Autonomous Driving: Need for AI and New Architectures

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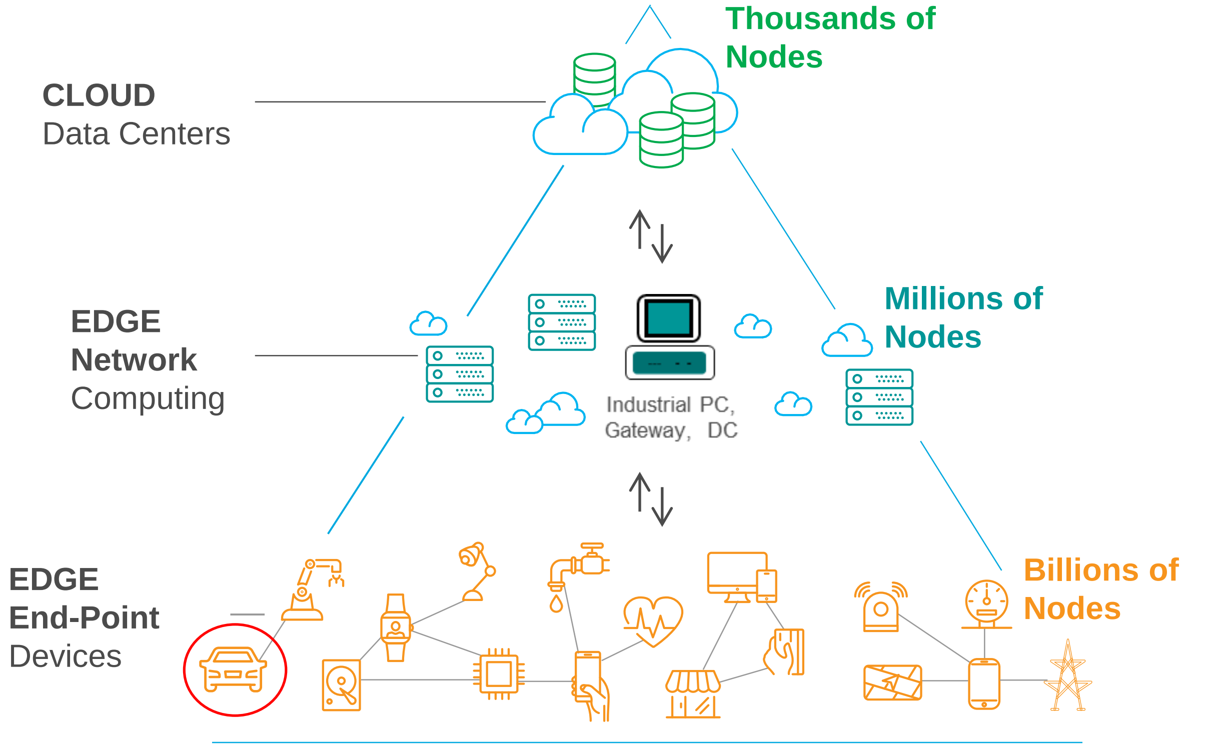
OUTLINE

- AI pervasiveness
- Vehicle and Semiconductor market forecast
- Role of SoCs and AI-based systems in future cars
- Why AI in Automotive
- New E/E architectures required
- Growth of electronic content and costs by autonomy levels
- Software: a noble gas
- Open challenges and opportunities

AI is pervasive: everywhere at the Edge and at the Cloud

- Cybersecurity
- Monitoring diagnostic
- Predictive maintenance
- Quality and testing
- Genome & chemistry simulation
- Retail & CRM
- Autonomous machine

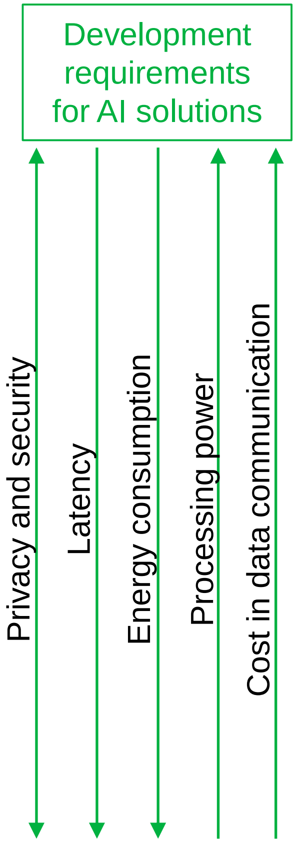


Factory
11 billion commercial and industrial IoT devices will be shipped by 2025, with growing implementation of AI/ ML functionality.

