

What drives silicon demand?

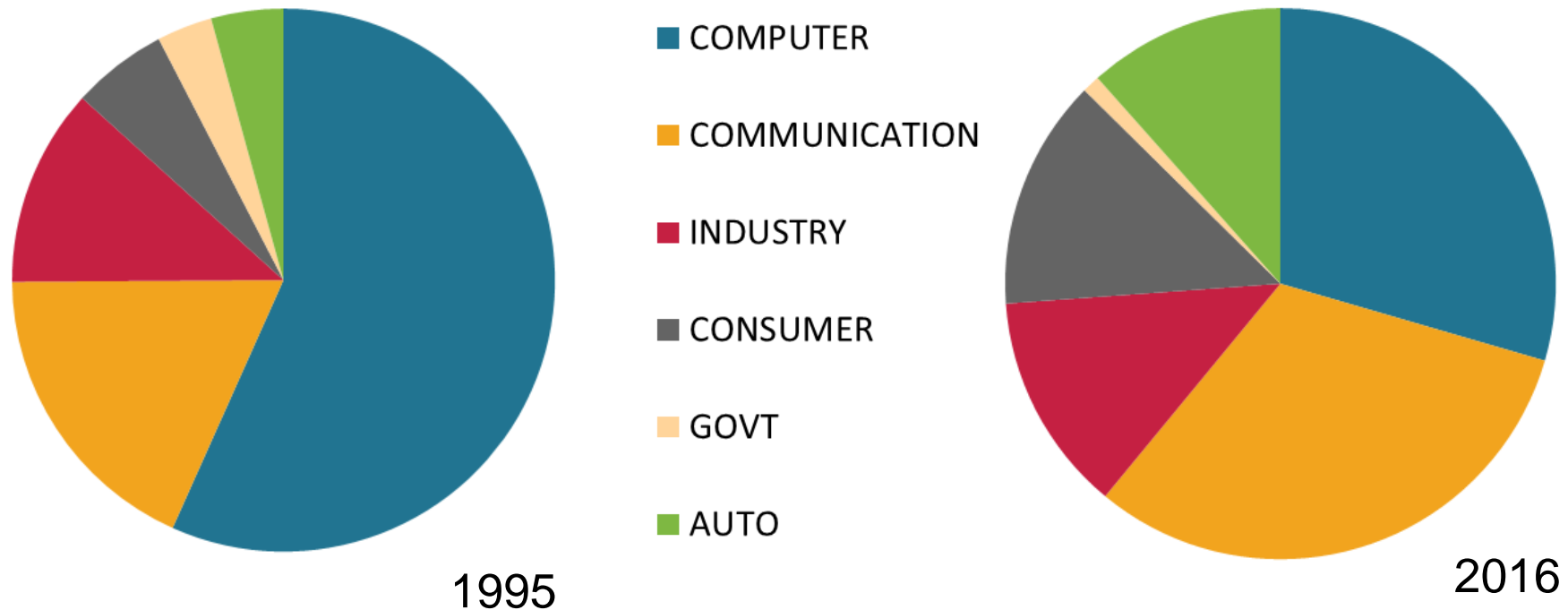
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Senior Vice President, Global Sales & Marketing

September 21, 2017

20 years back more than half of the semiconductor sales was for computing – today's markets are much more diversified

Percentage of semiconductor sales



► **Silicon demand less volatile on broader application and markets**

Sources: Computer History Museum, Catalog 107273410, WSTS 2017

Ever new applications for electronic devices and the infrastructure to support them continue to drive silicon demand

