Enabling Automotive IoT

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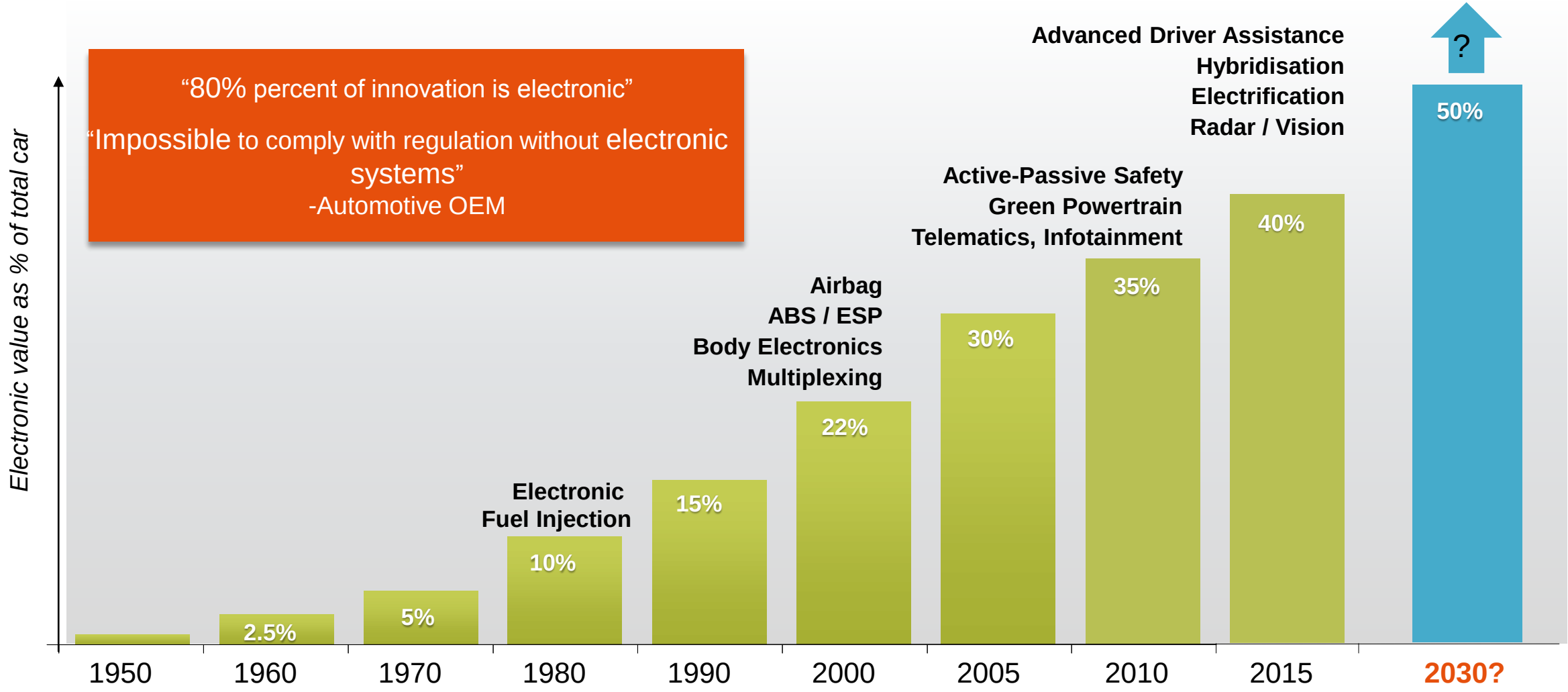
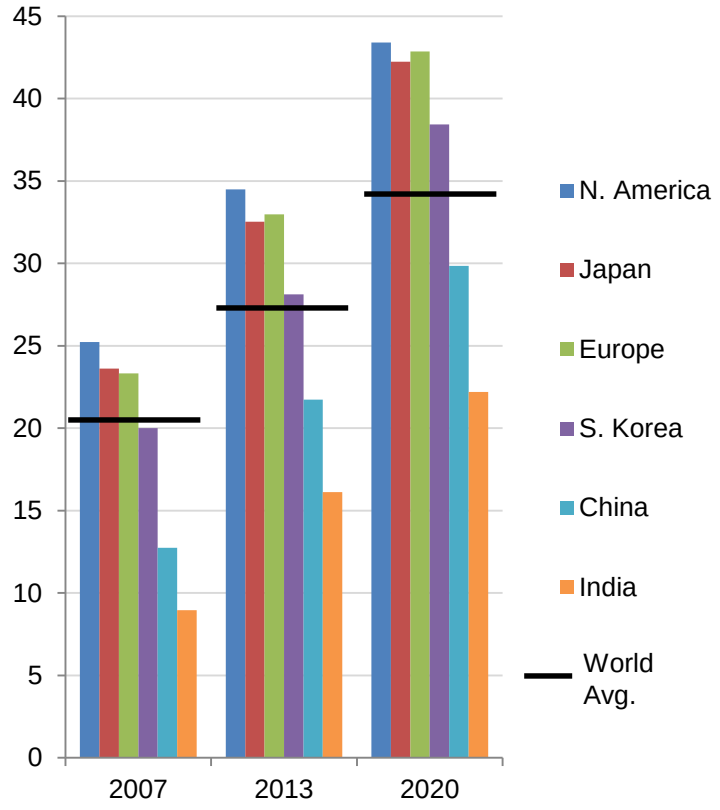
freescale™

