Design Sovereignty at the Edge and for the Device

- A European Perspective -

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Dr.-Ing. Gerd Teepe

T3-Technologies

Agenda

- What is T3-Technologies?
- The Semiconductor Growth Engine
- Semiconductor Design - Bridge between Applications and Technology
- Core Hardware
- What Europe should focus on

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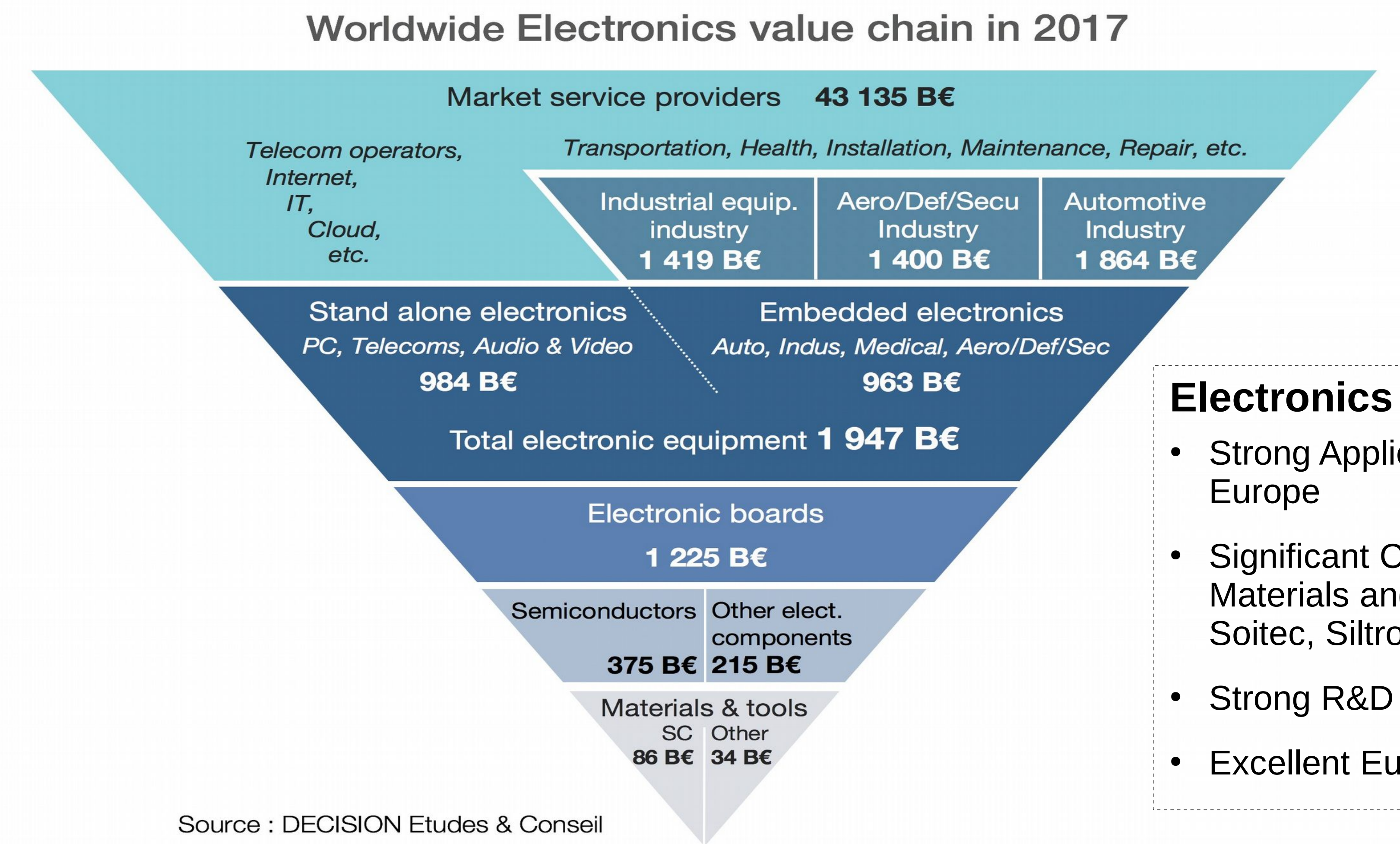
T3-Technologies

- Engineering Services in Microelectronics
  - Marketing: Product Description and Positioning
  - Design Projects: Construction, Setup and Management
  - Technology Consulting: Technology Choices and Benchmarks
  - R&D: Project Construction, Partner Search&Selection, Public-Funding, Project Management

