

Shaping the industrial Digitalization

Gerhard Fohringer, Siemens AG, Corporate Strategy | 08/2017

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decentral power by 2030 – enormous stress for power grids



of office building's operating costs () are energy cost

+60%

+60%

sub-urban passengers in Germany by 2030



~100%

production quality required to stay competitive



THERE SHERE

older than 60 by 2050



Thailand 4.0

Four stages of infrastructure development





infrastructure

infrastructure



intelligent infrastructure

Targeted investments drive increase in productivity, efficiency, capacity, resilience and quality of life

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Siemens, your trusted technology partner

Power Generation	Power Distribution & Transmission	Traffic Management	Building Automation

Siemens, your trusted technology partner





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Siemens is addressing these challenges using digital technologies – building on Electrification – Automation – Digitalization



Siemens creating benefit along entire customer value chains





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Electrification – Automation – Digitalization: a strong and complete offering for our customers



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"We don't get a chance to retry or rebuild or service or redesign. We have <u>one</u> shot..."

> Bill Allen, Mechanical Design Engineer, Nasa's Jet Propulsion Laboratory

Siemens Software

~ / / /

SpaceX Falcon Rocket

"There is nothing inherently expensive about rockets. It's just that those who have built and operated them in the past have done so with horrendously poor efficiency."

> Elon Musk, CEO, SpaceX

Siemens Software

Infiniti Red Bull Racing



"We can't win races without leveraging world class technology"

> Al Peasland, Technical Partnership Manager, **Red Bull**



Siemens Software Digital Enterprise Suite for Maserati



 Customer seeking to reduce time-to-market while maintaining highest quality and increasing model variety

Solution

 Siemens software for product development and simulation integrated with production engineering

Outcome

- Development time reduced by 30%
- Time-to-market reduced from 30 to 16 months

Siemens Software – benefit for Siemens

- €3.3 bn cross-divisional business
- Strong growth and high-profit
- Stable, recurring revenue stream



Simulation: from physical to virtual







Siemens Software | Simulation Digital Twins across verticals





Challenge

 Products, systems of infrastructure & people are becoming increasingly complex – harder to design and to optimally control

Solution

- Simulation for rapid virtual prototyping
- Testing of control actions prior to execution

Outcome

- Optimized design and operation of infrastructures
- Increased productivity, efficiency, resilience and availability

Simulation Software – benefit for Siemens

- Strong differentiator for digital portfolio
- Key for closing the life-cycle data loop

Siemens Software | Simulation | Digital Factory LMS stiffness simulation



Siemens Software | Simulation | Digital Factory

Siemens Software | Simulation | Energy Management Power System Simulator PSS for grids







Siemens Software | Simulation | Mobility Virtual Vehicle Research Center





Digital Services: from repair to performance

Siemens Digital Services Predictive maintenance for high-speed trains in Russia



Challenge

 Safe-guarding highest availability of trains at down to -40°C in exposed environments

Solution

 Analytics on sensor data of critical components for predictive maintenance

Outcome

- 99% availability in harshest conditions

Digital Services – benefit for Siemens

- €1.0 bn cross-divisional business
- Strong growth and high-profit, recurring revenue
- Capitalizing on 800,000 connected devices

Siemens Digital Services Predictive maintenance for high-speed trains in Spain



Challenge

 26 high-speed trains at Renfe Spanish Rail Company (Madrid-Barcelona-Malaga)

Solution

- Analytics on sensor data of critical components for predictive maintenance
- Performance contract with availability guarantee
- Passengers are reimbursed for delays >15 mins

Outcome

- On-time rate of 99.9%
- 60% passengers switched from aircraft to train

Digital Services – benefit for Siemens

- €1.0 bn cross-divisional business
- Strong growth and high-profit, recurring revenue
- Capitalizing on 800,000 connected devices

Optimize building performance



Challenge

Reduce own carbon footprint, target to become first net-CO2 neutral industrial company by 2030

Solution

Navigator: Energy Efficiency Monitoring at >10 factories and office locations¹ in Germany

Outcome

Energy consumption reduced by up to 20%

Dr. Roland Busch

MindSphere: the IoT operating system



Enhanced Electrification and Automation Smart Motors – connected to MindSphere



Challenge

- Lacking transparency on operational machine data of drive applications
- Limits to performance and reliability improvements

Solution

- Smart Box with integrated vibration, magnetic flux and temperature sensors
- Wireless connection to MindSphere for monitoring and analytics applications

Outcome

- Increased availability
- Improved performance
- Optimized serviceability

Enhanced E&A – benefit for Siemens

- Expanding #1 position in automation
- Enhancing the installed base for Digital Services
- Enabling the MindSphere ecosystem

MindSphere enables the digital transformation your business



Entry point to digitalization

Every machine holds a wealth of data. MindSphere helps to understand it by connecting physical infrastructure to the digital world.

