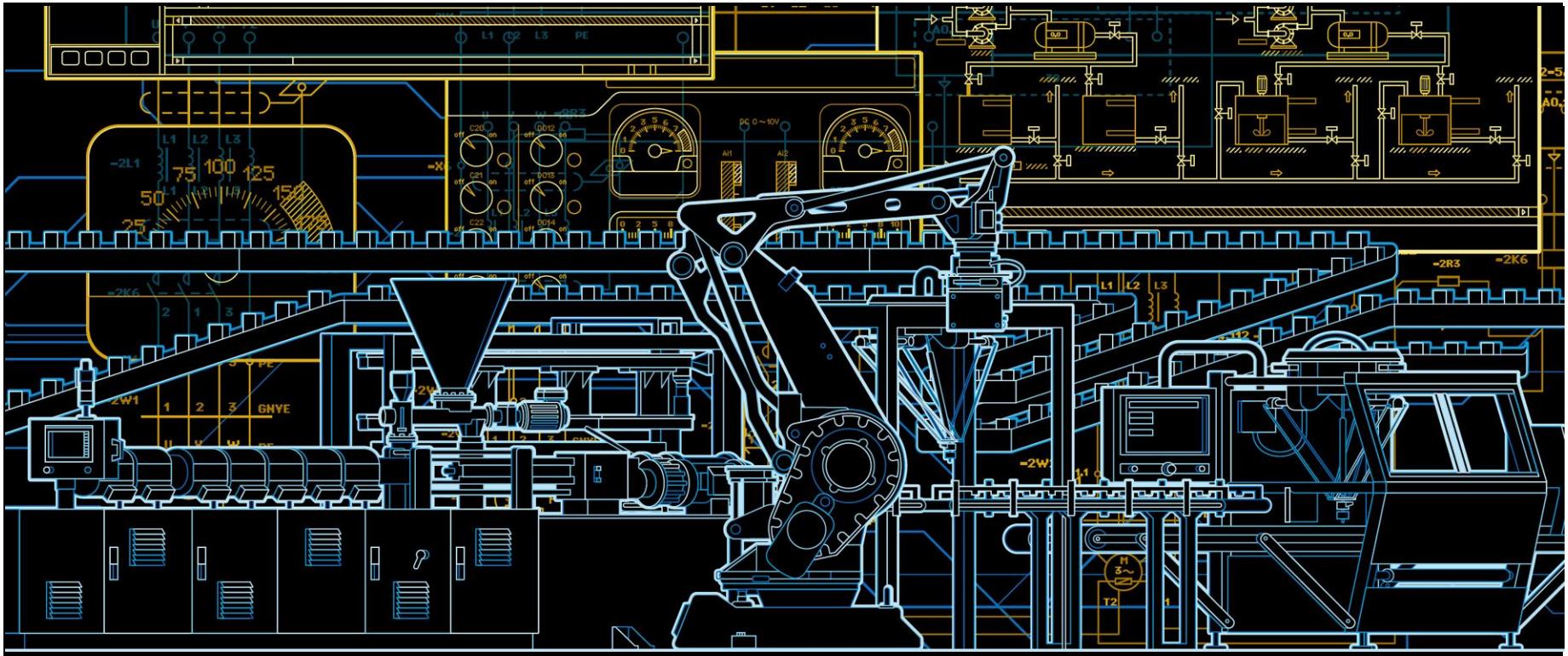


Alf Isaksson, ABB, Västerås, Sweden

A perspective on the Internet of Things, Services and People in the context of Sustainability and Optimization

Plenary at IEEE CASE 2015, Gothenburg, 27 August, 2015

Outline

- ABB & ABB R&D
- Grand challenges for automation
- Future of automation?
  - Internet of things, services and people
- Examples
  - Monitoring
  - Sustainability & Optimization
- Summary & Conclusions

What are We Doing at ABB?

We make sure that “two holes in the wall” are not just “two holes in the wall”,

but rather a secure source of environmentally friendly electricity…

…and that the factories of the world can produce what they want in an efficient, safe and sustainable way!

Power and Productivity for a better World!

A Global Leader in Power and Automation
Leading Market Positions in Main Businesses

~145,000 employees

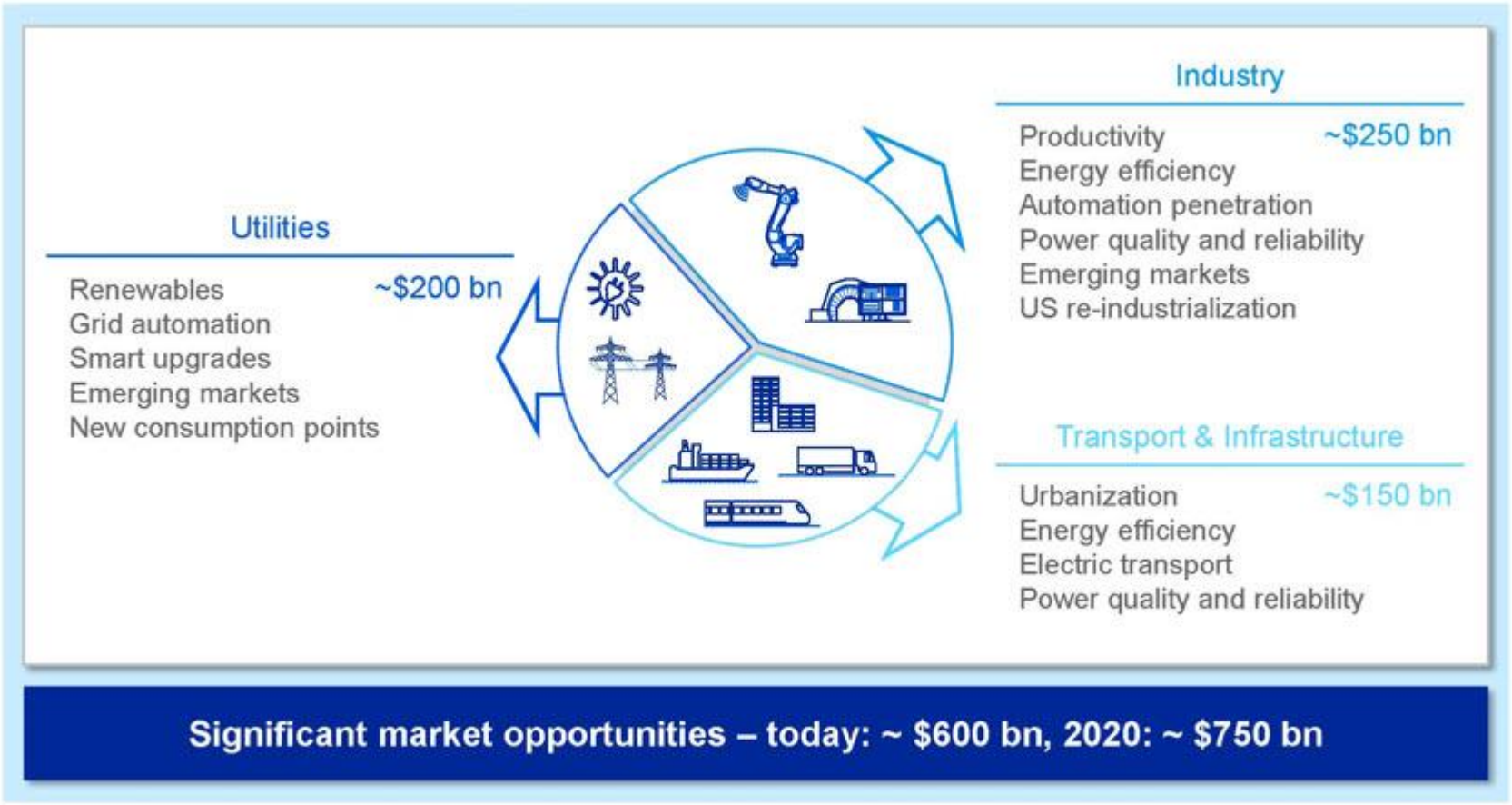
$42 billion
In revenue (2014)

