Siemens Future Forum @ HANNOVER MESSE 2014

From Big Data to Smart Data

Thomas Hahn

The Evolution of Big Data

Digital data
~ 1960

- Digital data collection
- First databases

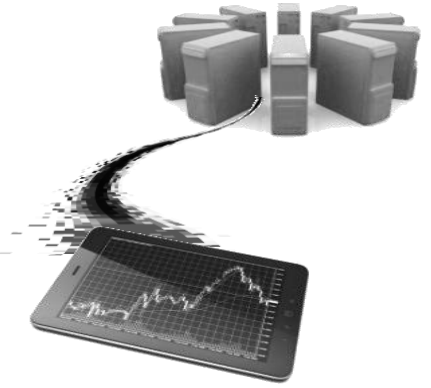
Data warehousing
~1986

- Data cubes
- Relational databases
- Financial data

Data Mining
~1993

- Statistics
- Artificial intelligence
- Machine learning
- Unstructured data

Big data analytics
~2015



- Stream processing
- Massively distributed
- NoSQL databases
- Heterogeneous data and knowledge
- Petabytes of data

Big Data Analytics is key
for protecting and extending existing businesses and creating new services

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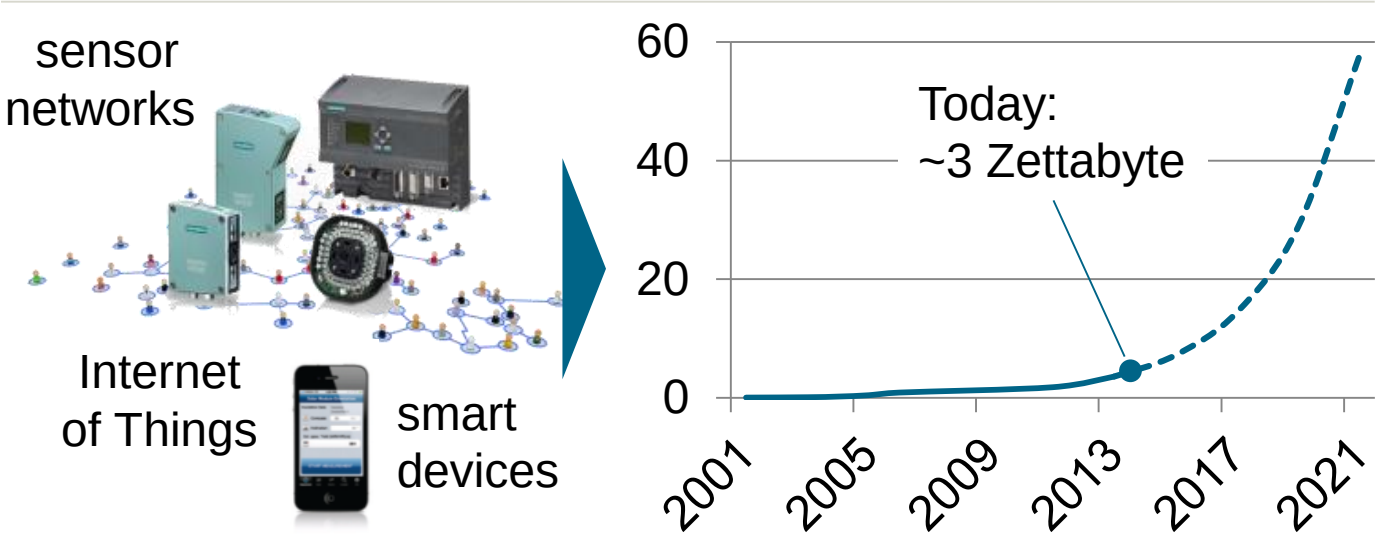
Technology push

- Proliferation of **smart sensors, smart devices, apps and Internet of Things** leading to data volume doubling every two years
- Combination of data analytics with system and sensor understanding enables complex **decision support** embedded into operational processes



- New SW and HW architectures enabling **massive data processing**

Big Data Analytics is key
for protecting and extending existing businesses and creating new services

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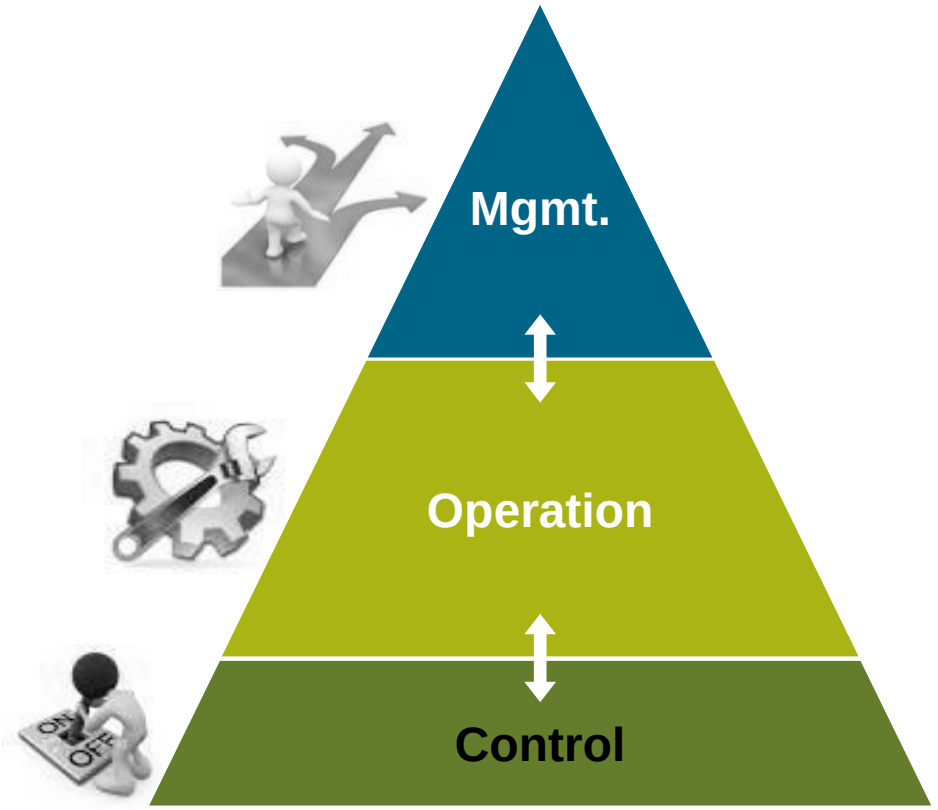
Market pull

