



Semiconductor Supply Chain Integration

@Industrial semantic interoperability summit 2026
Turning semantic interoperability into industrial competitiveness in an AI-driven world

Hans Ehm Supply Chain Innovation
DNV, Oslo 9.6.2026



Infineon is a global leader in power systems and IoT

Global leader

in automotive, power management,
energy efficient technologies and IoT

~57,000

employees¹

Market position

Automotive

#1

TechInsights,
March 2025

Power

#1

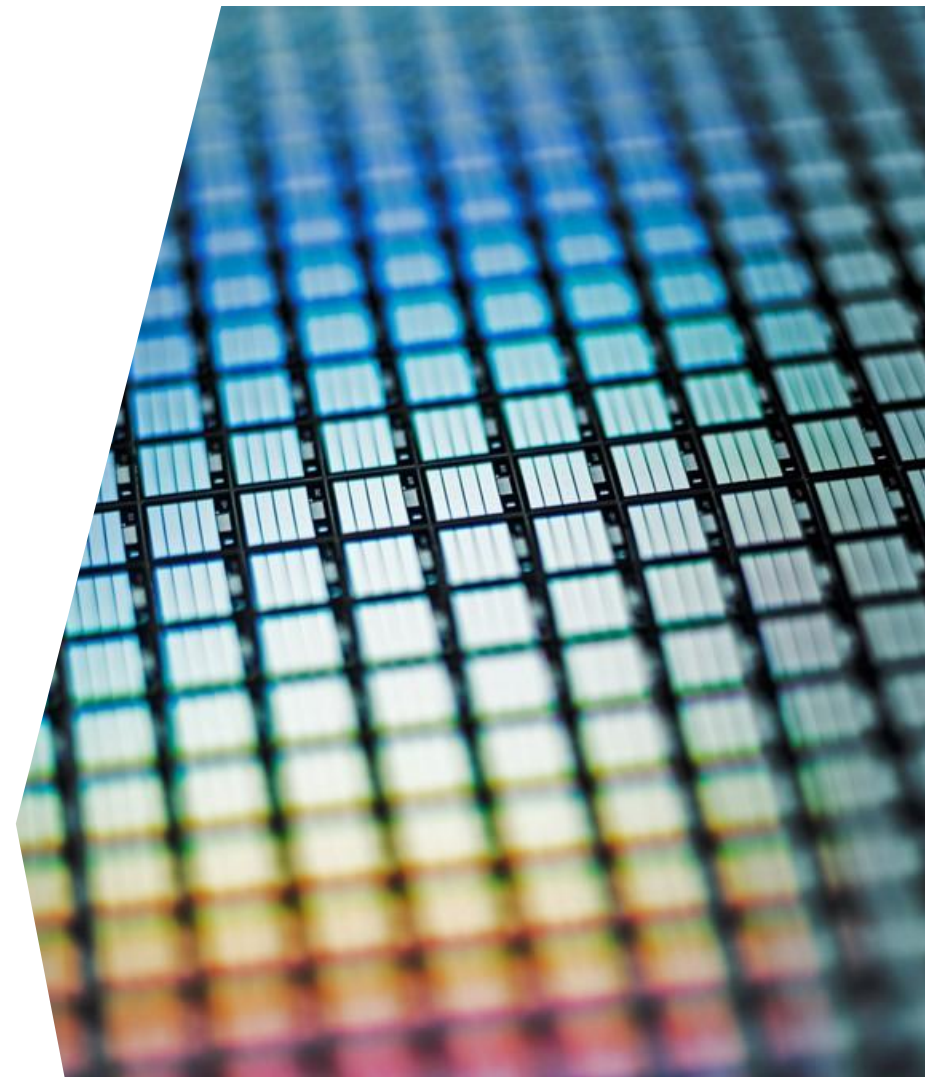
Omdia,
October 2025

Microcontroller

#1

Omdia,
August 2025

¹ As of 30 September 2025



Infineon at a glance

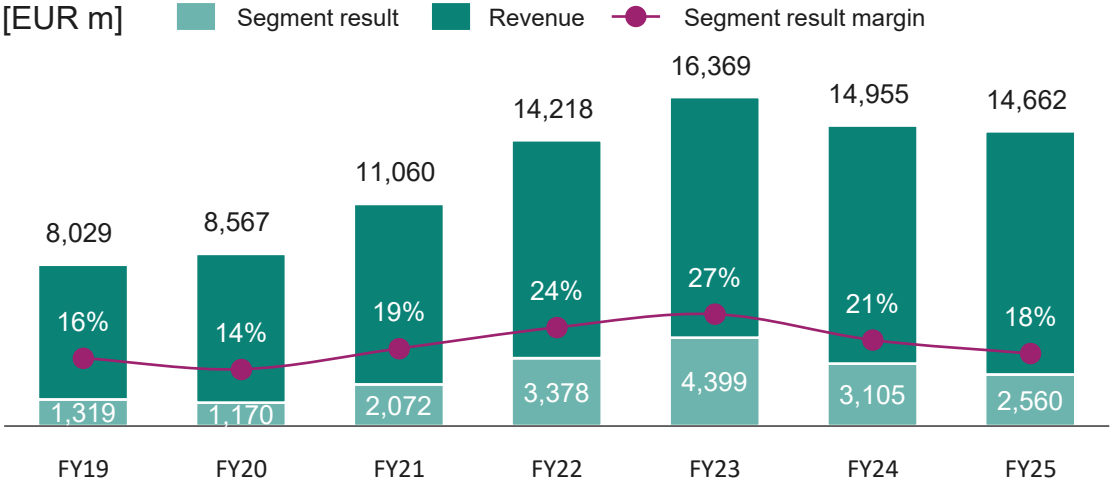
Growth areas

Energy
green and efficient

Mobility
clean and safe

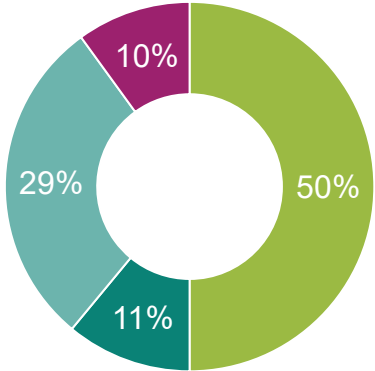
IoT
smart and secure

Financials



FY25 revenue by segment¹

- Automotive (ATV)
- Green Industrial Power (GIP)
- Power & Sensor Systems (PSS)
- Connected Secure Systems (CSS)

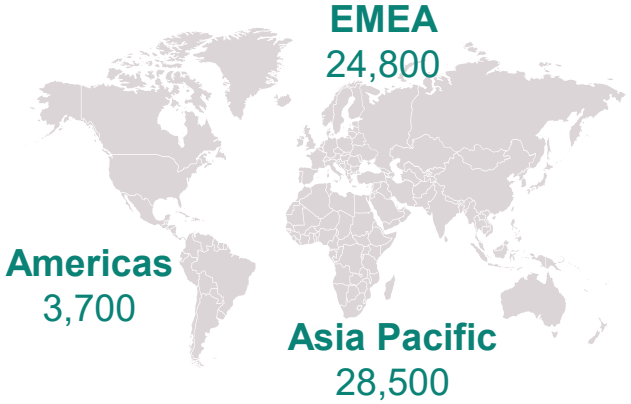


Employees¹

57,000
employees worldwide

75
R&D and

14
manufacturing locations²



For further information: [Infineon Annual Report](#).
¹ 2025 Fiscal year (as of 30 September 2025) | ² As of 30 September 2025

Your presenter today:



- [Hans Ehm M.S./OSU & IFX Sen. Principal Eng. Supply Chain](#)
- Experience - 10y FE, 10y BE & 20y Supply Chain
- 10y+ Head of [Supply Chain Innovations](#)
 - Processes & People & DtC Audits
 - Resilience & Simulation & Trends
 - AI & DL & Quantum Alg. & Solutions
 - Digital SC for Decision support & Funding
 - Semantics/Knowledge Graph; Complexity Management & Sustainability



Additional commitments (see also [Publications on google scholar](#) and [Research Gate](#)):

- Leading working group SCM of ZVEI; Supported BMWK ETA (Expertenkreis zur Transformation der Automobilindustrie); Co-Led VDA 6.8.; Industrial Advisor for yearly [Informs/WSC/MASM and Keynote 2023](#)
- Supporting EU KDT projects like [AIMS5.0](#) & Initiator of EU SC³ & [SC4EU](#) project - **Semantically connected semiconductor supply chains**; Co-Leading WP 2 of [Semiconductor-X](#) & German Quantum projects - QuBRA, QuaST & QuSOL;
- Former Board Member of ASCM/APICS/SCC (associations behind SCOR); 15y in “Aufsichtsrat” of [camLine Holding AG](#) ([SPACE product](#) – statistical process control in Semiconductor Manufacturing); EU Sherpa on Standardization for Resilience [SEMI Supply Chain IAC founding member](#); **Co Lead [EU Industrial Alliance Proc. / Semic. Techn. WG on supply chain](#)** and joined in this function G7 semiconductor point of contact in June/25 in Toronto/Canada

