicle service	Due date of next service visit, oil level, brake wear
Dynamic traffic	Traffic jams, obstacles, signs, parking spaces
Environmental	Temperature, rain
User profile	Personal profile picture/avatar, settings as navigation, media, communication, driver's position, climate/light, driver assistance
Sensor	Radar, ultrasonic devices, gestures, voice

*Example from BMW I-series

The driven hour - 2019



The driven hour - 2019

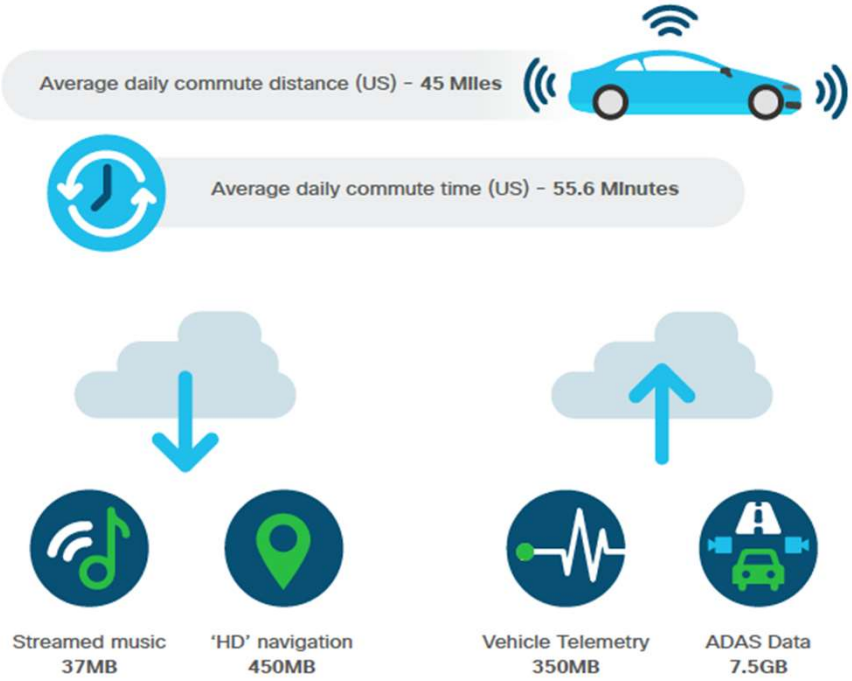


The driven hour - 2019

Average smartphone daily data volume (US)
286MB

Equates to daily volume of
5.3 vehicles

The driven hour – 2024

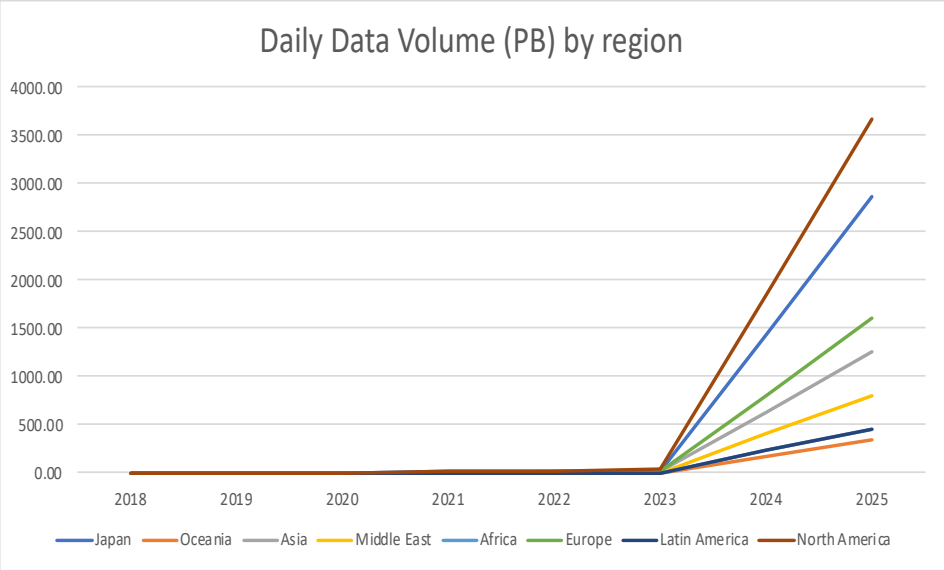


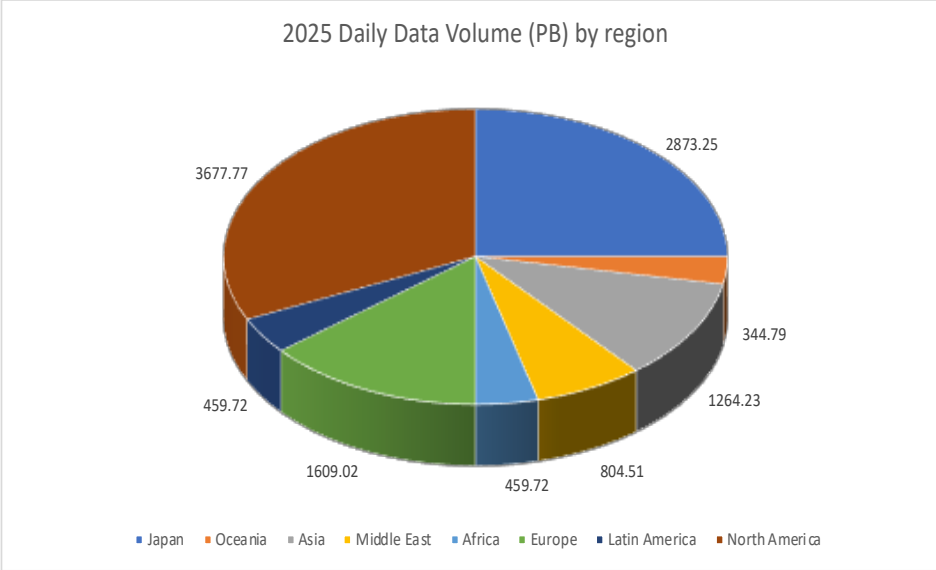
The driven hour - 2024

Average vehicle daily data volume in 2023
8.33GB

Equates to daily volume of **5.2 smartphones** in 2024

OEM - Data volume generation by region





Forecast based on current global vehicle production figures

Application-based vehicle communication options

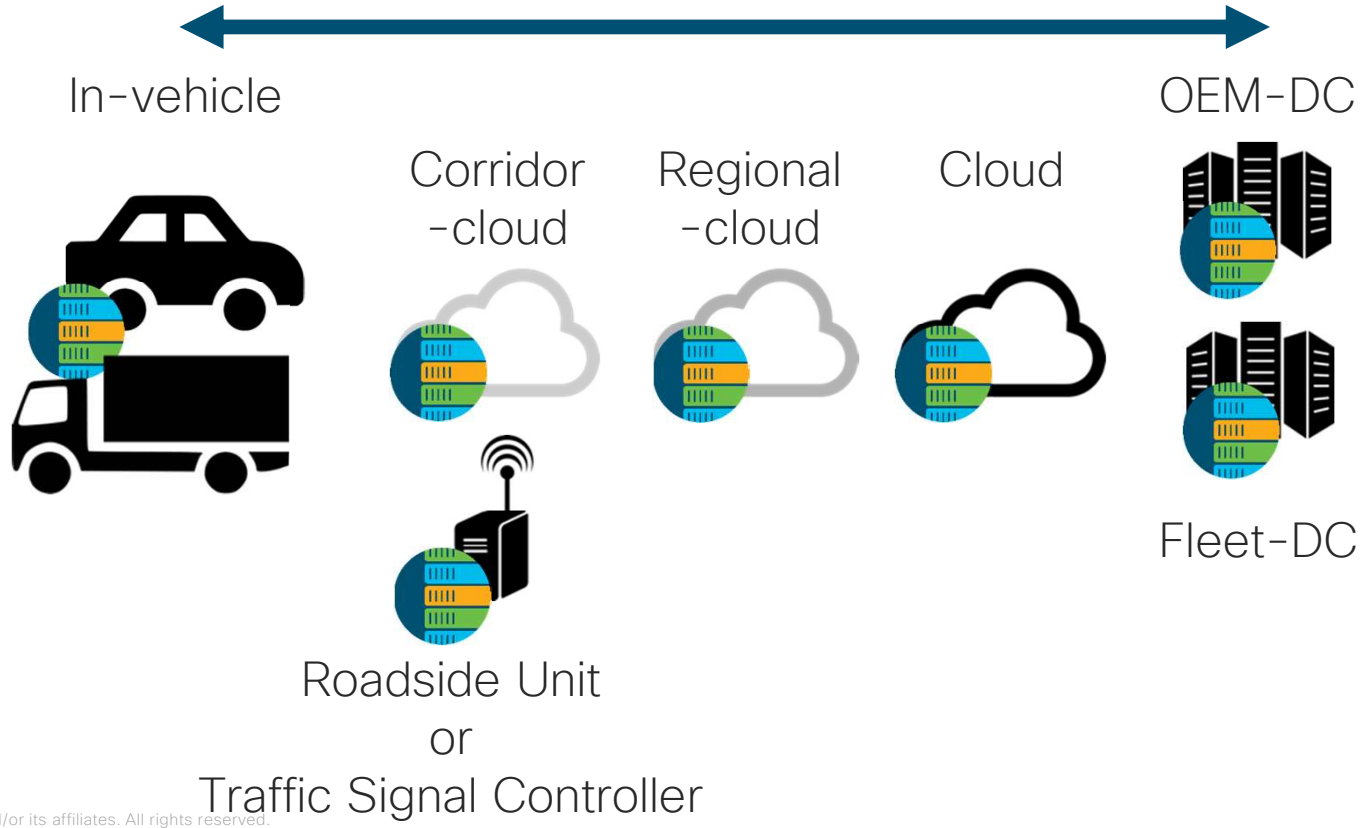
Application	V2X	Fleet operator	3rd Party	Public Operator	Safety or Value-added	Hi/lo Data volume	Time-sensitive (*not low latency)	Frequency of exchange	Primary comms path	Secondary comms path
ITS Safety	V2V, V2I	No	No	Yes	Safety	Low	Yes	High	DSRC/ C-V2X	