Present in +100 countries

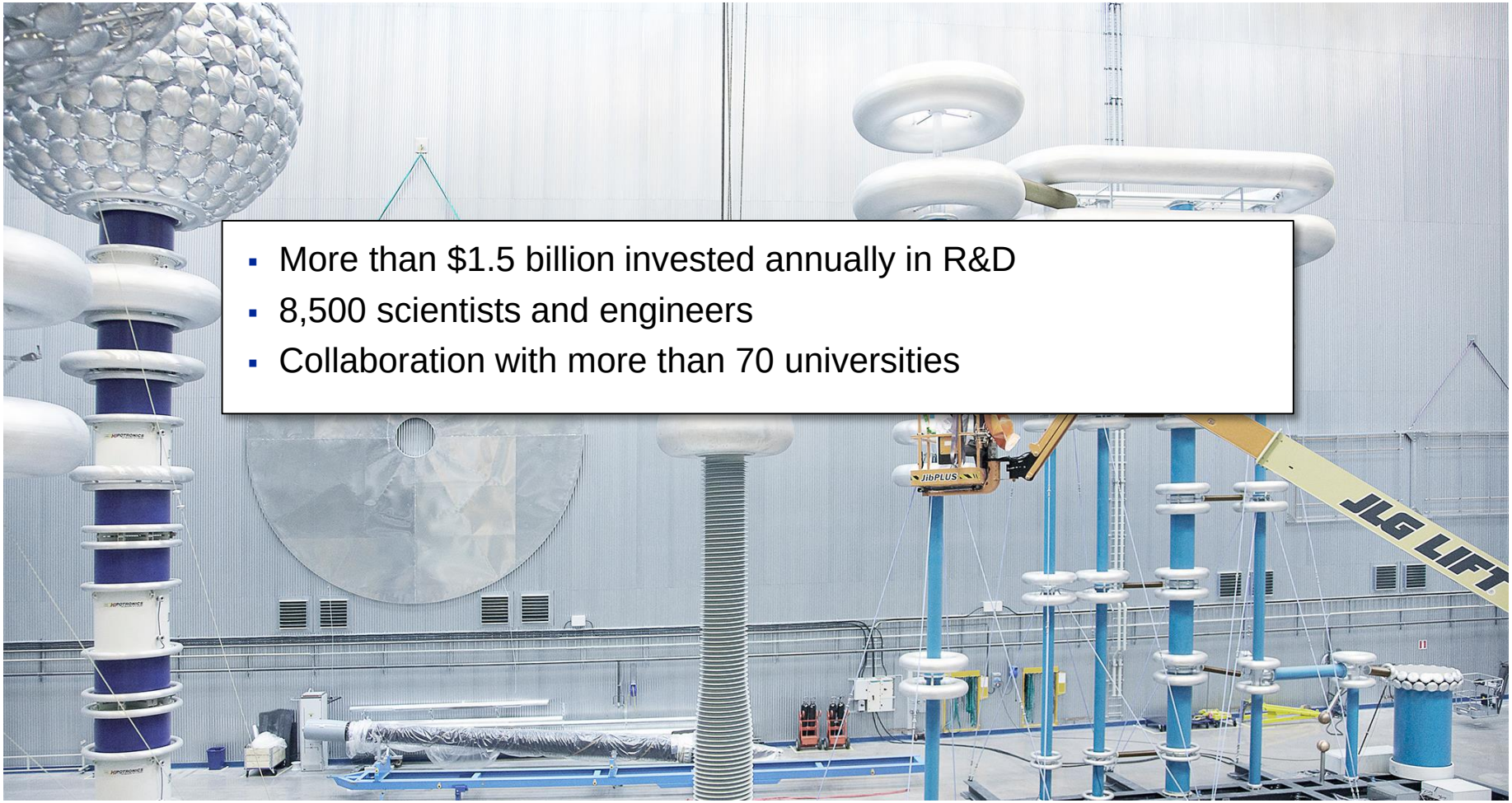
Formed in 1988
merger of Swiss (BBC, 1891) and Swedish (ASEA, 1883) engineering companies

Well positioned in attractive markets

Power & automation demand drivers in three customer segments

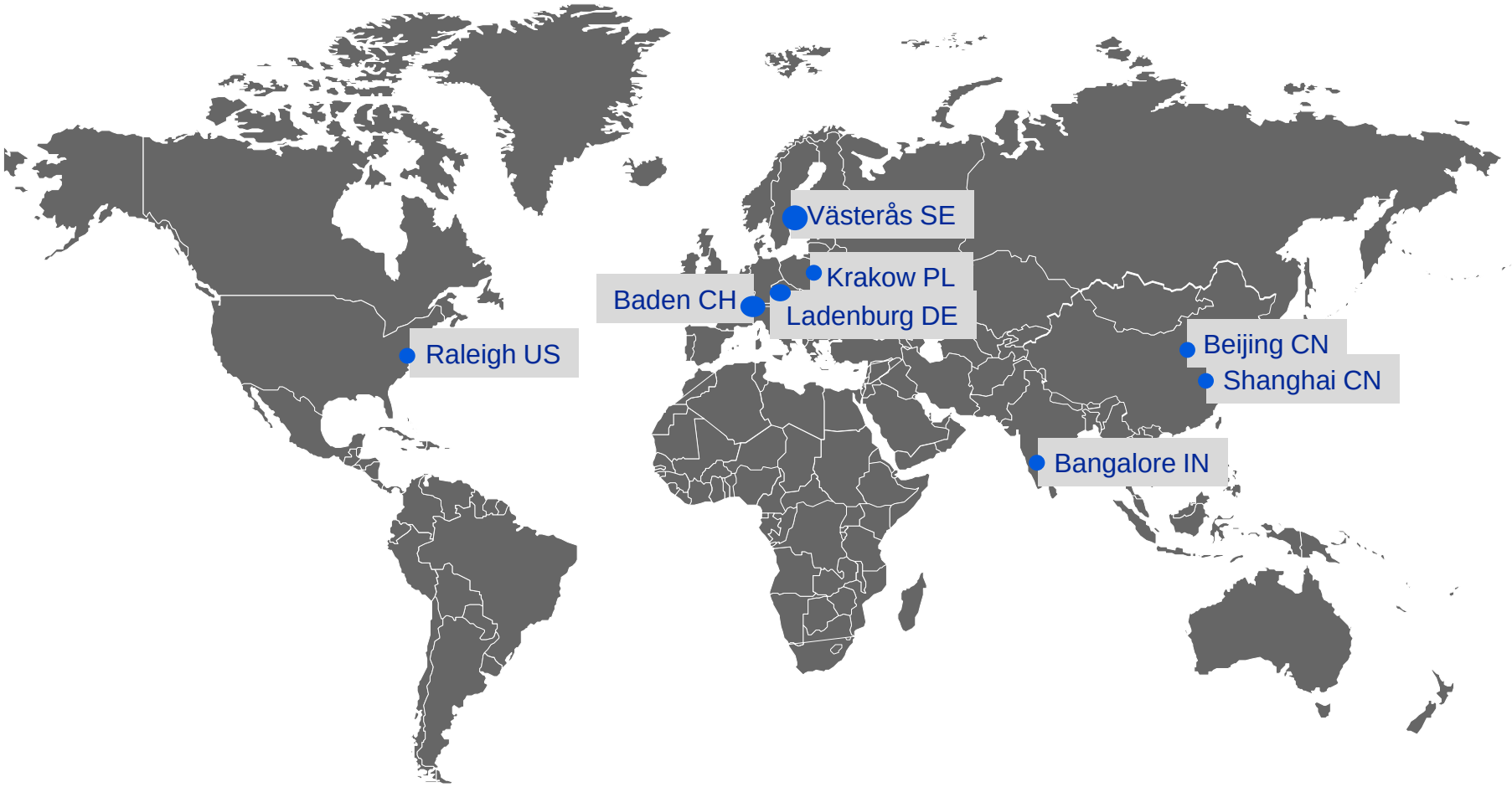


Innovation is Key to ABB's Competitive Advantage
Leadership Built on Consistent R&D Investment



- More than $1.5 billion invested annually in R&D
- 8,500 scientists and engineers
- Collaboration with more than 70 universities

Corporate Research Centers



Close to major customers, universities and ABB‘s business responsible units

Corporate Research: Local Labs and Research Areas

Chief Technology Officer
Claes Rytoft, ad interim

Global Research Manager
Franz Schmaderer

Communication
Stefan Svensson

Control
Alf Isaksson

Electromagnetics
Robert Chin

Materials
Jens Rocks

Mechanics
Xiaolong Feng

Power electronics
Waqas Arshad

Sensors
Andrea Andenna

Software
Roland Weiss

Switching
Riccardo Bini

CHCRC
Stefan Ramseier

CNCRC
QinJian Liu

DECRC
Jan-Henning Fabian

INCRC
Akilur Rahman

PLCRC
Marek Florkowski

SECRC
Mikael Dahlgren

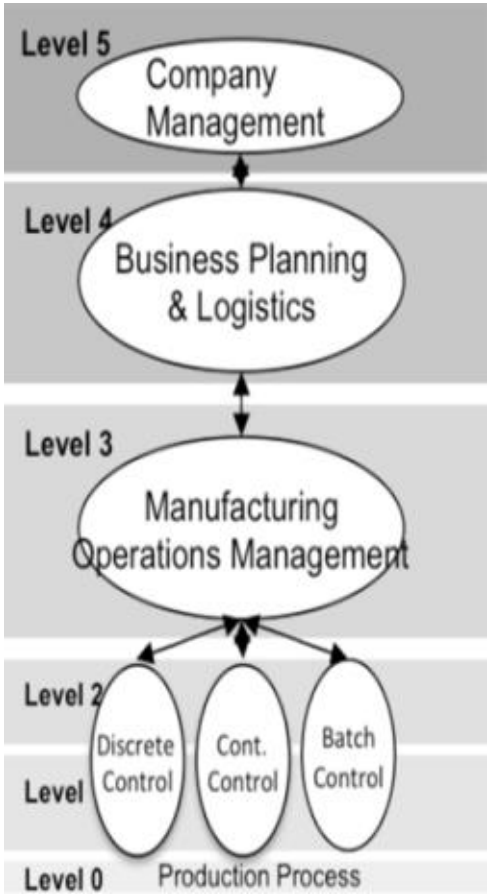
USCRC
Le Tang

Grand Challenges for Automation

Grand challenge for automation # 1
The sustainable 100 % available plant

- predictive maintenance which would allow all maintenance to fall within periods of scheduled process stops
- planned stop periods should be reduced by 50% through use of intelligent diagnostic embedded in all devices
- productivity would thereby increase substantially across all manufacturing and process plants by the elimination of unplanned stops
- holistic optimization of total process to remove bottlenecks and further increase productivity
- energy efficient equipment performing optimally at each operating point through integration of intelligent embedded component
- 100% secure wireless communication lines and remote diagnostics fully utilized in plant operation
- flexibility in production down to batch quantities of a single unit
- ease-of-use in operation based on intuitively understandable information displayed ergonomically