- Experience of CEO:
  - 38 years of Experience in the Semiconductor Industry
  - Diploma and PhD fom RWTH Aachen University (1981/1986)
  - NEC-Tokyo: Research in fault tolerant microprocessors (1986/87)
  - Motorola: Design, Design Management, Marketing, Product Management (1987-2004)
  - AMD: Direction of Dresden Design Center (2004 - 2009)
  - GLOBALFOUNDRIES: Design Enablement Center, Technology Marketing (2010 - 2018)

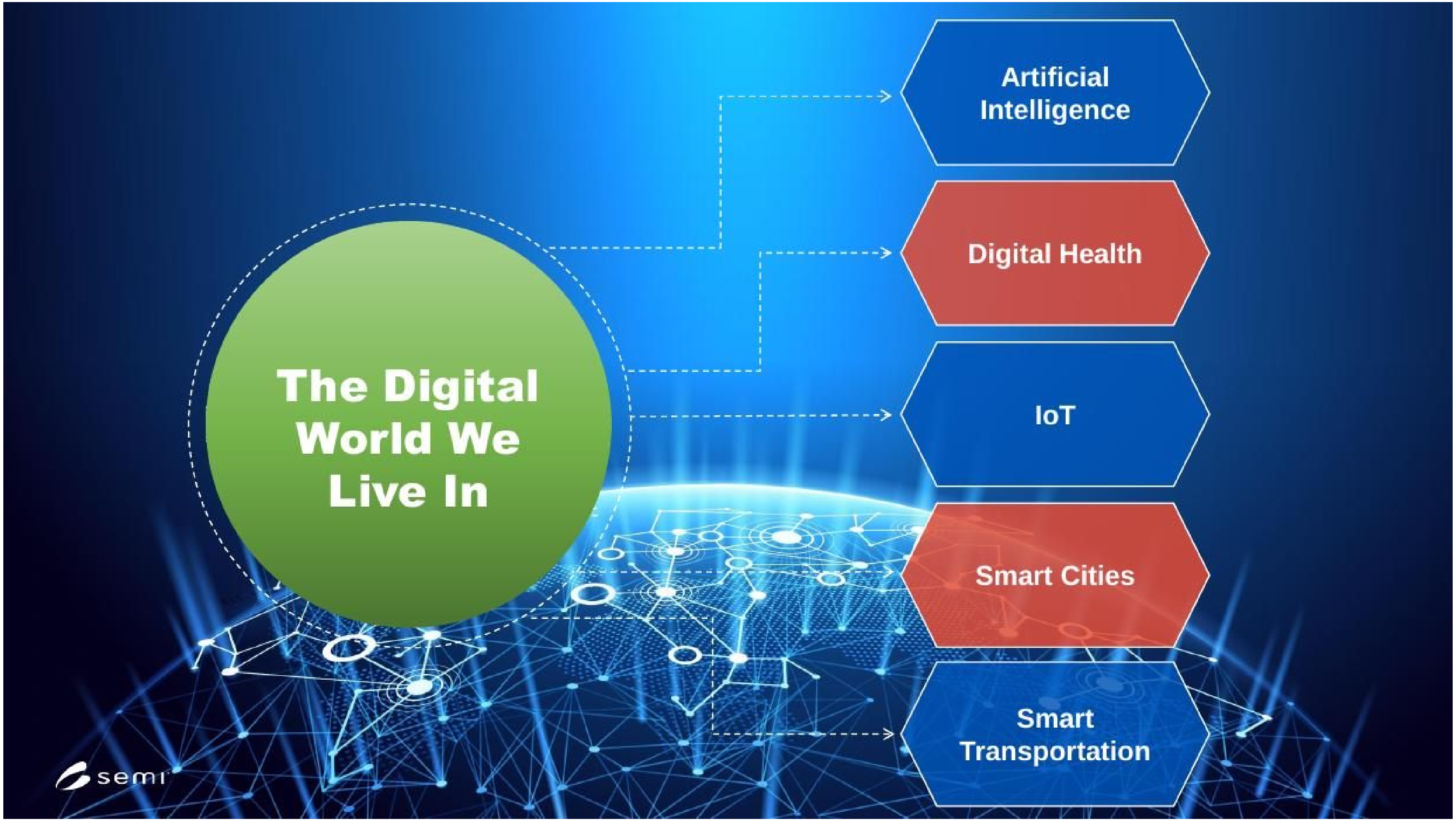
Value Chains building on Electronics



Electronics Value Chain

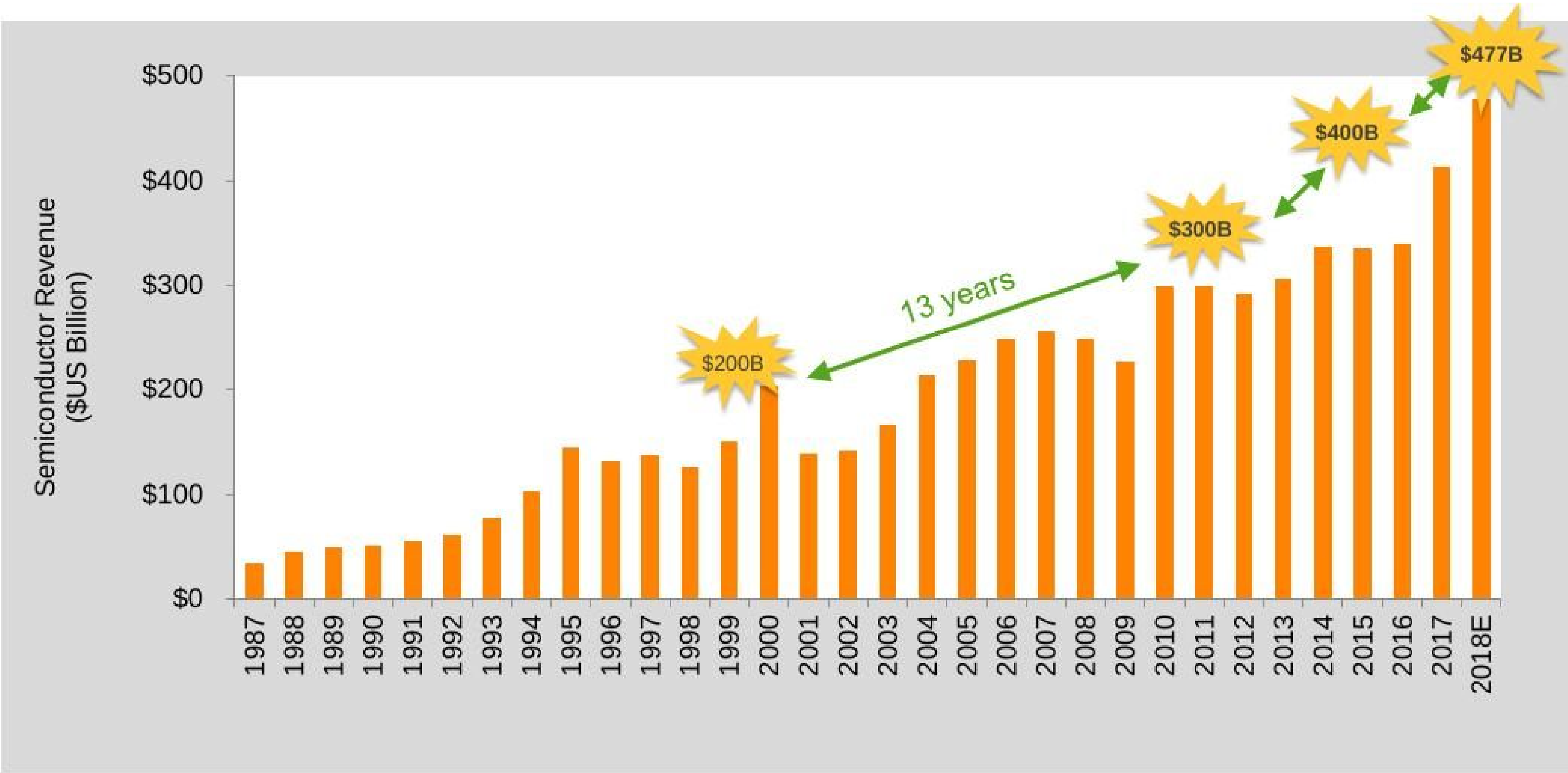
- Strong Applications Industries in Europe
- Significant Contributions globally in Materials and Tools (e.g. ASML, Soitec, Siltronic, …)
- Strong R&D in Materials
- Excellent European Infrastructure