Predictive Health Maintenance	V2C	Yes	No	No	Value-added	Low	No	Periodic	Wifi	Cellular
Navigation Services	V2C	No	Yes	No	Value-added	High	Yes	Periodic	Cellular	Wifi
Advanced Driver Assistance Services	V2C	No	Yes	No	Value-added	High	No	Periodic	Wifi	Cellular
Real-time logistics planning	V2C	Yes	Yes	No	Value-added	High	Yes	Streamed	Cellular	Wifi

Applications are key

Key questions

- WHO values the data?
- Who pays for the comms and the cloud services
  - If no one values the data, it doesn't leave the vehicle
- What is the 'cost' of the required compute & storage?
- Where can the application be executed most 'cost effectively'?

Where is the ‘Edge’ compute?



Data volume transmission – Time

Market year	Description	Daily transmitted data volume (GB)	Upload time (9Mbps Cellular upload BW)	Upload time (17Mbps Broadband upload BW)
2018	Vehicle telemetry	0.013	12sec	6sec
2019	Predictive Health Maintenance suite	0.05	48sec	25sec
2021	1st Gen Connected Car application suite*	0.33	5m 88sec	2m 43sec
2024	2nd Gen Connected Car application suite*	50	13h 15m 22sec	7h 1m 5sec

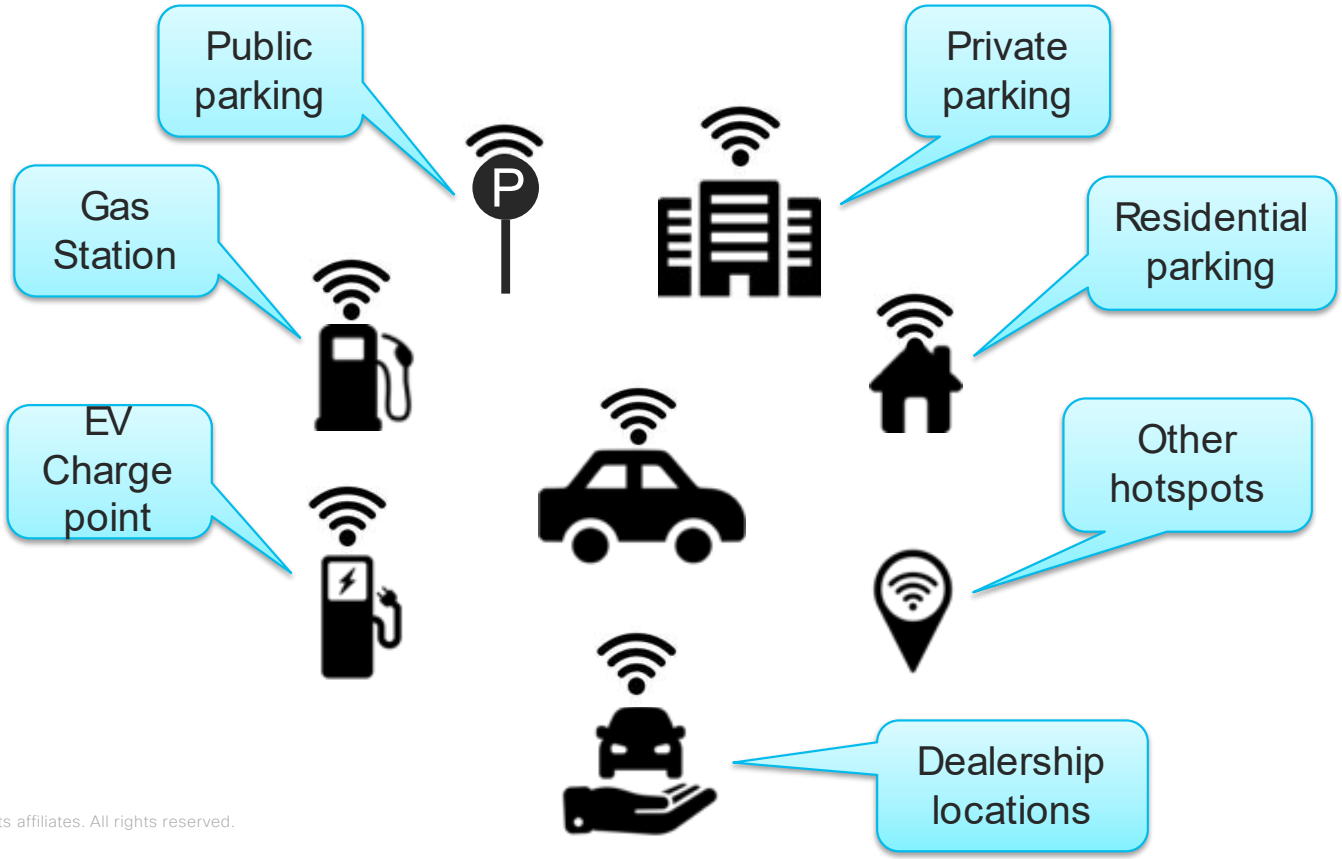
* Data processed on-board prior to transmission.
* Intent is to deploy suite across all models in that year