- Rising **customer expectations**
- **IT players** moving into Siemens home turf
- Competitors' **M&As** yielding **tangible offerings**
- **Data analytics technologies enables** optimized **service business** and will **differentiate our Siemens systems and solutions**
- **New business models** (e.g. DaaS) and **eco-systems**



Focus of data analytics is changing: From description of past to decision support

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Value and Complexity

Act

Analyze

Inform

Descriptive	Diagnostic	Predictive	Prescriptive
What happened?	Why did it happen?	What will happen?	What shall we do?

Examples

Descriptive	Diagnostic	Predictive	Prescriptive
• Plant operation report • Fault report	• Alarm management • Root cause identification	• Power consumption prediction • Fault prediction	• Operation point optimization • Load balancing

Current penetration across all industries (according to Gartner 2013)

Descriptive	Diagnostic	Predictive	Prescriptive
99% Adopt by vast majority but not all data	30% Adopted by minorities	13% Still few adopters	3% Very few early adopters

Smart data to business principle: Combination of domain, device and analytics know-how

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Data from Siemens‘ Products and Solutions

Domain data

"Smart data to business"

Installed products & systems, processes, sensor data

Data → Data analytics → Business Intelligence → Business Innovation → Value Generation

Customer benefit

- Performance increase
- Energy saving
- Cost reduction
- Risk avoidance / security

E.g. Power plants

E.g. Power grids

E.g. Factories

E.g. Hospitals

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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Smart data to business example (1/9): Optimization of gas turbine operation

Energy system
- Market drivers
- Customer needs
- Product cycles

Gas turbines
- Mechanical Engineering
- Thermodynamics
- Combustion chemistry
- Sensor properties

Autonomous Learning
- Neural Networks
- Smart Data Architecture processes data from 5000 sensors per sec.

Results
- Reduced NOx Emissions
- Extension of service intervals

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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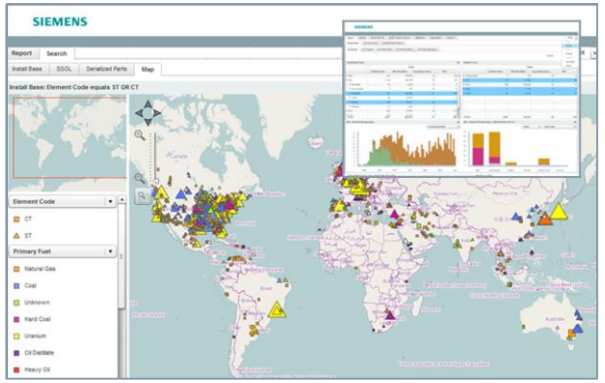
Smart data to business example (2/9): Service intelligence for gas turbine fleet



Energy system
- Market drivers
- Customer needs
- Product cycles

Gas turbines
- Mechanical Engineering
- Thermodynamics
- Combustion chemistry
- Sensor properties

Service analytics
- Integration of more than 30 data sources
- Six millions records per day

Results
- Faster outage planning
- Faster issue resolution
- Improved forecast of service events

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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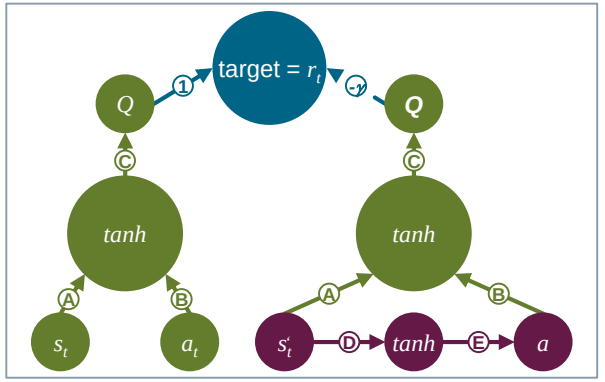
Smart data to business example (3/9): Optimization of wind parks (Project ALICE, CeBIT)



Wind power
- Market drivers
- Customer needs
- Aerodynamics
- Meteorologics

Wind turbines
- ~12,000 installed
- Mechanical Engineering
- Sensor properties
- Controller design

Autonomous Learning
- Neural Networks
- Robust policy generation despite very noisy data