Video Surveillance
A recent trend in the safe city market is the development of next generation smart cameras, which leverage AI-enabled high compute powered network cameras.

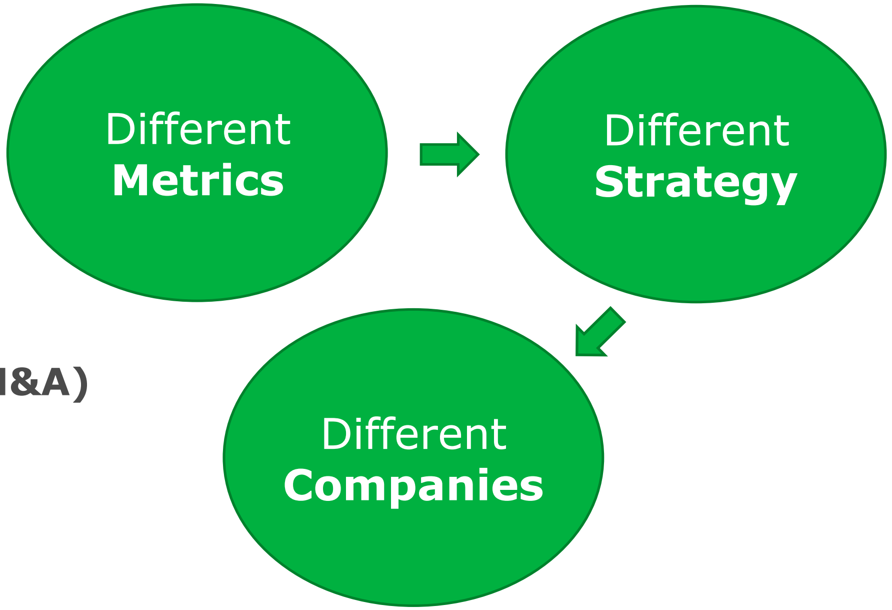
Hospital
To date, over 350 algorithms (also known as machines) have been developed specifically for medical diagnostics, funded with more than $4 billion in venture capital.

Data Center
Servers shipped with specialized co-processors for artificial intelligence (AI) and machine learning (ML) will make up over 10 percent of global server shipments by 2022.