Semiconductor Growth Factors



Source: SEMI-Europe

Semiconductor Industry Revenues



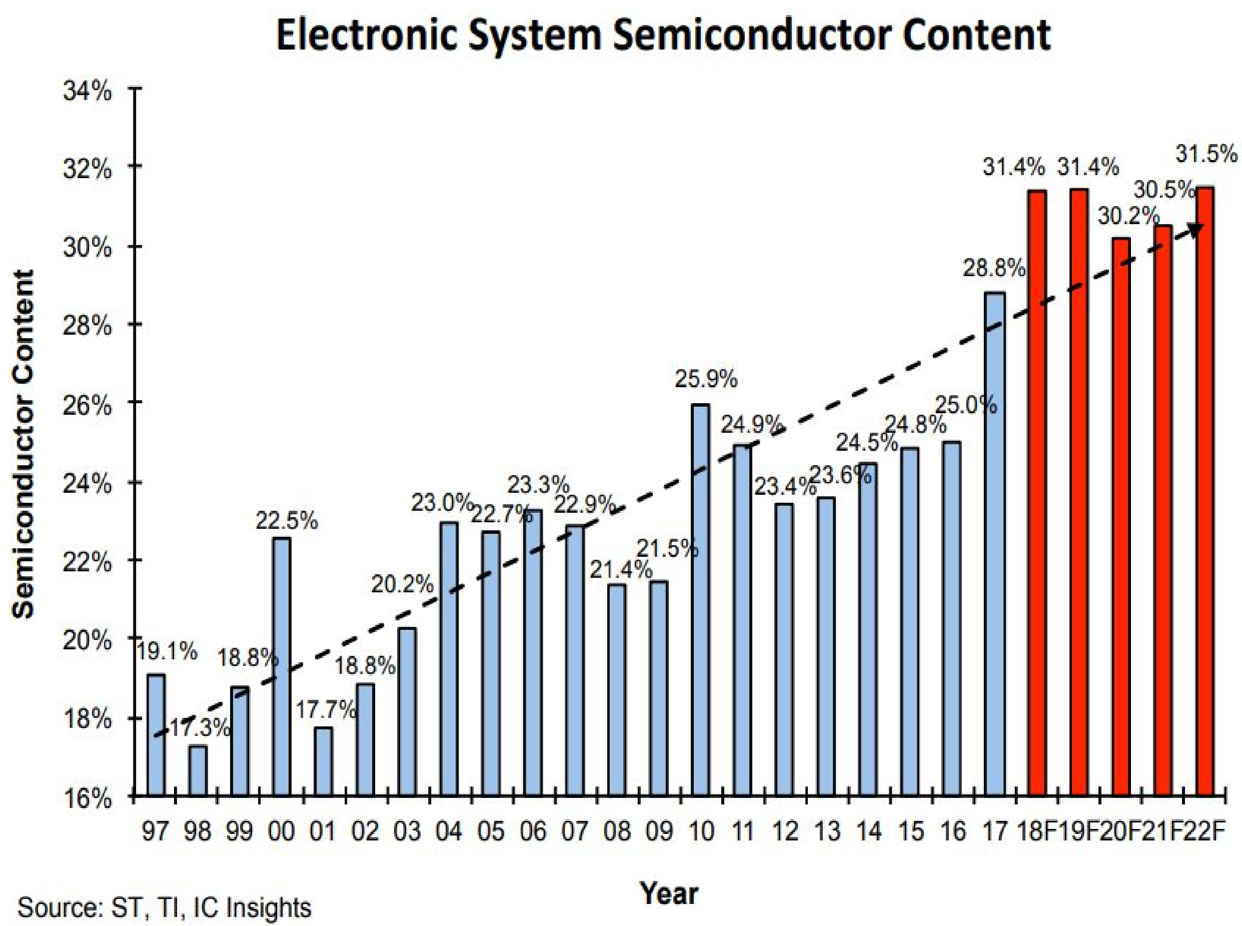
Source: SIA/WSTS historical year end reports, WSTS Autumn Forecast November 2018

Semiconductor Content Growth

Source: ICINSIGHTS, July 2018 report

The electronic system content is on the rise. Microelectronics is key in defining the product features.