Grand challenge for automation # 2
Engineer system 10x today's complexity with 10% today's effort

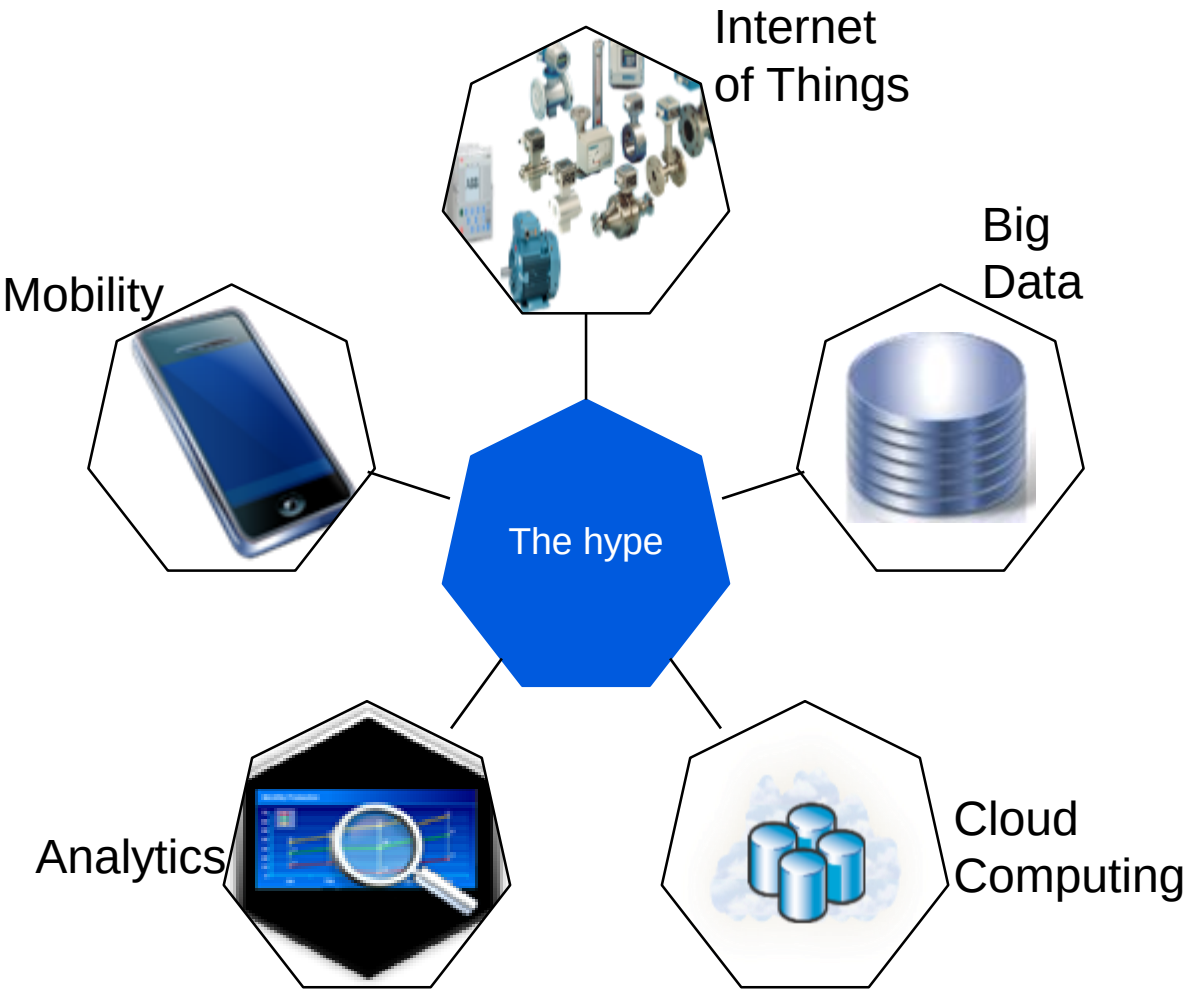


- tools handling several levels of complexity in an intuitive fashion must be developed
- simulation and verification tools for establishing the feasibility and security of a solution must be found
- software and hardware of several generations must be possible to easily integrate with the help of tools
- software and hardware of different applications must be easy to integrate via a common platform ex. CAD information and Instrument diagram with control systems
- ease-of-use must be emphasized in all aspects of the system engineering process decoupling the complexity into manageable components
- workprocess to support effective cooperation with networked expertise physically located in different geographies
- solutions to be able to manage plant information over the entire lifecycle of all assets

What can we expect from the future?

Market Trends

The Five Major Trends that Manufacturers Must Follow

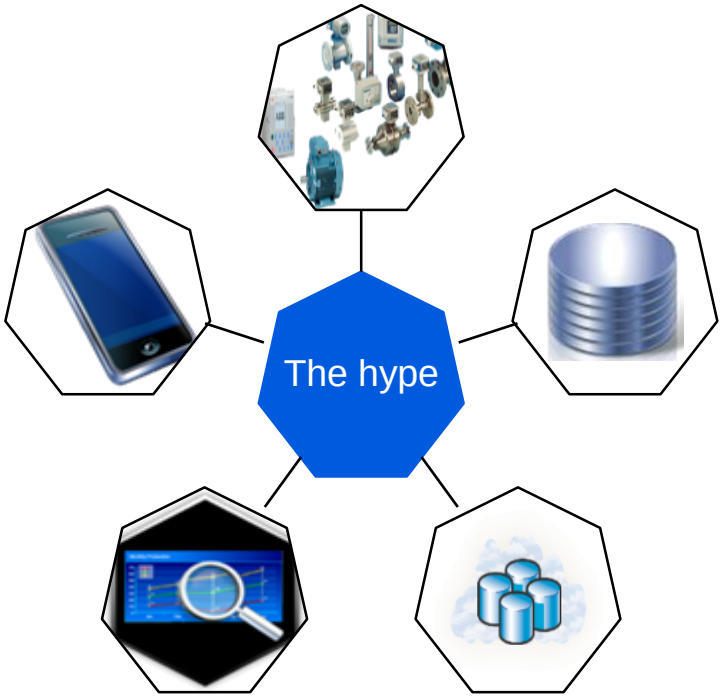


Market Trends

The Five Major Trends that Manufacturers Must Follow

What the customer really needs

- Safety
- Lower cost and simplified operations
- Production efficiency
- Better asset utilitization / ROA
- More effective decisions



Internet of Things

Mobility

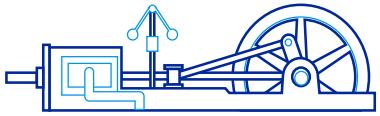
Analytics

Big Data

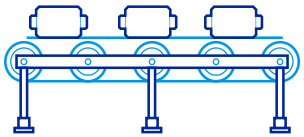
Cloud Computing

The Internet of …
Global trend – 4th industrial revolution

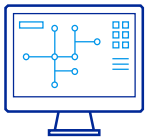
Industry 1.0 – 1712
First practical steam engine



Industry 2.0 – 1870
First elevated conveyor belts



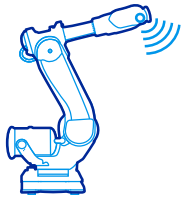
Industry 3.0 – 1969
Electronics / software based control

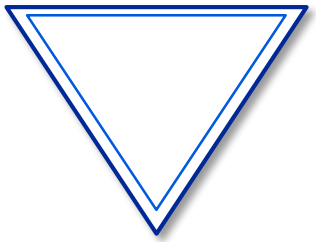


Industry 4.0 – today and tomorrow
Internet of …

People

Things





Services

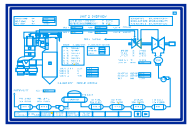


ABB leads proactively with new connected offerings

Today
An industry perspective on big data

- Facebook:
  - 1 Billion transactions/day[1]
- A Typical Chemical/Oil & Gas Company
  - 2.6 Billion transactions/day per plant

"Big Data? Been there, done that.,,
Mike Williams – Dow Chemical[2] (Retired)

Sources: 1) McKinsey & Co. 2) Dow Chemical has approximately 350 plants

Revolution or Evolution
My Subjective View…

- Merriam-Webster: “Revolution = A sudden, extreme, or complete change in the way people live, work, etc.”
- Evolution is something that can be expected if the environment is supportive and there is enough time





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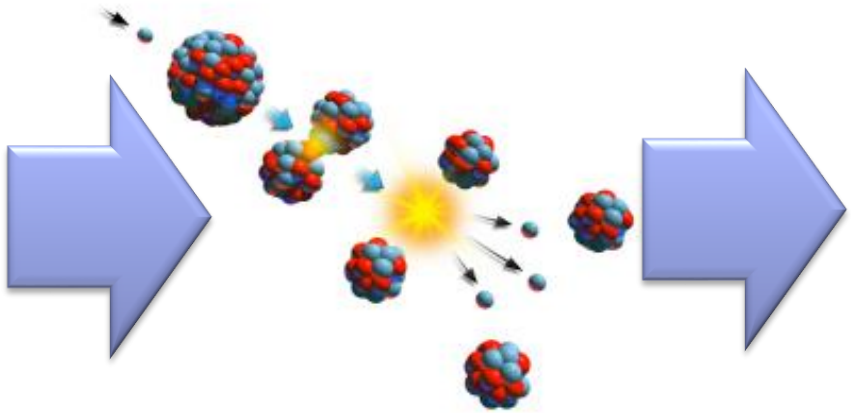
- Revolution should comprise a completely new unexpected development direction, a paradigm change