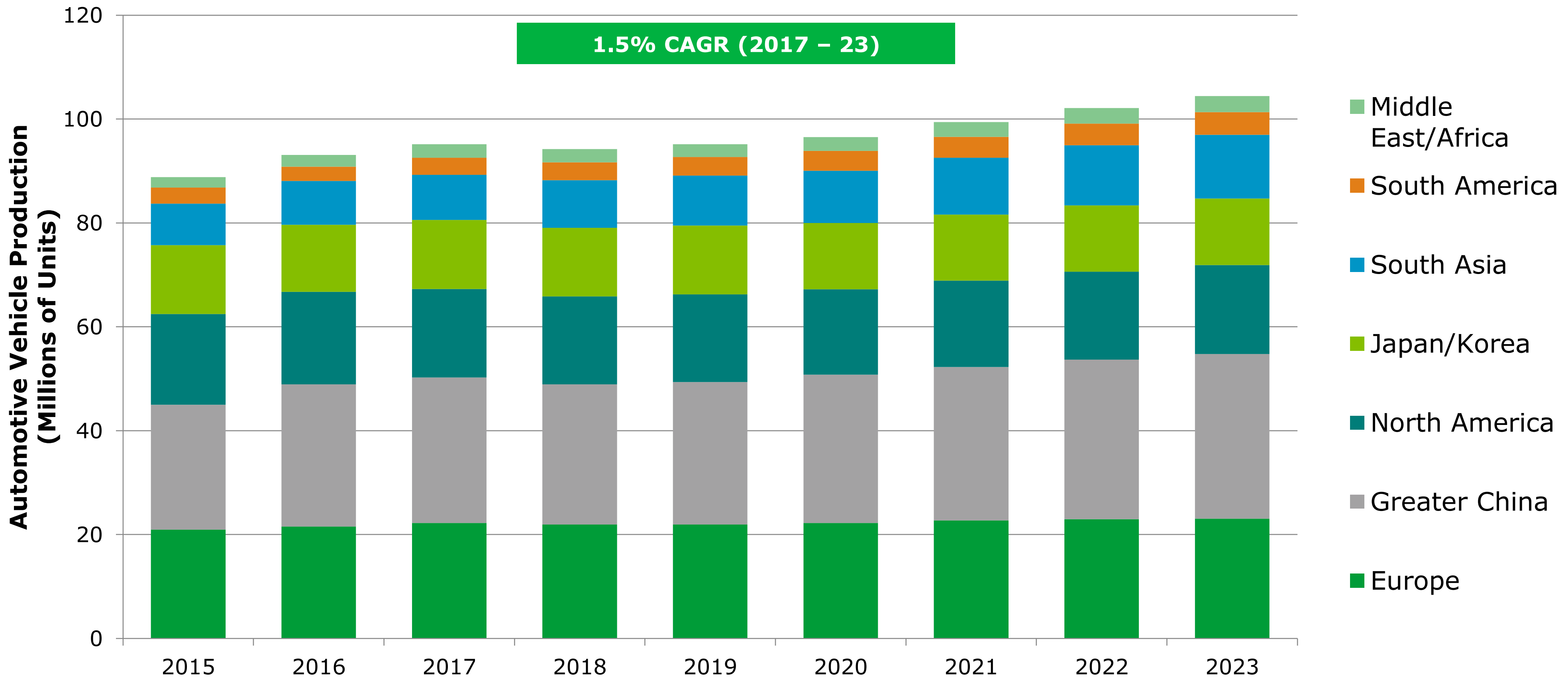


Different Metrics for Investment and Research engagement:

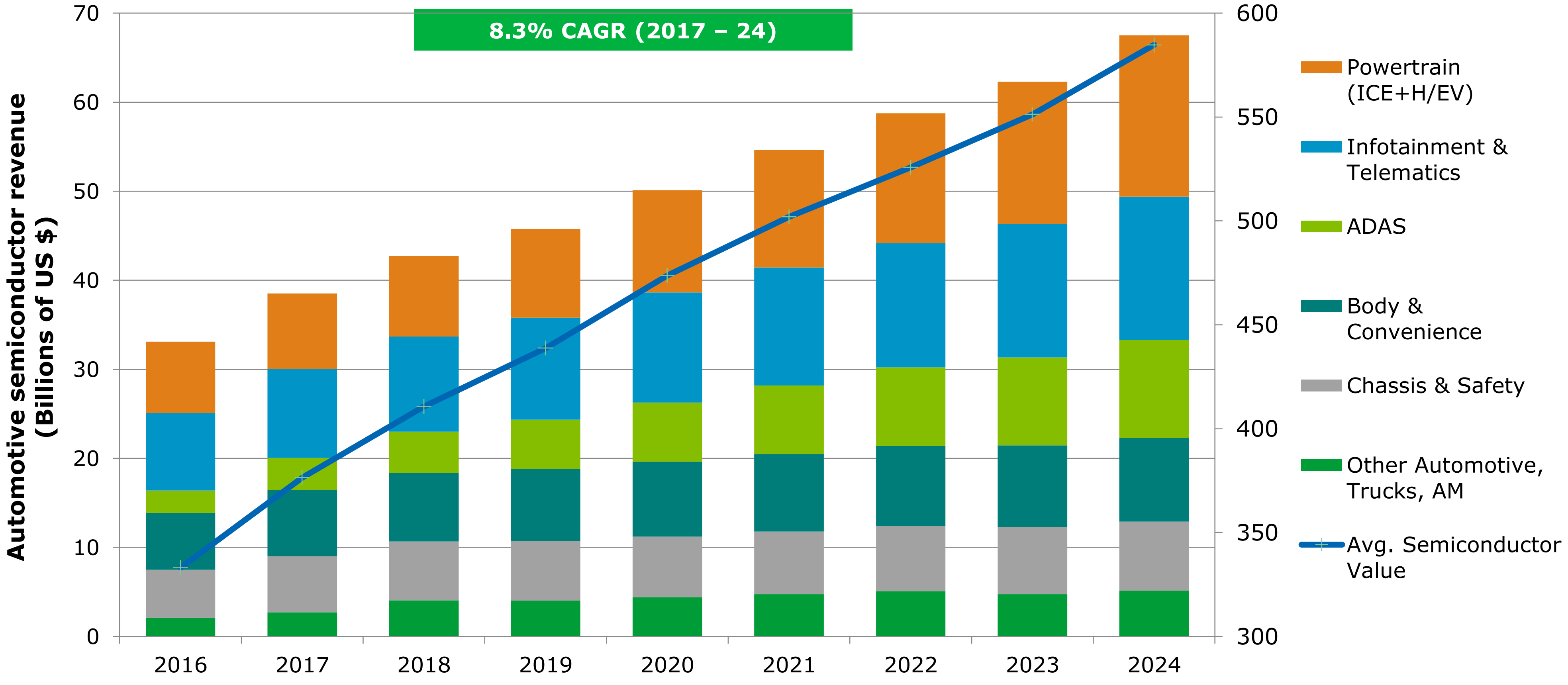
- **Business Case:** Investment (Legacy Equipment, Process node and Product Life cycle) and ROI
  - Market Volumes (i.e. Shipment) vs Time frame
  - Revenue Expectation
  - Market Momentum & Growth expectation
  - Margin
  - Technology Readiness
  - Competition analysis
- **Regulatory needs/assessment**
- **Eco-system development and needs (Partner and M&A)**
  - Start-up and new players
- **System Complexity (HW and SW)**
  - Memory and Interfaces
  - Key performance parameter:
    - Processing/Data workload, Latency, Power, Safety
  - Silicon differentiation in data-processing: GPU, CPU, TPU…up to Heterogeneous SoC;