Data volume transmission – Cost for Carrier

Market year	Description	Daily transmitted data volume (GB)	4G/LTE	5G – forecast (30% cost reduction vs 4G)	Wifi
2019	Vehicle telemetry	0.013	$.025	$.0175	$.0008
2020	Predictive Health Maintenance suite	0.05	$.095	$.0665	$.003
2022	1st Gen Connected Car application suite	0.33	$.594	$.4158	$.019
2025	2nd Gen Connected Car application suite	50	$82.22	$57.554	$2.73

- Assumption – 3% reduction in cost per annum, based on Deloitte Industry reports

Wifi opportunities



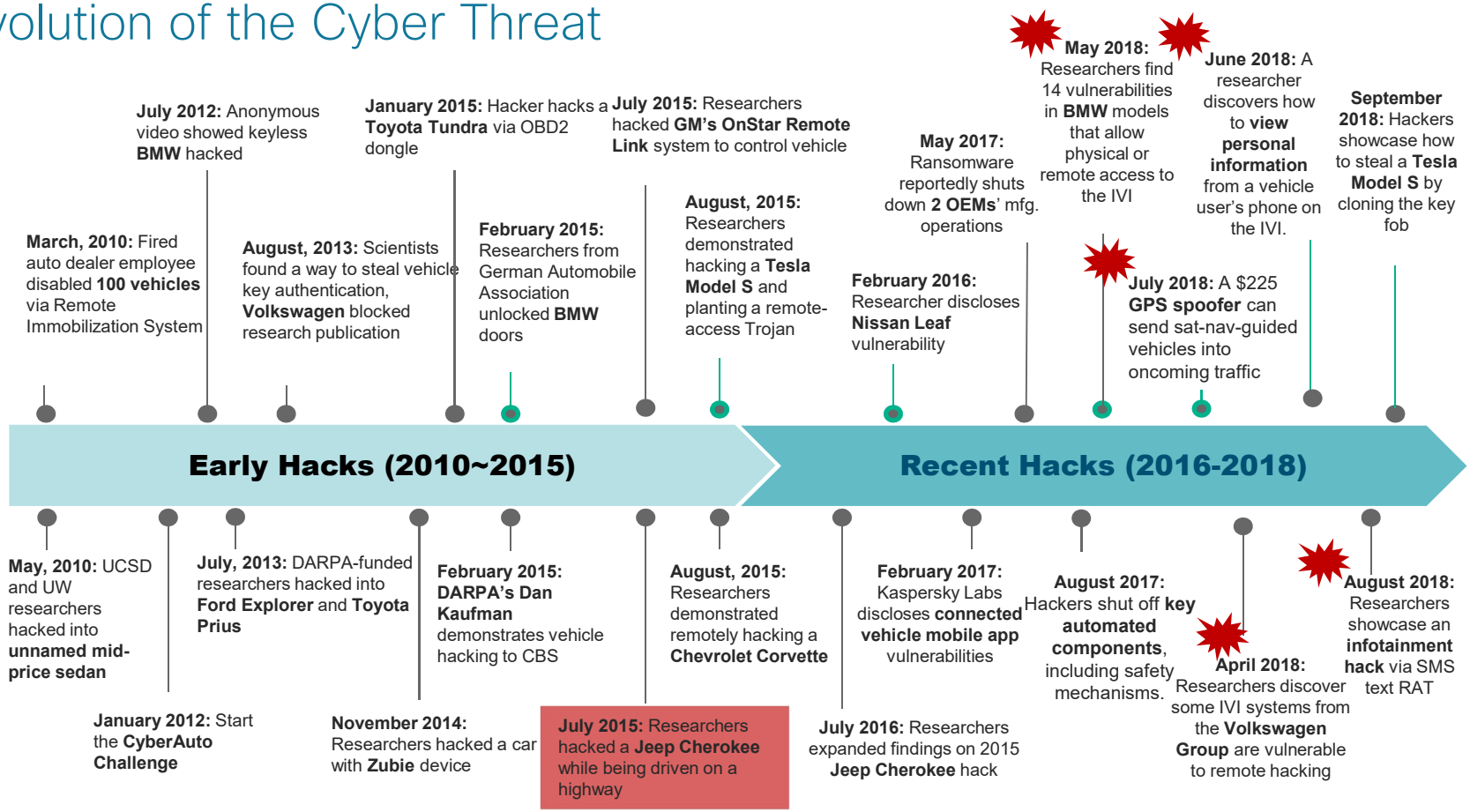
Connected Car and the Communications challenge

- What does the application need?
- Cellular AND Wifi not Cellular or Wifi
- Ethernet over power (EV charging)?