$E = mc^2$



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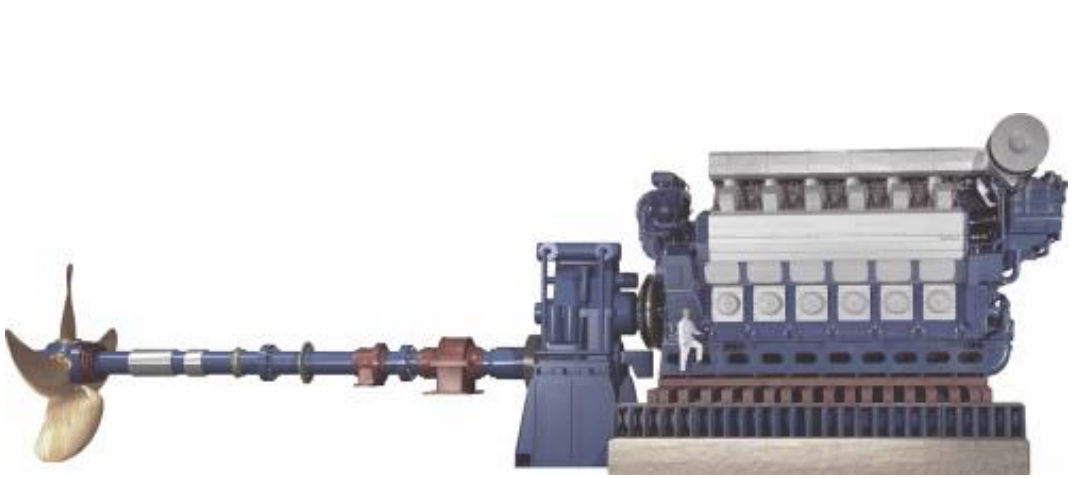
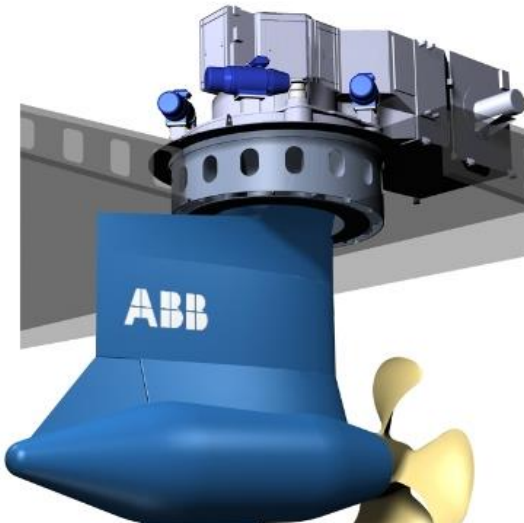




The French Revolution 1789
Caused a Real Change

The French Revolution 1789
Caused a Real Change
Nevertheless, the process took 10 years (1789-1799)*

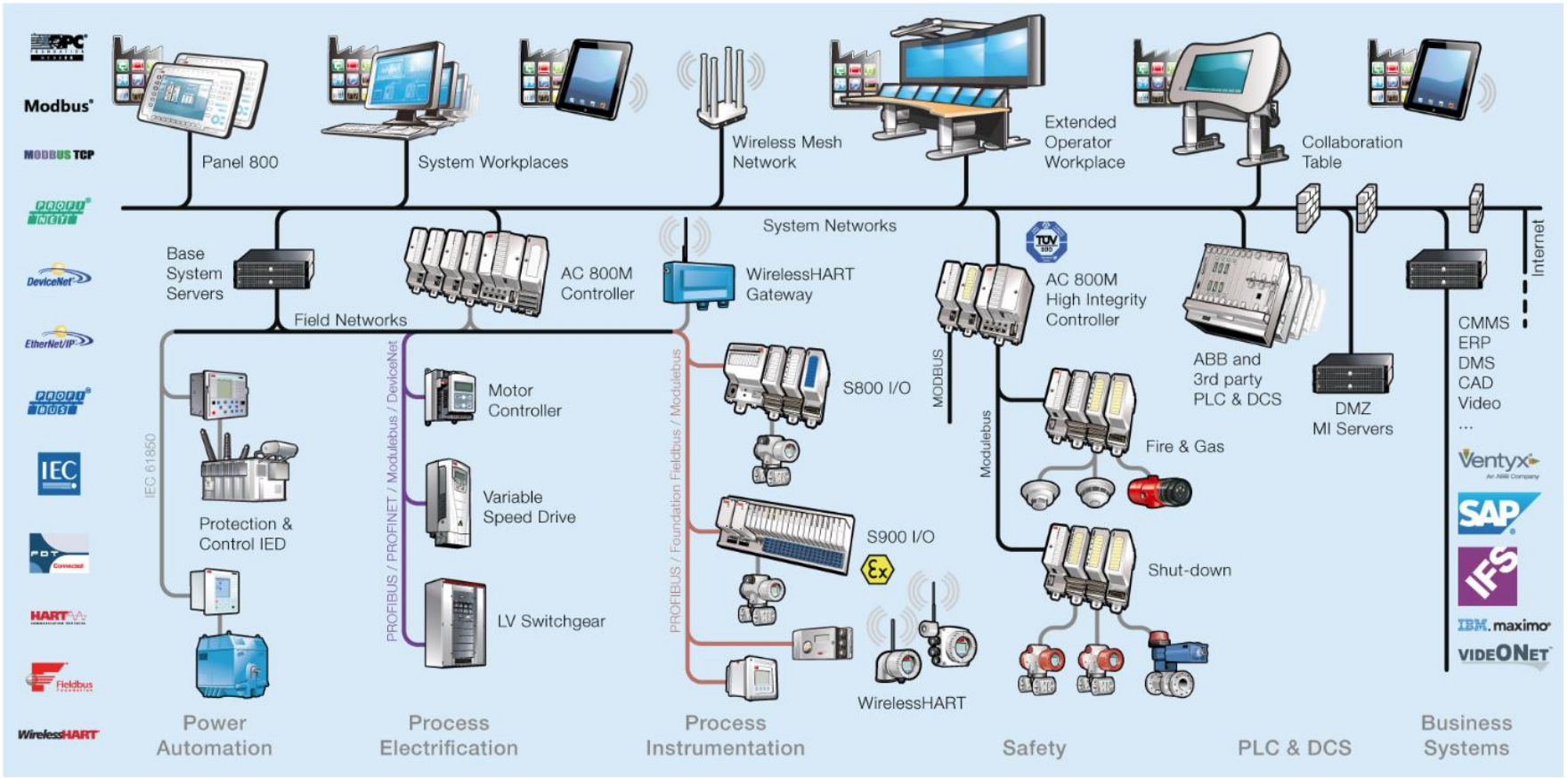
Democracy!

* see e.g. www.history.com/topics/french-revolution

Industry 4.0

It is first time that an industrial revolution is announced prior its occurrence.