Vehicle production rises slowly



Electrification, automated driving and connectivity
Fueling automotive semiconductor growth



Implication of AI and Deep Learning

Major advantages in comparison with traditional machine vision

- **Assumptions:**

> New silicon solutions will be developed with focus on AI algorithm

> The functional safety aspect will be addressed by the entire supply chain

- **Deep learning can:**

> Allow detection and recognition of multiple object ➔ improve perception

> Perform semantic analysis of the area surrounding the vehicle

> Reduce development time of ADAS and IVI systems (once DL is in steady-state)

> Reduce the power required compared to the same operation w/ traditional algorithms

- **Deep Learning needs help**
  > Recognition/Prediction of actions and Fusion - Bayesian Net and other stochastic algorithms may complement DL in the run to autonomous cars (L4-L5)
- **Required precondition:**
  > Telematics will be broadly deployed to: 1) enable gathering of "real" patterns and data for training 2) allow over the air system update and security

Extra Requirements for Deep Learning in **ADAS & AV**

- **DL in ADAS for Autonomous functions requires in-vehicle HW:**
  - Latency: for active function system needs to react in less than 70-80ms
  - Deep Learning offer deterministic latency also for “noisy” input from sensors
  - Performance: TFlop/TOP/TMAC is barely the minimum
- **Power:**
  - Individual sensor subsystems need to stay in the power budget of 4W;
  - Sensor Fusion ECUs might allow targets up to 15-20W or more. Some OEMs expect already they need to find a trade off if no silicon is available and performance needed.
- **Backhaul and data storage infrastructure:**
  - Connectivity (IoT) is a need to:
    - Store training data and vehicle parameters.
    - Update/Upgrade the system
- **Data acquisition** is a challenge for validation and test: mix **Real** & **Synthetic** data (Simulation)
- **Safety** is the biggest uncertainty to have autonomous car based on AI.

Standardisation is a must have

Evolution of human machine interface (HMI)

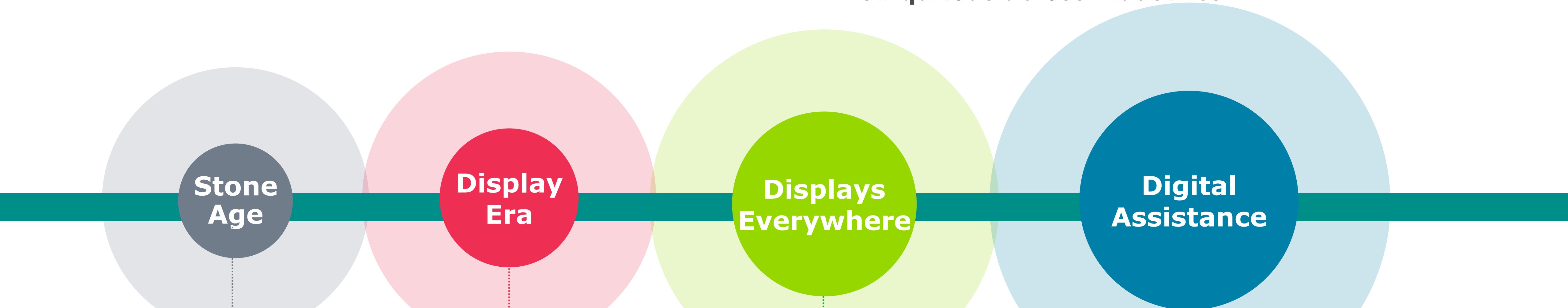
What pushed the changes?