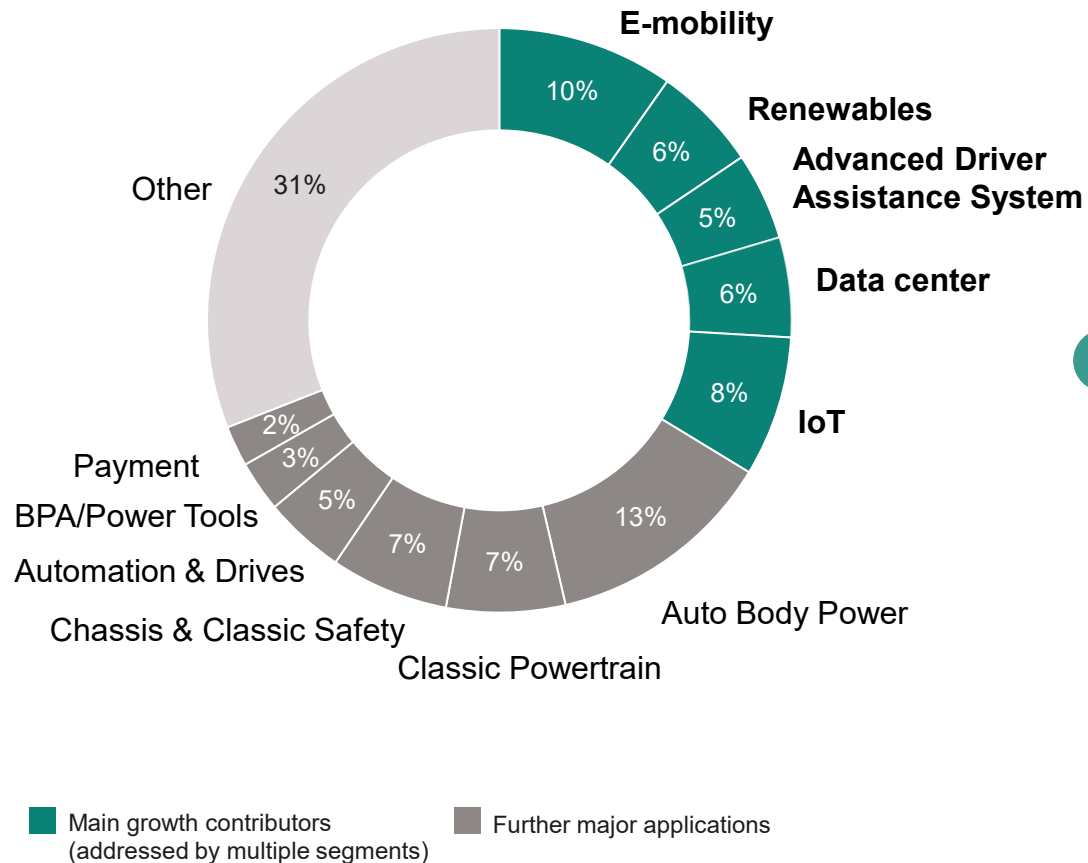
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Supply chain has to manage a broad product portfolio with a large number of customers – example Infineon



Share of revenue per application



Our products



SiC Power Modules for E-mobility & Renewables



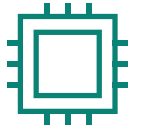
Microcontrollers for Advanced Driver Assistance Systems



MEMS Microphones for smartphones & -watches



CO₂ sensors



..and thousands more

Our success story



#1 market position in **automotive & power**, **#2** in **sensors** and **microcontrollers**



We serve a large, global client base with over **125,000 customers**



Highly complex product portfolio with more than **10,000 SKU** and **>60 bn products** produced p.a.

Add on 2: Carbon goals are aligned with the Paris Climate Agreement's 1.5 °C target



Better Manufacturing, better Supply Chain → Higher Capacity Utilization; better Commit Quality
→ More CO₂ reduction

CO₂ burden¹

3 million tons of CO₂ equivalents

Footprint



Handprint

CO₂ savings²

~100 million tons of CO₂ equivalents



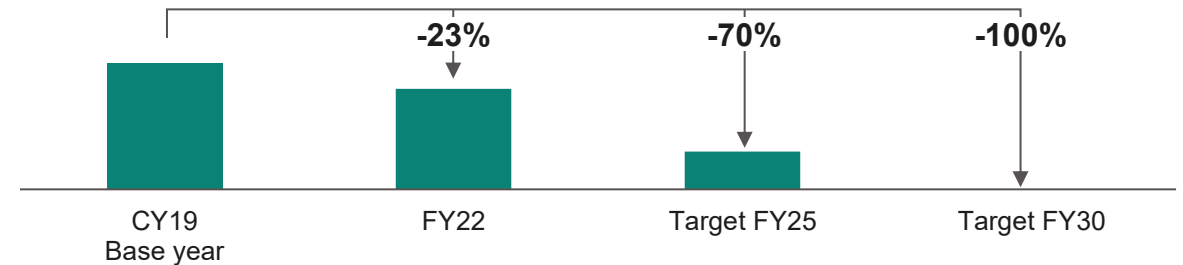
Ratio
> 1:10+

On the road to carbon neutrality³ we achieved significant milestones by

- Using green electricity in Europe and North America
- Completing abatement system in Kulim

Infineon's CO₂ target³ by 2025 and 2030

Net CO₂ emissions in million tons of CO₂ equivalents



» Net ecological benefit: CO₂ emissions reduction of more than 127 million tons

^{1, 2, 3} For further explanation see "ESG footnotes" in the appendix

German/European Society can (could) be proud of those semiconductor companies reducing the E2E CO2 emissions & contribute to resolve climate challenge



$$-(\sum_x \text{red arrow with } x) + \text{green arrow with } x = \text{CO}_2 \text{ Equivalents}$$

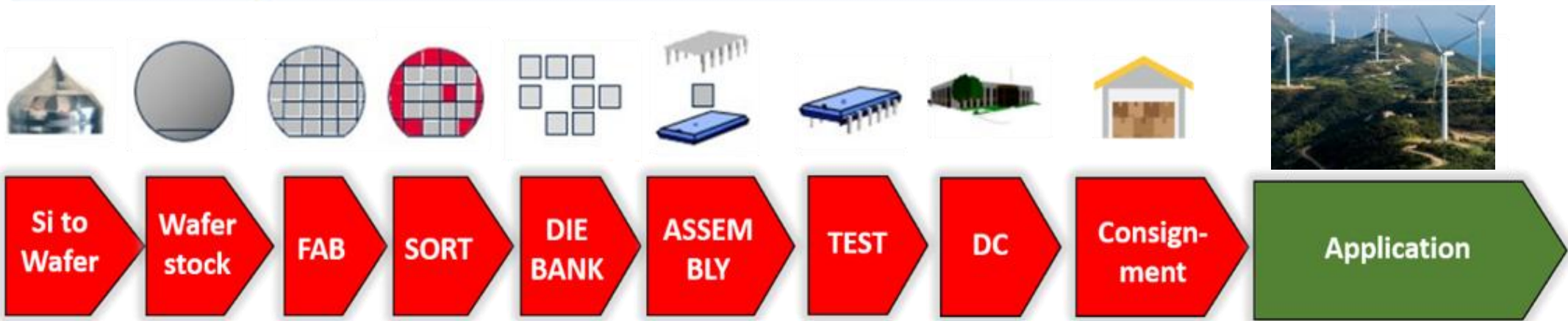
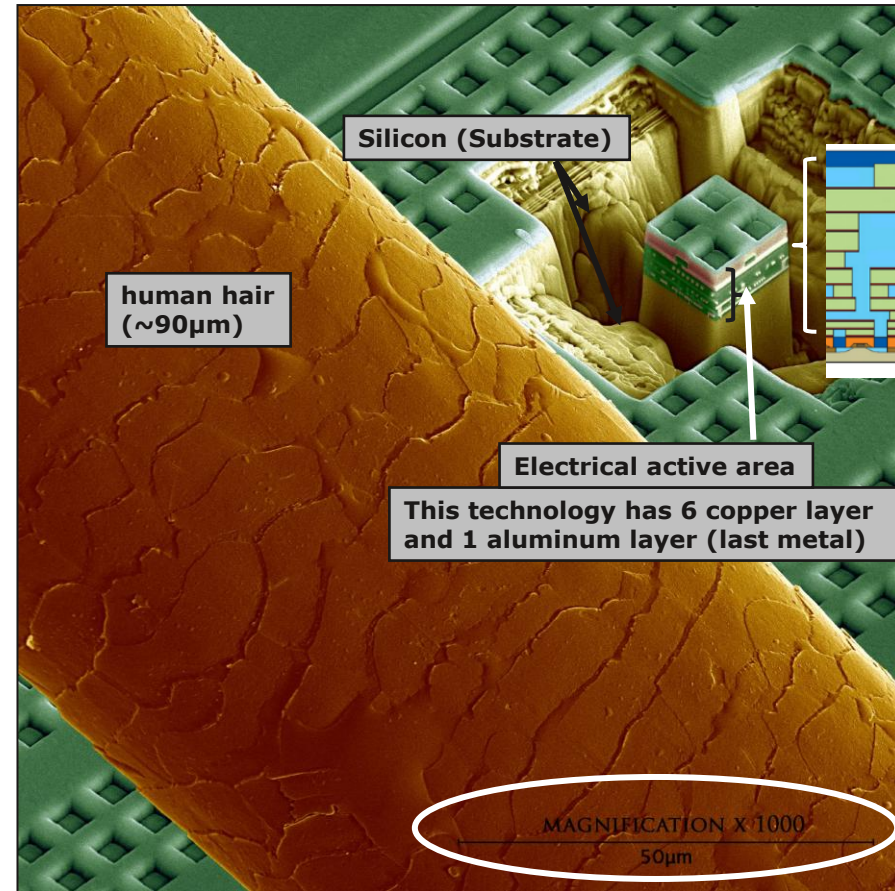
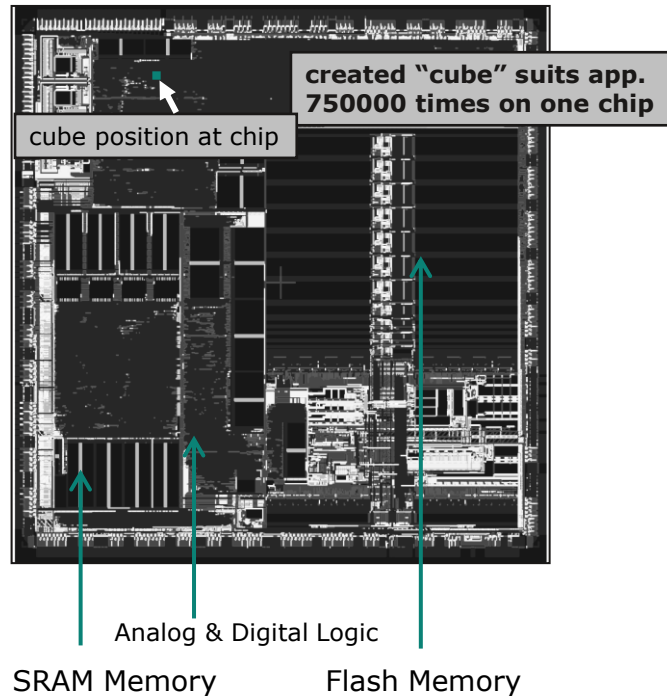