Results
- 1% increase of annual energy with optimized control policy

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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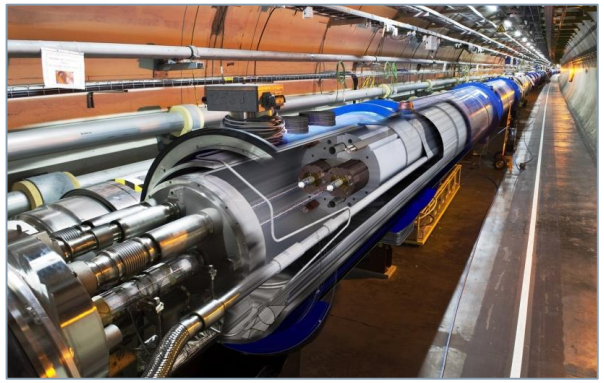
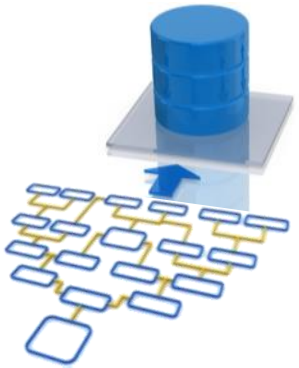
Smart data to business example (4/9): Health check for CERN's Large Hadron Collider





Automation infrastruct.
- Market leader in industry automation
- Strong presence in all business areas

Autom. components
- Complex: hundreds of SCADA systems and SIMATIC control systems

Rule and pattern mining
- >1 terabyte of operational data generated per day
- Detect fault patterns

Results
- Early warnings to increase Operating Hours

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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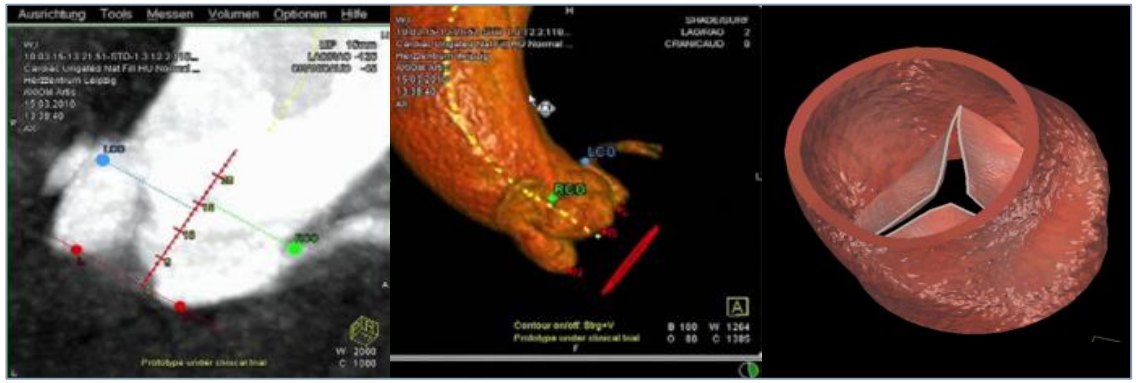
Smart data to business example (5/9): Image-guided diagnosis and therapy for heart valves



Healthcare Ecosystem
- Cost / effectiveness
- Accurate diagnosis / therapy
- Less invasive surgery

Imaging Scanners
- Robotic imaging
- Interventional imaging
- Low radiation
- Reconstruction & fusion

Machine Learning
- Image databases
- Fast machine learning
- Identify relevant structures

Results
- Industry wide unique feature that automates workflow and guides the surgeon
- Applied to thousands of valve implants
- Next generation in the pipeline

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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Smart data to business example (6/9): Smart City Research Aspern, Vienna

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City infrastructure
- Market drivers
- Customer needs
- Power networks
- Building technology

Smart Grid / Smart building
- Electrical engineering
- Power storage
- Smart meters

Smart City Cockpit
- Integration of smart grid, smart buildings, water and mobility
- Analytics dashboard

Objective

"My clear goal now is to become the greenest city in the world."

Michael Häupl, Mayor of Vienna

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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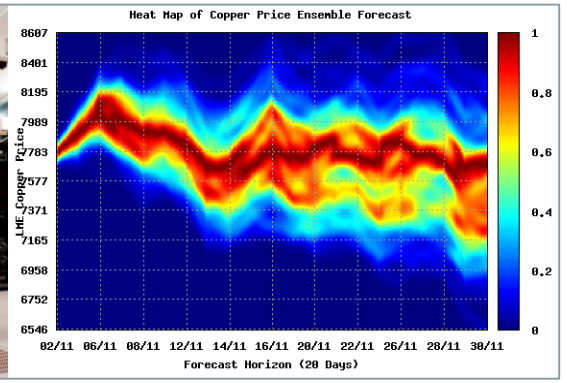
Smart data to business example (7/9): Procurement and Trading based on Neural Network Forecasts



Economics
- Commodity market and commodity prices
- Market Behavior
- Financials

Computer cluster
- Operation/ Utilization of Multicore CPU Clusters (500+ cores)
- Multicore computing

Econometrics w/ neural nets
- Time Series Data Management
- Modeling and Analysis

Results
- Predict com-modity prices for optimal procurement decisions and trading
- Prescriptive: Decision support based on expectation and risk

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

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Smart data to business example (8/9): Condition Monitoring for Water Supply Networks

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Levee Building
- Hydrology
- Geology
- Weather Forecasting

Levee Sensors
- Pressure
- Temperature
- Geometrical deviation

Neural Networks
- Time Series Data Management
- Anomaly detection (Slipping)

Results
- "Effectiveness of levee reinforcement has to be increased by a factor 4 which is impossible without innovation."