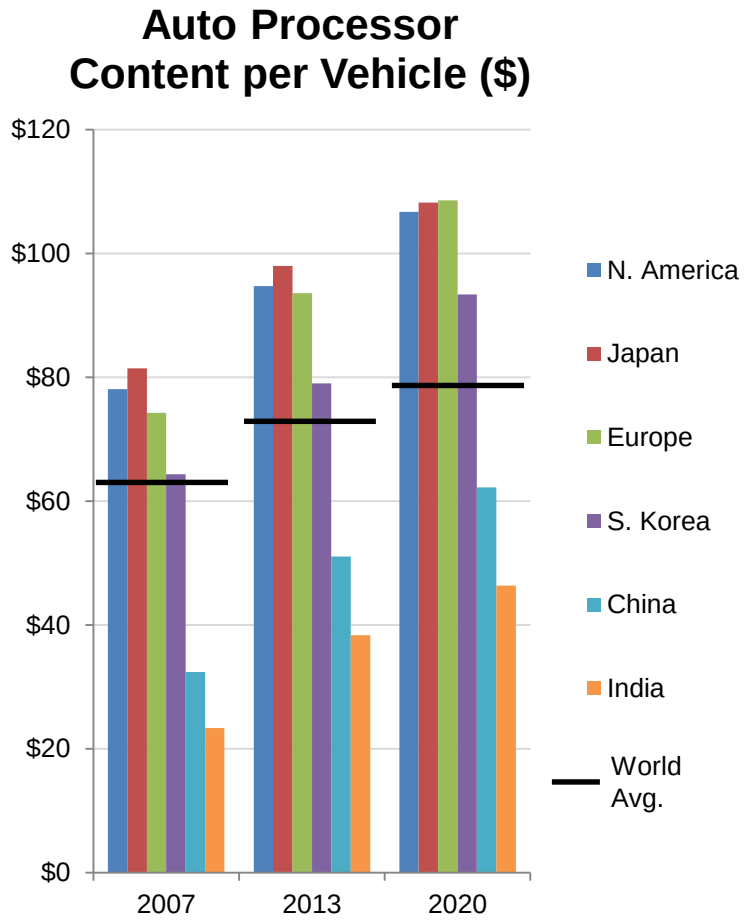
External Use

Automotive Electronic Content Growth



Automotive Processors Per Vehicle Trends





Source: Strategy Analytics (Jan '14)

Automotive Semiconductors Megatrends

The semiconductor content in vehicles continues to grow with 10% growth in 2014 creating a market of $29 B. 2015 is forecast for continued strong growth of 7.5%. *

A Greener World

New energy vehicles; tighter electronic control of ICE; weight reduction through networked nodes

Secure Connectivity

The car as IoT node; wireless gateways, code security and consumerization of the vehicle

Mobility for Everyone

Vehicle content race in China; bringing comfort and safety features across the fleet

Safer Travel

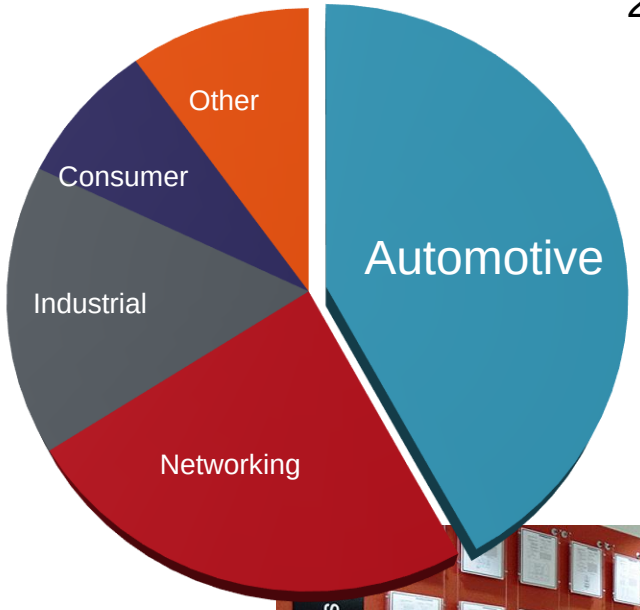
ADAS as the catalyst to autonomous; functional safety and zero defect mandatory for zero fatalities

* HIS press release January 26,2015, “2014 was a Bumper Year for Automotive Semiconductors. (http://press.ihs.com)

Automotive MCU Product Leadership

Megatrend	Safer Travel		Electrification Going Green	Connectivity	Electrification Emerging Markets	
Application	Radar	Vision	Powertrain	Gateways	General Body and Chassis	Actuators and Sensors
				CAN lin FlexRay Wi Fi Ethernet		
Key Technology	High perf. ADC and DSP	Image processing	CPU/timer performance and instrumentation	Communication interfaces Security	ARM Cortex Software and Tools	MagniV with HV analog
Value Proposition	**Highest performance and system integration**	**Leading image processing AND functional safety**	**Leading performance architecture**	**Highest networking bandwidth AND security**	**Reduce our customers R&D and time-to-market**	**Reduce system size and manufacturing cost**