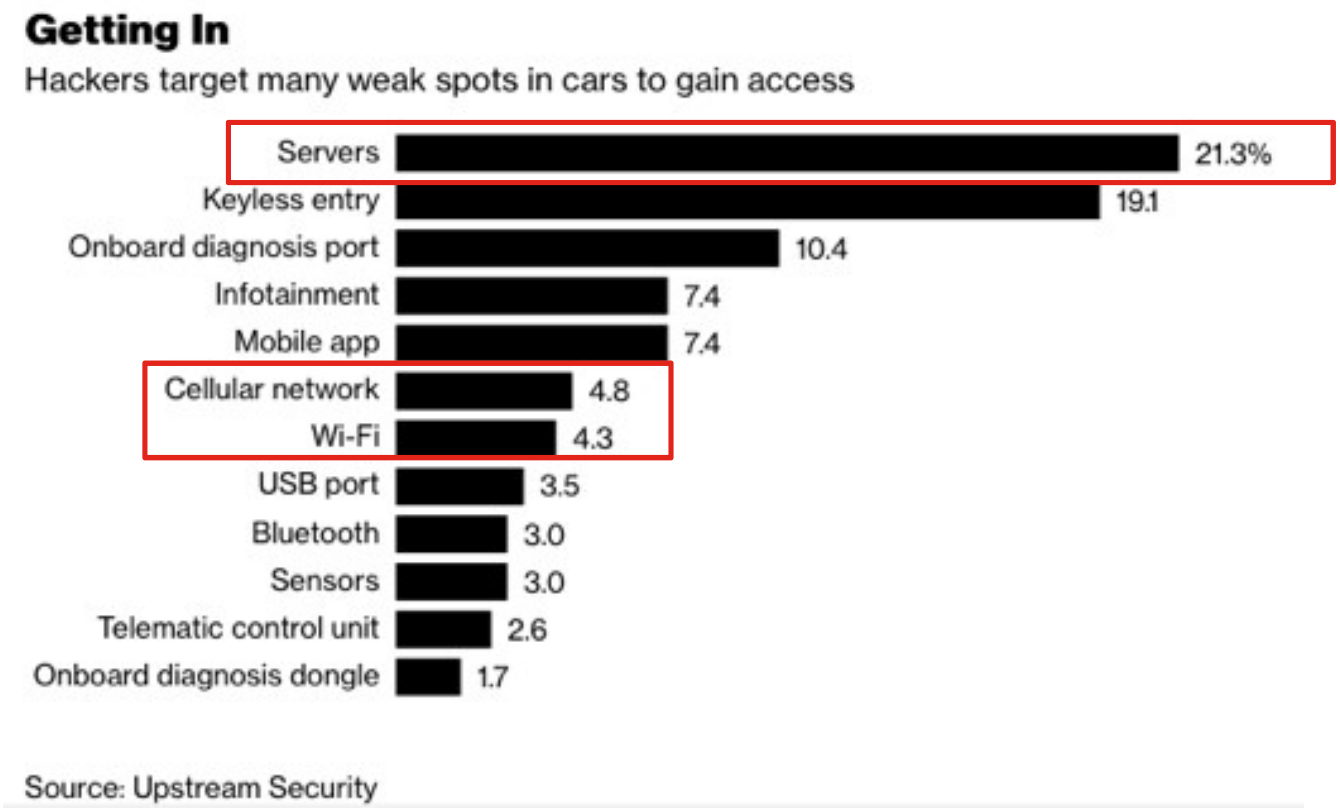
- Requires policy-driven routing to select the ‘right’ path on an application-by-application basis

The Internet of Threat

Evolution of the Cyber Threat

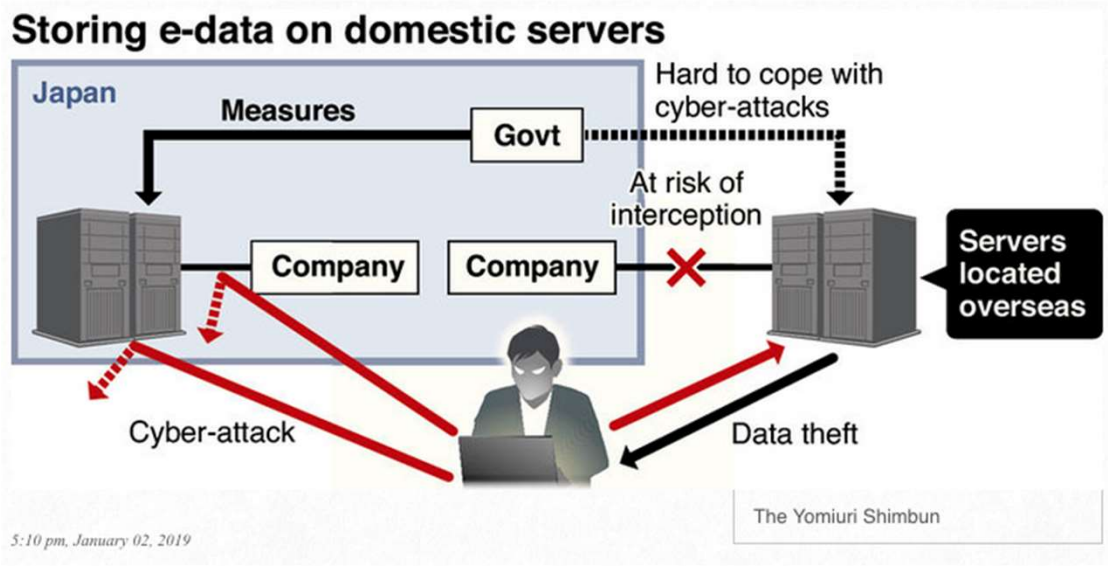


Why attack for one, when you attack many?



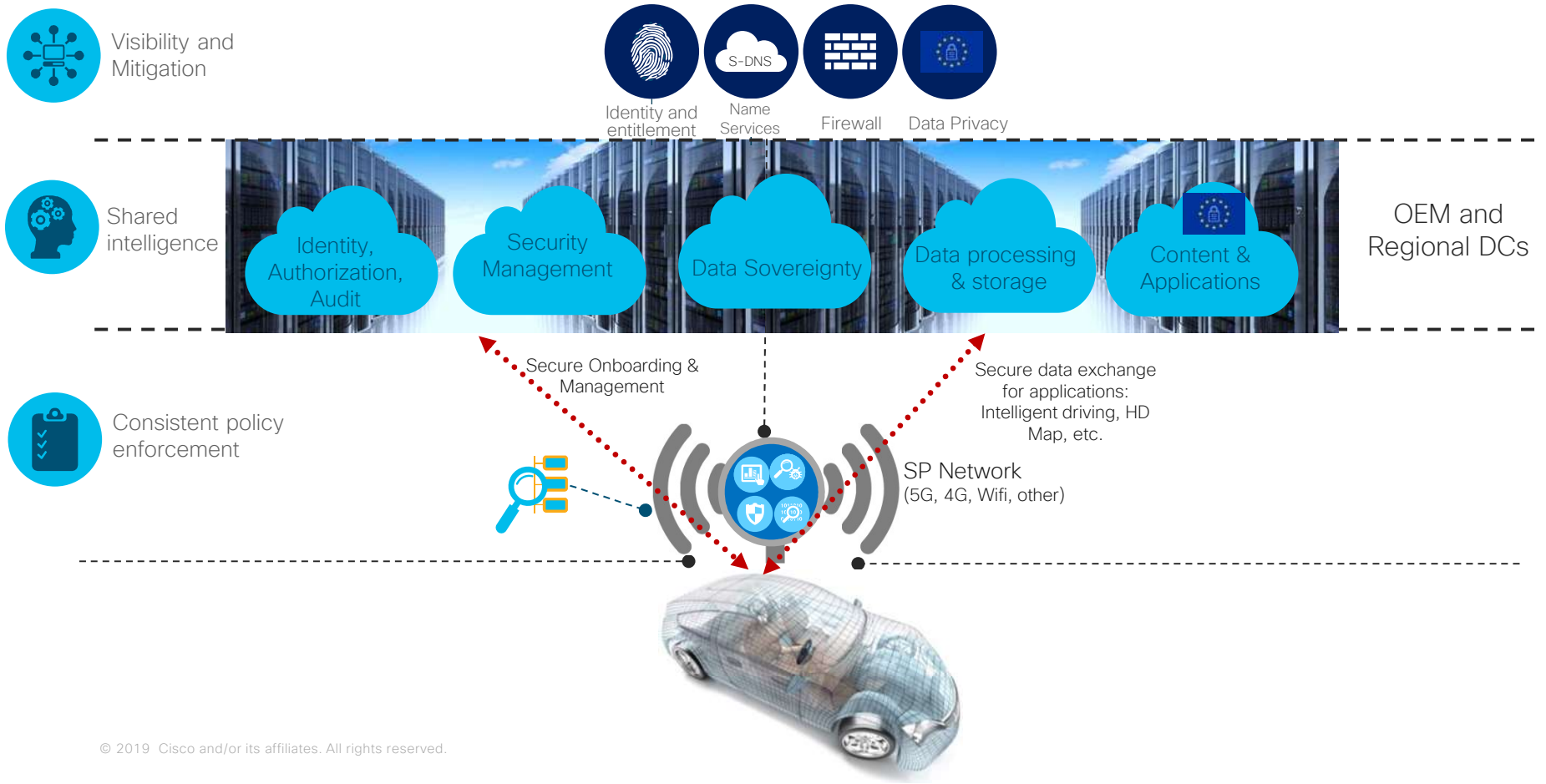
Govt to urge infrastructure data be kept on servers in Japan