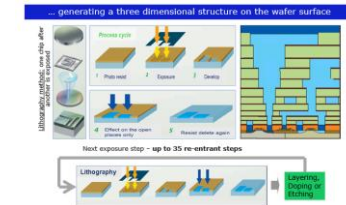
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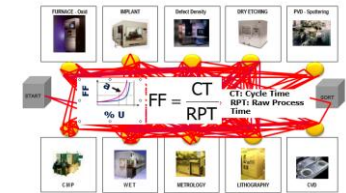
Semiconductors are tiny, complex manufactured in a global network



The process - Process control



The Fab - Yield & supply



The global supply chain - demand

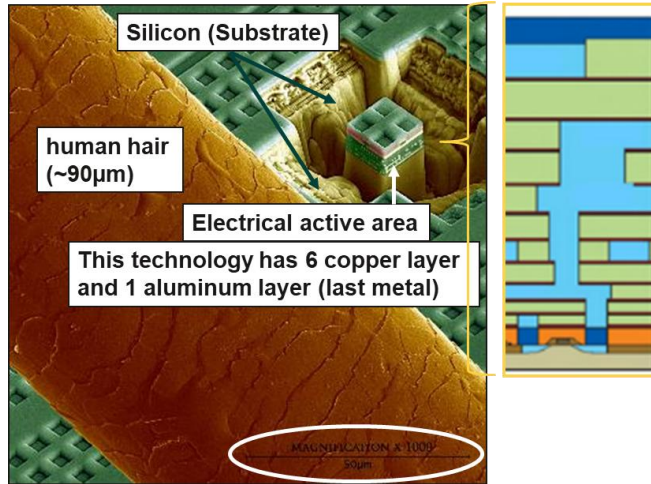


DataSpace: From ns and nm to years and thousands of km

$10^{-9} \text{ to } 10^9 \text{ s} * 10^{-9} \text{ to } 10^7 \text{ m} \sim 10^{34} * \text{Other dimensions}$

Semiconductors are complex to manufacture and prone to high demand fluctuations requiring an exceptional Supply Chain

High Complexity



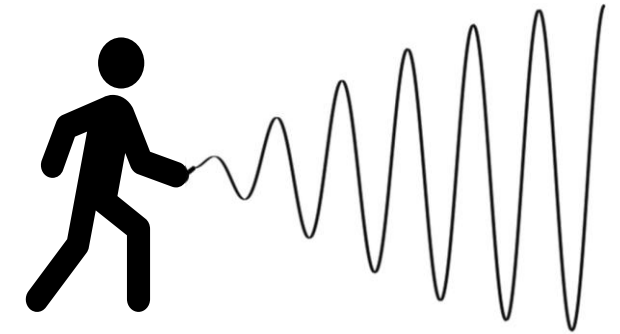
- High **complexity** of **semiconductor** manufacturing process
 - >1,000 process steps
 - Up to 6 months Production Time
- **Short life** cycle of **end products** sometimes as short as 1-2 years

Global 365/24 production



- **Fabs** running **365/24** in a **global network** (business continuity)
- **>50 Locations** incl. SiFo & Subcon
- **Capital intense** e.g., Fab Dresden EUR 5 bn

Demand Volatility



- Extreme **demand volatility** of the **semiconductor market** with
- **Amplifications** of **fluctuations** called the **Bullwhip effect** (~5-10x higher than GDP)
- **Short Customer** order **lead times** 4-12 weeks

For Resilience the Supply Chain orchestrates a network of FE, BE, DC, Silicon Foundries and Subcons like one Global Virtual Factory – but why?



Flexibility and Speed are essential – that we learned from Frontend Production – lean for complex flow production

Frontend Processes: The birth of a chip from blank wafer to our printed design

FURNACE - Oxid



IMPLANT



Defect Density



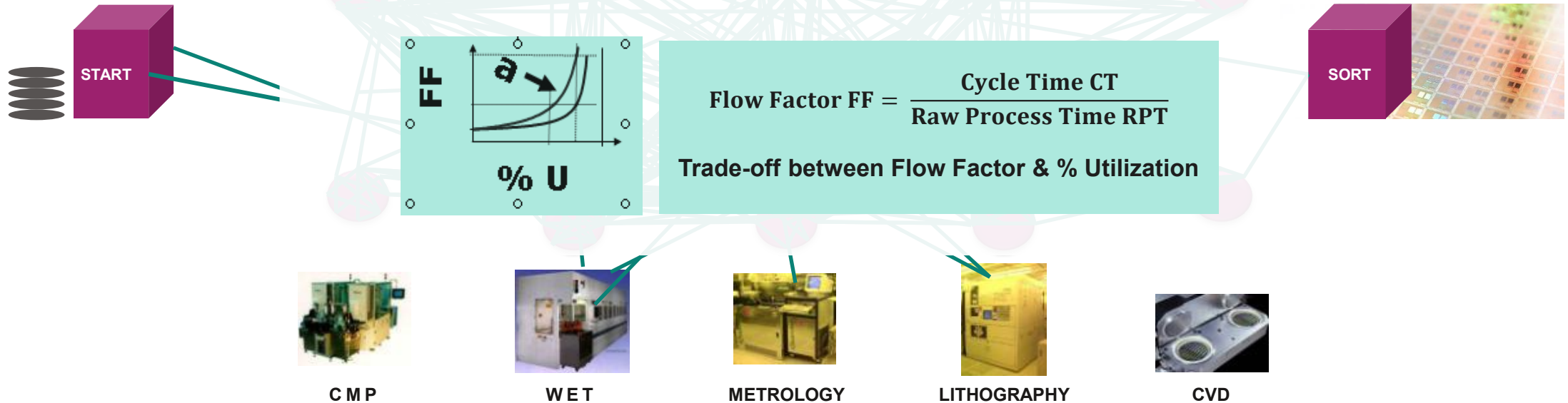
DRY ETCHING



PVD - Sputtering

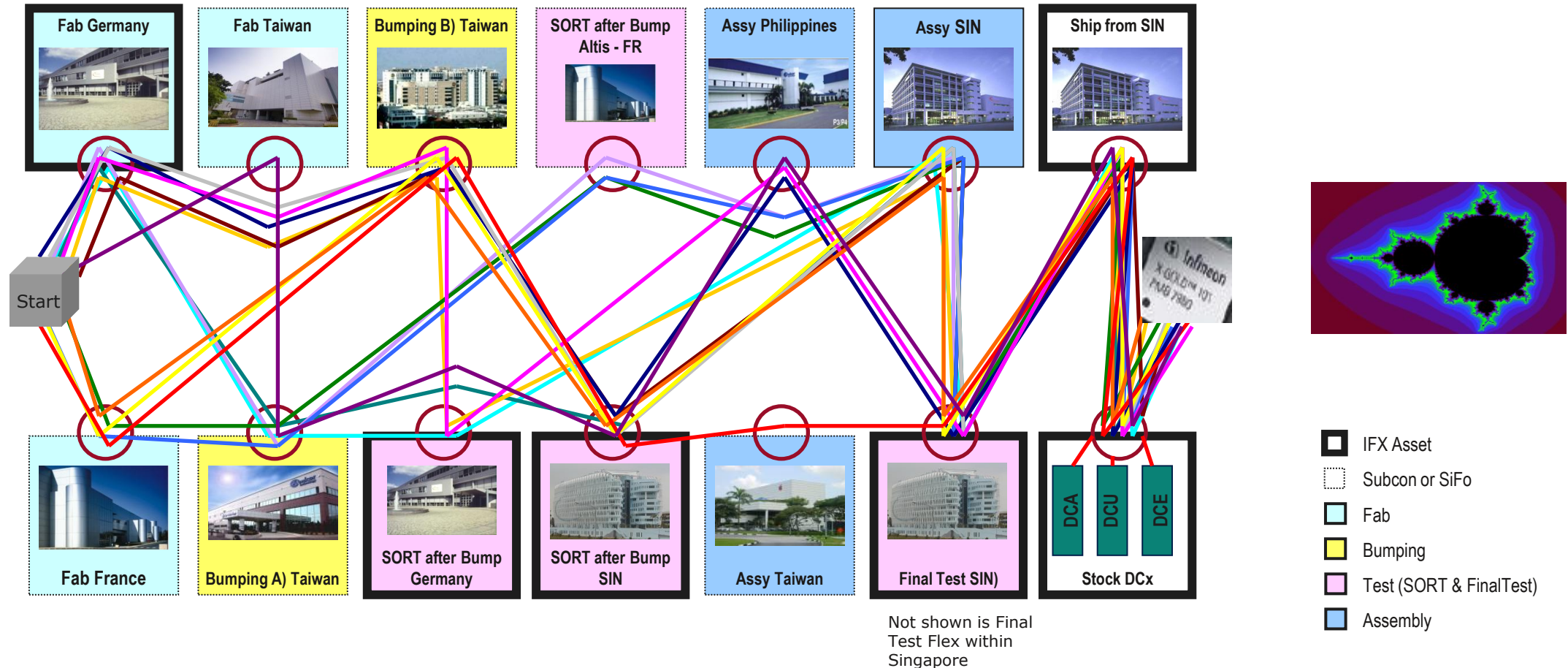


How to manage capacity constrained by complexity?