Peter Jansen, Waternet

Domain know-how + **Device know-how** + **Analytics know-how** = **Smart Data**

SIEMENS + Customer

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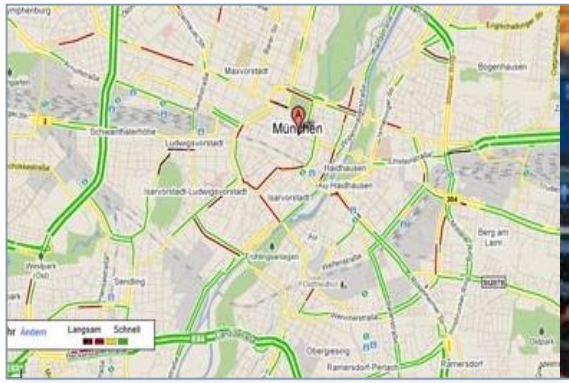
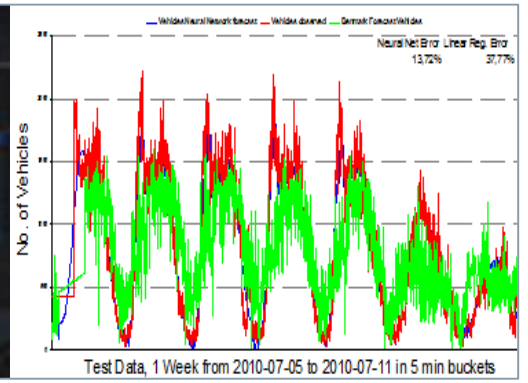
Smart data to business example (9/9): Advanced Traffic Forecast from Floating Car Data





Traffic Management
- Traffic Flow Models
- Traffic Planning

Traffic Sensors
- Induction Loops (traffic lights and guidance systems)
- GPS and Car Data

Neural Networks
- Time Series Data
- Traffic Forecasting
- Optimization of Traffic Flow

Objective
- Highly accurate traffic forecast
- Improve short-term traffic prediction by combining data sources

Domain know-how (SIEMENS + Customer) + **Device know-how** + **Analytics know-how** (SIEMENS) = **Smart Data**

Smart data to business examples: Lessons learned

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For all use cases/ business cases the data value stream needs to be specifically designed or adapted due to varying data types, data amount, data quality, data sources, data models …
➡ „One-size-*doesn‘t*-fit-all“

Based on today‘s technologies the combination of analytics know how and application know how can generate new business and value add (Smart data to business examples 1–9)

To create new business, new technologies need to be developed e.g. in the areas of multicore computing and cloud computing, but also new mathematics for analytics are necessary (artificial intelligence, neural networks …)

The combination of different data from different data sources (e.g. customer data + Siemens data) and their common analysis leads to advantages for both partners e.g. floating car data combined with Siemens traffic management systems data

Security and data protection need to be integral part of all technical solutions along the data value chain (data value stream)

Smart Data Innovation Lab:
Siemens and Fraunhofer jointly leading the Smart Cities Working Group

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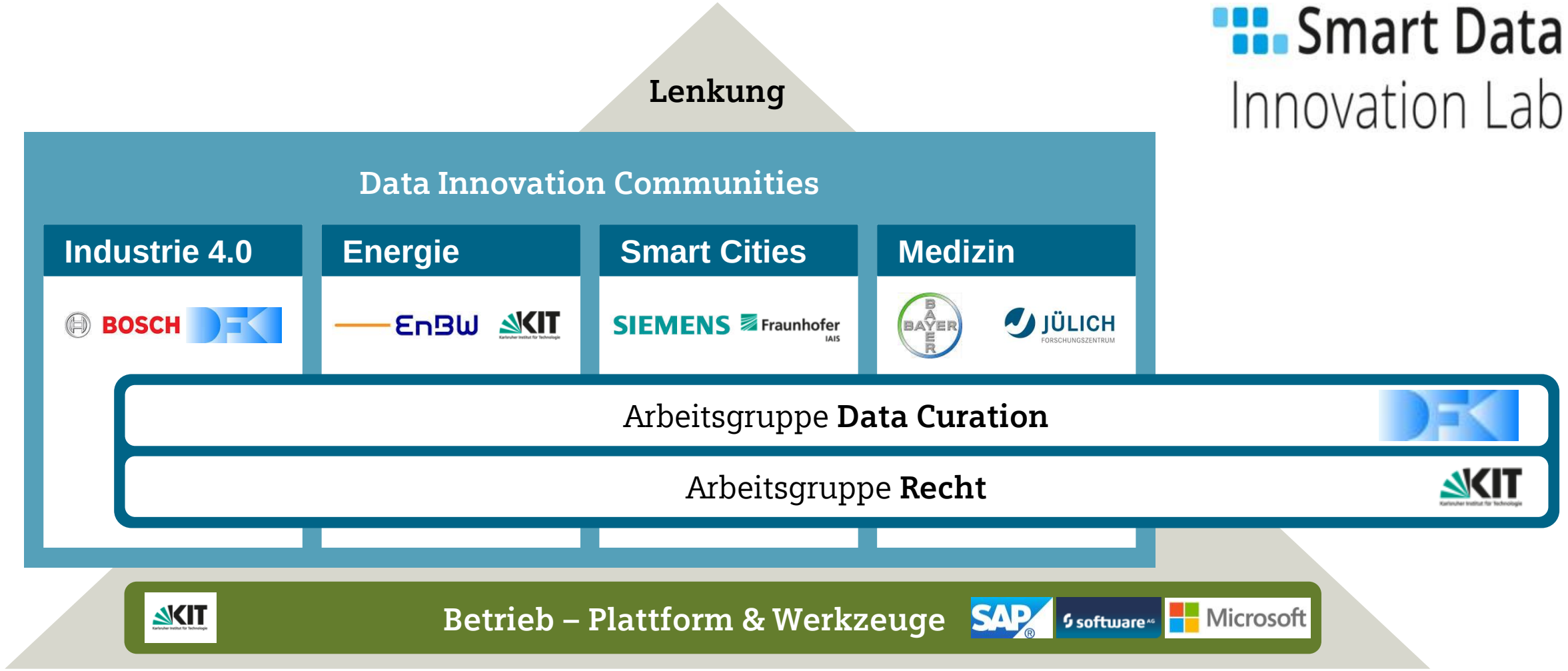