"Guideline for Establishing Safety Principles will stipulate the storage of data on servers governed by domestic law as a "desirable security measure." Since there are limitations to applying domestic law to servers located overseas, the government is effectively asking operators to keep data within Japan."



http://the-japan-news.com/news/article/0005454289

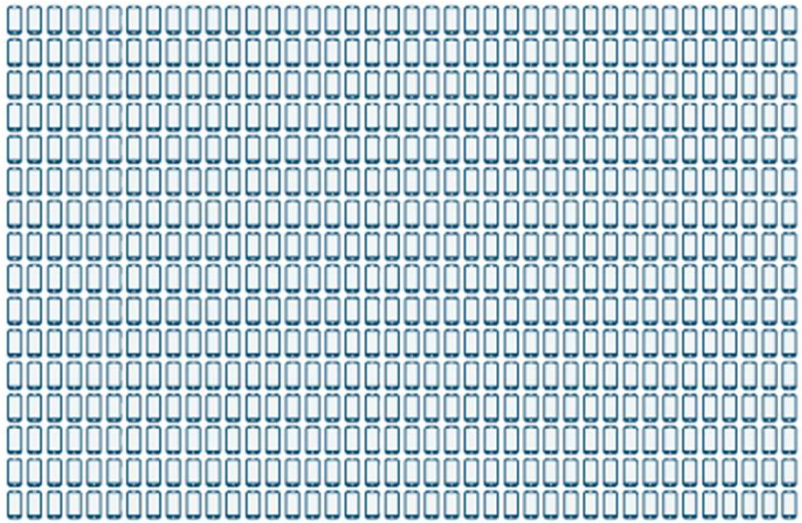
End-to-End Security Architecture



So what about those autonomous vehicles?

1 Vehicle = 2500 smartphones

Autonomous vehicle daily data volume
4TB



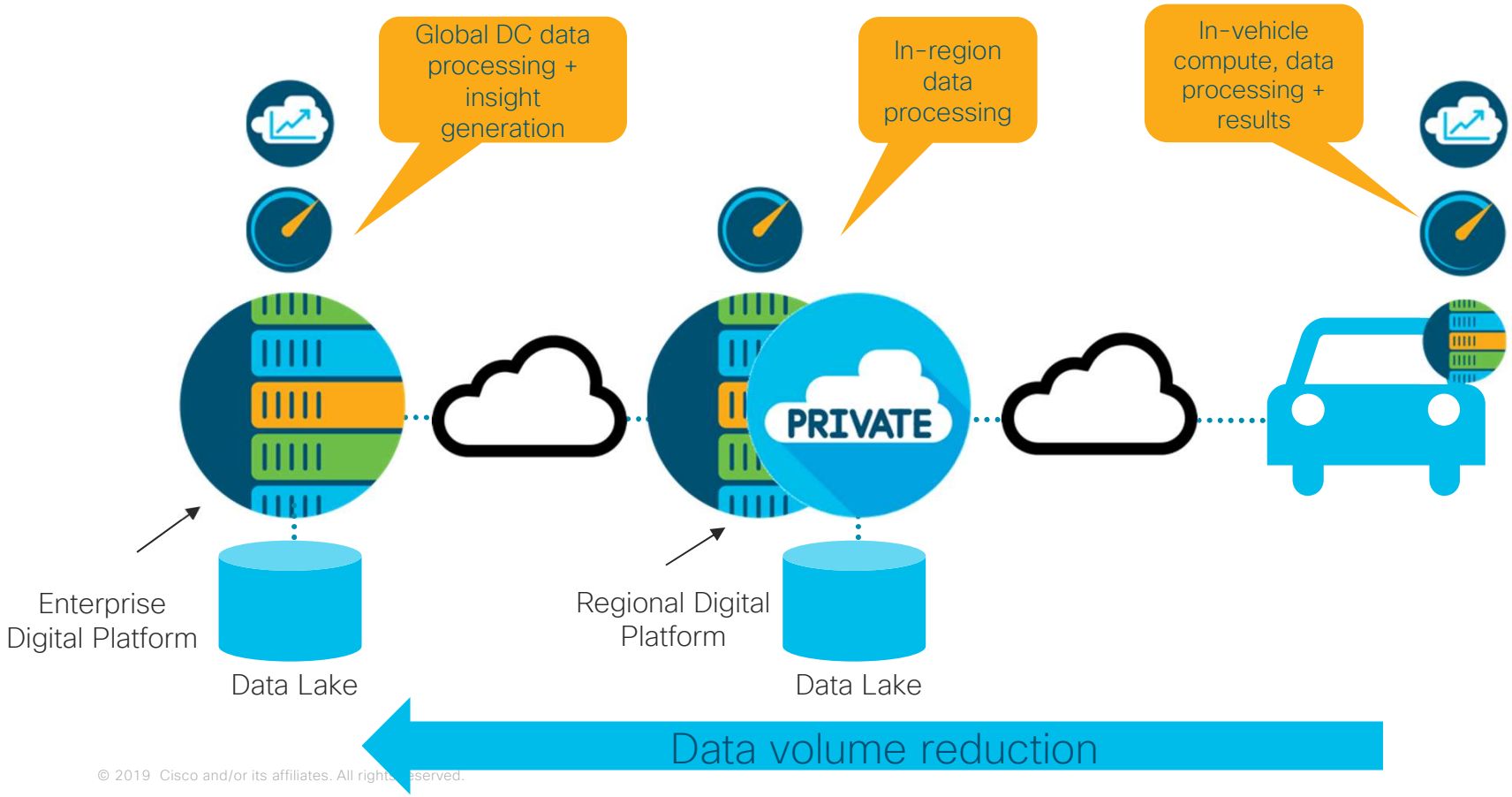
Data volume generation – Autonomous Vehicle control software vendor comment