Electronic equipment contains multiple devices built on tailormade Si substrates



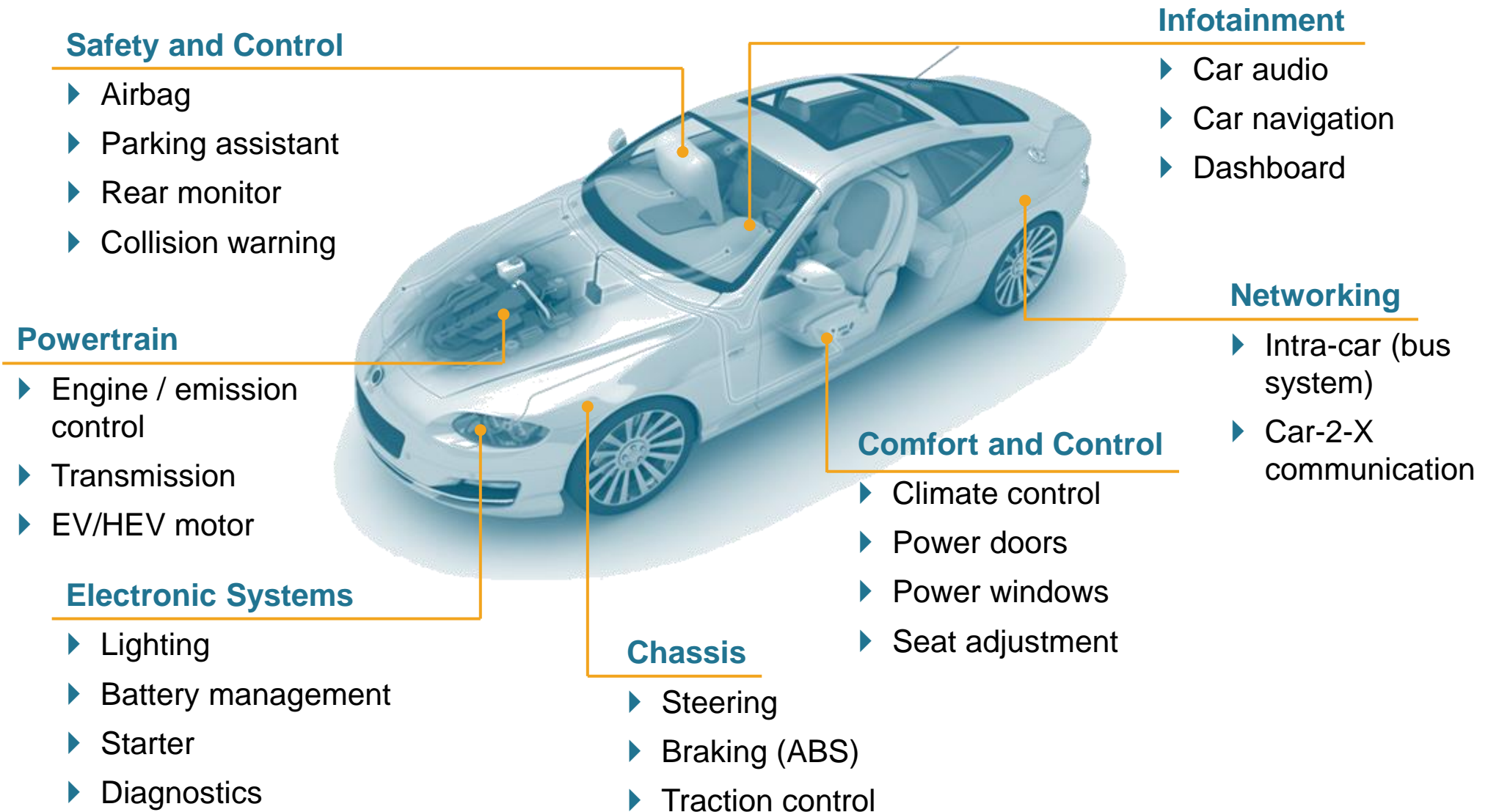
A large, dark, cylindrical silicon wafer is being processed in a cleanroom. The wafer is suspended by a thin wire and is being polished or etched. In the background, a person wearing a white lab coat and a mask is visible, working on the equipment. The scene is brightly lit, and the overall atmosphere is clean and industrial.