- Diverse technologies: from displays to AI
- Lowered costs
- Influence of consumer electronics
- Increased customer needs

AI

Why human machine interface?

- High added value and brand differentiation
- Limited performance and cost
- Steady algorithms
- Available data
- Not safety critical
- **Ubiquitous across industries**



Buttons & knobs

Displays & more displays
- Resistive displays
- Basic speech recognition

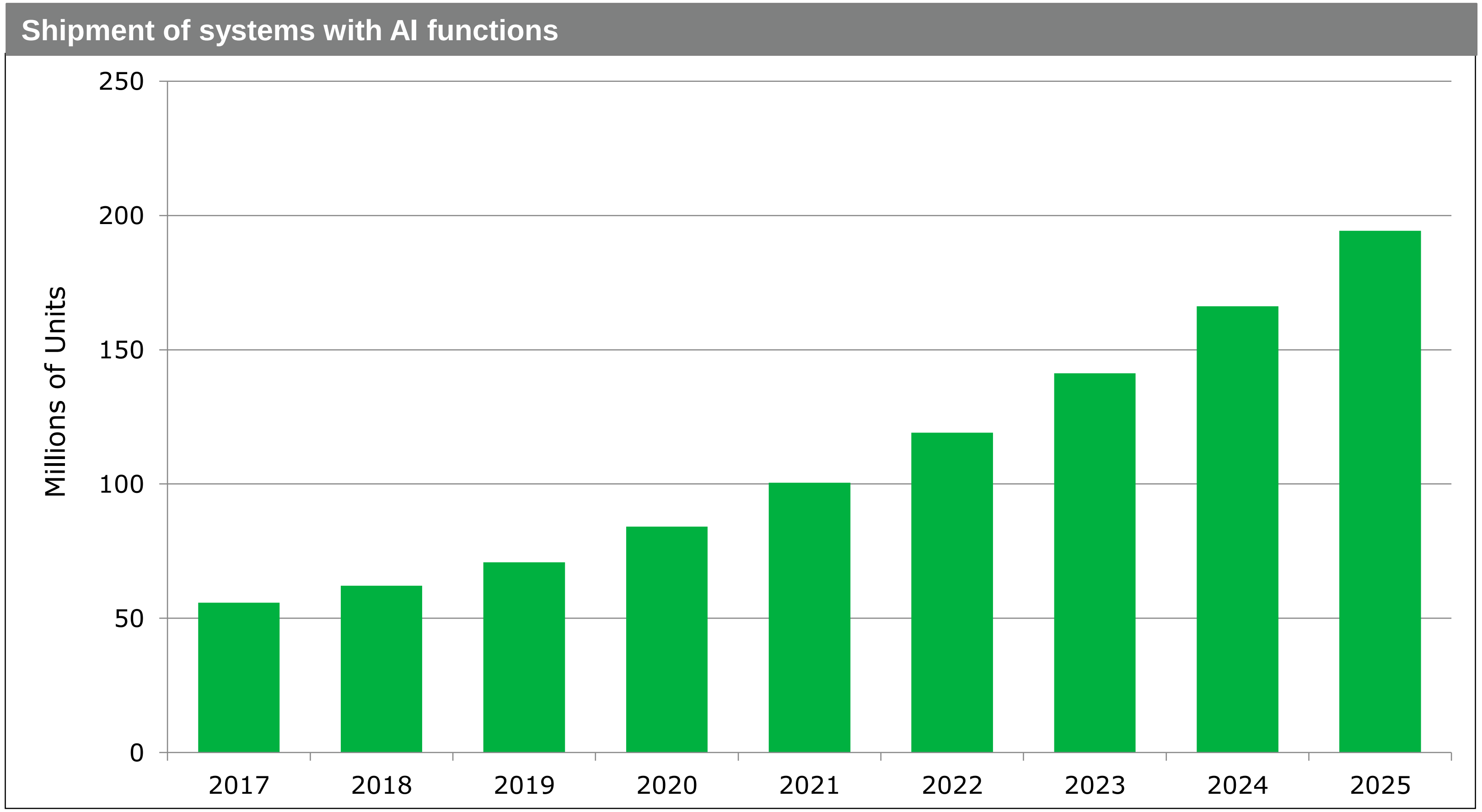
Displays out, audio in
- Capacitive displays
- Advanced speech recognition
- Speech-to-text and text-to-speech