Data is seamlessly captured, transferred and made available for meaningful analysis



Foundation for development of applications

MindSphere supports developing applications and using them as well as offering them to other users



Multiplier for digital services and new business

Digital services can be developed and provided to other users to reduce downtime, increase output and use assets more effectively



Driving business success with powerful industry applications and digital services

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Quickly and easily

connecting real things to the digital world

Creating a strong partner ecosystem

with Open Platform as a Service (PaaS)

Enabling unmatched closed-loop innovation

with the complete digital twin



Open partner eco-system





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DAAC setup

Data Analytics and Application Centers are responsible for driving Digitalization at Siemens in respective vertical markets



Develop new business models, apps and digital use cases in focus verticals based on understanding market demands, deep domain know–how and digital expertise

Source: Digitalization Program

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Industrie 4.0: from design to production



Design and simulate the product NX CAD/CAE/CAM



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>1 >2 >3

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Simulate the physical behavior

Simcenter





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Design and simulate electronic systems

Mentor Graphics





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Develop, simulate, validate, and manage embedded software

Polarion ALM





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Digital Twin of the Production

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Simulate and improve human and robotic work processes

Teamcenter Manufacturing, Tecnomatix Process Simulate and Plant Simulation, PLCSIM Advanced, TIA Portal



Standard Mode Snap Pick Intent Component Pick Level ++++ 0, 0, 0

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Production engineering



Automatically generate the PLC code for TIA Portal

Production Systems Engineering

>1 >2 >3



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Production engineering



Fast and efficient engineering and commis-sioning

Totally Integrated Automation Portal





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Digital Twin





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Electrification – Automation – Digitalization: a strong and complete offering for our customers

Maintenance & **Automation & Operation Design & Engineering** Utilization Siemens Software **€4.3bn** s Digital Services **Unmatched Software Suite** 800k connections. +12% y-o-y €3bn order backlog at Power ~70m contracted meters +++ Profit The cloud-based, open IoT operating system **MindSphere Platform as a Service** Enabler: Infrastructure as a Service (storage, processing power, provider agnostic) #1 position in automation, **Digitally enhanced Electrification and Automation** ~30mn automation systems
 Ŝ M Holistic IT security concept

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What's next?

Innovation – closing the life-cycle data-loop





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Siemens Innovation MindSphere & the Digital Twin – operational data for product optimization



Challenge

 Reaching the next level of design and product quality of cranes by feeding operational product sensor data back into design

Solution

- Collection and management of data using MindSphere and Teamcenter product data management software
- Direct interface to design tool NX
- Co-operation with Aalto University

Outcome

- Effective, efficient and reliable product improvement
- Closing the life-cycle data-loop

Benefit for Siemens

- Enhancing E-A-D via data based learning
- Growing a the MindSphere ecosystem

What's next? – Full leverage of the closed-life-cycle data-loop and artificial intelligence

Business Deductive Artificial value Intelligence → Continuous improvement Closed **Prescriptive** life-cycle → Decision support data-loop **Predictive** Data analytics → Understanding & predicting **Descriptive** Data → Monitoring & transparency **Depth of data-use**

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Siemens Innovation NO_x emission reduction of gas turbines based on machine learning



Challenge

- Conventional NOx emission reduction approaches reaching limits
- Tightening environmental regulations

Solution

 Machine learning algorithms for optimization of control parameters

Outcome

- 15–20% additional NO_x reduction
- Providing more sustainable balancing power

Benefit for Siemens

 Enhancing the electrification & automation portfolio – expanding leadership

Siemens Innovation Machine learning & distributed analytics – intelligent grid controllers



Challenge

- Reliably classifying and locating faults in power grids
- Conventional methods at ~80% reliability

Solution

- Machine learning applied to ~70,000 fault events
- Resulting optimized algorithms embedded in SIPROTEC[™] protection relays
- Real-time streaming and interpretation of grid data

Outcome

- Considerably improved reliability of locating faults
- Faster recovery times, reduced maintenance cost
- Enabling large-scale integration of solar & wind

Benefit for Siemens

 Enhancing the electrification & automation portfolio – expanding leadership

Reinventing how we innovate



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Enabling your digital inspiration beyond todays limitation



Werner von Siemens might have called it "Erfindergeist" (inventiveness). We call it "Ingenuity for life".

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Siemens is passing through the digital transformation itself and adapting its processes to the new reality



Example – Electronics facility in Amberg, Germany



Fast ~1 SIMATIC product per second >1,200 product variants in the team center



Flexible 24 hours between order and arrival at customer **Efficient** Roughly nine-fold increase in shop floor utilization since production start (1990) High-quality Fewer than 11dpm, for a quality level of 99.9989%

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Siemens digitalization ecosystem – Technology platforms, world-class talent pools and partners

Digital Factory Process Industries Simulation & operational Simulation & operational software software Powerful Mobility **Building Technology** combination of Automation in large installed base Energy Management Wind Power physical and Strong vertical domain know-how large installed base Fossil Power Generatior virtual world (hD Teradata. Atos 🕞 Bentleu Leading partner Partnership for analytics Cloud platform Strategic alliance Strategic alliance Industrial cyber security - Strong IT partner ecosystem ecosystem - Complementary strengths IBM SAP 🗲 Cerner accenture JV for smart grids Alliance for Healthcare IT Integration partner 3D-Printing Cooperation Investment Founding next 47 - Modern software development >12 start-ups Investing in methods founded, e.g. > €800 million - Digital skill pools expanded innovation Collaboration with invested in Turning ideas into - Leveraging external innovation ubimake cotervo business > 1,000 startups 180 start-ups

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