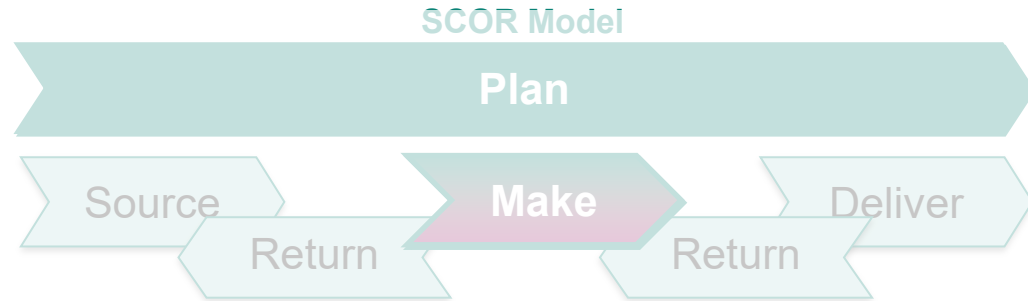
Crisis learning: Flexibility & Speed are essential to Supply Chain – Our global SC is our new Fab since 2009

Each new supply chain was a step to win Customers via **capacity increase** –
Example from the qualification flexible mobile phone business



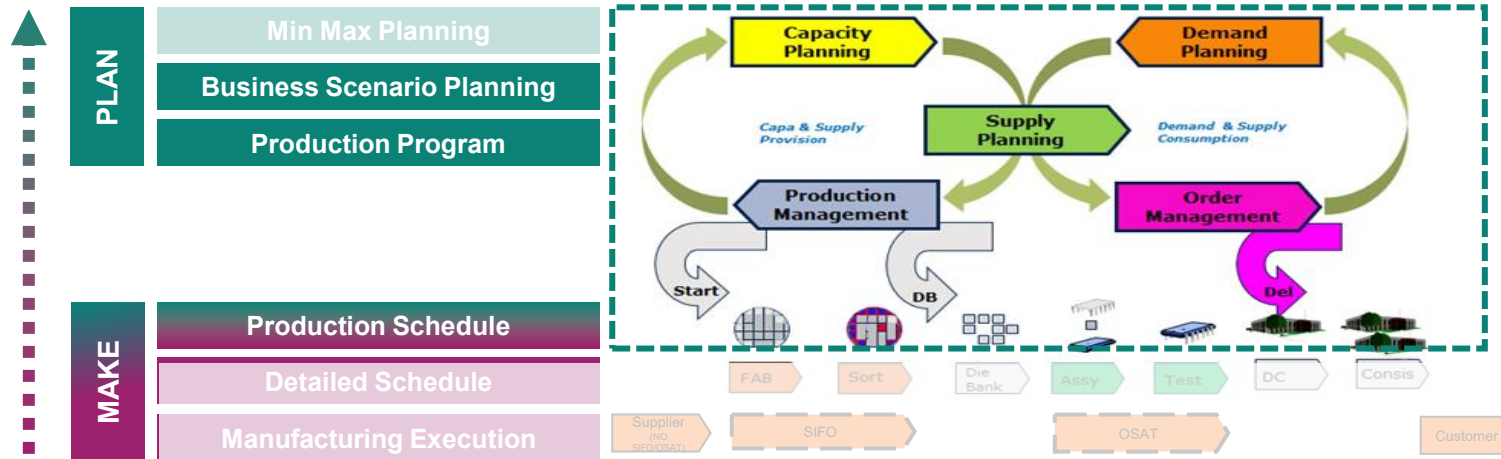
Besides physical flexibility in the Make processes, daily (Re-)Plan process is executed in the Plan process

The Supply Chain Operations Reference (SCOR) model guided our approach to Supply Chain Excellence



- The SCOR Model is a Reference centered around satisfying customer's demand.
- It was developed by PRTM, AMR Research and the Supply Chain Council.

Future



The focus in our **Supply Chain** are the **Plan** and **Make processes**. The ATP (Available to Promise) is the glue

These are detailing our daily operations as well as **promising** and **fulfilling** our demand.

That is why the Supply Chain orchestrates the network of FE, BE, DC, Silicon Foundries and Subcons like one Global Virtual Factory



Does this really need to be so complex? We have found no better way & experts see us leading – also US Gov. & EU KDT



2010

SCC
Supply Chain
Excellence Awards

SUPPLY CHAIN
AWARDS

Excellent Supply Chain Management
solutions come at a prize.
Win it. 2023

by PwC
Finalist Nov. 2023



2012

Supply Chain Management Award 2012

Selected successful best practice company



2010

European SCE Award: Education



2014



ROI: Best of the Best Industrial
4.0 Award for smart supply chain



2016

21/22



20/21

FINALIST
Supply Chain Innovation



2020

2025



Industrial Excellence Award

Report for

INFINEON AUSTRIA - VILLACH
Austria

Villach – Austrian „factory of the year“
with global supply chain (focus GAN)



2024

Industrial Excellence Award Germany 2017

And the Winner is: Infineon!

Jetzt ist es offiziell: Infineon gewinnt den diesjährigen „Industrial Excellence Award Germany 2017“ in der Kategorie „Enterprises“ – vergeben durch die WHU (Otto Beisheim School of Management). Die Preisverleihung findet am 4. Oktober im Rahmen der „Industrial Excellence Conference & Award“ in Berlin statt.

2017

ASCM global Award on SC
excellence – 2000+ people
conference

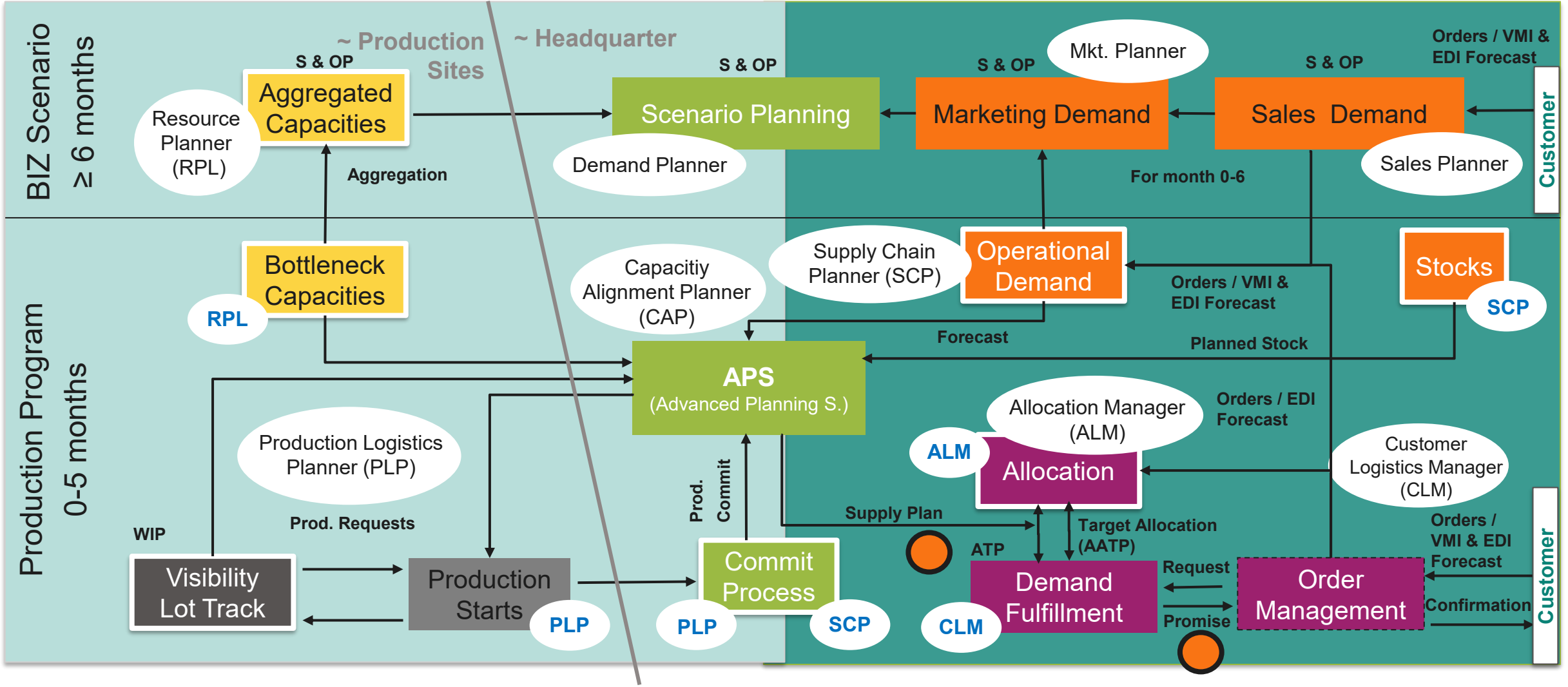


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Daily >1 Million Order (Re-)Confirmations & Improvements is competitive advantage – enabled by a superior Master Data Management system for best of breed IT Tools

Matching in Corporate Supply Chain – more than a million automated decisions per day

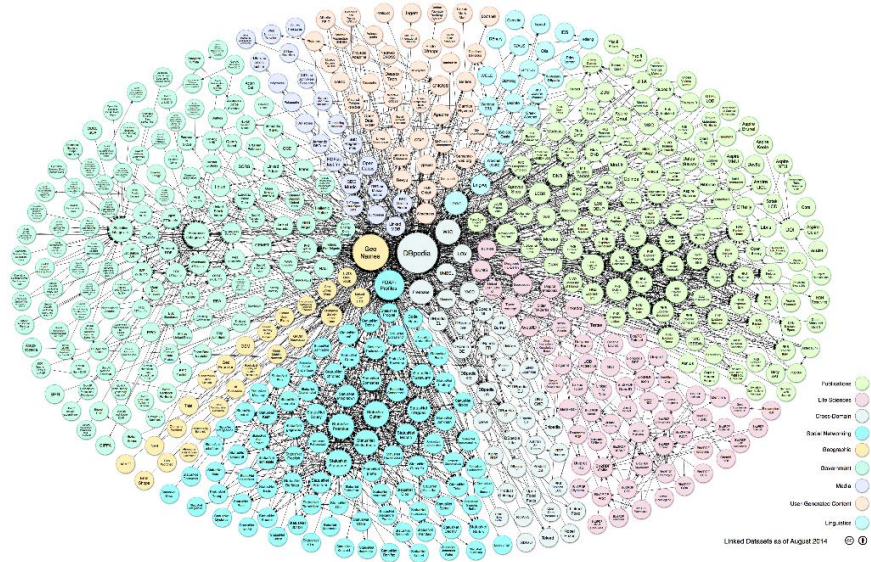


Backbone for AI are semantically understood Data – a success story in B2C at social nets, search engines, online shops, LLMs and other areas

- Social graphs (Facebook & weChat)
- Search engines (Google & Baidu)
- Online shops (Amazon & Alibaba)
- LLMs (ChatGPT, Perplexity ...)