Automotive is Freescale's Core Business



18,000 employees
$4.6B revenue in 2014
6,000 patent families

1978 MC6801 First **Engine Control** MCU

1988 First 32-bit **68 K** MCU

1993 First 32-bit MCU w/ **flash memory**

1994 First 8-bit **CAN** MCU

1997 **MPC500** 32-bit RISC MCU

2006 First 32-bit MCUs (FlexRay™+Ethernet) for Advanced Vehicle **Networking**

2007 First **dual-core** Automotive 32-bit MCU

2009 First t**riple-core** Automotive 32-bit MCU

2010 New 55 nm **MPC57oo** Power Architecture® Line Announced with dedicated security core

2012 First **ISO 26262** certified MCU

2013 First sampling **55 nm automotive** MCUs

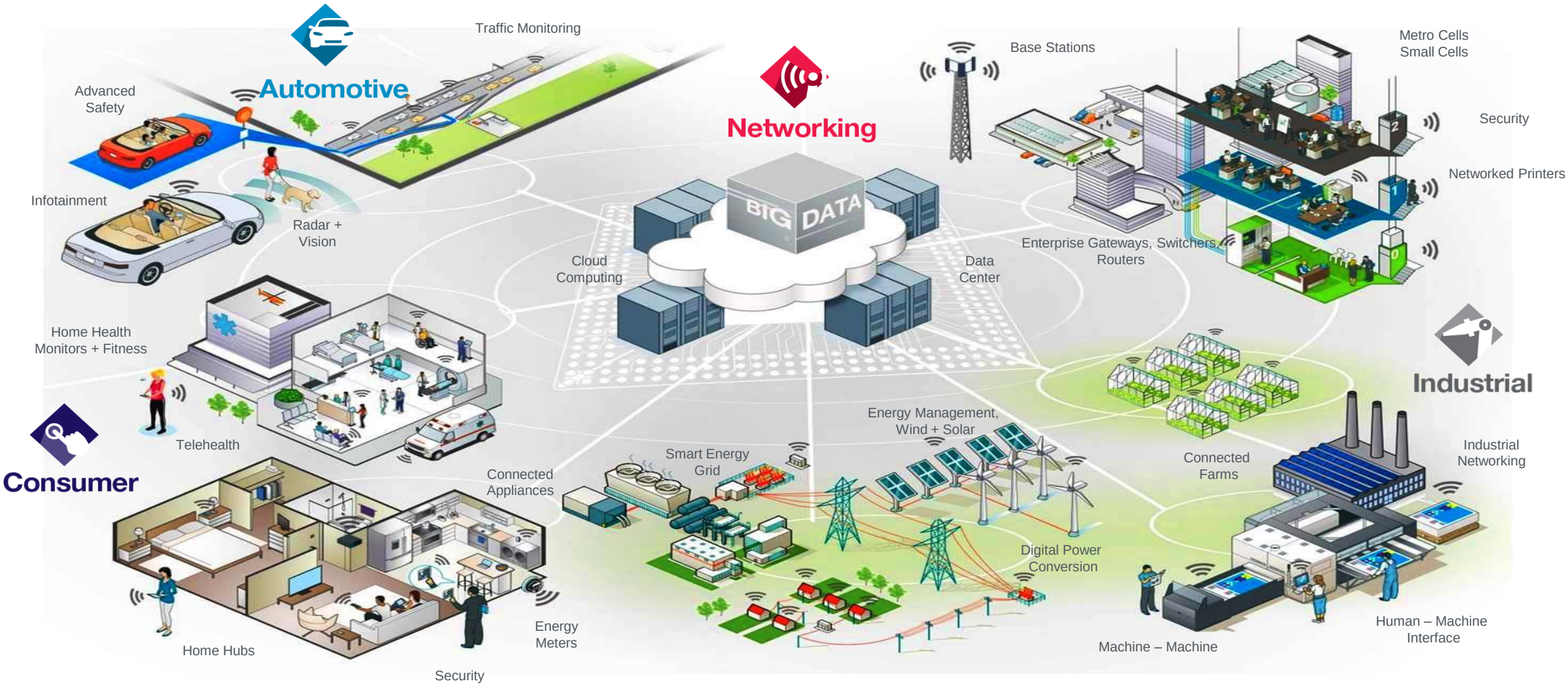
2014 First quad core **Fault Tolerant** MCU for Brake by Wire Applications

2015 S32V – first **automotive vision** SoC with reliability, safety and security

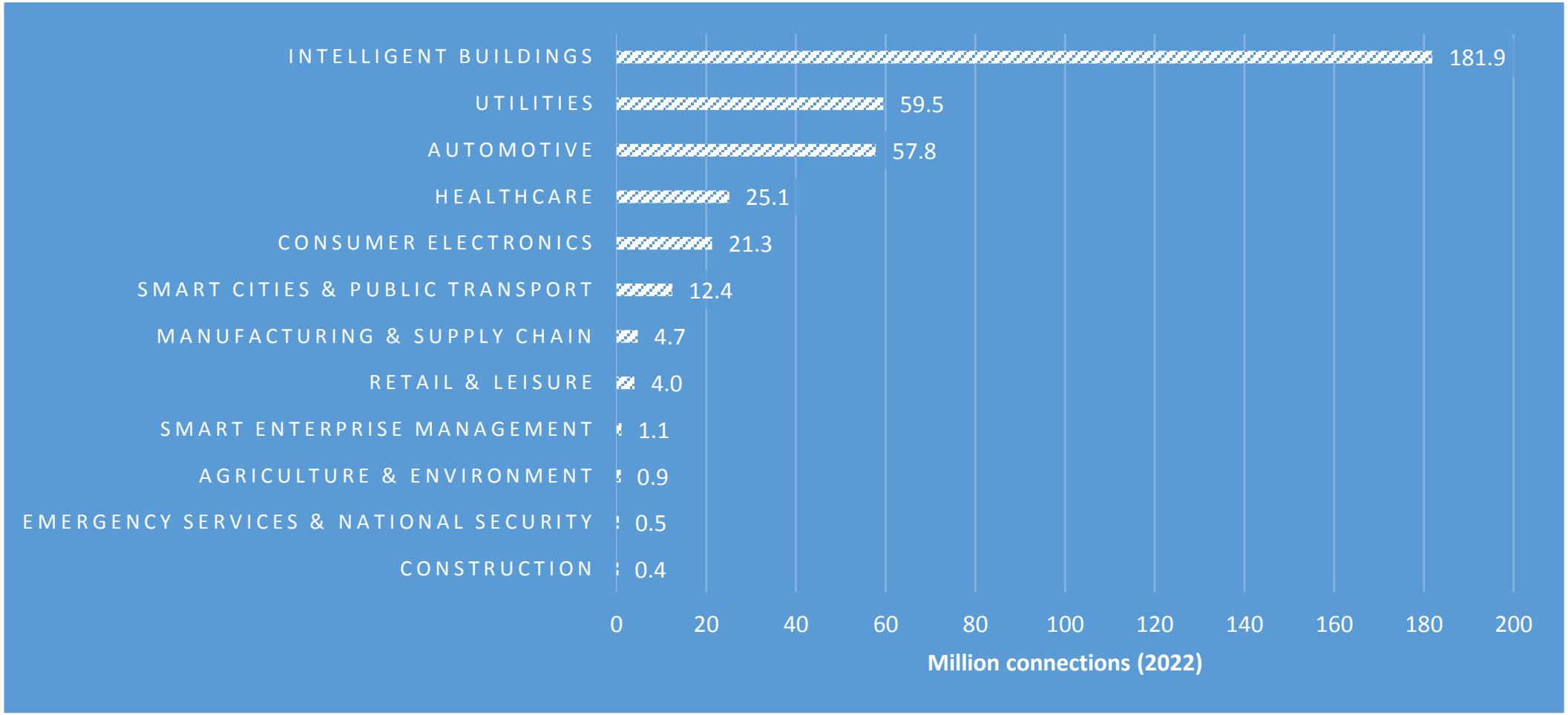
IoT ?