Advanced audio & gestures
- Natural voice recognition
- Interpret human speech and gestures
- Enable tasks and services
- HD and >10” displays

Cost, Performance and Power for Autonomous Vehicles:
still far from high volumes vehicle production

- Power consumption is critical in automotive
  → where can compromises be acceptable?
- Performance 50<TOPS<100 looks to be the target in L4-L5
  → is silicon today able to cope with it and ensure a long term roadmap?
- Sensor and ECU add up to several thousands of dollars
  → what is the Business Model?
  → where is the ROI?
- ISO26262 is the biggest challenge considering ML deployment

AI in Automotive: Infotainment and ADAS



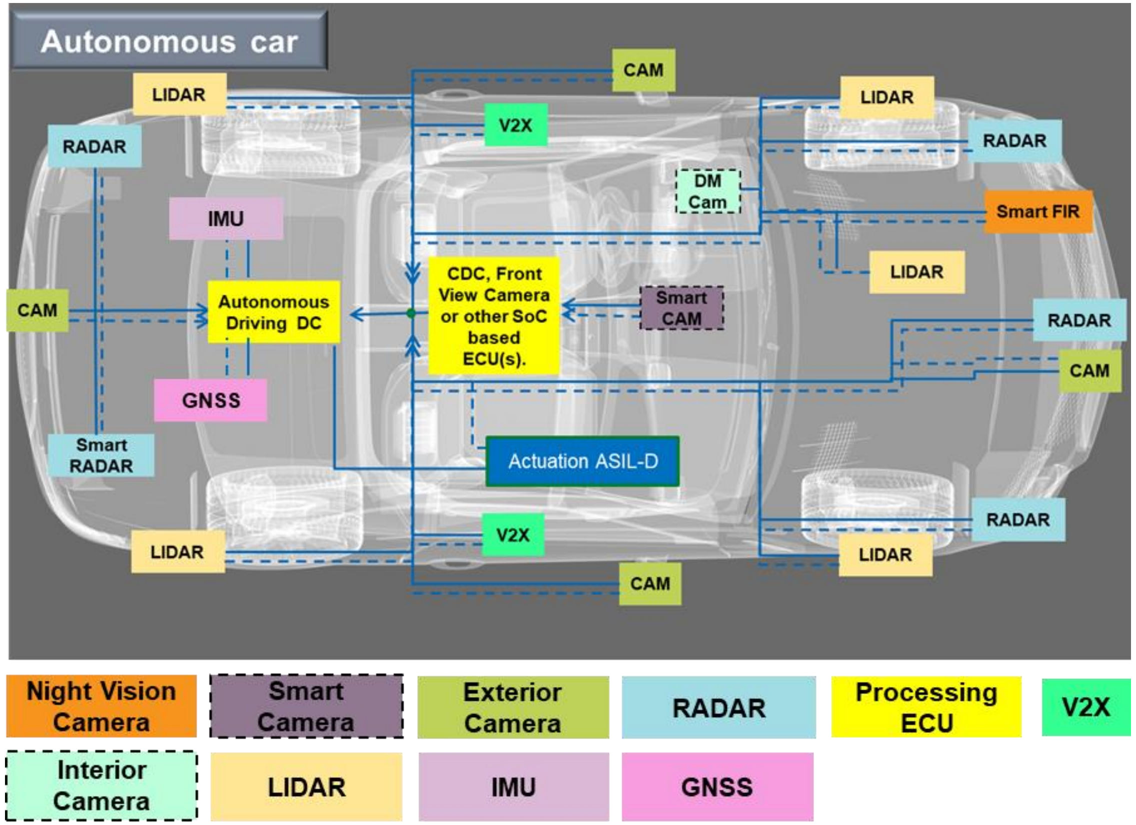
Typical ADAS content from level 3 to 5

	ADAS Modules	L3	L4	L5
	Ultrasonic Sensors	12	12	12
Radars	Long-range Radar	1	1-2	1-2
Radars	Short/Mid-range Radar	2-4	2-6	4-6
Cameras	Exterior Camera	5-8	12	8-15
Cameras	Interior Camera	1	1	1
Cameras	Night Vision Camera	0-1	0-1	0-1
Lidars	Long-range Lidar	~ $2-3k	~ $3-6k	~ $6-9k
Lidars	Short-range Lidar	0-2	0-4	0-4
ECUs	ADAS Domain Controller	0-1	0	0
ECUs	Autonomous Driving DC	1	1-2	2
	TOTAL (without ultrasonic)	**14**	**22**	**25**