Example of a large B2C Ontologies



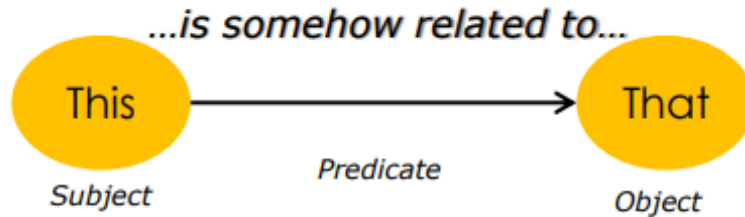
Example of a small Knowledge Graph using the FOAF (Friend Of A Friend) Ontology in Social graphs

Semantic Web technologies and ontologies

Set of standards established by the [World Wide Web Consortium \(W3C\)](https://www.w3.org/), overseeing the continuous development of the web

An ontology is a collection of triples intended to organize data about a certain domain. It utilizes concepts such as classes, class hierarchy, properties, property hierarchy, property characteristics and basic data types.

RDF Triples for limitless integration

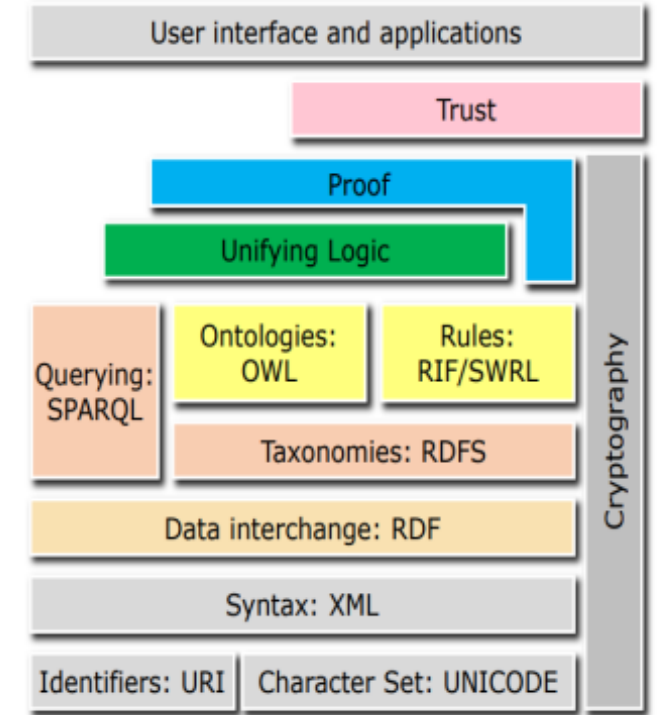


Applications, trust and traceability

Digital Twin

Semantic and reasoning layer

Foundations of the (semantic) web



The Semantic Web technology stack

✓ BENEFITS

Well defined and common understanding of concepts and data

Data integration from heterogeneous data silos in a unified view

Big volume data management

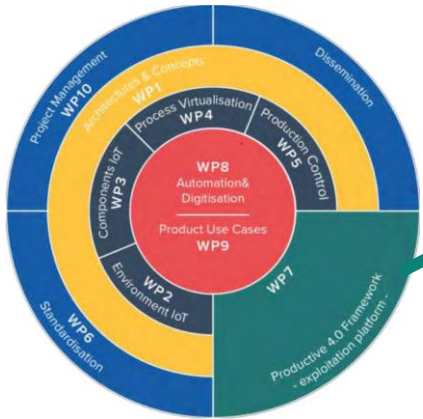
Data analytics and hidden knowledge identification

An enabler for Artificial Intelligence, Deep Learning, Simulation

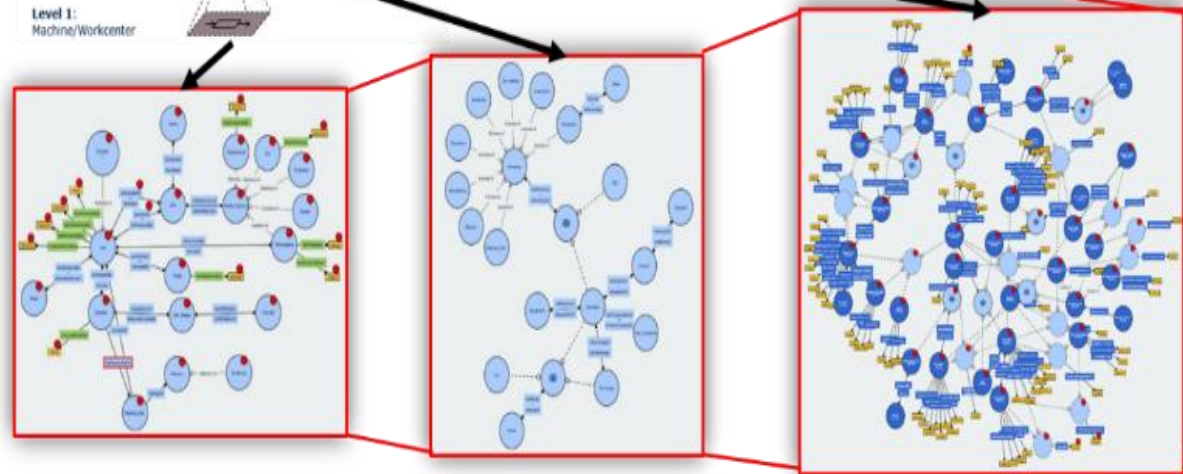
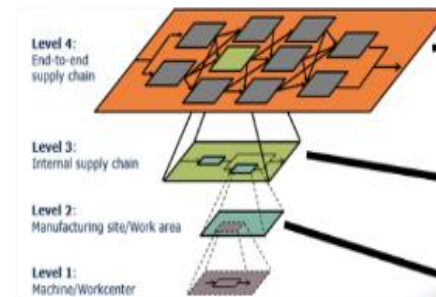
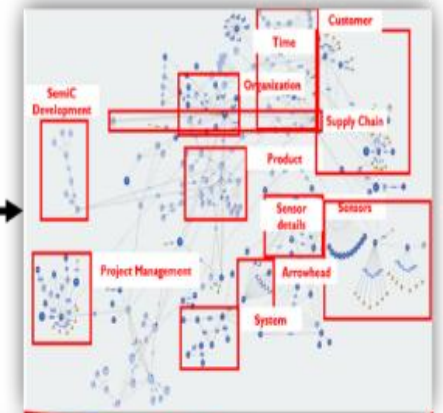
The Digital Reference, a result of Productive4.0 is the B2B semantic web for semiconductor & supply chain containing semiconductors

Productive 4.0 (2017-2020)

- **goal:** achieve improvement of digitalizing the European industry by electronics and ICT
- **partners:** 109 participants / 19 countries



WP7: Reference architecture solutions for digital production, supply chain networks and product lifecycle management



Work packages of Productive4.0

Digital Reference: An open sourced, Semantic Web-based holistic model for semiconductor and supply chains containing semiconductors

- Organized into clusters , also called lobes
- Facilitates inter-company collaboration and data integration via a common vocabulary and semantic space
- Already used as reference in several projects



Digital Reference Ontology Website

← ↻ 🏠 <https://ifx-dr.github.io/DigitalReference/index.html> 🔍 ⌕ ⭐



Home

Metadata

Lobes

Namespaces

Update

Digital Reference

Digital Reference (DR) - upper ontology introduced by the H2020/ECSEL project Productive4.0 in 2017, is a supply chain-related Semantic Web mirror of the semiconductor industry and supply chains containing semiconductors.



Open visualization on full screen



[Digital Reference Website](#) (Live Demo)

The Digital Reference, organized in topic clusters (lobes), provides the structure of a knowledge base readable for humans and computers alike. It represents all stages of the semiconductor supply chain with several sub-ontologies that currently consist of concepts, hierarchies and organizations [Ehm et al. 2019], [Ehm et al. 2020], [Ramzy et al. 2022].

Download the latest version

Propose an update



Propose an update

Contact us to suggest changes to the Digital Reference

Digital Reference Lobes

1. Cloud

Network/Remote Servers that store, manage and process data

2. Organization

Structural and managerial aspects among various stakeholders

3. Planning

Making strategic decisions and creating plans

4. Power

Electrical energy consumed or dissipated by electronic devices or components

5. Process

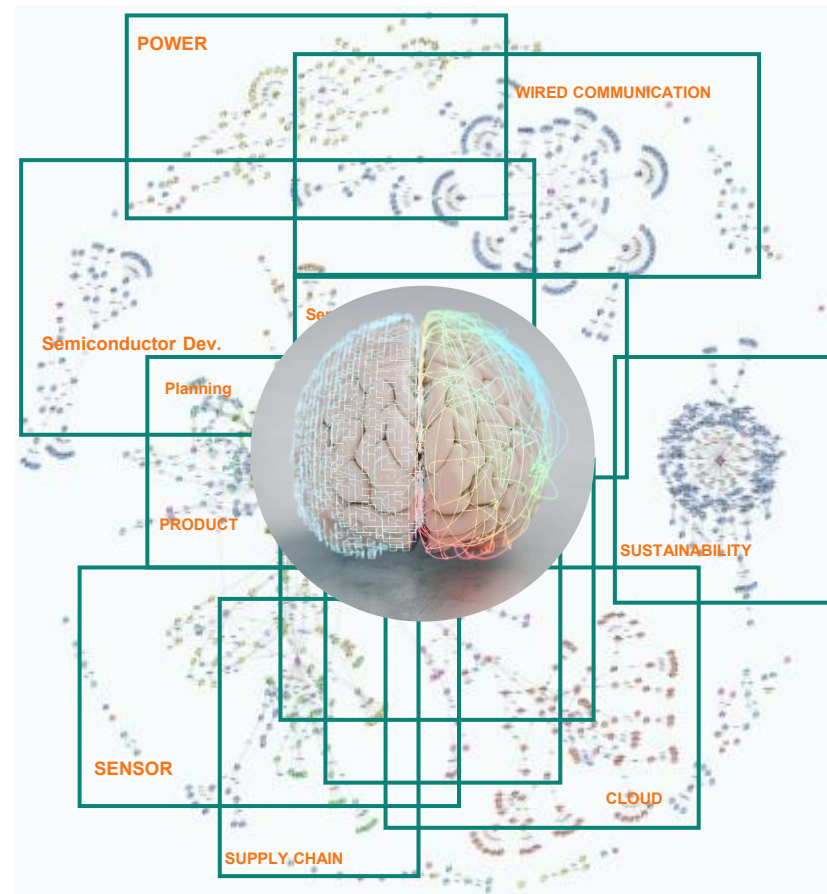
Series of actions designed to achieve goal within a system