It has been the case for Telecom products (like smartphones) but now we see it happening for industrial and consumer products. (Automobiles, Home-robotics, Toys&Games, White Goods, Medical Applications)



Europe is in a Sandwich Position

Pressure from the West

USA

Disruptive Business Models and smart value chains for the entire world

EU

Industrial supplier of the world (automotive, machine building, …)

Asia-Pac

Manufac-turer for the world (and moving forward)

Pressure from the East

Source: GLOBALFOUNDRIES

Design Bridges from Technology into Application

Technology

22FDX

14FF

RF

Design Bridge

Applications

Automotive

Industrial

Energy

Telecom

IoT

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Sovereignty-Topics for Europe

Technology Sovereignty

- Architectures (Microprocessor-Cores, Networks, Connectivity)
- Semiconductor Manufacturing
- Packaging & Assembly
- Supply Chain
- Security
- Data Sovereignty

→ Design →

Application Sovereignty

- Artificial Intelligence
- 5G/6G (Network Applications)
- IoT
- Digital Health
- Transportation
- Smart Cities

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Scaling in Computing

<table>
<tr><th>Entity</th><th>Multiple</th><th>1st App</th><th colspan="3">Scale-up</th></tr>
<tr><td rowspan="3">CPU</td><td rowspan="3">Multi-Core</td><td>PC</td><td>Compute-Cluster</td><td>Data-Center</td><td>Cloud</td></tr>
<tr><td>Network Switch</td><td colspan="2">Network</td><td>Edge</td></tr>
<tr><td colspan="4">Embedding --- Device</td></tr>
<tr><td colspan="6"></td></tr>
<tr><td>Simple CPU</td><td>GPU (SIMD)</td><td rowspan="3">Co-Processing</td><td colspan="3" rowspan="3">Scale up</td></tr>
<tr><td>MAC</td><td>TPU (SIMD)</td></tr>
<tr><td>Mac or Neuro</td><td>NPU (MIMD)</td></tr>
</table>

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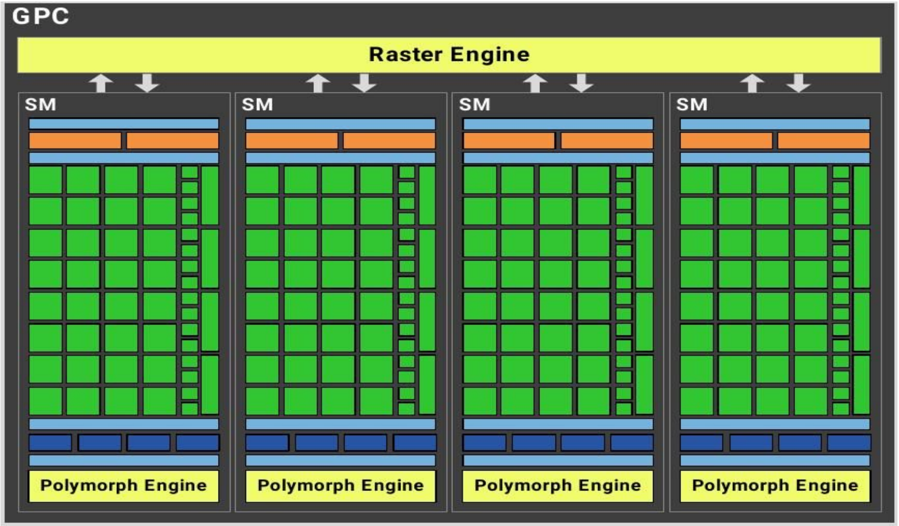
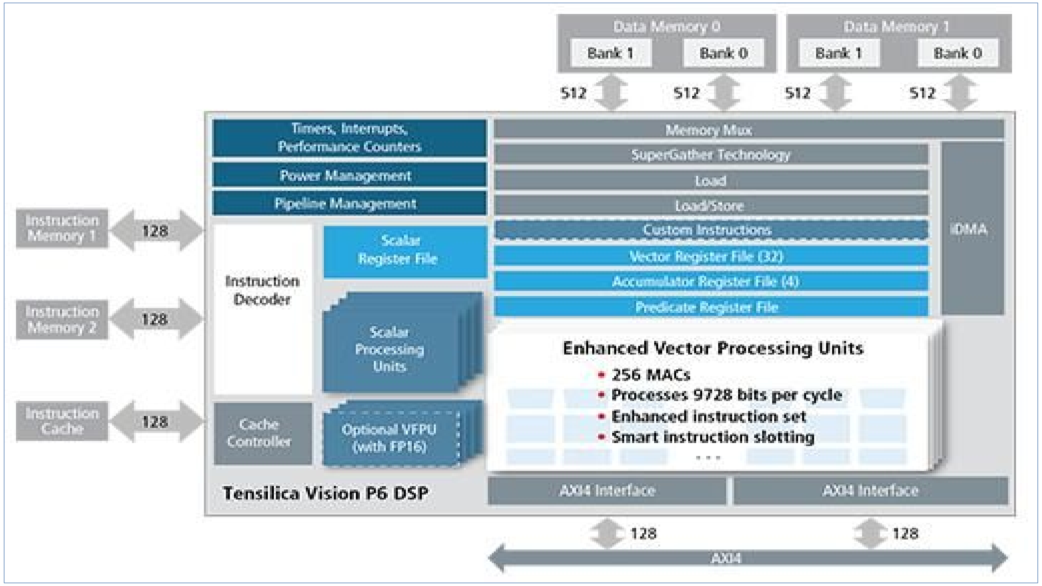
Distributed versus Parallel Computing