- Internet of **Treats**
- Internet of **Threats**
- Internet of **Tracking**
- Internet of **Technology**

The Internet of Things



Projected IoT Market Size by Sector in 2022



Source: Machina Research

“103 exabytes of data is generated by vehicles every day”

Source: IBM

What Automotive IoT Means to Me

Attributes:

- Security
- Connectivity
- Robustness

Enabling:

- Consumer experience
- Big data analytics
- Extra compute resource
- New connections

IoT or Not IoT?

Consumer Experience	Big Data Analytics	Extra Compute Resource	New Connections
Remote diagnostics	ITS / Smart City	Voice recognition?	Driver assistance (V2X)
ECU software update	Electronic component wear monitoring		Collision avoidance (V2X)
Health monitoring			eCall?
Map updates			Electronic toll collection
EV battery status			Pay as you drive insurance
Real time weather			
Real time traffic			

Challenge 1: Functional Safety

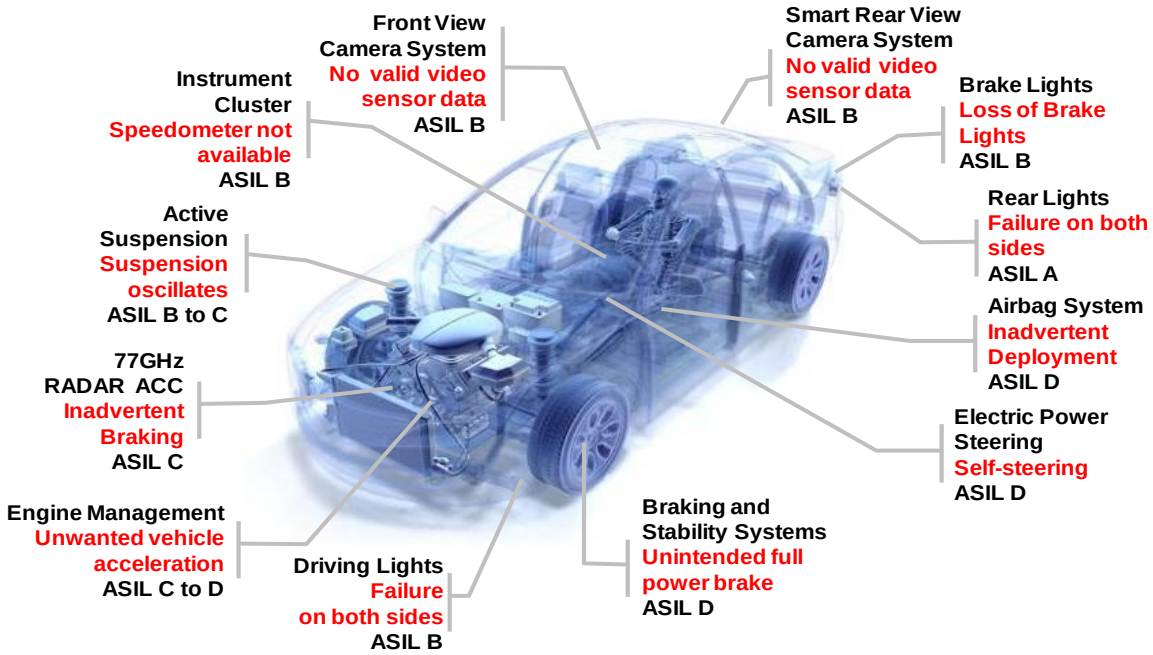
Functional safety is the **absence of unreasonable risk** due to hazards caused by malfunctioning behavior of electrical/electronic systems

- **Hazards**: potential source of harm
- **Harm**: physical injury or damage to the health of people

Failures are **main impairment** to safety:

-**Systematic**: failures that can only be eliminated by a change of the design or manufacturing process