6. Product

Item or service to fulfill a need of customers

7. Semiconductor Development

Process of researching, designing and creating semiconductors device to meet advancements and demand



8. Semiconductor Production

Manufacturing process of creating integrated circuits and other semiconductors device

9. Sensor

Device or components that detects parameters and converts them into electrical signal for further usage

10. Supply Chain

Network of activities from the source to end consumer

11. Sustainability

Practice of meeting needs while considering balancing environmental, social, and economic issues

12. System

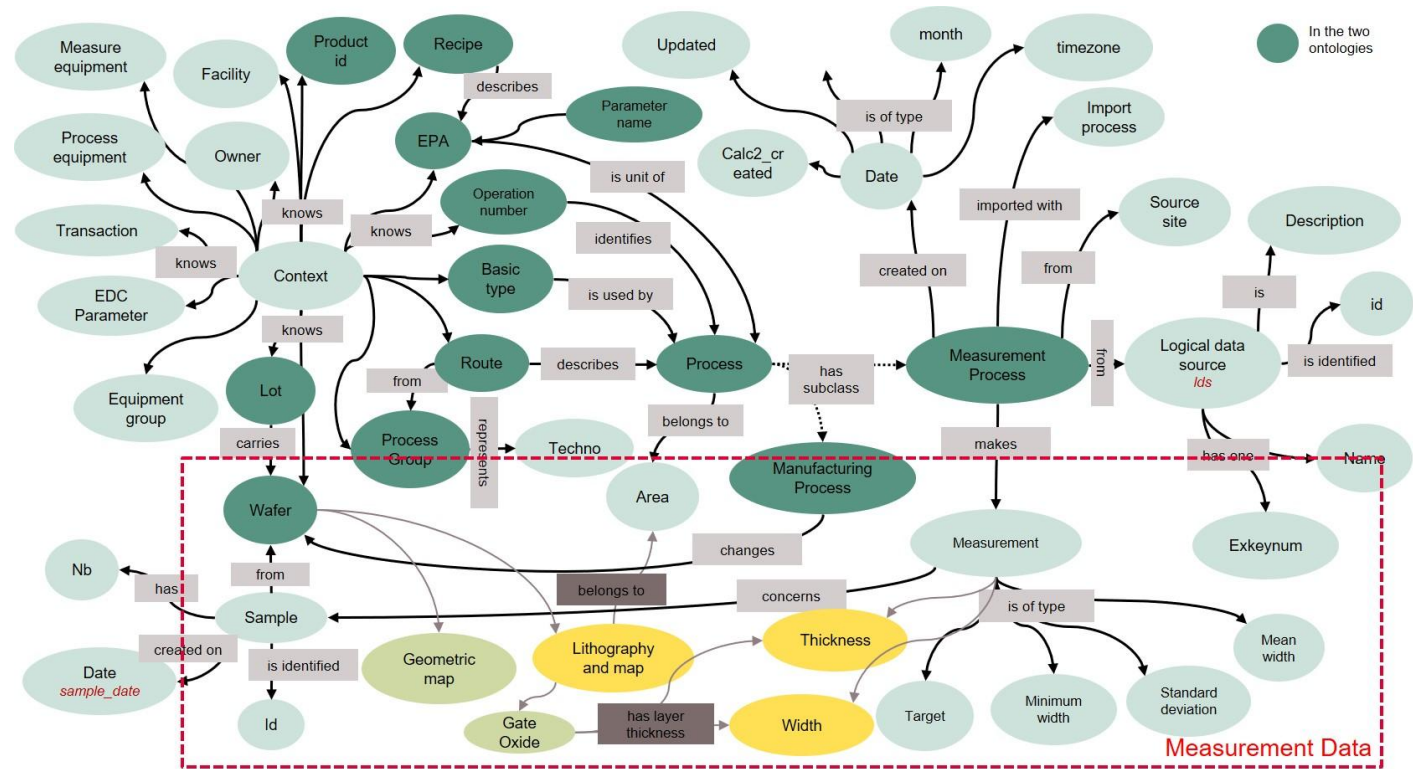
A collection of components that work together to perform specific function

13. Time

A measurable dimension in which events occur sequentially and can be used to qualify the duration between occurrences

14. Wired Communication

Transmission of data or signals through physical connections such as cables or wires



GAIA-X or Catena-X to make use of Digital Reference by incorporating .owl files

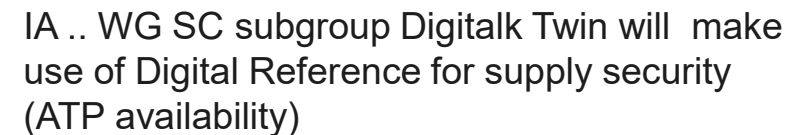
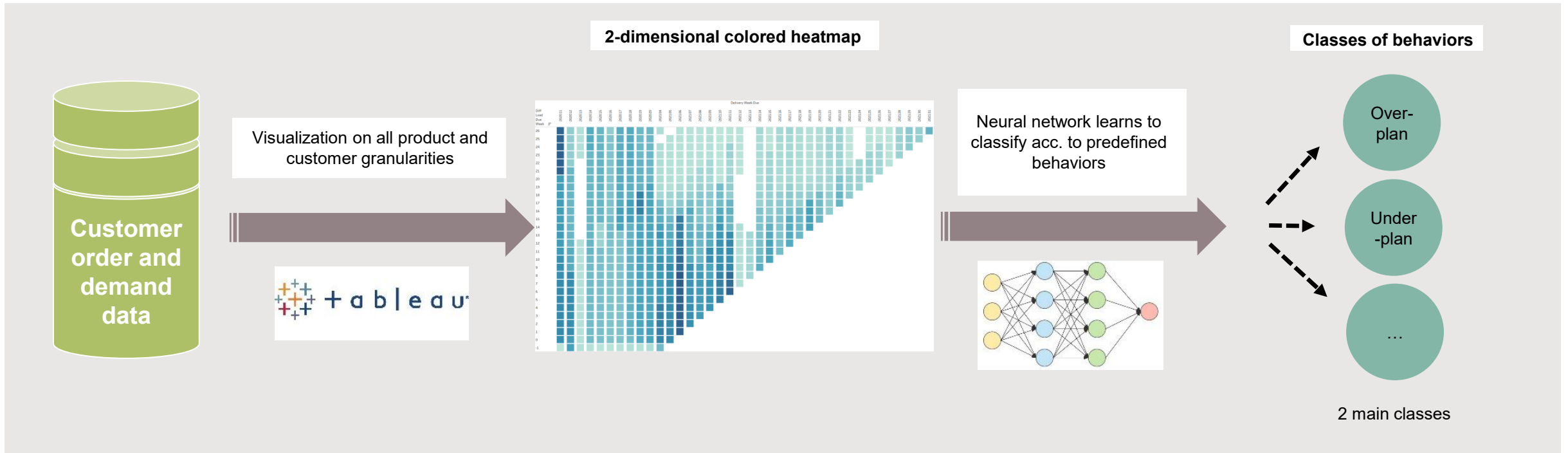


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Classifying Customer Behaviors for Improved Planning: Heat Maps & Image Recognition



Desire

- **Visualize** customer behaviors with heat maps
- **Classify** customer ordering & change patterns with **image recognition**
- **Improve** supply chain planning quality by exploiting available data

Action

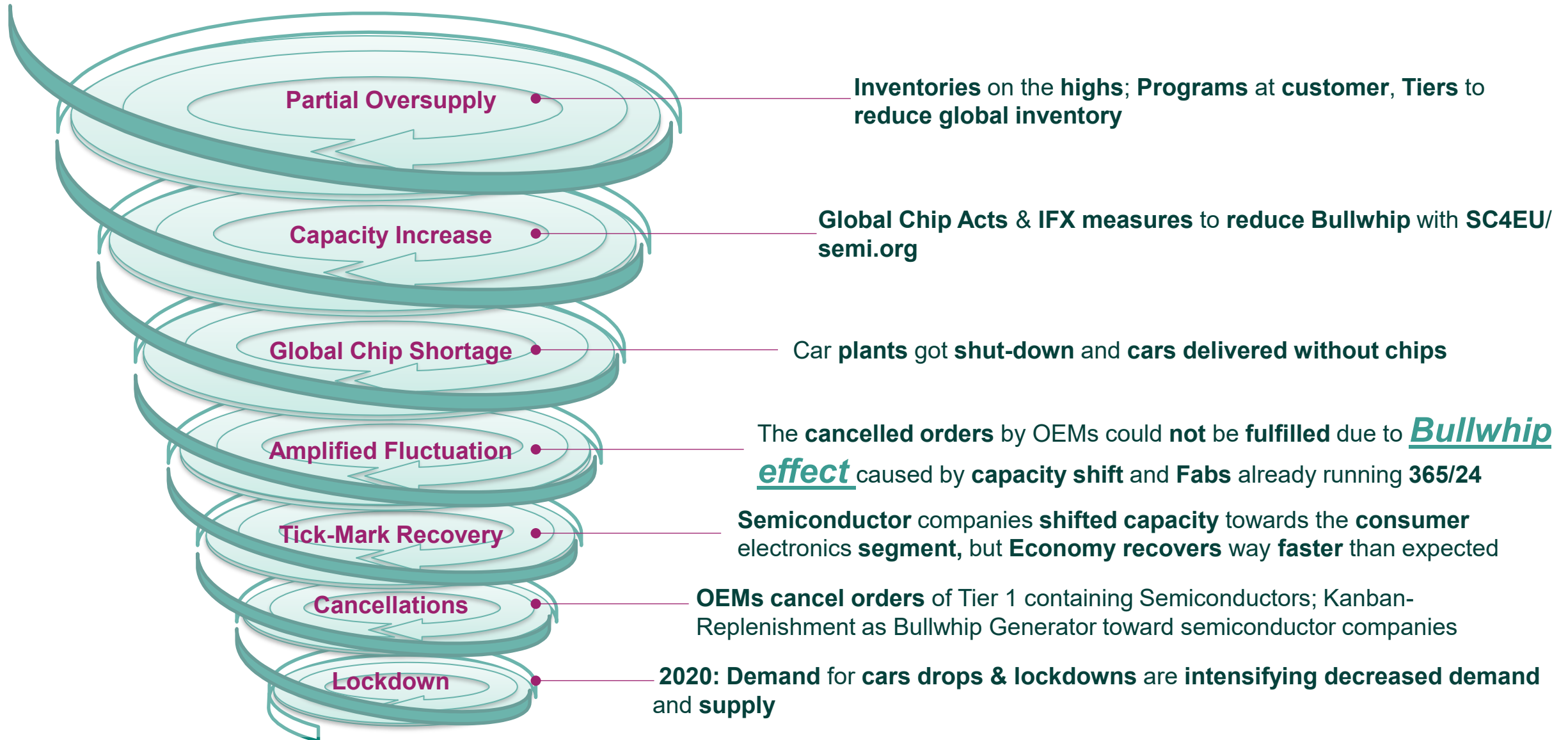
- **Ph.D. thesis** with TUM – Prof. Schiffer (2020-2024)
- **Joint work** within Infineon departments
- **Partially funded** by German and European projects SC³; productive 4.0