Attribute	Parallel Computing		Distributed Computing	Neuromophic
Example system topology	SMP	MPP	1) Internet 2) Data Center	Human Brain
Programming	P-threads OpenMP	Message Passing (MPI)	HTTP XML/SOA Mash-up APIs	Machine Learning
Industry leaders	IBM, Sun, HP servers	HPC Niche	Google, Yahoo, MS Live	- none as of yet -
Scalability	Poor	Moderate	Outstanding	Outstanding
Fault Tolerance	Failures are fatal	Failures are feared	Failures are *assumed* in the architecture	Failures are *worked* into the production system (yield)
Progress assessment over last 30 yrs	**Very poor**	**Moderate**	**Substantial**	Significant progress since the early analog work

Parallel Computing



Source: Nvidia GPC



Source: Cadence Tensilica Vision-P6

GPU Engines

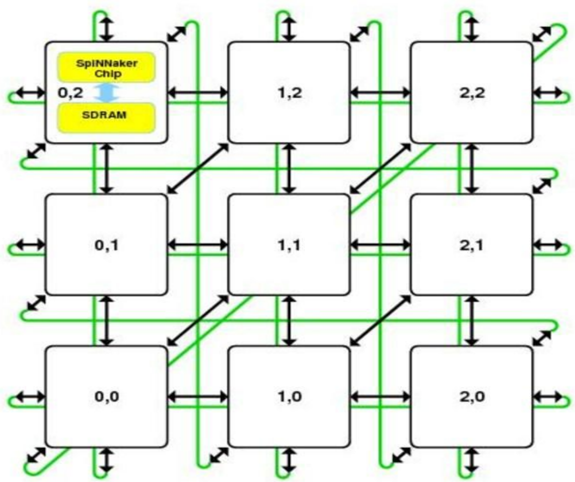
- Up to 5000 integer cores
- Integer Data Flows
- Main Application: Gaphics-Shading

CNN-Engines

- 256 MAC units (and more)
- SIMD-Architecture
- Main Application: Image Recognition

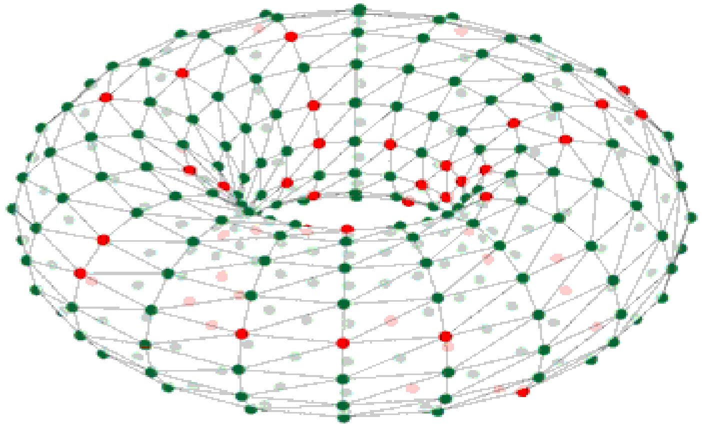
Neuromophic Computing

Modeling the Human Brain: Computing within the Memories



The SPINNACKER Project

Up to 500.000 connected ARM processors



The Humain Brain Project (HBP)