AUTOMOTIVE

**... drives silicon for devices
in the car and for networks**

Remember the good old Volkswagen Beetle...

Modern passenger cars are stuffed with electronics



Source:McKinsey

Carmakers are working intensively on autonomous driving Which will need even more silicon for infrastructure and networks

Cloud



Requirement for Connectivity

- ▶ High-definition map downloads in real time
- ▶ Sensor data uploads for machine learning
- ▶ Over-the-air firmware and software updates

Benefit of 5G Network

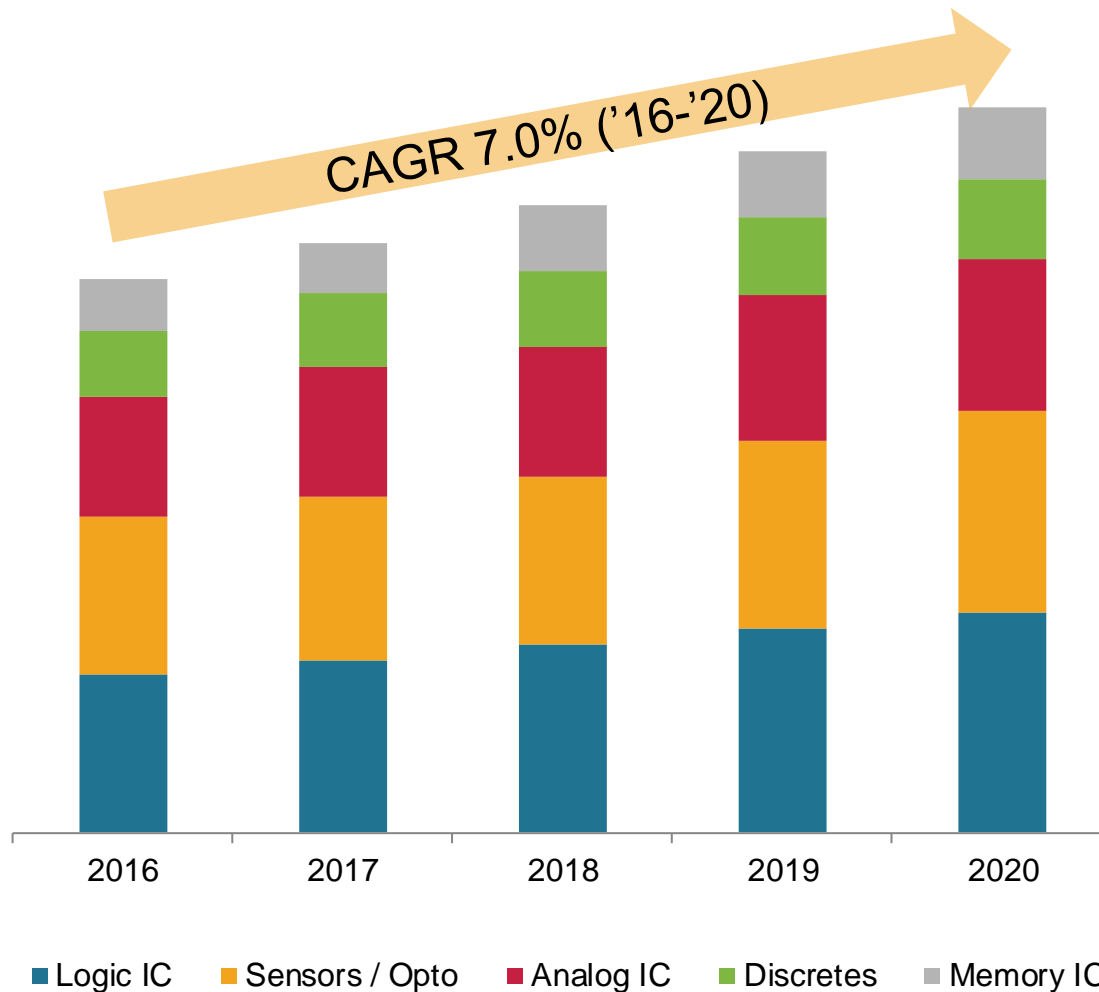
- ▶ Faster speed: Handle massive amounts of data generated by autonomous cars
- ▶ Ultra latency: Max 10 GB per second (600 times faster than today's LTE*)
- ▶ Vehicle-to-vehicle and vehicle-to-infrastructure connectivity:
Maximize use of available data, control traffic
- ▶ Intel® is offering Intel GO™ Automotive 5G platform for automakers' development