Regardless: We Face a Tremendous Transition
Automation Network and Hierarchy



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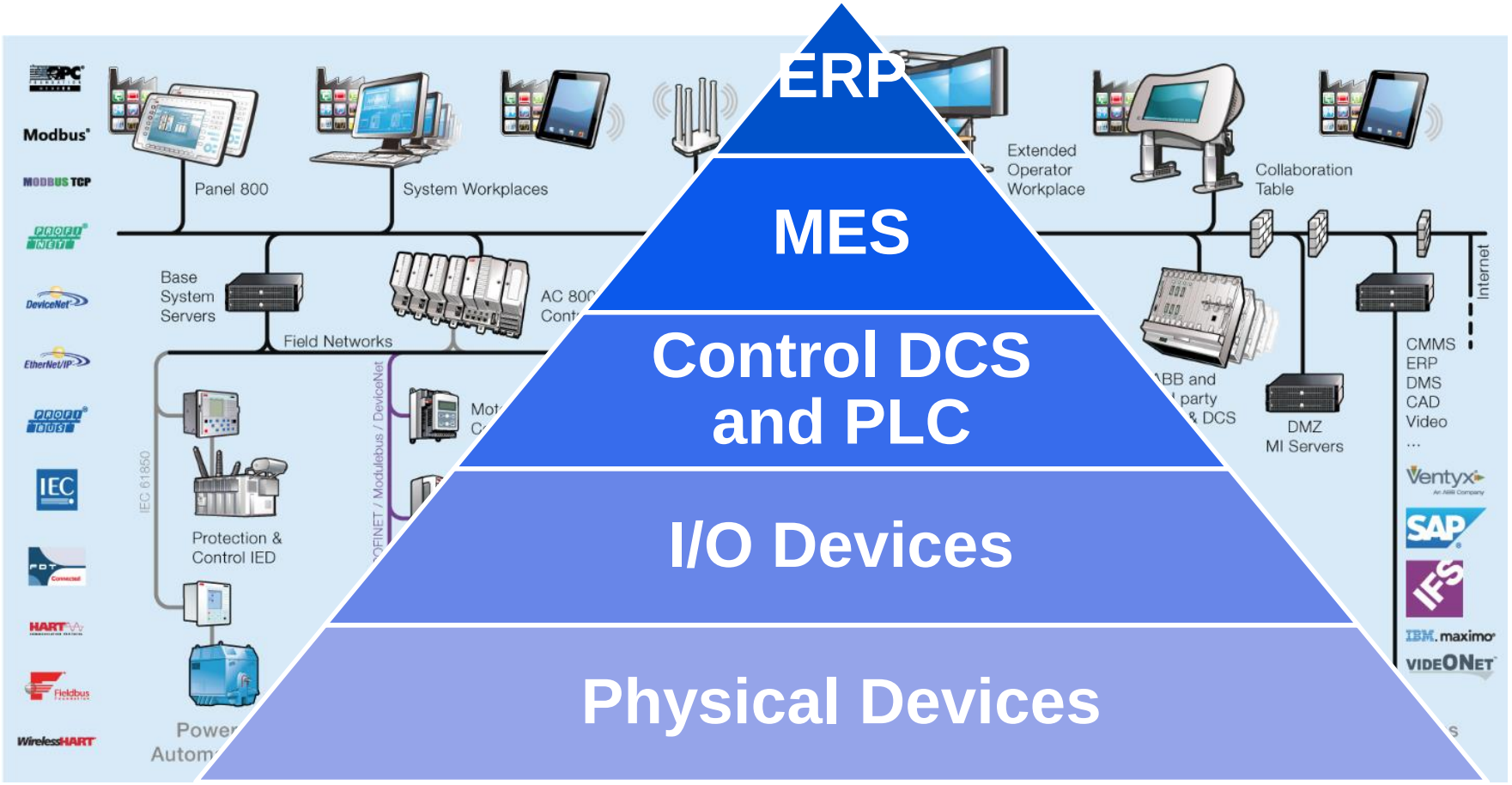

Regardless: We Face a Tremendous Transition
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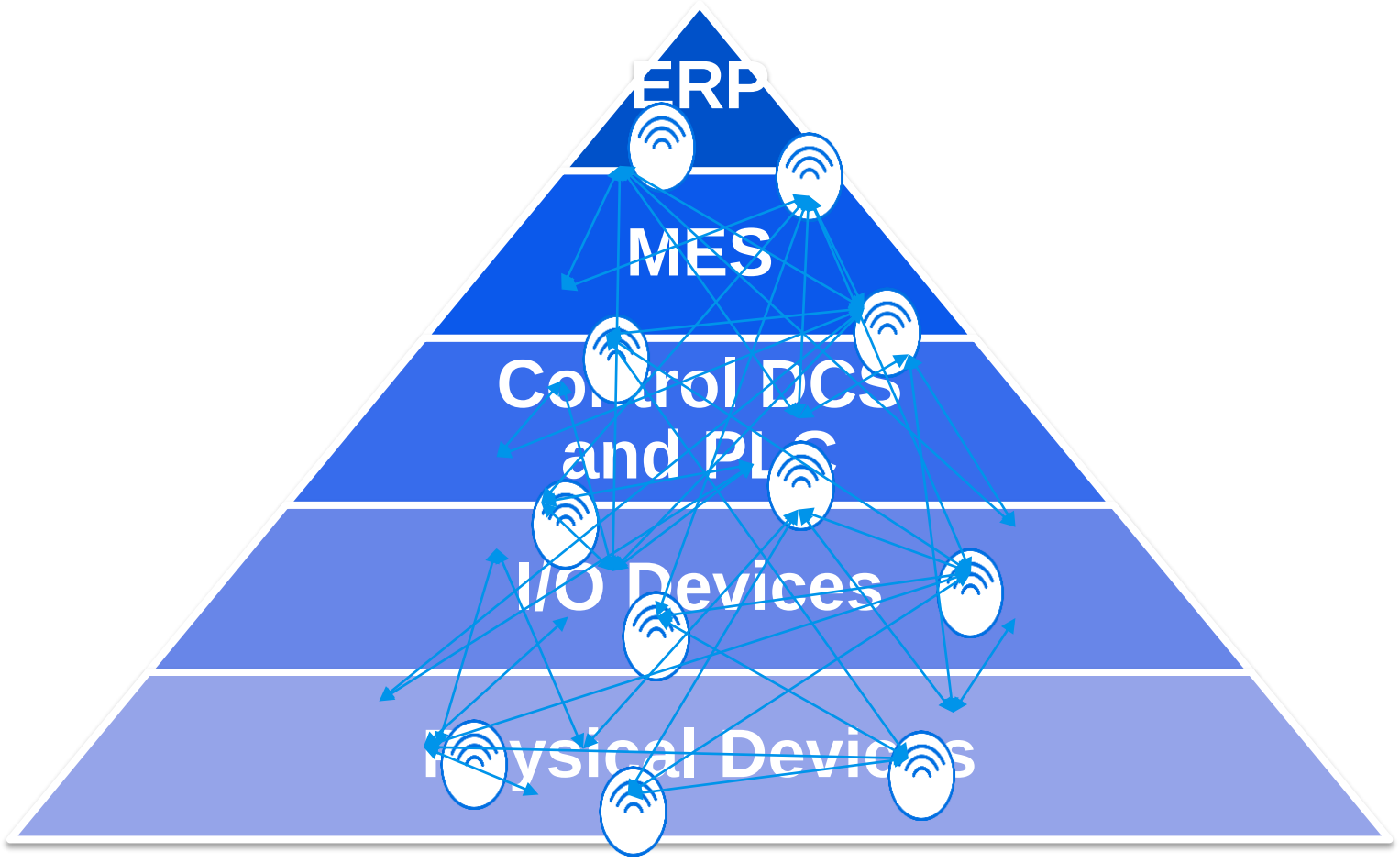


End of Isolated Solutions
Balancing Between Control Systems

Energy availability and pricing

(smart grids)

Grid control

Industrial demand-side management

Production Management

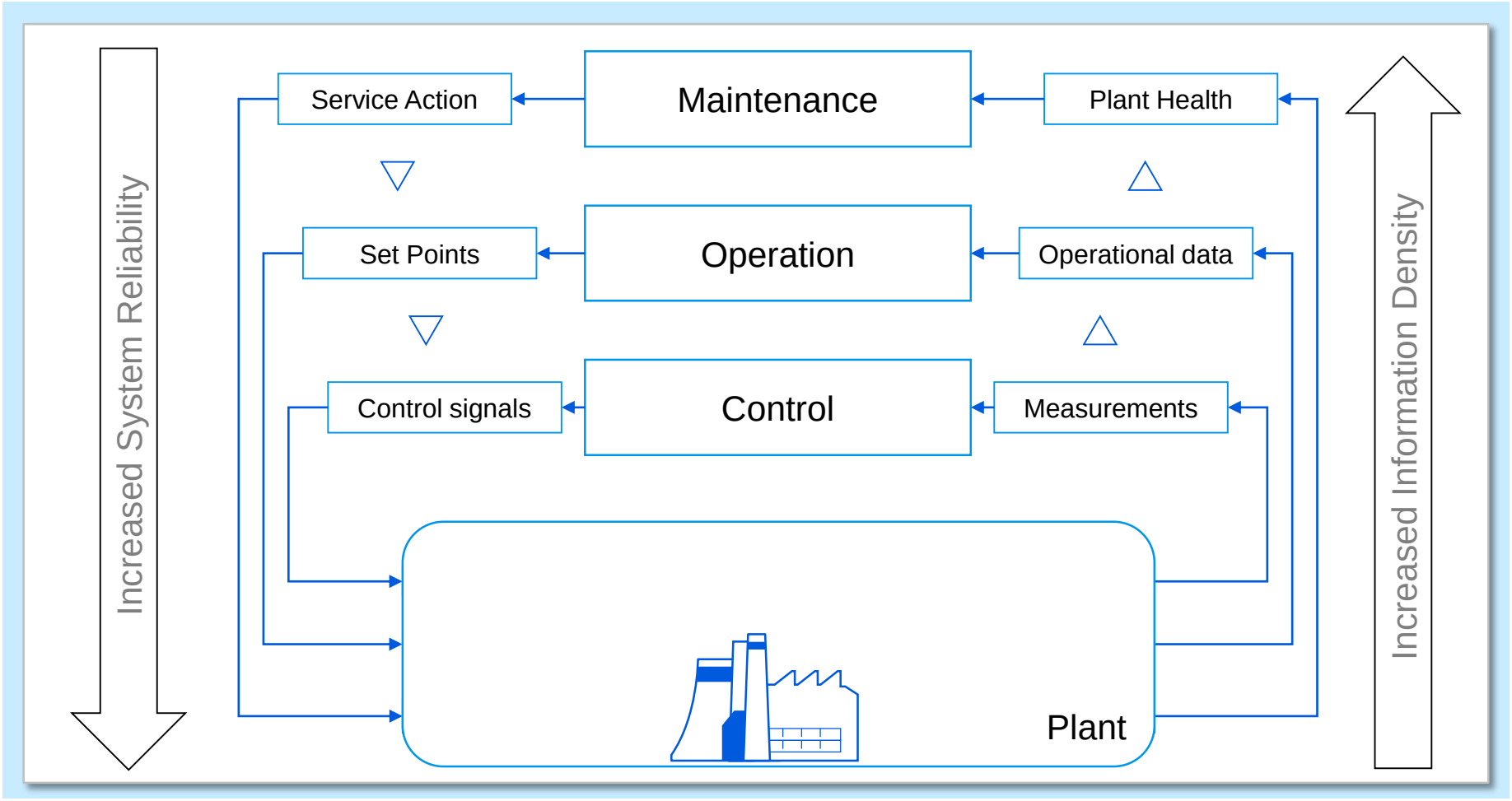
(P&S, APC, Analytics, …)