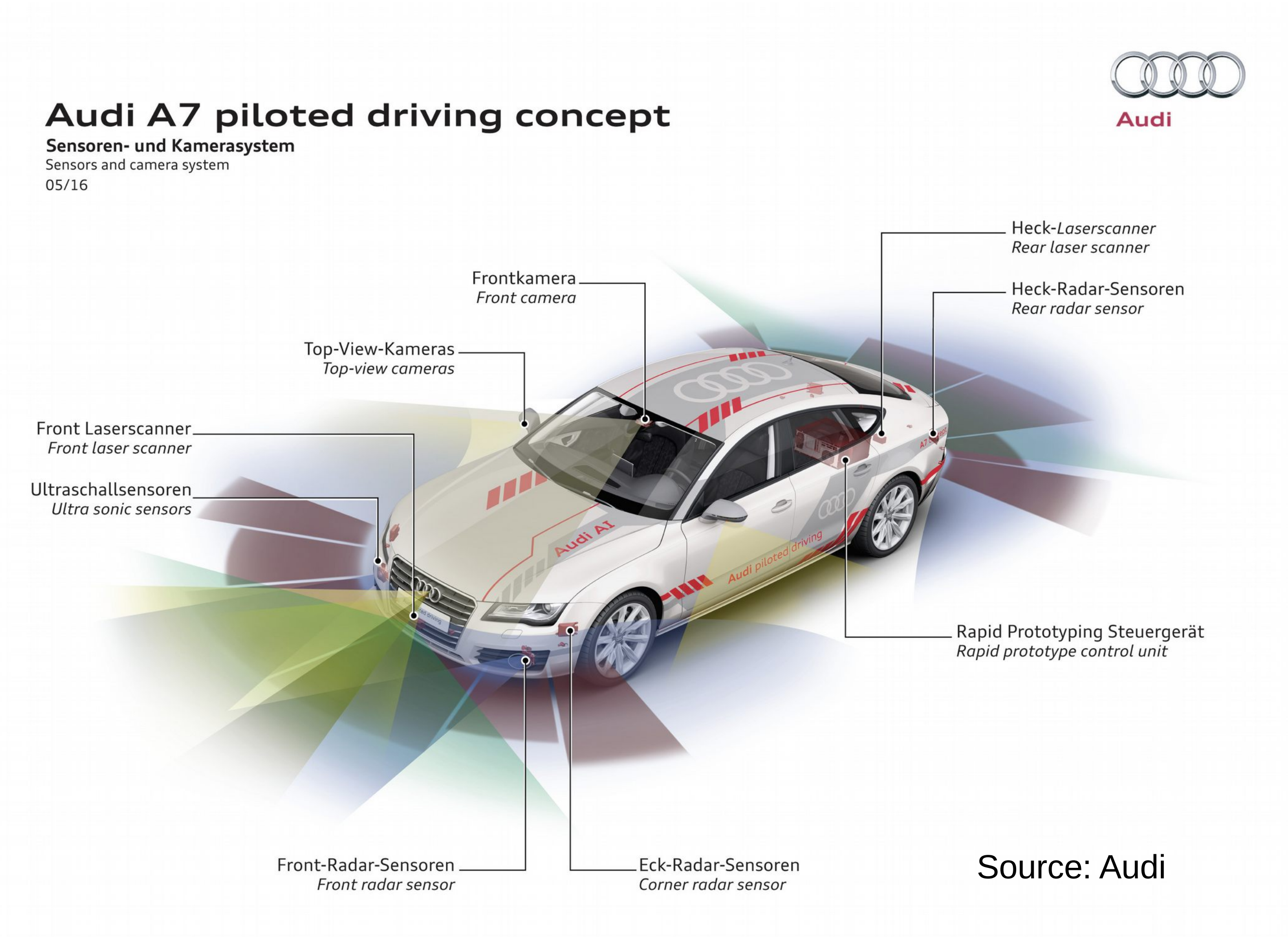
Torus of connected compute elements including memories

USA: Darpa Synapse Program

Core Landscape Today

Core Family	Source	AI	5G-6G	Device	Edge	Cloud	Comment
X86	Intel, AMD				○	●	PC, Server, Cloud
ARM	ARM	○	●	●	●	○	Initially from Telecom-Device
RISC-V	Open Source	●	●	●	●	○	..the new LINUX for hardware?
Tensilica	Cadence	●	○	○			Intended for flexibility in design
Tegra	Nvidia	●		●	○		Proven AI architecture
ARC	Synopsys		○	●			Will this break through?