* Fastest average LTE speeds in the U.S.

Source: Audi EMFT-YOLE Sensors for IoT in Munich (Jul 2017); Intel News Fact Sheet (Jan 2017)

Silicon wafer area used in automotive applications expected to grow at 7% CAGR in the next years driven by Logic and Sensors

Si area for automotive wafer market



Automotive silicon area growth by device type (2016 – 2020)

	CAGR	Growth contribution
Logic IC	8.6%	36%
Sensors / Opto	6.3%	25%
Analog IC	6.3%	19%
Memory IC	8.7%	12%
Discretes	4.8%	8%
All Devices	7.0%	100%

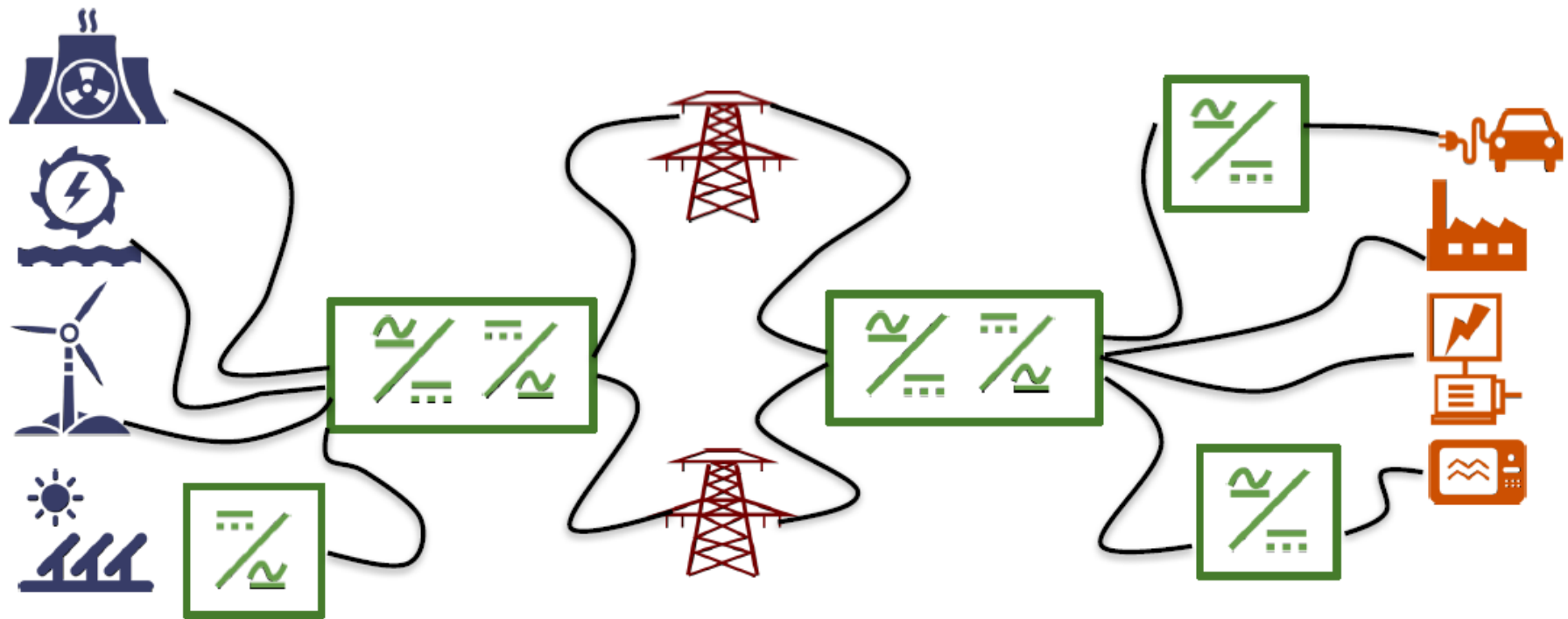
Source: IHS Markit Technology (Q3'17 Update)