***Architectures based on existing pilot car platforms from BMW, Volvo, Audi, Nissan..**

Possible architecture for L4/L5 in model year 202x

Asymmetric redundancy



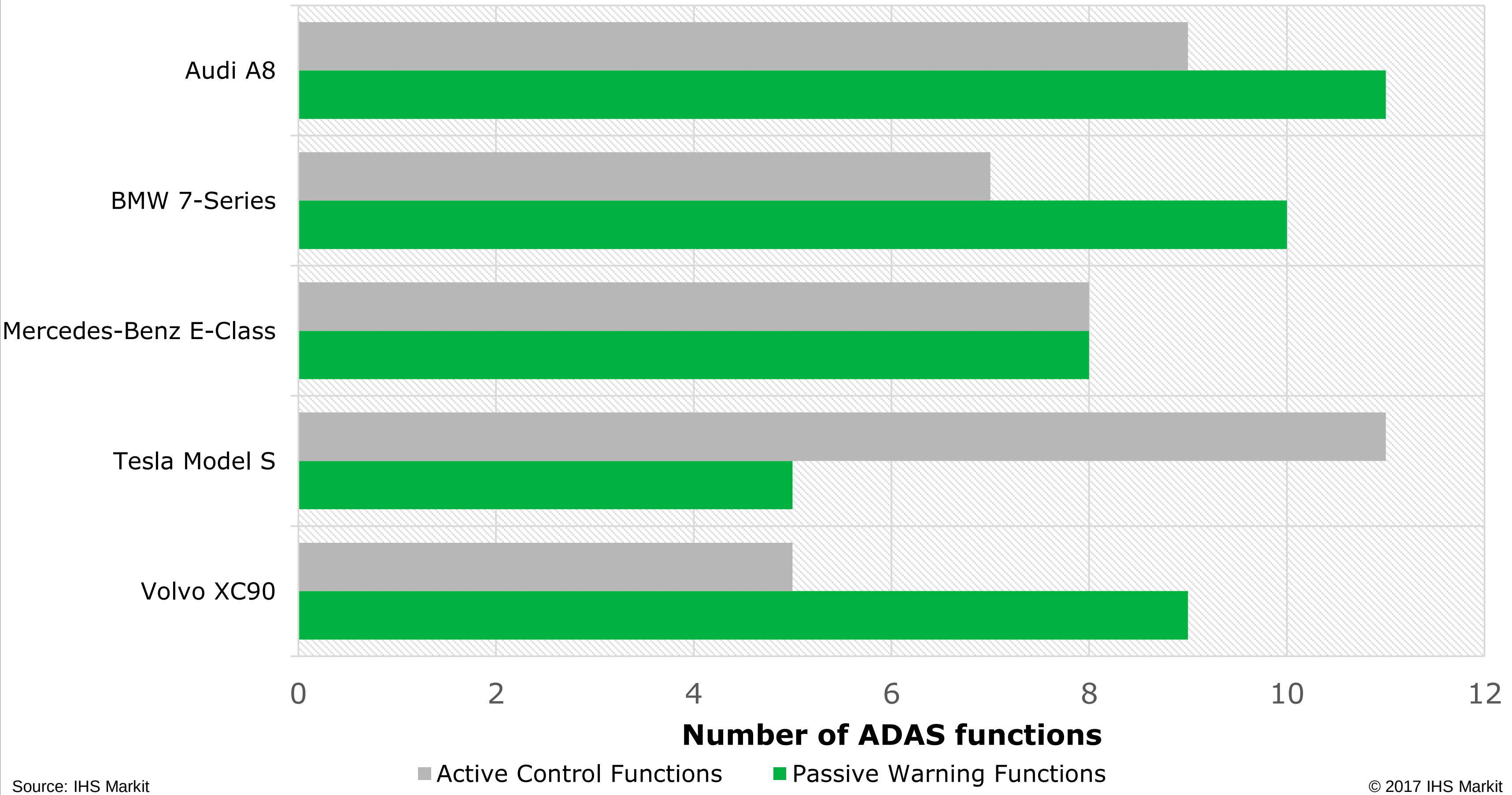
Source: IHS Markit

- No Driver - Redundancy for L4/L5 is key
  - Two identical (or nearly) Domain Controllers
    - Provides complete redundancy.
    - Expensive but comprehensive.
    - DC2 can either share normal operations with DC1 or act just a back up.
    - Redundant network and power supply
  - Limited or distributed redundancy
    - Cockpit Domain Controller (CDC) and/or Front View Camera are candidates because of their processing capabilities.
    - Lower cost than symmetric redundancy but maybe less comprehensive.