Integration of scheduling and control

Process variations, e.g. quality, yield, disturbances (DCS)

Process control

Information Management
Reliability vs. Information Density



Examples
Monitoring

Application Example: Robotics

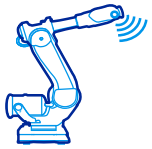
Remote Service Center

People

Clients can access actionable information from smartphones and tablets

The information is available at any place, any time

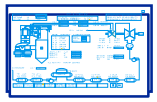
Things



Intelligent and connected robots

Sending data to cloud servers for back-up, reporting, diagnostics, and benchmarking

Services

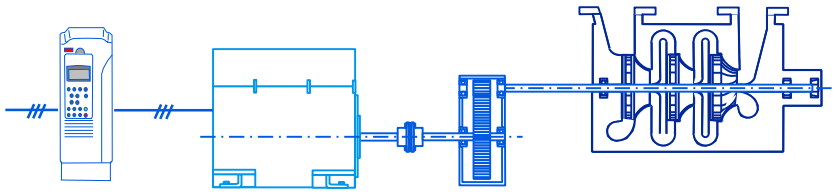


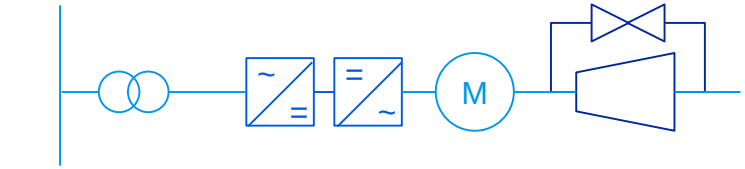
Central service unit remotely monitoring robots to support clients 24/7

Provides analytics to optimize robot usage and predict maintenance needs

Industry 4.0 in action

Service Example: Package Monitoring
Monitoring and Diagnostic Potential



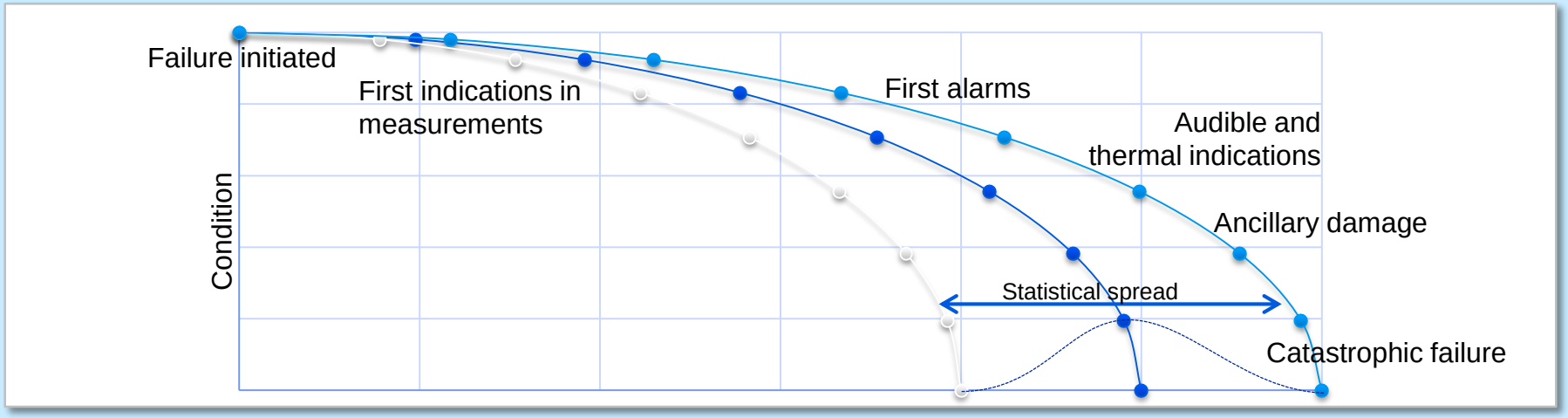


Device health and performance is derived from the analysis of the devices diagnostic data collected

Health or performance can also be observed in measurements from devices along mechanical, electrical, or control connections

Integrating monitoring data from all sources in the plant including electrical and control systems provide thorough information

Fleet Management
Predictive Maintenance Potential



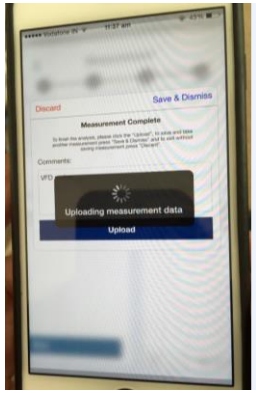
Good statistical knowledge important for accurate predictive maintenance

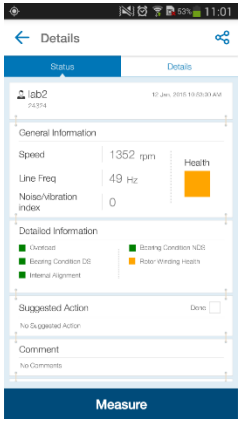
Time to react increased with improved predictive methods

Failure patterns observed in the fleet can be identified early in measurements

Integrating and analyzing monitoring data from a variety of installations of the same device type throughout the industry is essential

Application Example
Integration of Mobile Measurement





Challenge:

Cost: fixed installation of diagnostic sensors too costly, they may be too expensive, or too rarely used to justify the investment

Age: Installed equipment was installed at a time when these sensors were not available (30-50 years ago)

ABB solution:

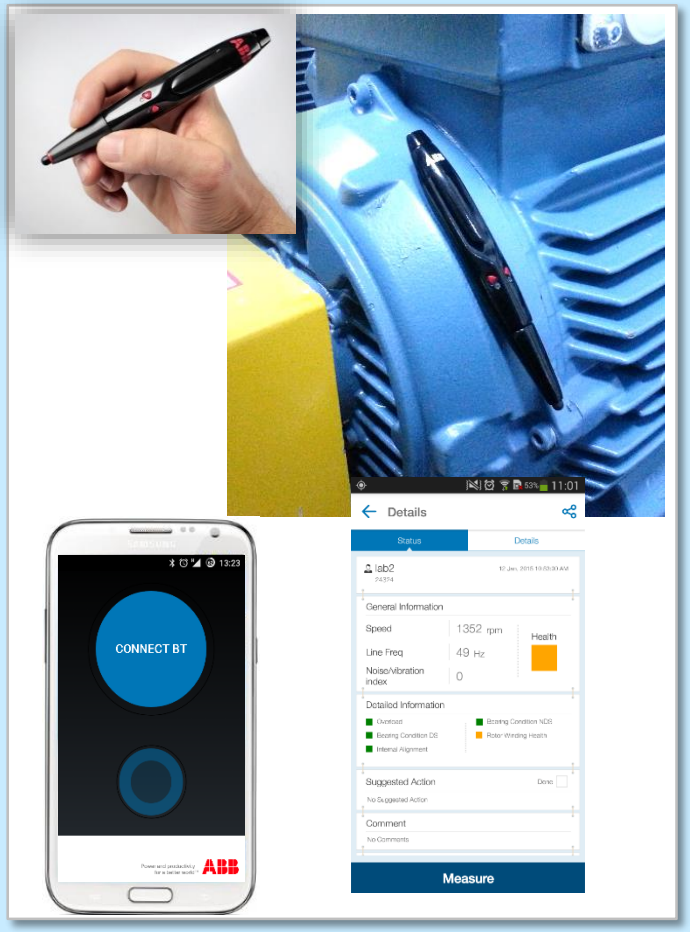
Use of mobile phone sensors to diagnose equipment ad-hoc

- Accelerometer for vibrations
- Compass for magnetic field
- Microphone for noise

Quick health indication sufficient to initiate further actions:

- Store device fingerprint and detect trends
- More precise measurements
- Service technician intervention

Application Example
Integration of Mobile Measurement



Challenge:

Cost: fixed installation of diagnostic sensors too costly, they may be too expensive, or too rarely used to justify the investment

Age: Installed equipment was installed at a time when these sensors were not available (30-50 years ago)

ABB solution:

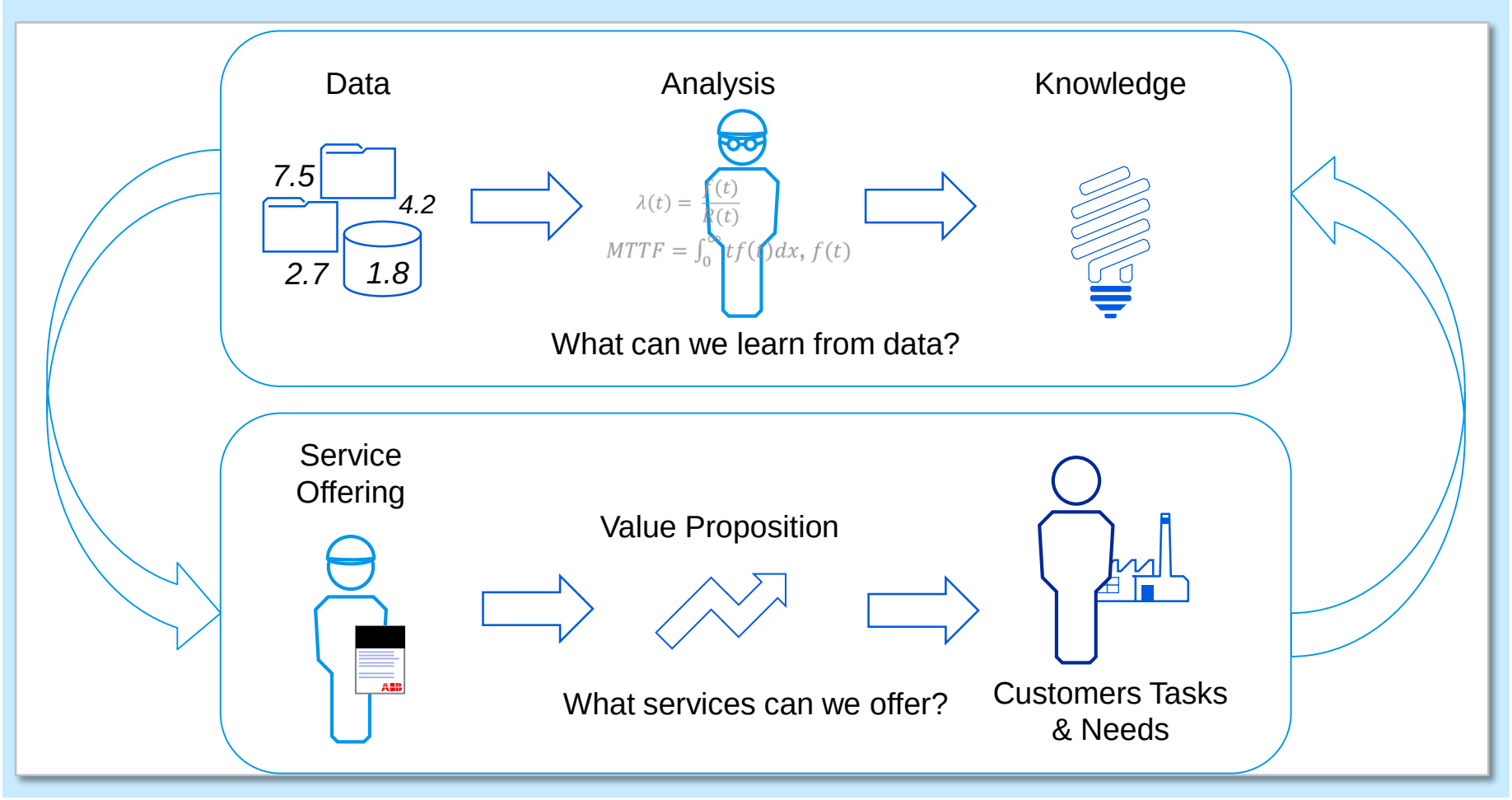
Use low-cost low power sensors in form of a Bluetooth-connected pen

- Accelerometer for vibrations
- Compass for magnetic field

Quick health indication sufficient to initiate further actions:

- Store device fingerprint and detect trends
- More precise measurements
- Service technician intervention

Remote Services
Data driven services



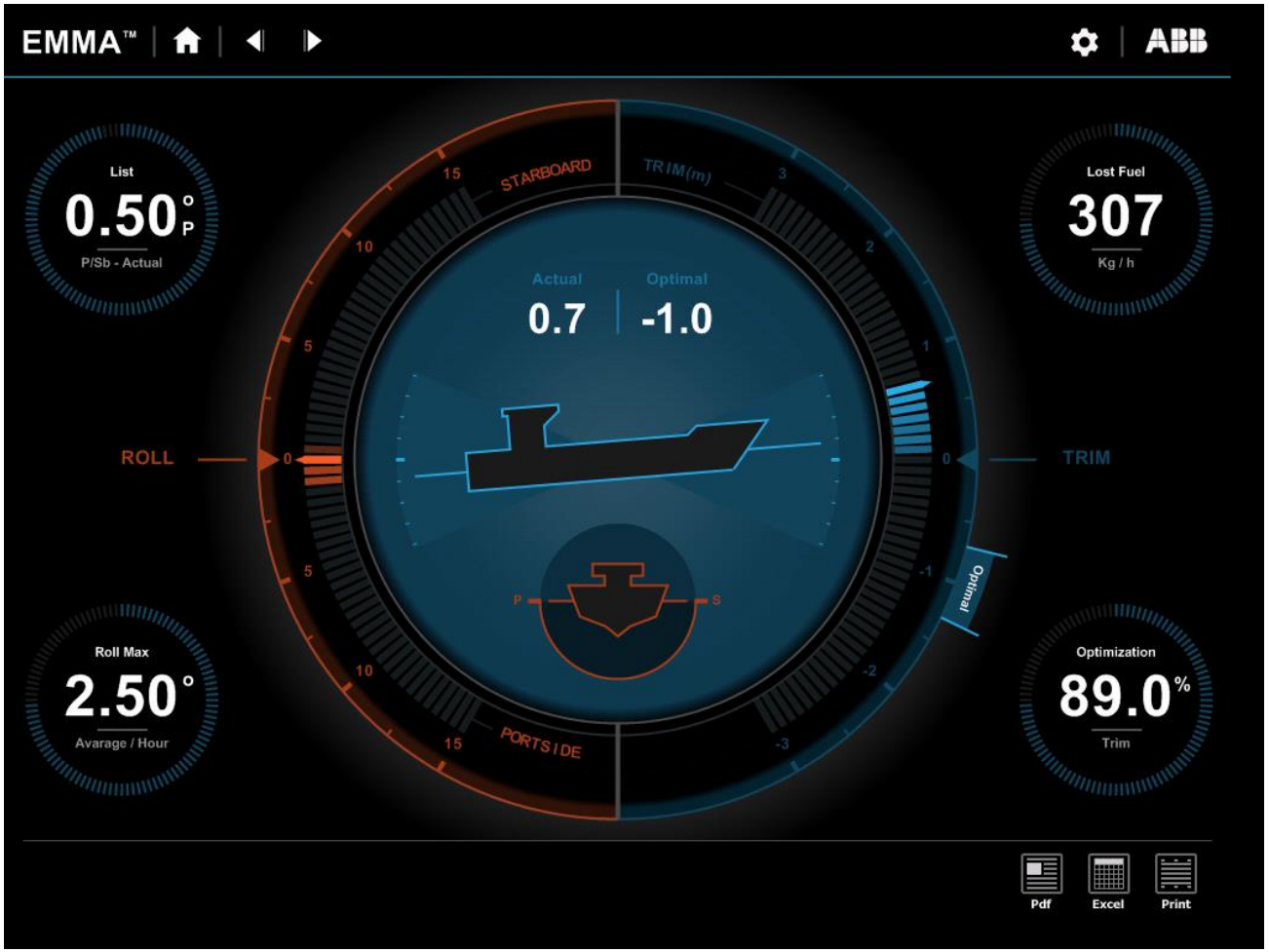
Examples
Sustainability & Optimization

Energy Efficiency through Automation
Software solutions often involving optimization