POWER DEVICES

...are everywhere and their
silicon demand grows
continuously

Power devices are everywhere – silicon based devices convert electricity multiple times before consumption



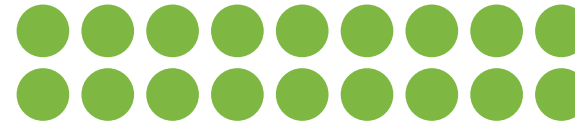
- ▶ Conversion of electric energy includes changing voltage, frequency and type of current (direct  vs. alternating ).
- ▶ Voltage ranges from hundreds of kilo Volts in power lines down to below 1 Volt in the logic chips within your smartphone.

Source: Basics of power electronics, Point The Gap

The more power, the more silicon is needed in the inverter: from fractions of a wafer in an e-bike to ~20 wafers in a train.

200 mm wafers

ABB electric train



6000 kW

CAT large mining truck



3500 kW

Tesla Model X



500 kW

BMW i3



125 kW

electric bike

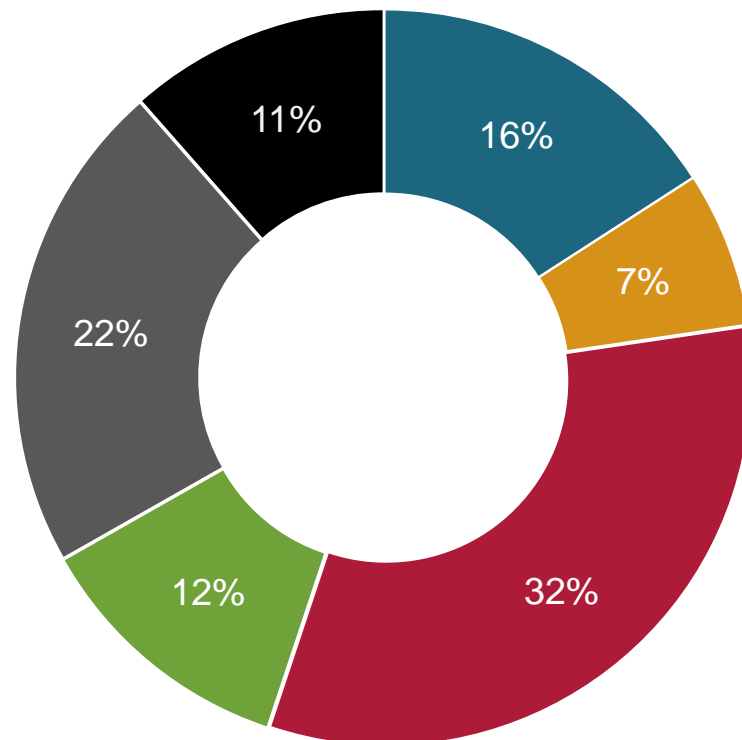


0.25 kW

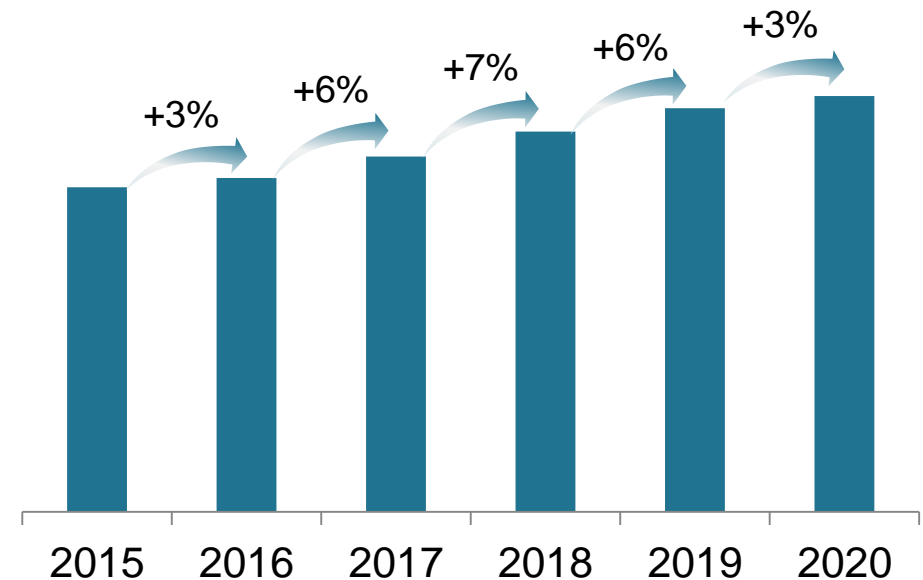
Source: e-bikeshop.co.uk, pickuptrucks.com, abb.com, , tesla.com, bmwusa.com, Siltronic estimates

Silicon demand for power devices is expected to grow continuously in the next years, along with all other electronics.

Silicon wafer demand for power (by area, 2017)



Silicon area demand forecast for power devices



Source: IHS Markit Technology (Q2'17 Update, demand for Power Transistor & Thyristors, Rectifier & Power Diodes, Voltage Regulators, Amplifier/Comparator)

