Digitalization and Digital Twin in the electricity system

Lunch Lecture TU Delft PowerWeb, October 11th 2018
Power Technologies International optimizes technical system performance and maximizes business value

Energy Business Advisory
- Opening doors to future value creation
  - Infrastructure development
  - Business transformation
  - Market advisory
  - Transaction advisory
  - Solution engineering

Power System Consulting
- Complete set of analysis, design & optimization studies
  - Steady-state system studies
  - Dynamic system studies
  - Transient system studies
  - Protection & control system studies
  - Power quality & earthing studies

Software Solutions
- State-of-the-art system planning and data management
  - Planning and simulation of power systems
  - Planning and simulation of pipe networks
  - Model and data management
  - Dynamic and protection security assessments in operation
Energy Business Advisory: Unlocking Tomorrow – Opening doors to future value creation

Infrastructure development

- Technology advancements enable modern infrastructures, driving economic, social and environmental value for a sustainable future.
  - Infrastructure strategies
  - Community energy plans
  - IoT strategies (internet of things)

Business transformation

- Value-driven optimization of capabilities and technology infrastructure of a utility to create the industry leaders of tomorrow.
  - Utility of the future strategies
  - Business model transformation
  - Managed transition programs
  - Grid asset management concepts

Market advisory

- Adequate models, plans and strategies to enable clients to not only survive but thrive in challenging markets.
  - Integrated resource plans
  - Market entry and regulatory strategies
  - Market forecasting and analytics
  - Risk Management

Transaction advisory

- Holistic advisory driven by a deep understanding of the industry enables low risk, high value transactions for our clients.
  - Target / investor identification
  - Due diligence
  - Contract structuring and negotiations
  - Valuation services

Solution engineering

- Integrated solution blueprints on a conceptual level for an effective, efficient and secure infrastructure.
  - Capability Architecture Management
  - Data and event reference models
  - Cyber security consulting

Adequate models, plans and strategies to enable clients to not only survive but thrive in challenging markets.

- Integrated resource plans
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- Market forecasting and analytics
- Risk Management
Digitalization is changing our world – even in everyday life

Today we only know when the bus is coming ...

... tomorrow the bus will know where we are and where we want to go
Digitalization in a networked world enables dynamic synchronization regardless of space and time

**Real world context**
- Measurable properties (load, temperature, ...)
- Non-measurable properties (value, goals, ...)

**Device / Actor (bus)**
- Actively changes its context based on business models
- Receives information / input
- Responds and creates value
- Generates output

**Process**
- Changes the real world context
- Is executed by a plant / actuator

**Digital context**
- Digital 'shadow' or projection of the real world context / reality
- Digitalized time series

**Subsystem Properties**

**Shared Context is synthetic and static**
- Bus driver not aware of passenger location / destination
- Passenger not aware of bus location
- Bus company models anticipated demand curves
- Bus schedules are created to match anticipated demand
- Passengers adapt their processes to bus schedules

**System Context**

**System context**
- Combined (aggregated) context of the combined subsystems and their contexts

**Context overlap enables process synchronization**
- Entities interact with each other to share context
- Interactions enable dynamic process synchronization:
  - Passengers aware of bus location and ETA
  - Bus aware of ride requests
  - On-demand scheduling
  - Optimized route creation
  - Shared QoS metrics and objectives to ensure quality

**Future: IoT will enable on-demand mobility**

**Today: Transport System is based on synthetic, static context**
Digitalization involves handling five steps of increasing complexity.

1. **Acquisition**
   - Digitalizing system properties makes them independent of space and time.

2. **Aggregation**
   - The aggregation of properties and time reflects the state of the system in the digital world and its behavior over time.

3. **Analytics**
   - Analyzing the past now makes it possible to predict the future state of the system.

4. **Application**
   - Interpreting the data in the business context allows identifying activities and setpoints for the target system state.

5. **Actuation**
   - Automation of activities and setpoints closes the loop.
Simplified perspectives are required for handling high levels of complexity

1. Business Environment
   Ecosystem, partner network, and interactions with other market participants

2. Capabilities
   Technical and organizational processes

3. Technology Architecture
   Field devices and applications for data analysis and business support

4. Digital Repository
   Data management, processing, and storage aspects of the networked system
The core IoT methodology of PTI is an extension of the known Digitalization Compass by two adjacent frameworks: Adaptive Eco-System Analysis Framework and Data Modeling Framework.

**Perspective**
- Business Environment
- Business Capabilities
- Technology Architecture
- Digital Repository

**Methodology**
- Adaptive Eco-System Analysis Framework
- Digitalization Compass
- Data Modeling Framework

**Key activities**
- Clients' stakeholder classification
- Eco-System modeling including interactions and value flows
- Objective Prioritization
- Capability Gap Analysis (As-is and Aspirations)
- Improvement measures/initiatives
- Technology existence check
- Technology utilization requirements
- Optimum deployment sequence
- Clients' stakeholder classification
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**Tools**
- Modeling Tools (based on Eclipse Modeling Framework)
- Model Repository
- Modeling Tools
- Optimization Tools
- Report Generation
- Modeling Tools (based on Eclipse Modeling Framework)
- Data Processing Module
- Data Handling Module
- Data Usage Module
Digital Twin concepts can provide significant value to the electricity grid

**Self Healing**
- Automated fault detection, isolation and service restoration
- Reduction of outage duration
- OPEX optimization

**Load Management**
- Dynamic usage of flexible load generation
- Optimized usage of grid capacity
- Avoided or delayed grid extensions

**Overload Reduction**
- Dynamic feeder reconfiguration
- Avoid overload situations
- Limit disturbance instances and duration

**Service Restoration**
- Dynamic feeder reconfiguration in case of loss of source
- Limit disturbance instances and duration

**Voltage Quality**
- Active voltage regulation
- Avoiding voltage deviations
- Avoided grid extensions
Christian Heuer
Global Head Energy Business Advisory
EM DG PTI EBA
Lindenplatz 2
20099 Hamburg
Mobile: +49 152 2889 4820
E-mail: Heuer.Christian@siemens.com

siemens.com