- **Random**: failures that can occur unpredictably during lifetime

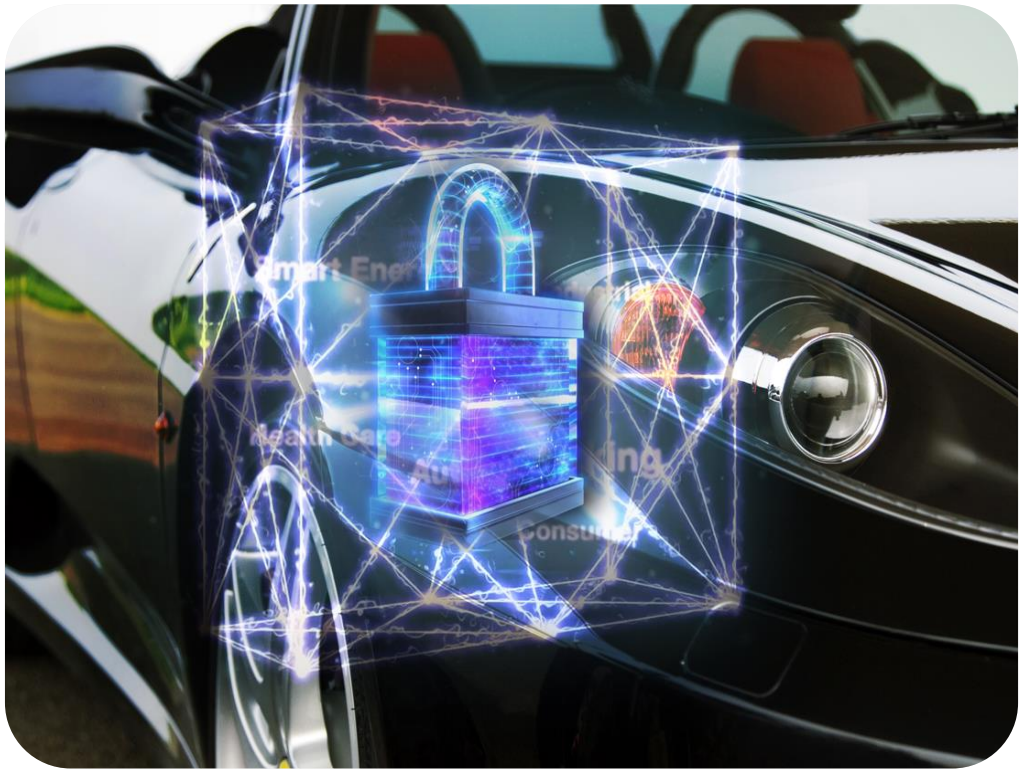


Challenge 2: Security

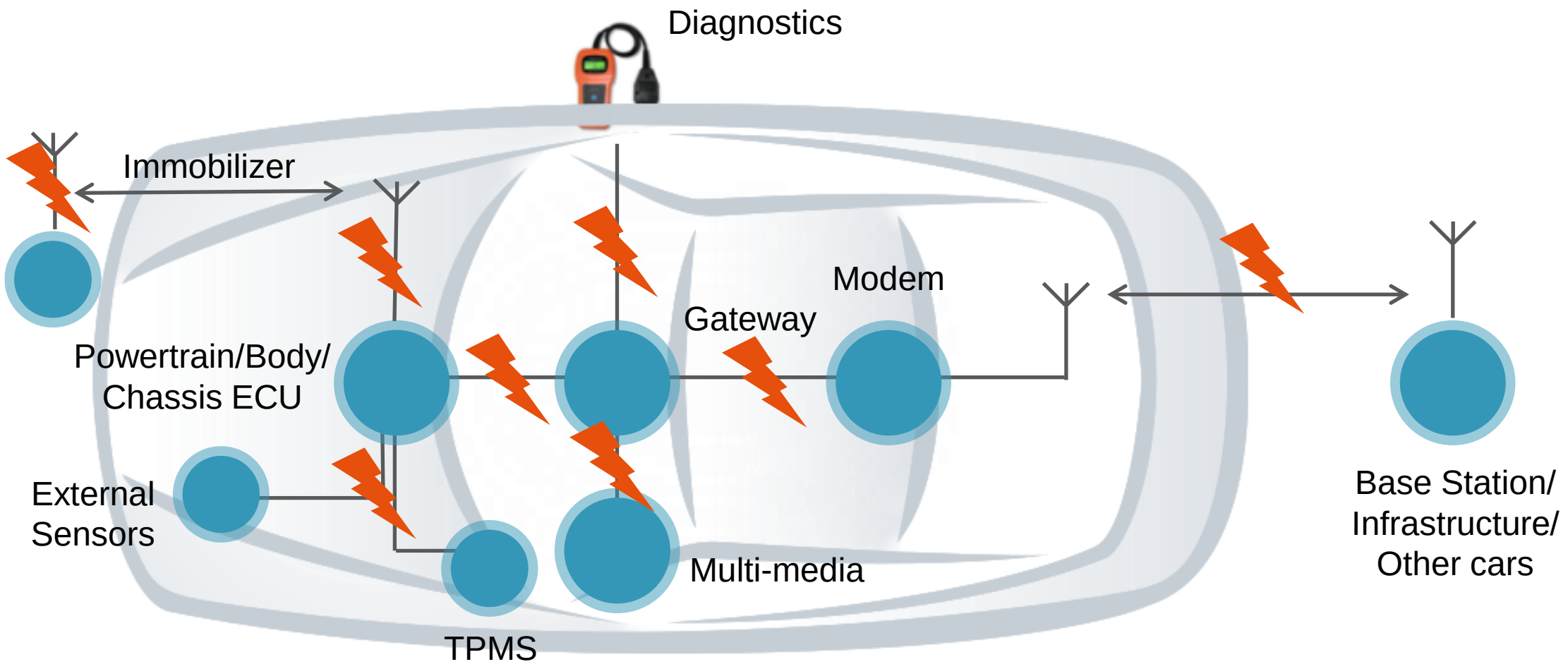
- Unfortunately security will be broken
  - ~86,000 new pieces of malware/day
  - When value of break exceeds effort to break
    - Cyber risk = threats X vulnerabilities X consequences

- System level approach to security required from the sensing nodes through various layers of embedded processing to the data centers
  - System only as strong as its weakest link
  - Automotive industry needs to learn from other industries rather than invent something new & specific

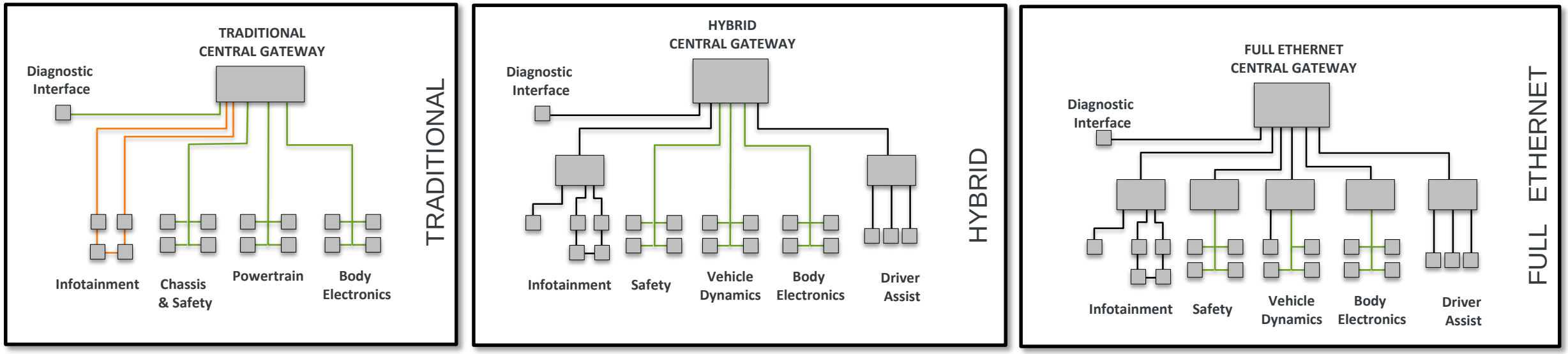
- Huge area for research & standardization over the next decade
  - Mutual authentication
  - Tamper detection
  - Monitor integrity of security