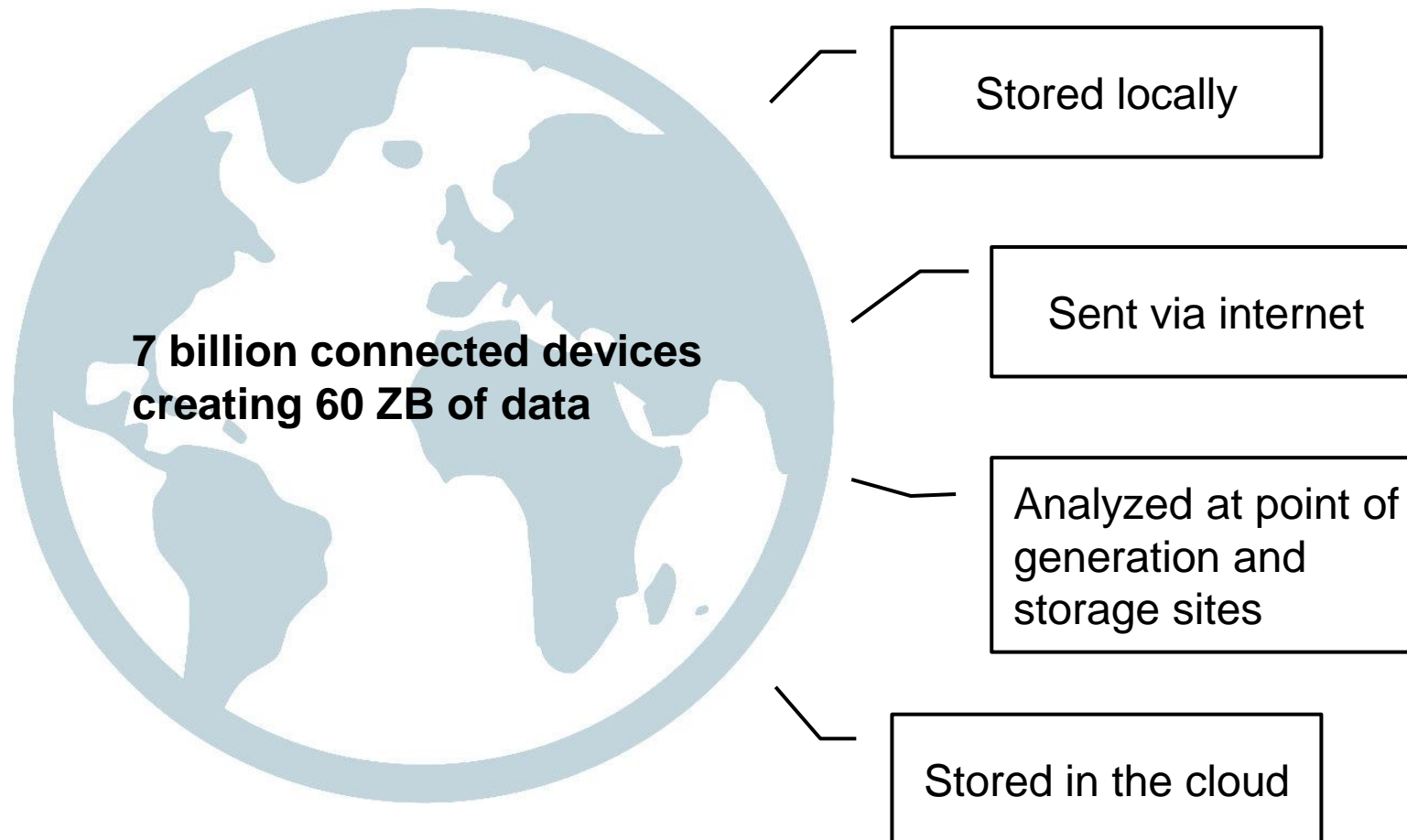


DATA EXPLOSION

...Silicon is needed to generate ever more data as well as to store, move and process it

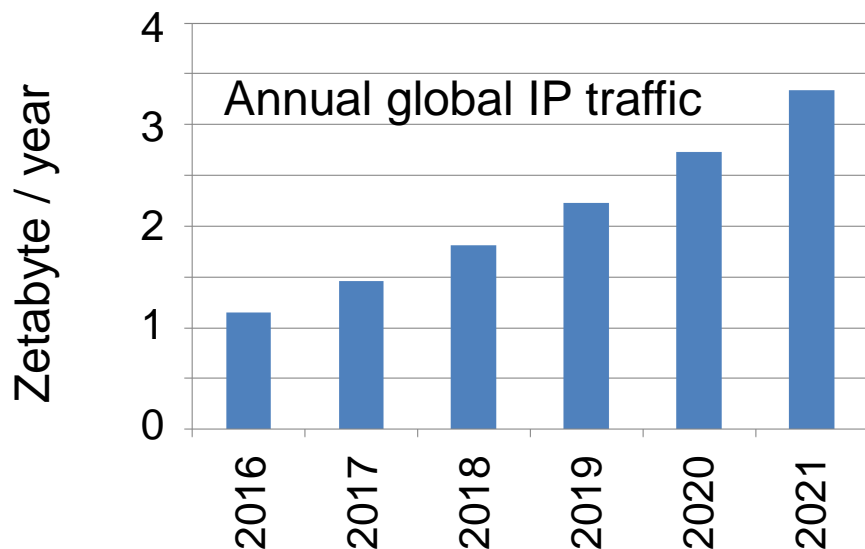