Audi on the path to autonomous vehicles



Source: Audi

Audi Architecture

- Sensor based (Image, Radar, Lidar)
- Data Fusion
- ZFAS central unit
- Massively parallel computing

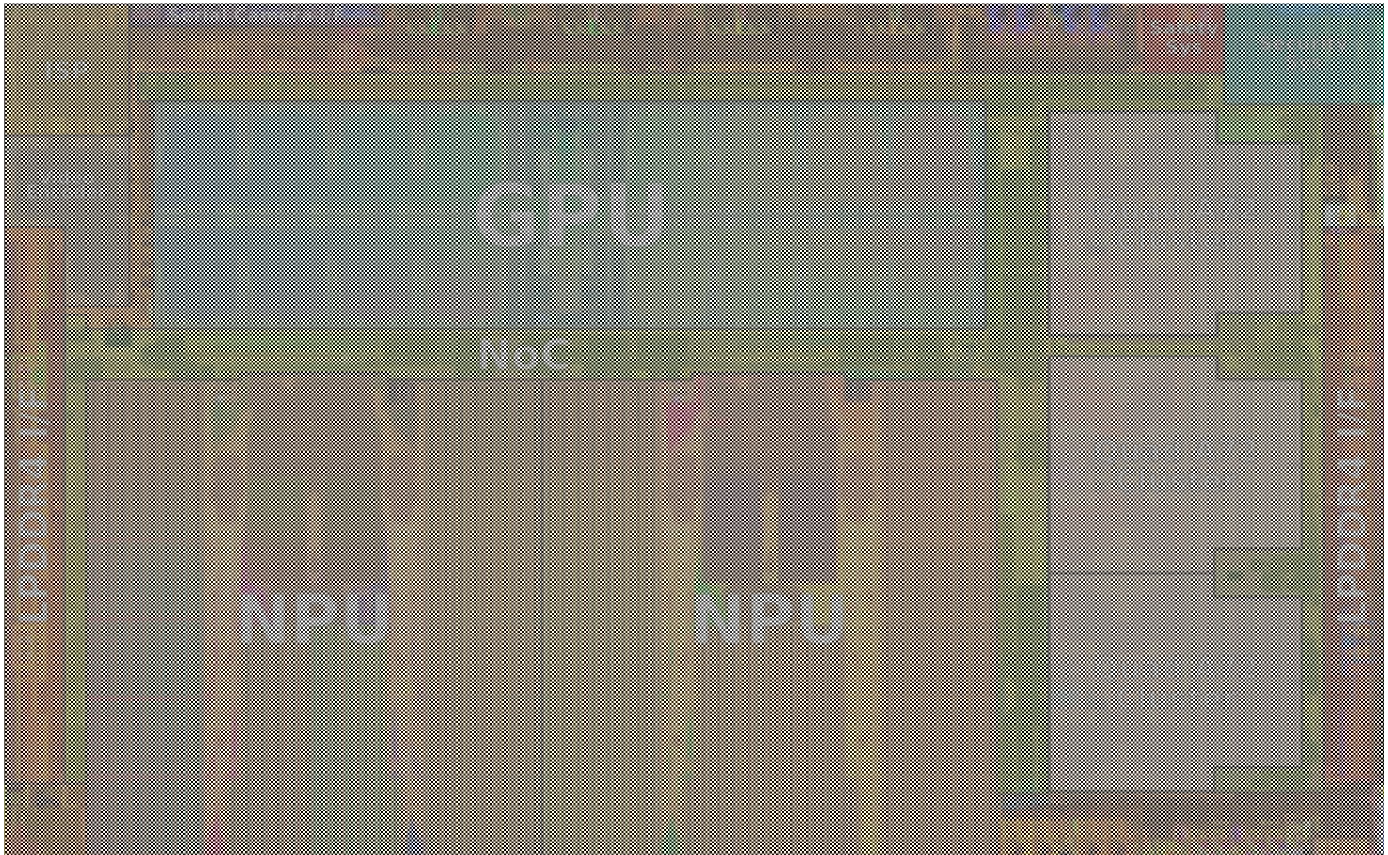
ZFAS – parallel computing architecture

Source: Audi

AUDI ZFAS Electronic Control Unit

- Driver Assistance Controller
- Data-Fusion using AI-Methodology
- Nvidia Tegra K1 Architecture
- Automotive Qualification
- Automotive Power Footprint

Tesla FSD Chip



Source: TESLA

FSD – Full Self Driving

- 14nm Finfet Technology
- 144 TOPS
- 72 Watt TDP
- 12 ARM Cortex A72
- 2 NPU (Neural Network Accelerator
- LPDDR4-I/F
- Encryption
- Safety-Supervision

Take-Aways

- Design is the bridge between Product and Technology

- General Purpose Devices are vanishing – If you don’t design it, you don’t get it.

- Sovereignity means choice of Value Chain in:
  - Production
  - Design
  - Tooling
  - Materials
  - Packaging

- “Open Source” is starting to become an alternative

Thank You