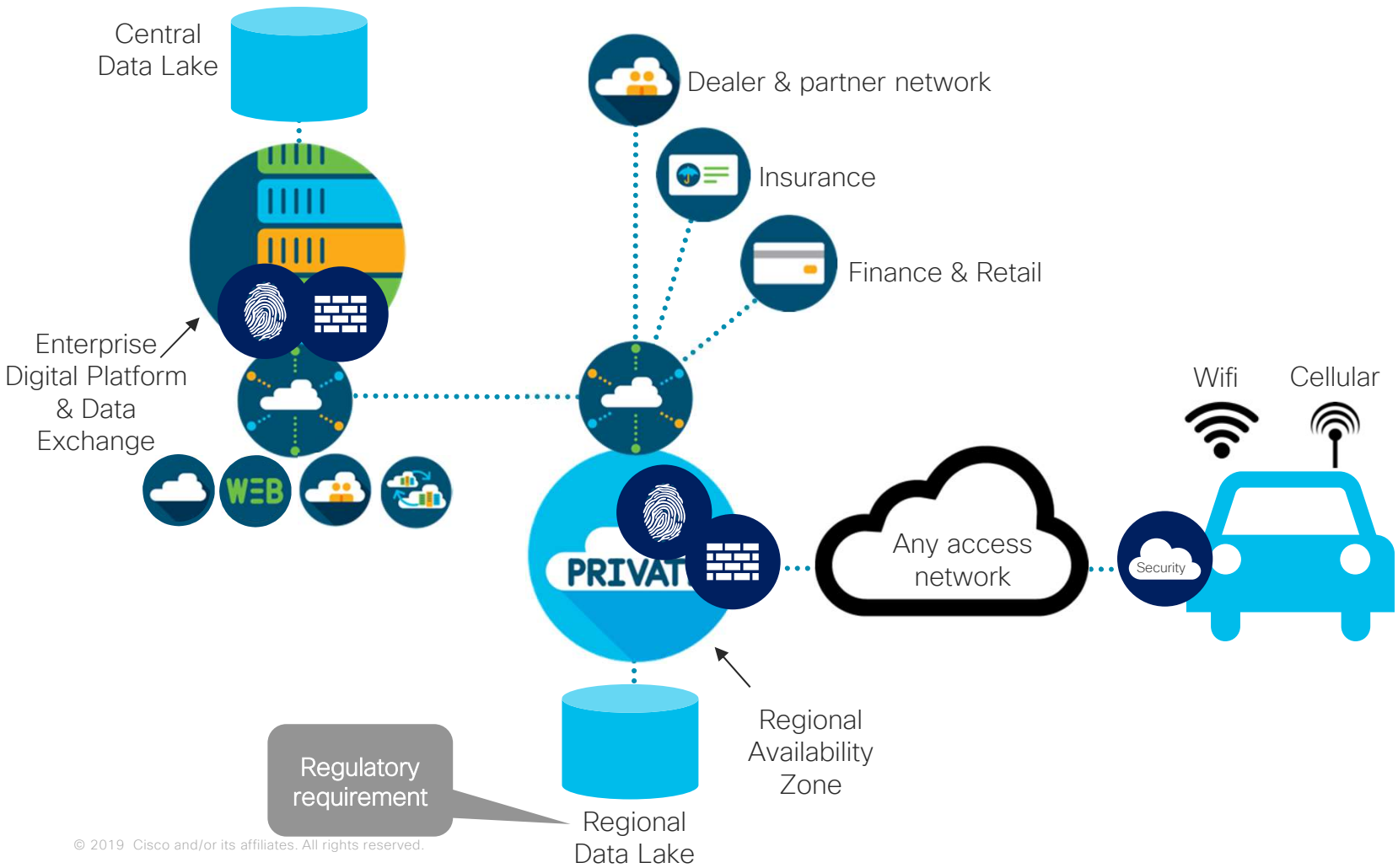
- Data is <u>not</u> required in real-time for vendor's purposes
- Current generation software stack, generates 200-250GB per driven hour
- Expect to reduce to 50-70GB 'in regular operation'
- Will be able selectively enable and disable data-storage subject to encountered events