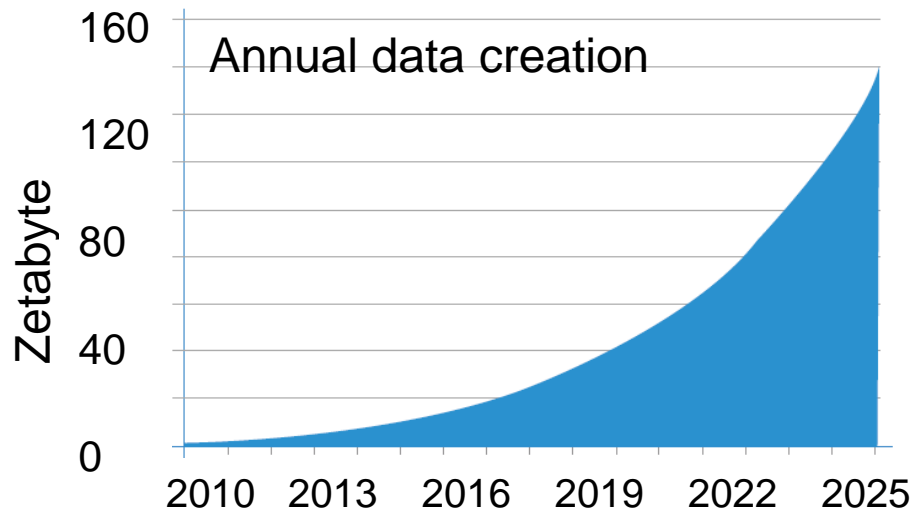
Data explosion: An inflation of connected devices and sensors lead to an unprecedented increase of generation of new data