Automotive Security Attack Surface



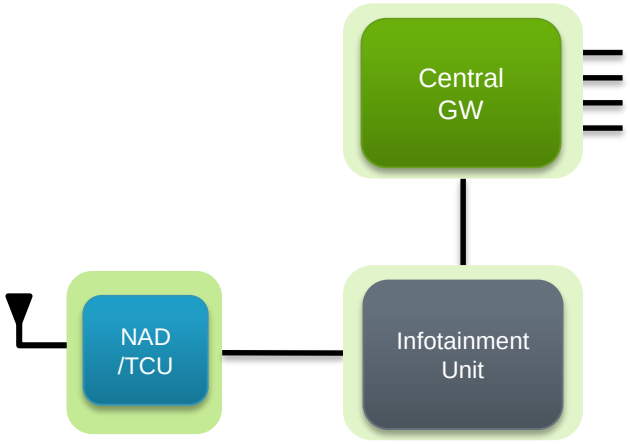
Challenge 3a: Connectivity (Internal)



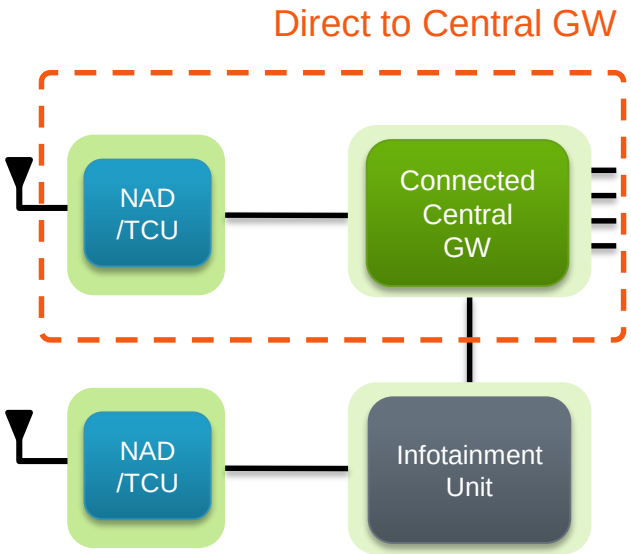
Traditional Auto (CAN, LIN, FR)
MOST
Ethernet 100Mpbs or 1000Mpbs

- Increased data rate driving network changes
- Emergence of new protocols e.g. SENT
- Adoption of industrial protocols e.g. Ethernet
- Every vehicle architecture is different

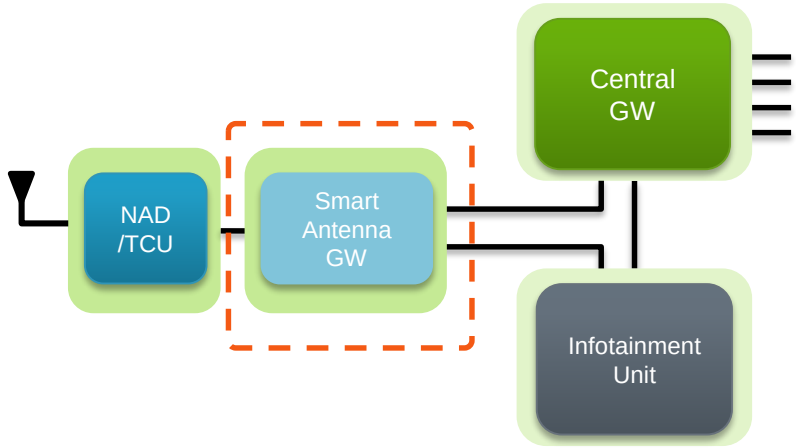
Challenge 3b: Connectivity (External)



Infotainment Connectivity



Separate OEM & User Connectivity



Smart Antenna Connectivity

- Increased data rate
- Many different connectivity schemes

Smart Antenna GW features:

- Connect to multiple wireless interfaces
- Host connected applications (e.g. Wi-Fi® Hotspot, FOTA)
- Packetize data into Ethernet for internal transmission

Challenge 4: Connection Technology

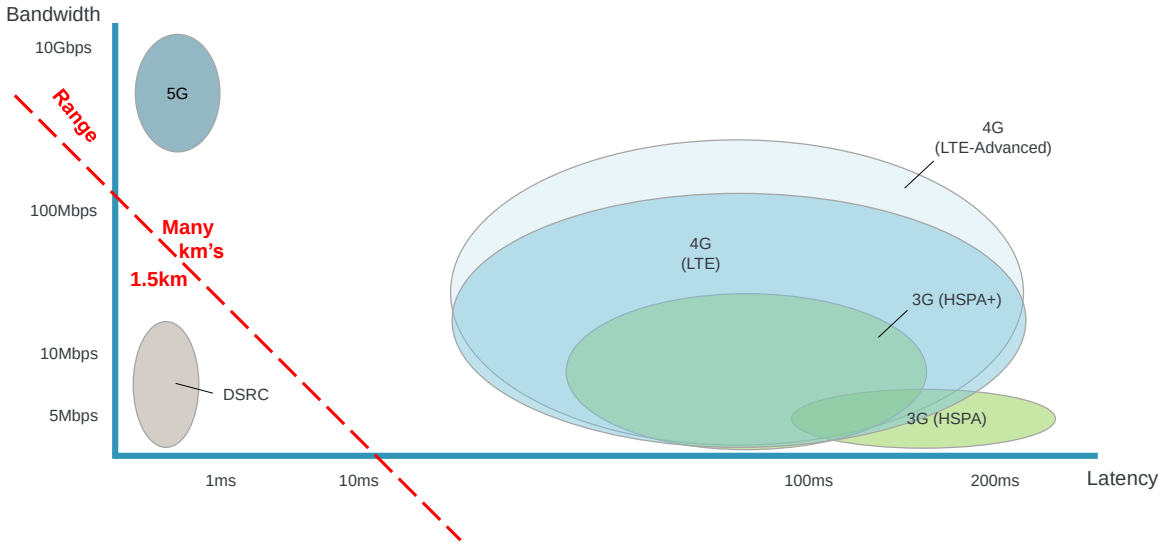
- Re-visit use case table
- Consider attributes of connection required
- Consider new legislation, e.g. eCall, NHTSA V2X