Outcome

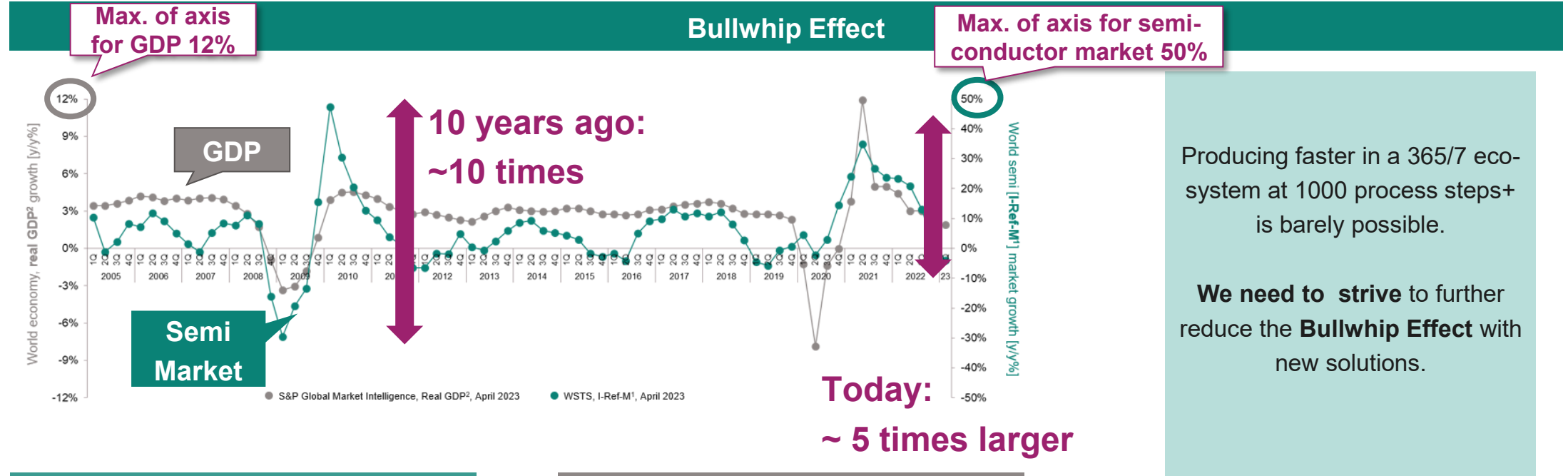
- **Characterized customer behaviors** for improved demand planning, order promising & potentially lead-time based pricing

Why is understanding Customer behaviour so important?

To mitigate Bullwhip effects e.g. triggered by Covid-19



Overshooting in the supply chain known as Bullwhip effect is not new - taming is not easy but of paramount importance – AI as an enabler



I-Ref-M = Infineon reference market = Total semiconductor US-Dollar-based market revenues excl. DRAM, NAND Flash, MPU.

Real GDP = Inflation-adjusted (real) Gross Domestic Product of all countries of the world; a total of local values converted within each case current US-\$ exchange rates.

Producing faster in a 365/7 eco-system at 1000 process steps+ is barely possible.

We need to strive to further reduce the **Bullwhip Effect** with new solutions.

Bullwhip Effect
(Semiconductors)

Overshooting in the supply chain known as Bullwhip is not new at all

Producing faster in a 365/7 eco-system at 1000 process steps+ is barely possible

→ Other solutions needed

SC a competitive advantage

Ideen zur Synchronisation der gesamten Supply chain:
vom Silizium Wafer zum Automobil

ITA Kongress, Wolfsburg
13. / 14. September 2010



Innovative semiconductor solutions
for energy efficiency, mobility
and security



Automotive Prozesse & IT 2012
12./13. September 2012 im Saarbrücker Schloss

Innovation in globalen End-to-End Supply Chains -
Herausforderungen für agile Prozessketten

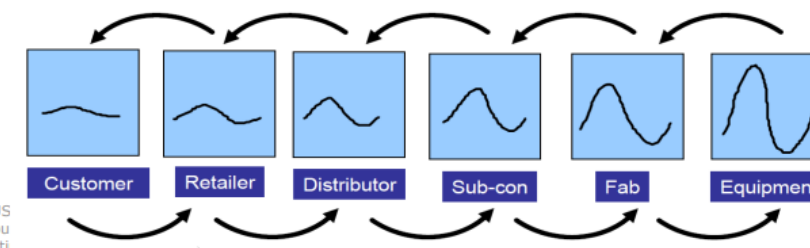
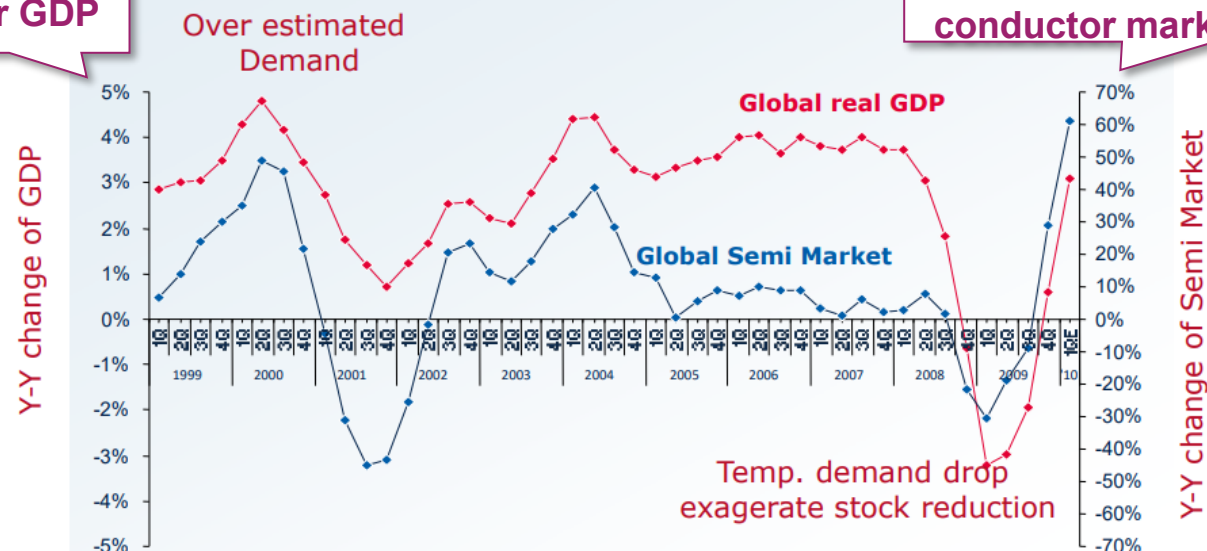


Sharp down turn are followed by steep up turn –
Aligned supply chains can reduce the bullwhip



Axis for GDP

Axis for semi-conductor market



Bullwhip Effect
Overshooting in
the value chain

d January & February sales figures for the

Overcoming the tactical demand bullwhip root cause → True demand via anonymized survey for improved forecast – SC4EU project



Remove the incentive for communicating tactical demand



Facilitate regular exchange of information along supply chains



Marketplace for different questions regarding demand, backlog, critical products etc.