Global automotive

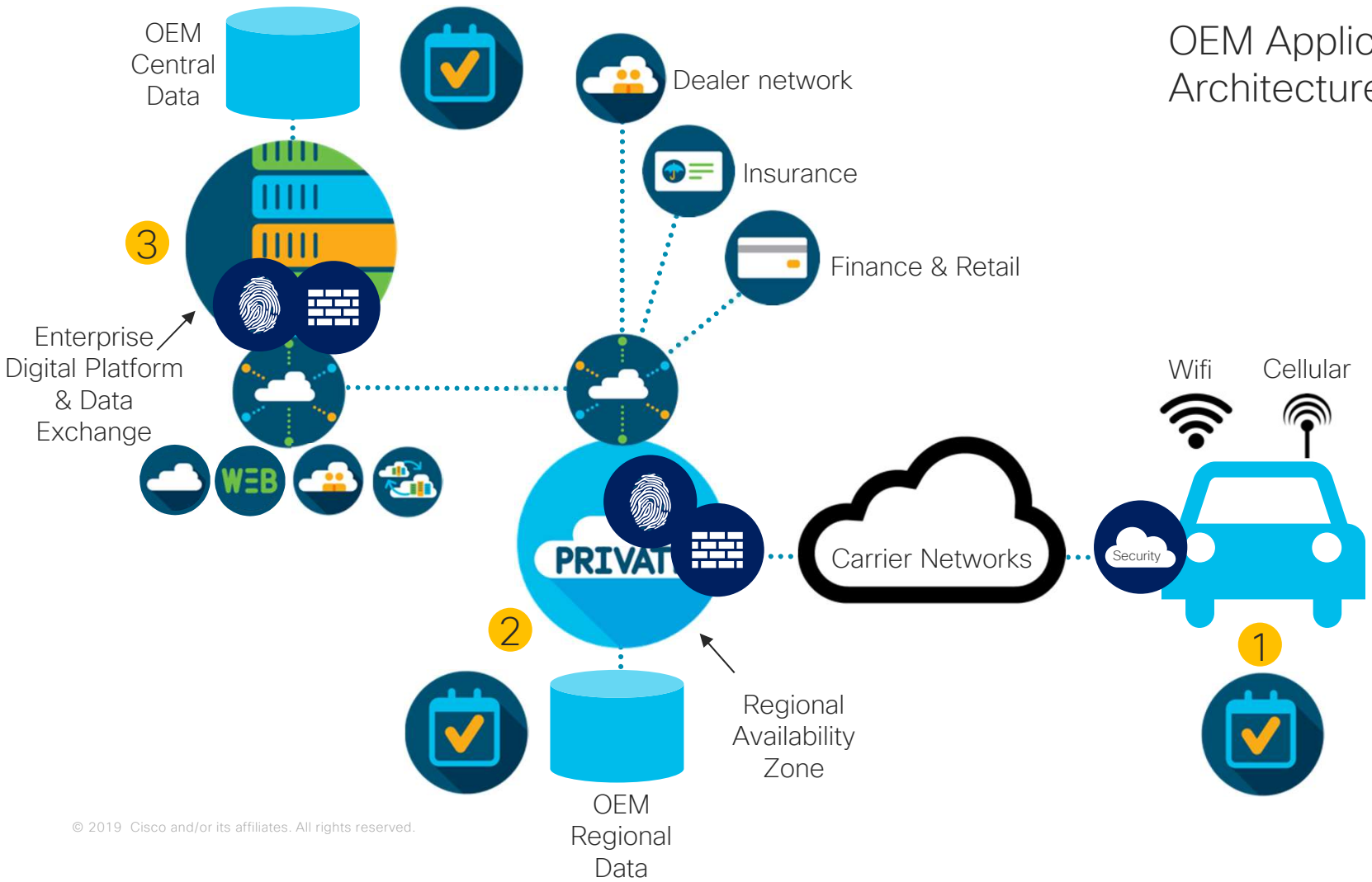
Global scale
Global challenge

Automotive Distributed Computing Architecture

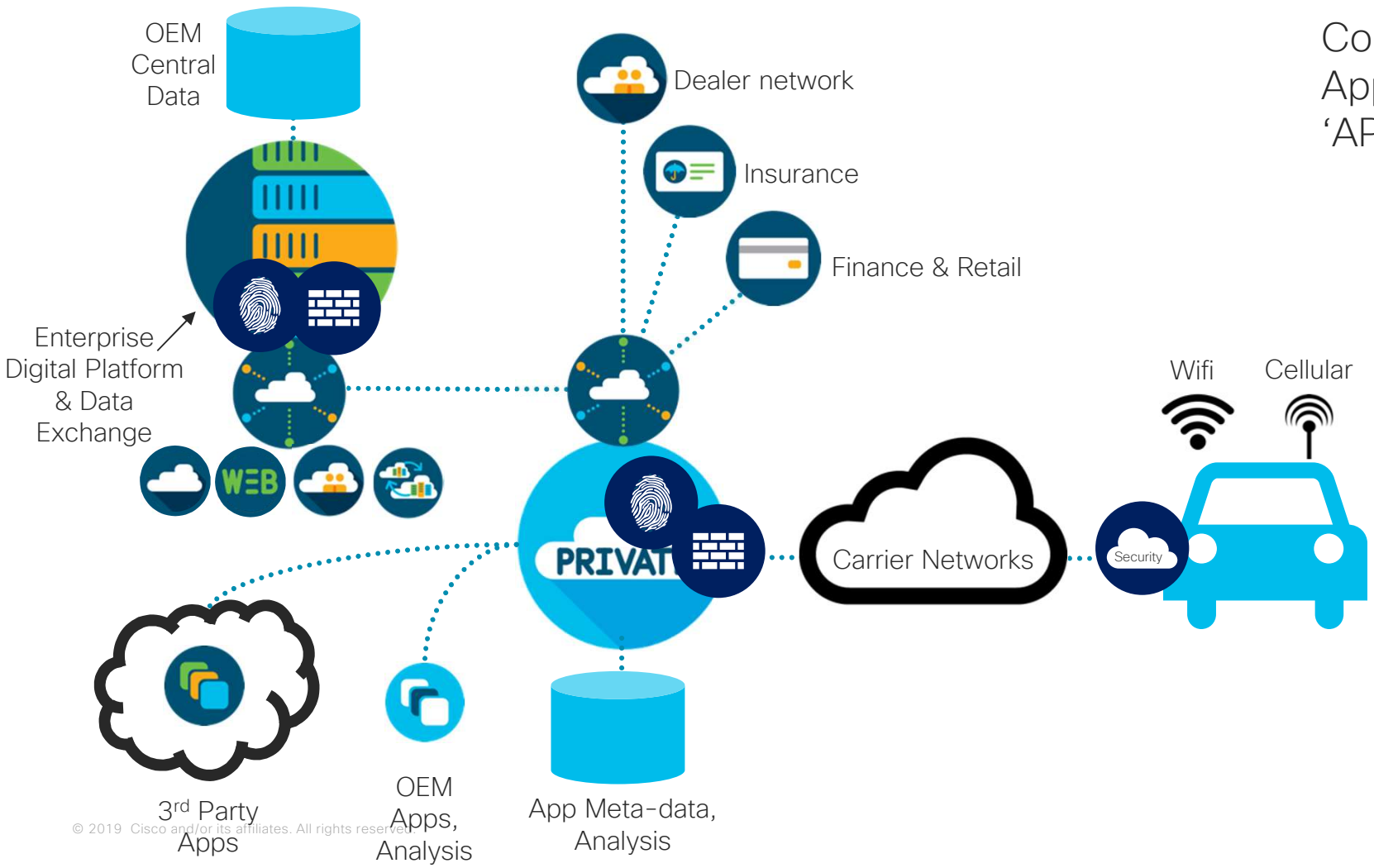




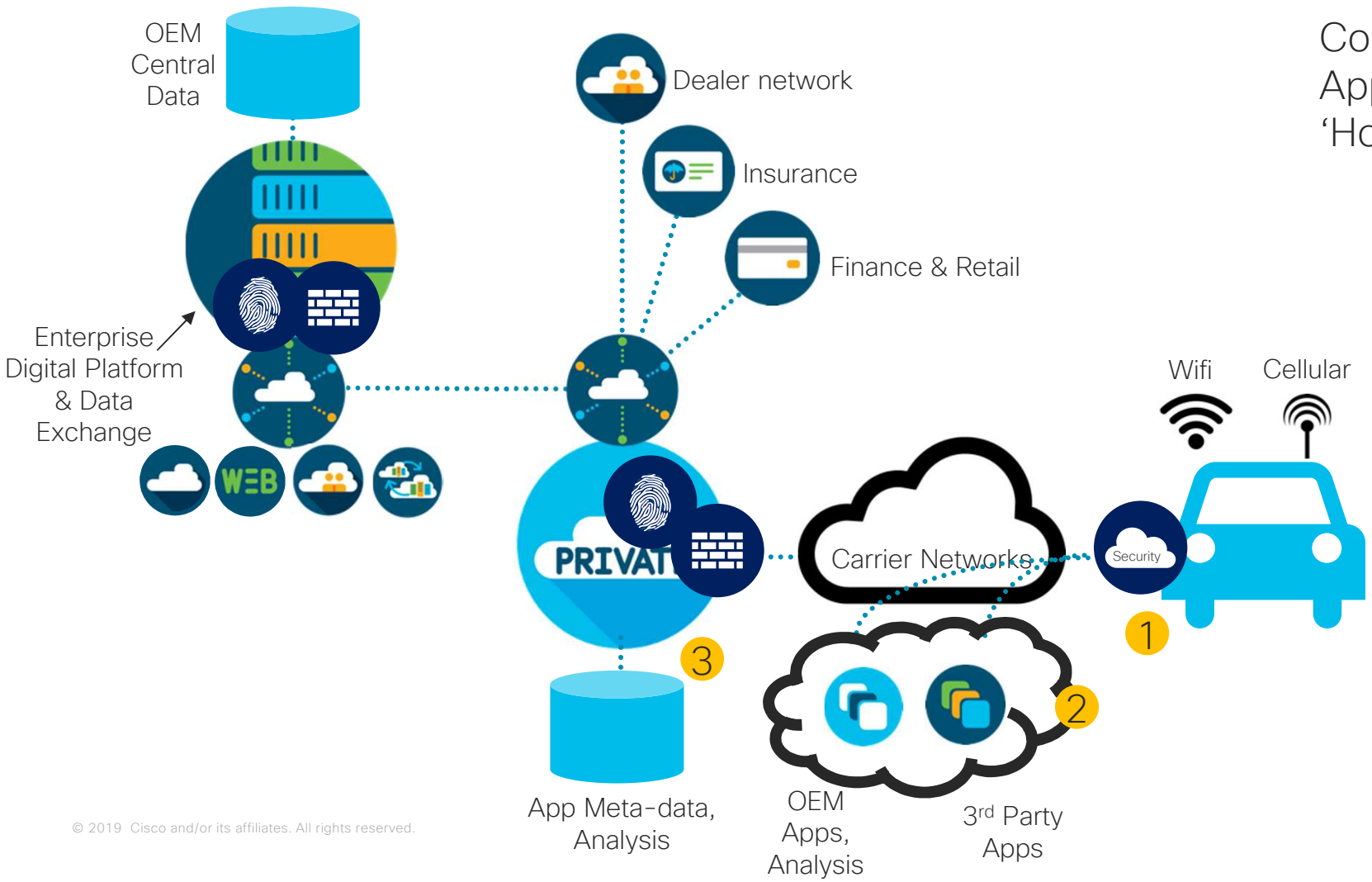
OEM Application Architecture



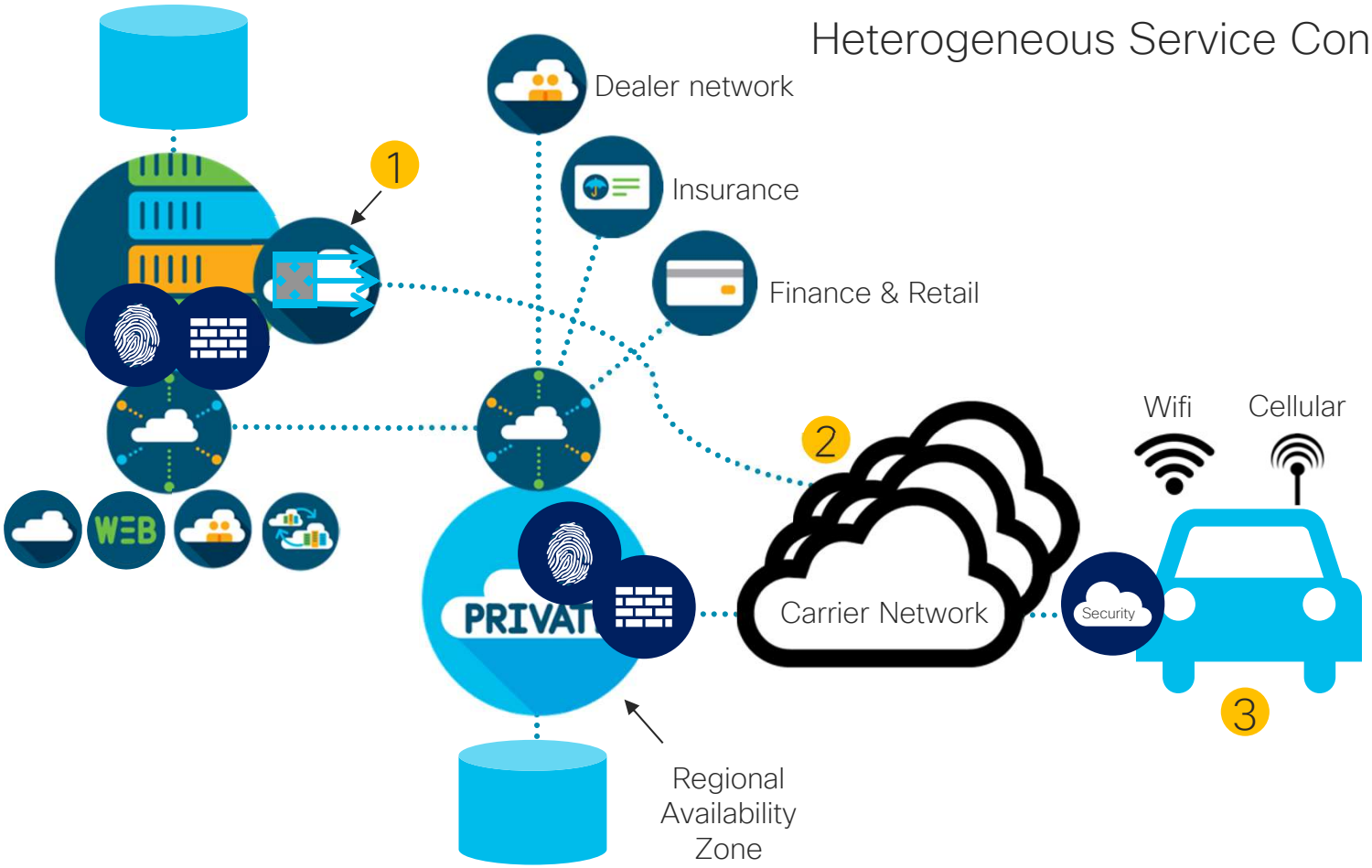
Consumer Application 'APN'



Consumer Application 'Hot potato'



Heterogeneous Service Consumption



Summary

Challenge

- How do we design, build and operate communication networks to support these data volumes, cost effectively and securely?
  - For Vehicle manufacturers
  - For Fleet operators
  - For Communications Service providers
  - For end users
- How does 5G enable new business opportunities?
- What other technologies do we need to consider?

How can we do things differently?

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SP360: Service Provider

Connected Car – The Driven Hour – whitepaper edition

Joel Obstfeld
April 10, 2019 - 0 Comments

Connected vehicles are considered to be one of the major drivers for investment in cellular communications technologies with forecasts projecting every new vehicle produced being 'connected' by 2025.

What does this mean with respect to the impact on communications networks? What are the applications driving the growth in data and what data volumes will network operators be expected to transport?

In a series of blog posts, starting with https://blogs.cisco.com/sp/connected-car-the-driven-hour, we examined today's Connected Cars, to consider the range of applications being used to provide information to the vehicle manufacturers, those designed for the consumer and the data volumes vehicles will generate and consume. We then looked forward to the next generation of vehicles, past the hype of '4TB per day' to understand what future applications may look like and what data volumes will these produce.

https://blogs.cisco.com/sp/connectedcar-thedrivenhour-wp

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