Smart data to business outlook:
The way to an ecosystem partner framework

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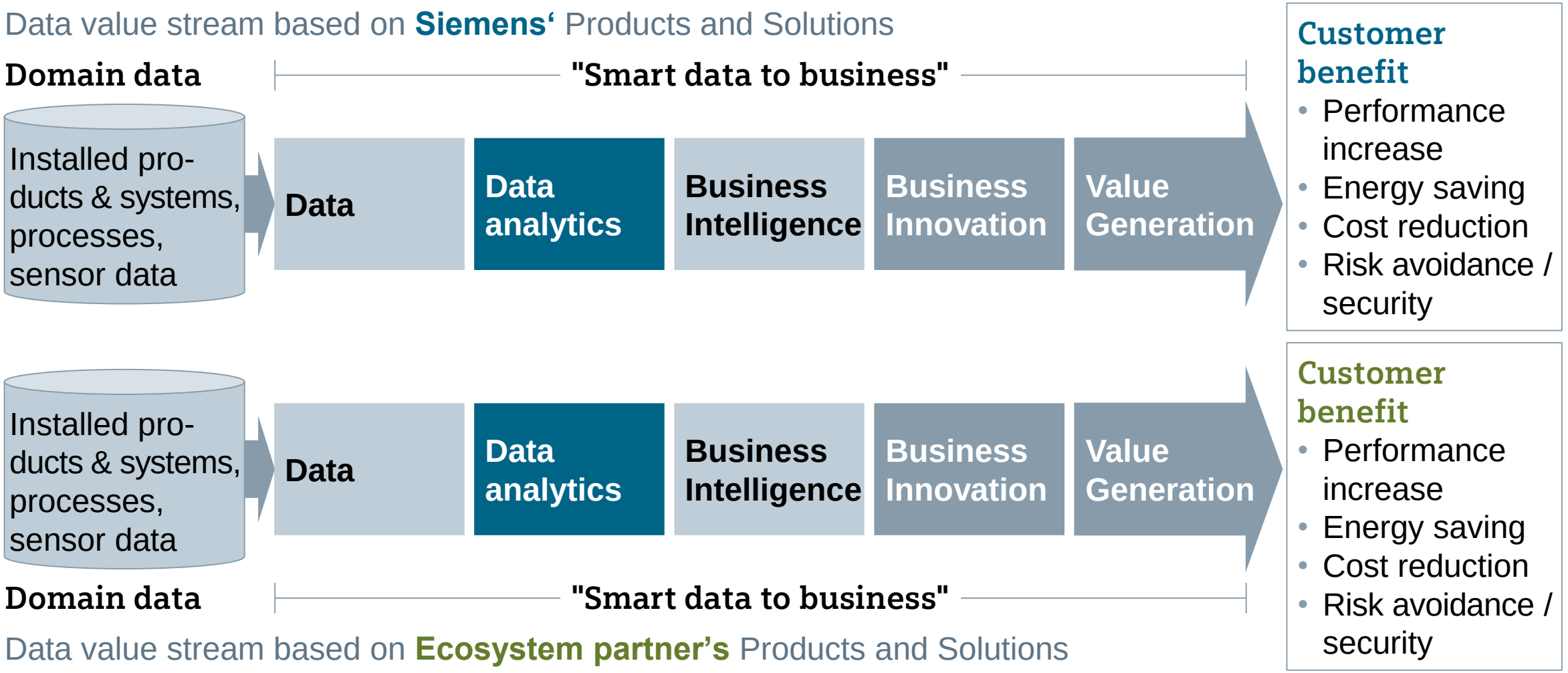

Smart data to business outlook:
The way to an ecosystem partner framework Sharing Data & Algorithms