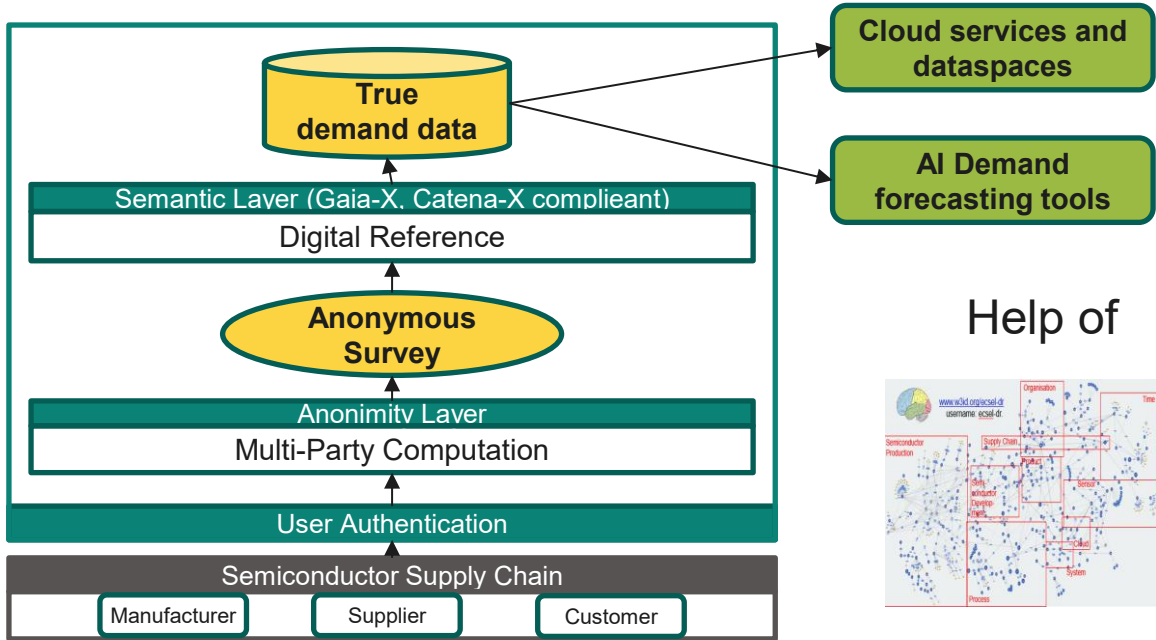


A true demand from the survey can be used as cleaned data for forecast modeling



SC4EU Project · 1.
True Demand Driven Semiconductor Supply Chains for Europe

Chips Joint Undertaking

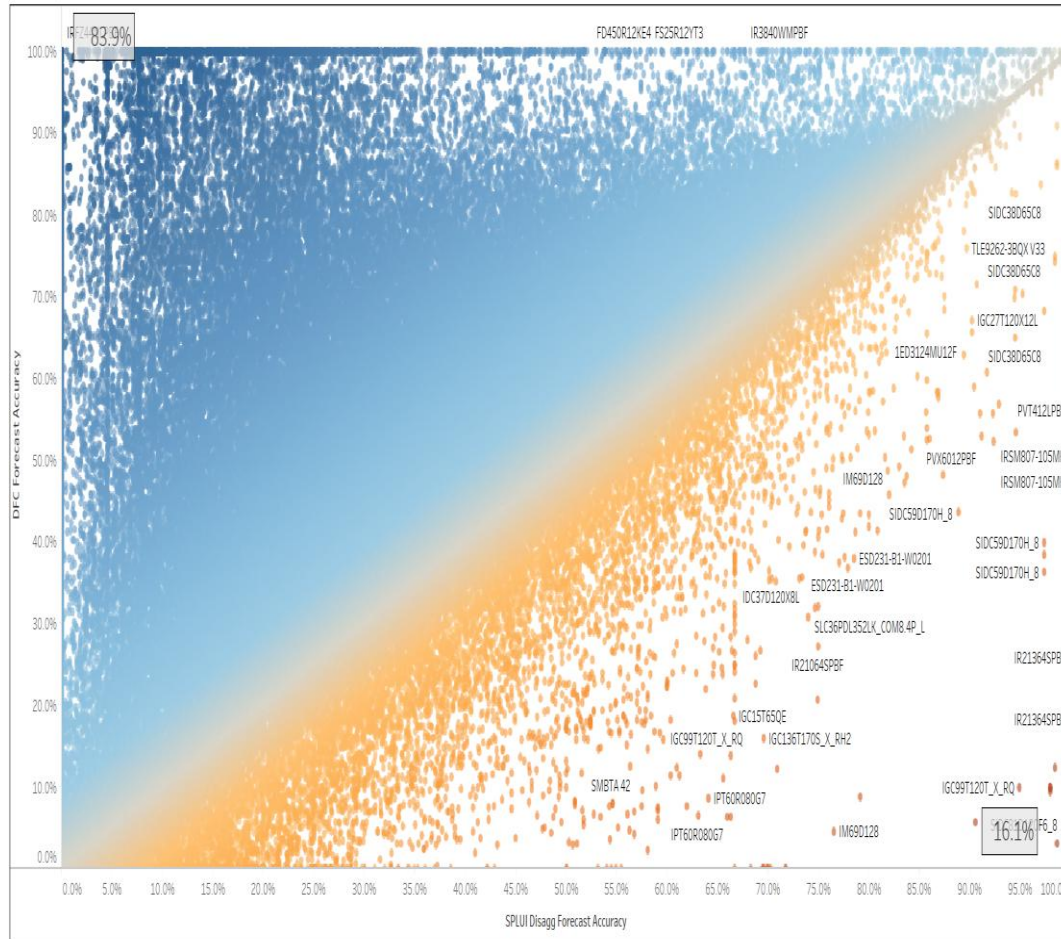


Une école de l'IMT



Results - Improved Forecast Accuracy enables high automation share and efficiency gains

84% of statistical/AI forecasted more accurate



84% of Plan Postions more accurate
forecasted with statistical/AI Tool

However, Usage significantly below
potential

**Still we see a substantial potential
to use more AI if we learn how to
work with AI better**

→ HAI Game brings us there

HAI Game



Challenge: Decision (support) with limited (no) explanation → Gaming

HAI Game – Alliance for Digital Competencies Project of Bavarian Ministry for Digital Affairs



- HAI Game as part of the project “Alliance for Digital Competencies” with 14 partners (started in April 2023)
- HAI Game for Externals, every Wednesday from 10 to 11 am CET
- Almost 1000 participants completed

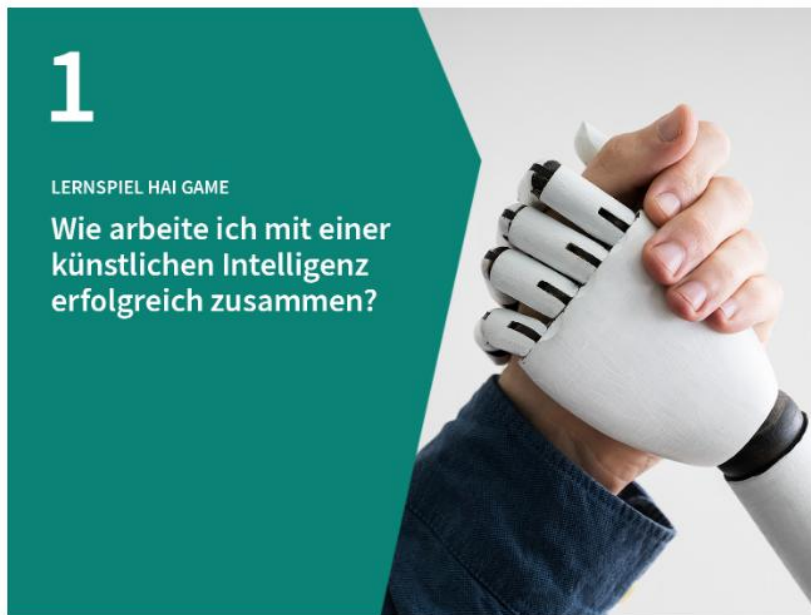
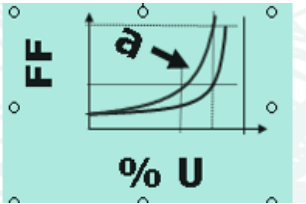


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Roadmap: Digitalization, Efficiency and Sustainability in the supply chain with AI based on semantically enriched Data



2007: [Lean for complex flow manufacturing](#) SC Academy



2013: Best of breed IT Tools with superior Master Data enabled daily Demand Capacity Match



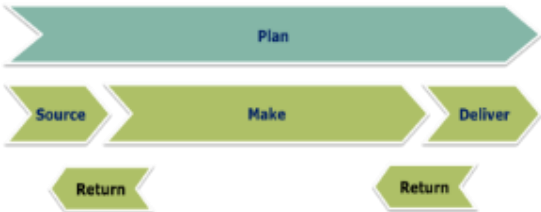
2018: Supply Chain with commit process one key enabler for a successful merger



2022/4: AI and Deep Learning; HAI Game as enabler
Further mergers like with Cypress

Our path towards Supply Chain a sustainable competitive advantage

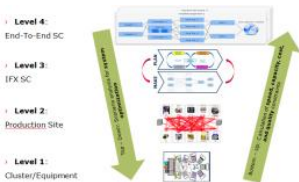
< 2007: Using SCOR 12.0 as a standard (Deliver focus)



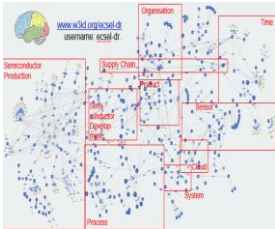
2010: Supply Chain is our global Fab (Make focus)



2016: Simulation enable further optimization in Plan, Make and Deliver



2020: Digitalization boost with Big Data & Semantics

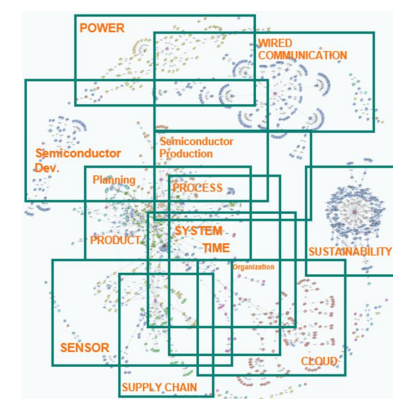
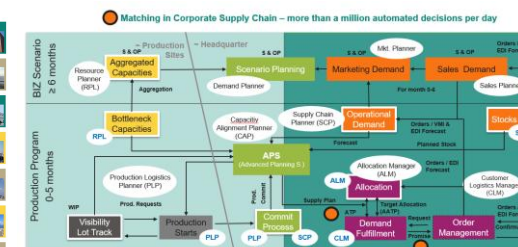
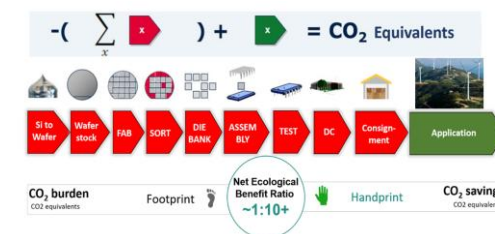
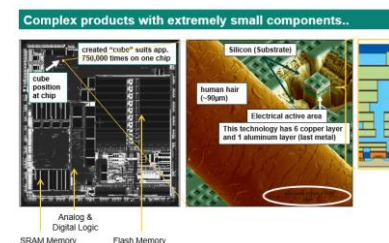


2025+: Leverage AI for True E2E Collaborations **with semantic data integration**; Prouddness for contribution to resolve climate change



Executive Summary

- The semiconductor industry is highly complex has intrinsic long production cycle times & suffers from the Bullwhip but is **the** technology enabler for CO2 reduction
- The daily execution of built up global physical flexibility is the answer to the challenge and this competitive advantage and is **enabled by superior Data Management** for best of breed IT system solutions
- **Semantic Data integration and knowledge graphs** are the AI enablers many AI applications (Forecast, Escalation prediction and mitigation, anonymous survey interpretation to overcome bullwhip and ...) but **humans also need to learn to work with the digital companion** (HAI game)



Interested? Get in contact with me – if you like

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Glad to be here physical and not from Corona Home office ☺

Mitigate the risk

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Harvest the chance

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Public available academic contribution best viewed at Research Gate:

www.researchgate.net/lab/Supply-Chain-Innovation-Hans-Ehm