*DC= Domain Controller

ADAS classification by passive warning and active control

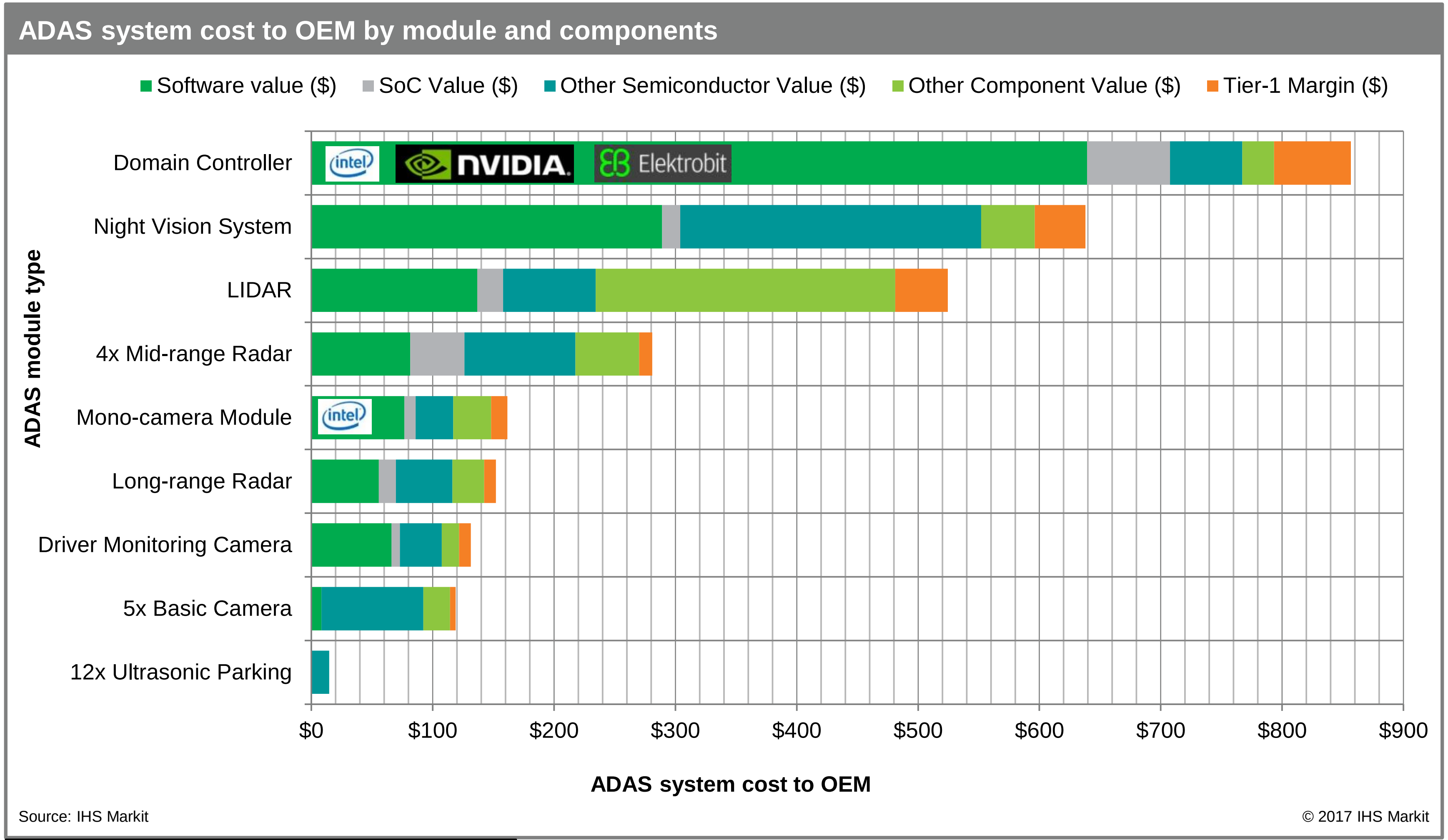
ADAS functional classification on 5 models



Source: IHS Markit

*The results of Tesla Model functions will be updated after investigation completes

ADAS system cost to OEM by component value on Audi A8



*Price of SOC does not include software value.

Thanks for your attention

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URL: https://technology.ihs.com/Research-by-Market