	Latency	Bandwidth
High	Remote diagnostics ECU software update Health monitoring Map updates Electronic toll collection Pay as you drive insurance Electronic component wear monitoring	Map updates
Medium	ITS / Smart City EV battery status Real time weather Real time traffic eCall	Remote diagnostics ECU software update Health monitoring Pay as you drive insurance Electronic component wear monitoring ITS / Smart City Real time weather Real time traffic
Low	Driver assistance (V2X) Collision avoidance (V2V)	Driver assistance (V2X) Collision avoidance (V2V) eCall EV battery status Electronic toll collection

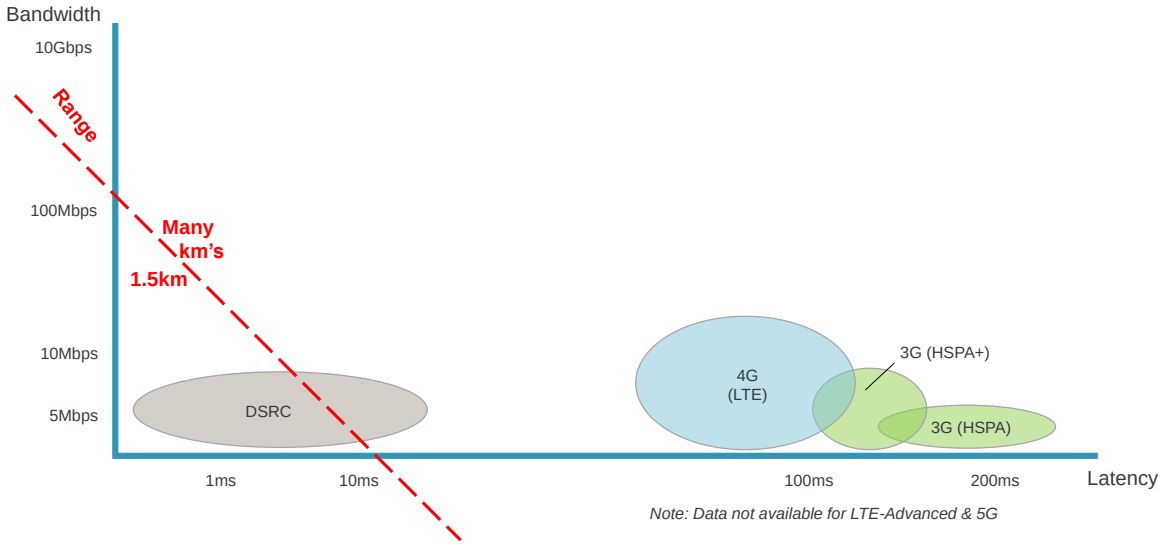
Challenge 4: Connection Technology

- Can one connection technology meet all the requirements?
- Maybe 5G can technically meet latency & bandwidth requirements
- DSRC range, cost & business case concern

Theoretical

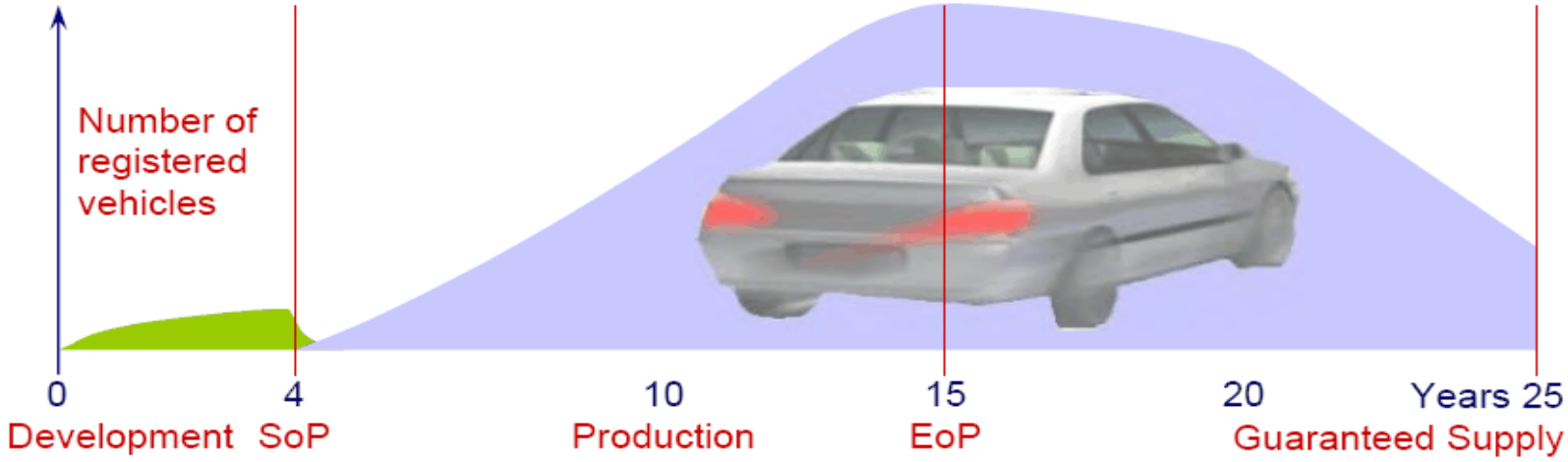


In practice



Note: Data not available for LTE-Advanced & 5G

Challenge 5: Automotive Development Cycles



Product Lifecycle Phases

- MCU development
- System development
- Vehicle Trials
- Vehicle production
- Vehicle in use
- System production

Reminder – why are we Connecting our Cars?

85% increase in UK road traffic since 1980, further 40% growth expected by 2040

Source: Department for Transport

Safety

- 183,670 UK Road casualties in 2013, incl. 1,713 fatalities*
- 80% of accidents due to human error
- UK Road casualties down 50% from 2000.