60 ZB of new data will be generated in 2021. Next year, more will be added...

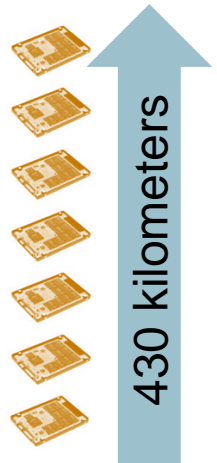


► Transmit, store and process these data fuels silicon demand

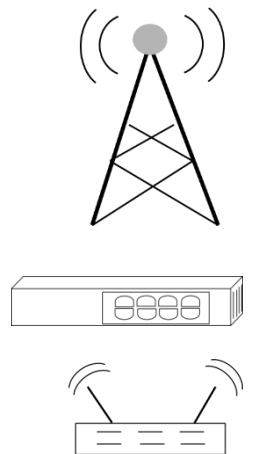
Silicon is needed to generate much more data, but even more Silicon is needed to store, move and process ever more data



- ▶ The number of networked devices will grow from ~17 billion in 2016 to ~27 billion in 2021
- ▶ By 2020, data centers are expected to have 1.84 Zetabytes of storage: If SSDs for this were stacked, they would stretch 430 km high -- the distance from Munich to Vienna
- ▶ Strong increase in cloud storage will drive 300 mm silicon demand for memory as well as high bandwidth communication



- ▶ With 24% CAGR, annual global IP traffic will reach 3.3 ZB per year by 2021:
- ▶ It would take more than 5 million years to watch the amount of video that will cross global IP networks each month in 2021.
- ▶ Infrastructure required to support this traffic includes items like routers, switches, hubs, 5G and cell equipment



Source: Cisco VNI Forecast, IDC Data Age 2025 Study, Cisco Cloud Index (GCI), IHS, Siltronic Estimate



SILICON MARKET GROWTH

**...fueled by new and more
devices enabling novel
applications in various
segments**

Silicon growth is fueled by new as well as simply more devices, enabling a multitude of new applications in various segments

- ▶ From application to device to wafer
 - ▶ electronic equipment contains multiple electronic devices
 - ▶ many devices may be used in various different end applications
 - ▶ devices are built on tailor-made substrates with different diameters
- ▶ Examples for growth drivers
 - ▶ Automotive: ADAS, infotainment, electro mobility
 - ▶ Power: renewable energy, smart grid, battery chargers
 - ▶ Data explosion: Connected Devices, communication, storage, Big Data, Artificial Intelligence

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