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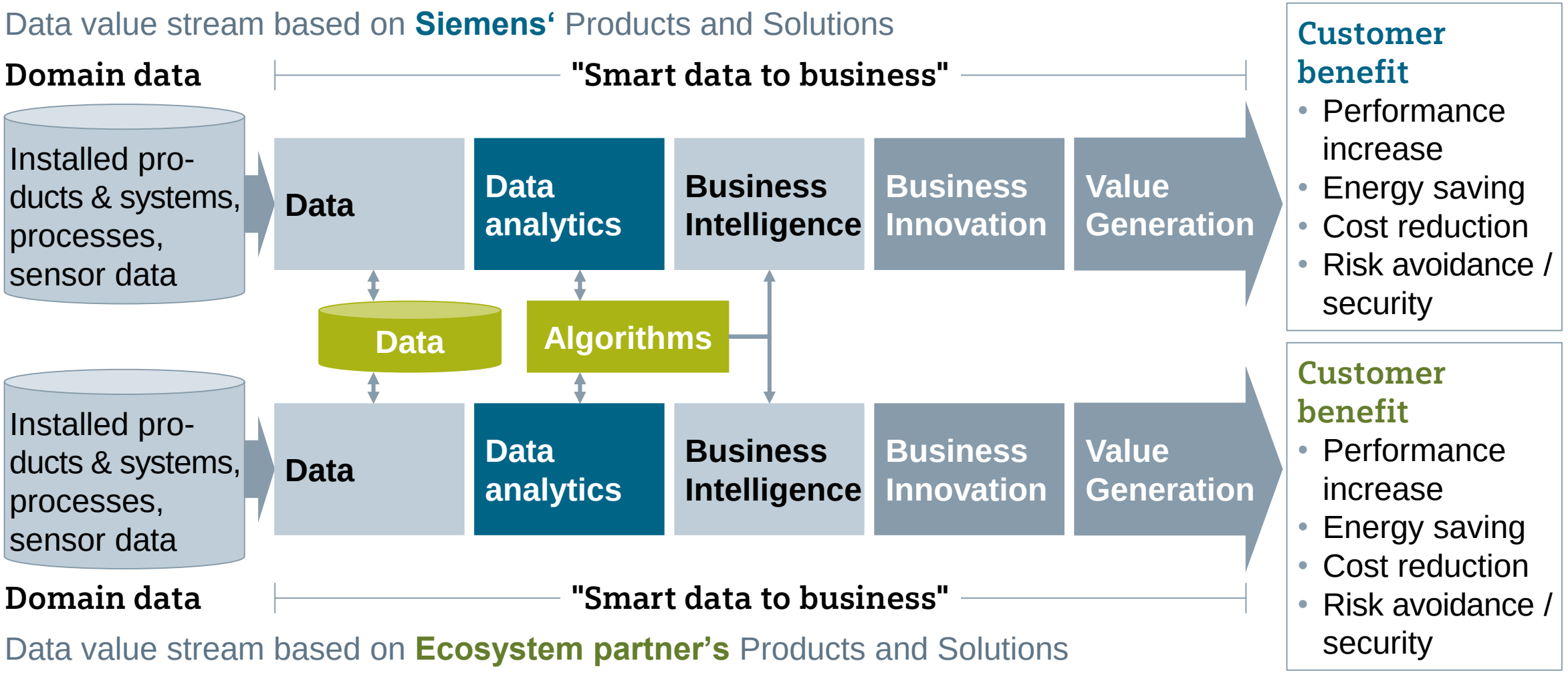

Smart data to business outlook: The way to an ecosystem partner framework: Using an unified Data Analytics Framework

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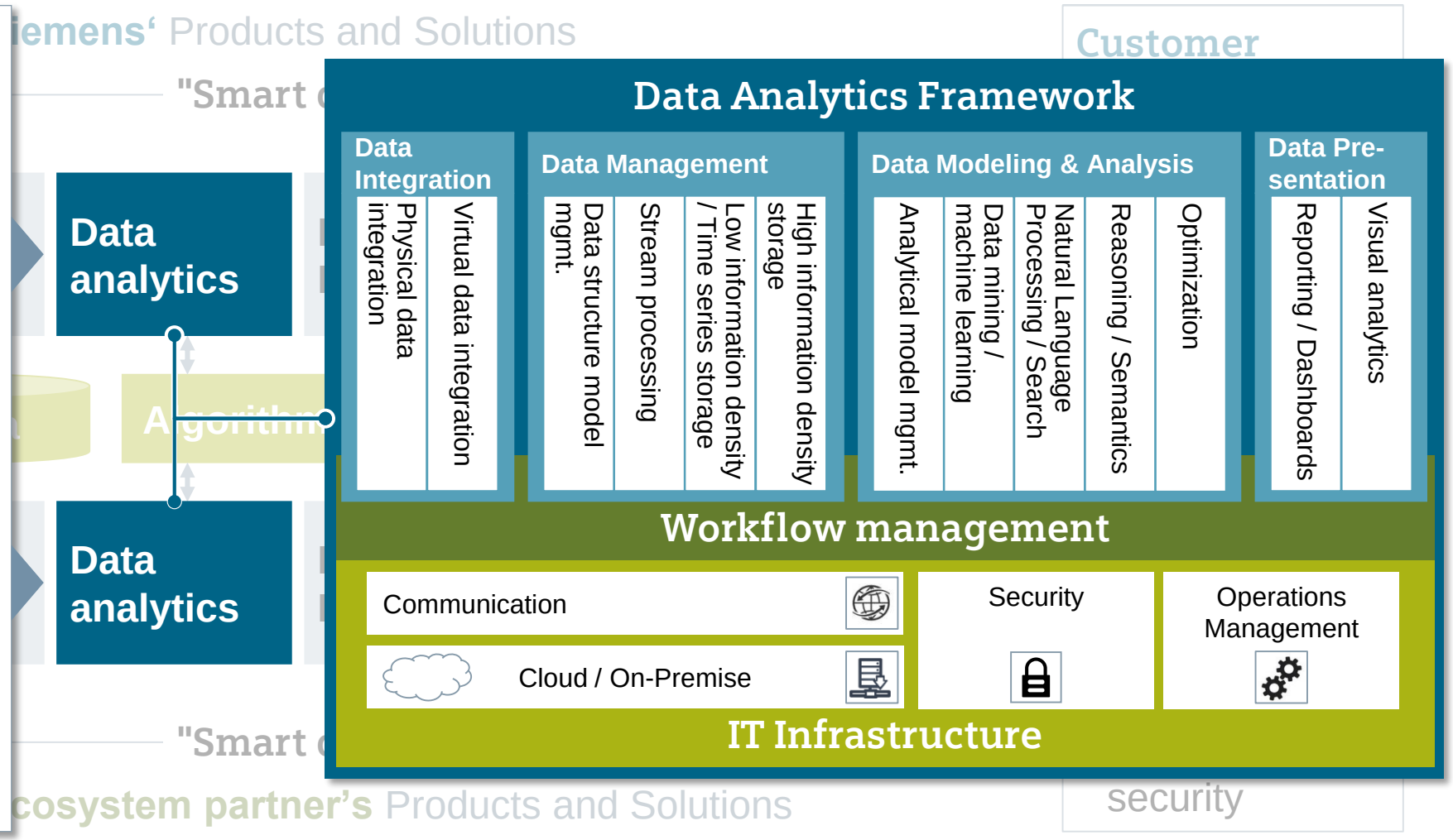
Features