Source: www.gov.uk

Congestion

- Average UK motorist spends 30 hours a year in traffic jams - 82 hours in London
- 7500km of European highways blocked by traffic jams every day

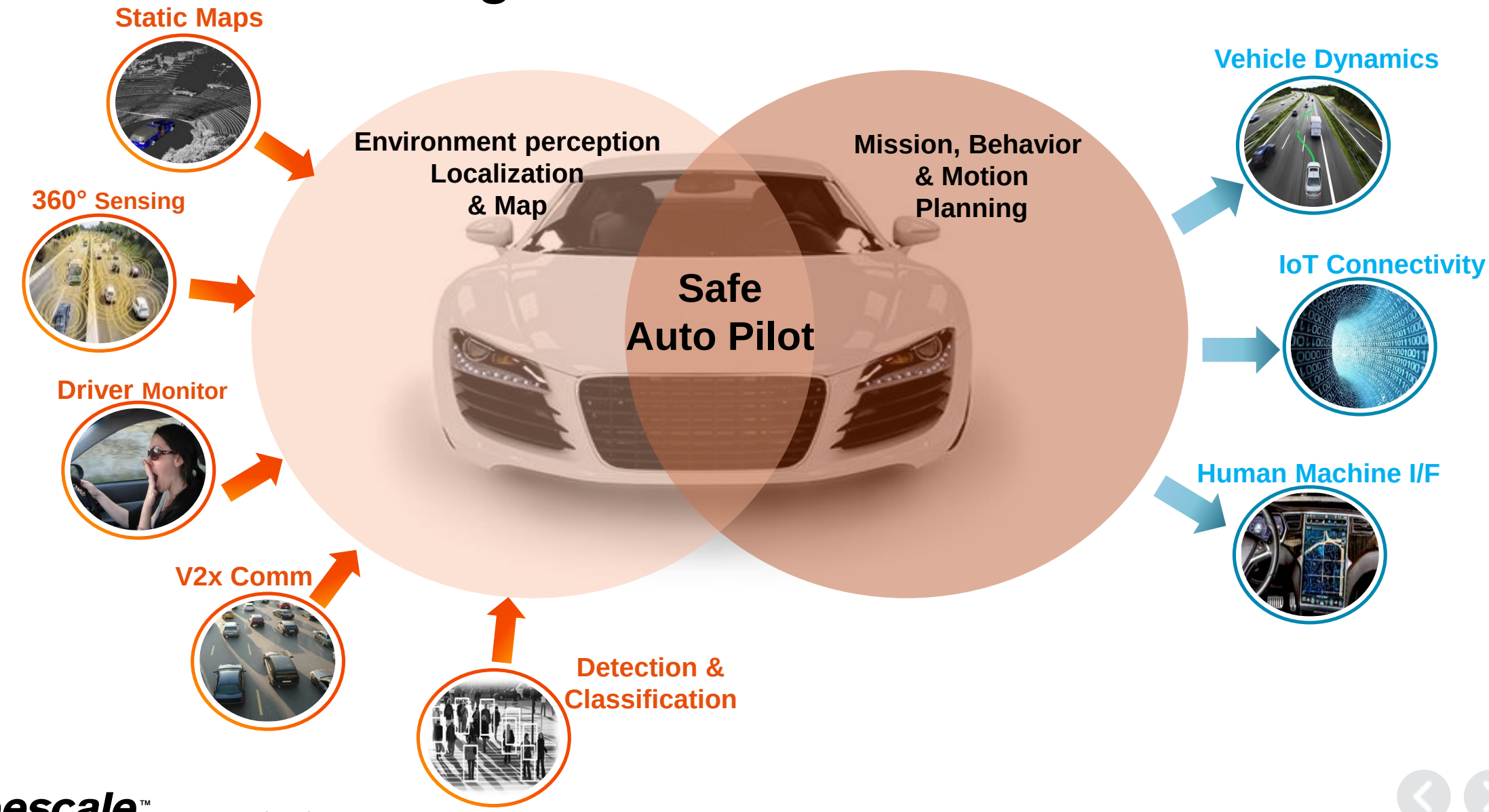
Source: INRIX

Emissions

- 54% increase in CO_2 emissions from domestic transport since 1980
- Congestion on roads and at airports adds 6% to the EUs fuel bill

Source: Eurostat

The Ultimate Challenge – Automated Drive



Automated Driving – Computing Challenges

Probabilistic → **Deterministic**

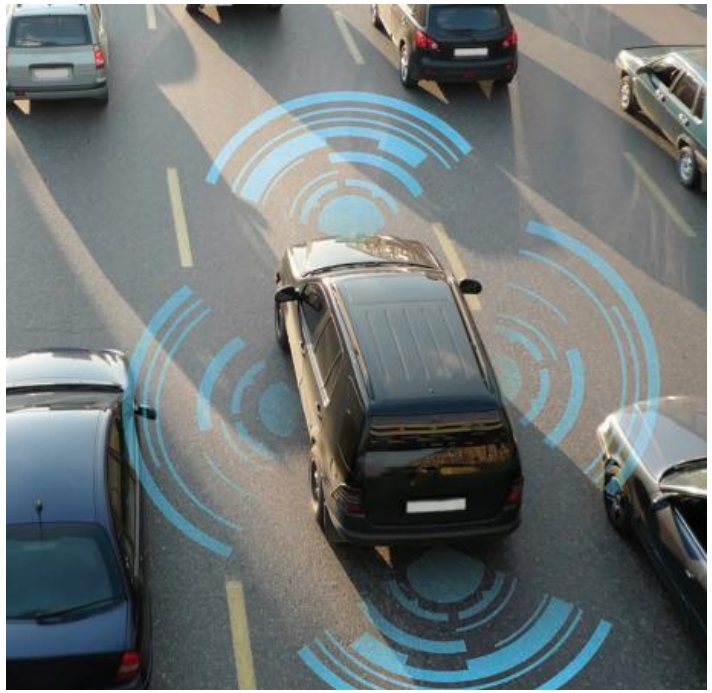
Automated Drive	Co-Pilot	Collision Avoidance	Self Parking	Lane Keeping	Collision Warning	Sign View

- Mission Planning
- Behavior Generation
- Motion Planning

- Sensor processing
- Dynamic Actuation
- Real time data management

Processing resources need to be dynamically managed to execute probabilistic AND deterministic functions
... Within the same vehicle context

Freescale Automotive IoT Vision



- Freescale will help **enable the Automotive IoT**
  - Security, connectivity & robustness
  - With our ecosystem partners
- IoT is more than marketing hype – it is a game changer in the services & safety of owning & driving a vehicle
- Automotive IoT still has many challenges
  - Functional safety & security
  - In-vehicle & external RF connectivity
  - Development timeline
- And combine them all into the ultimate challenge – the automated vehicle.

www.Freescale.com