- Modular and service-oriented
- Workflow-based
- Multiple operation modes
  - Cloud (public, private, hybrid)
  - On-premise
- Integrated security
- Protection of data at rest and in transit, during the whole lifecycle
- Protection of algorithms / models
- Compliance to industry standards



Smart data to business outlook: The way to an ecosystem partner framework: IT security architecture with world class reliability required

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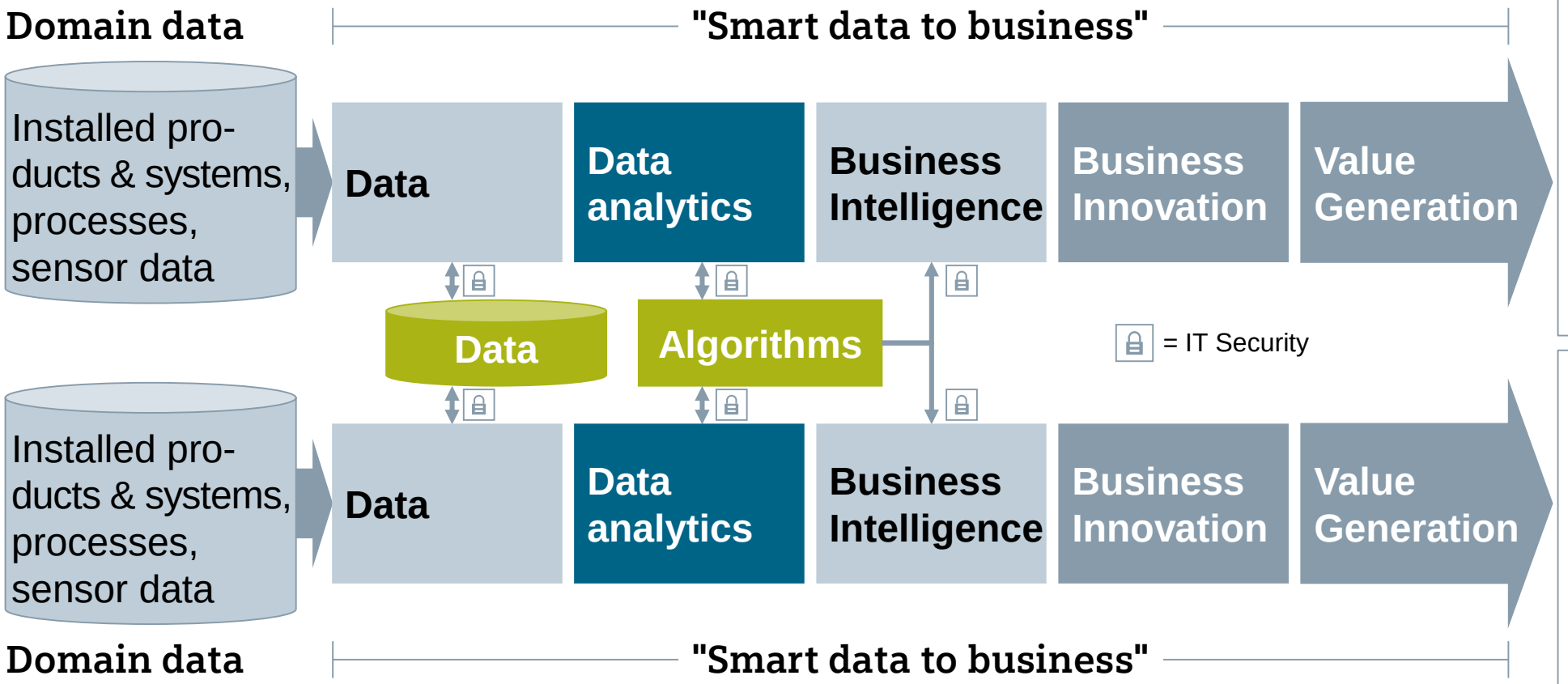
Data value stream based on **Siemens'** Products and Solutions



Customer benefit

- Performance increase
- Energy saving
- Cost reduction
- Risk avoidance / security

Customer benefit

- Performance increase
- Energy saving
- Cost reduction
- Risk avoidance / security

Data value stream based on **Ecosystem partner's** Products and Solutions

Smart data to business outlook: The way to an ecosystem partner framework: Cloud based architectures to be developed

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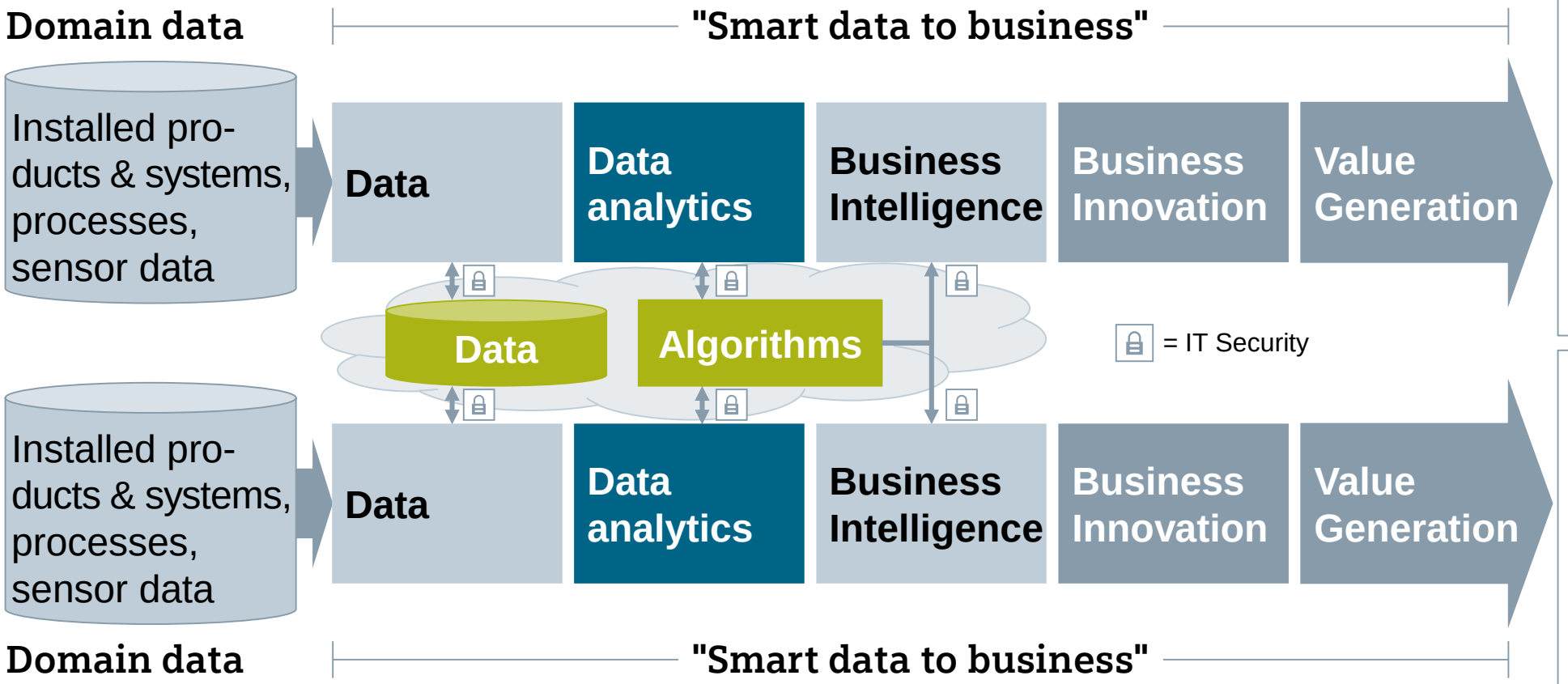
Data value stream based on **Siemens'** Products and Solutions



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Data value stream based on **Ecosystem partner's** Products and Solutions

Smart data to business requires the collaboration of researchers, scientists and specialists from different areas with different competencies

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Area	Competencies/ Know how
Computer Science	• Machine Learning • Database Theory • Software Enegineering
Mathematics & Statistics	• Numerical Mathematics • Statistics • Optimization (discrete, continuously, dynamic …)
Physics & Engineering	• Communications engineering • Control engineering • Automation engineering • E.g. Mechanics • Fluid mechanics • Experimental physics
Economics	• Econometrics • Finances • Business Science

Leveraging Business opportunities via Smart Data Ecosystems

Data value stream based on **Siemens'** Products and Solutions

Domain data

Installed products & systems, processes, sensor data

Installed products & systems, processes, sensor data

Domain data

Data value stream based on **Ecosystem partner's** Products and Solutions

We make Smart Data a reality

Creating a data analytics ecosystem with strong partners to enhance business value.

Thank you for your attention.

Customer benefit

- Performance increase
- Energy saving
- Cost reduction
- Risk avoidance / security

Customer benefit

- Performance increase
- Energy saving
- Cost reduction
- Risk avoidance / security

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Thank you!

Contact Information

Many thanks for your attention!

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