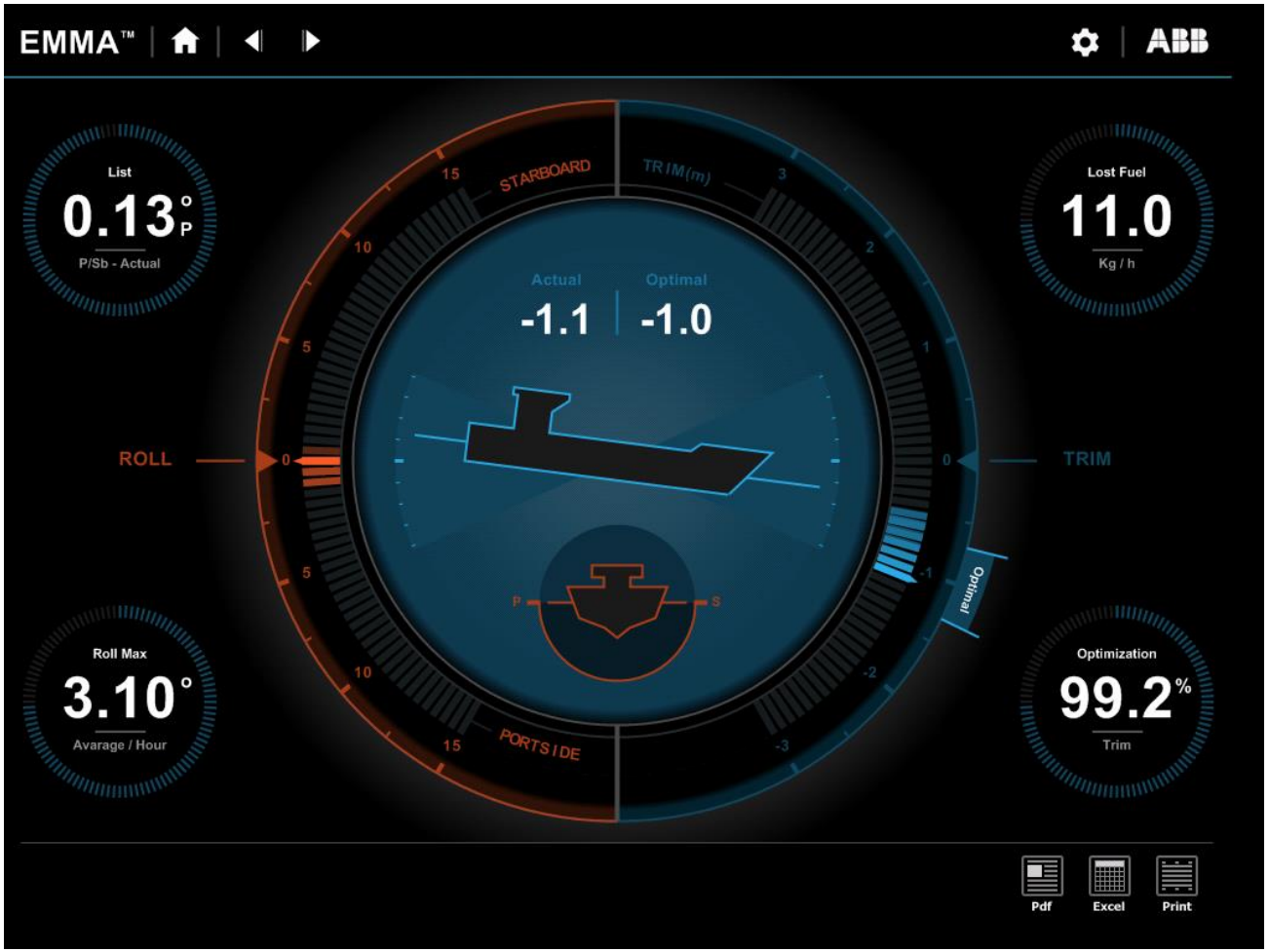
With and without trim optimization

4 MW less propulsion power.
Savings of $1 million per year.

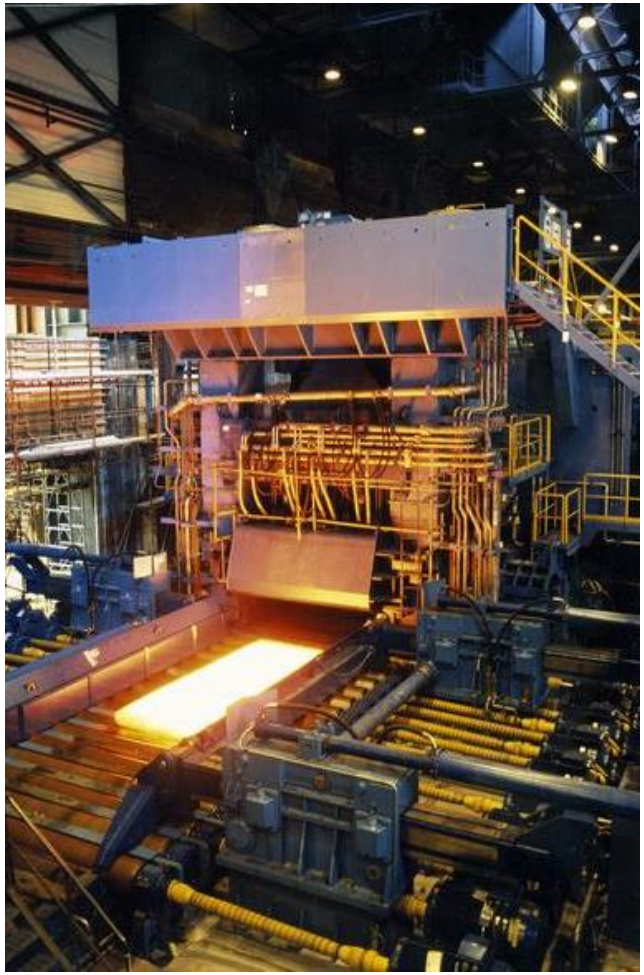
Advisory
Trim – not in an optimal state



Advisory
Trim – close to perfect



(Energy) Optimization in Hot Rolling Mills
Huge Potential



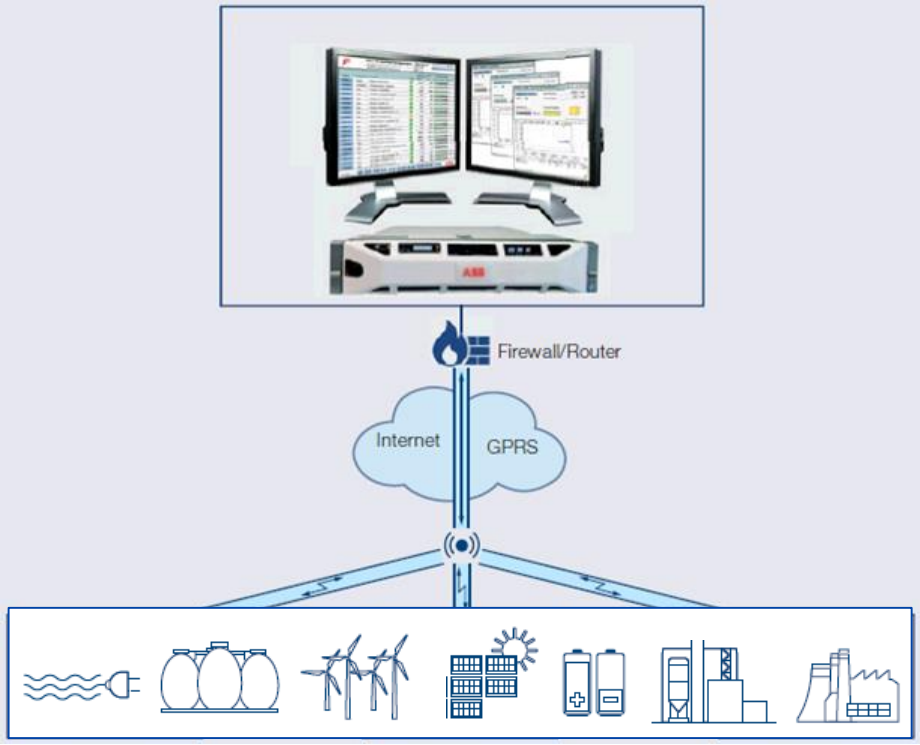
- Profile mills:
  - 7% reduction => 1.2 GWt/yr (>1000 profile mills globally)
- Flat mills:
  - 0,5% reduction => 1.6 GWt/yr (~400 flat mills globally)

ABB Roll.LABB™ Energy Minimization Results

- Plant:
  - Shiu Wing Steel Ltd, Hong Kong SAR, China
  - 750,000 MT of round and reinforcing bars with diameters from 10mm to 50mm
  - 15 stand mill configuration
- Benefits:
  - 10% reduction within reach
  - Improved yield
  - Tighter tolerances
  - Improved performance
  - Payback within a year

OPTIMAX® PowerFit

Optimizing control of Virtual Power Plants and MicroGrids



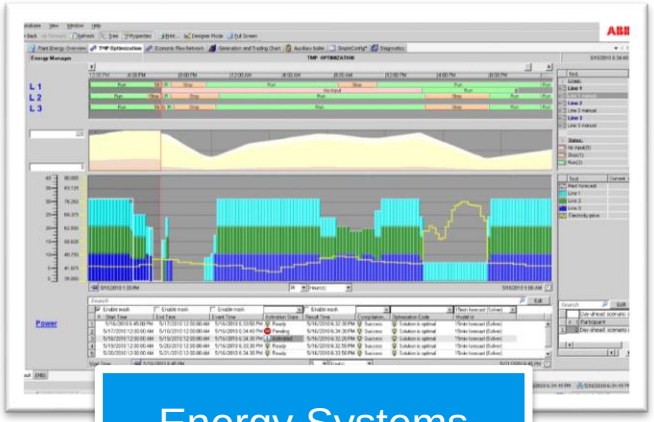
Task

- Aggregate many small production units and treat them like one big power plant
- Exploit multiple forms of energy (e.g. el and heat) and storages

Solution

- Build overall plant model (exploiting Modelica multi-physics)
- Formulate optimizing control task as mathematical program
- Online optimization of set points and plant schedules

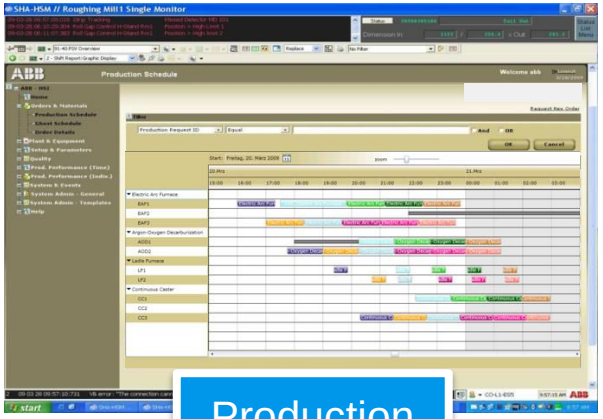
Industrial Demand-Side Management (iDSM)
Combine Production Planning and Energy Management



Energy Systems Scheduling

iDSM module

Coordination through
- Monolithic model
- Model decomposition
- Data exchange

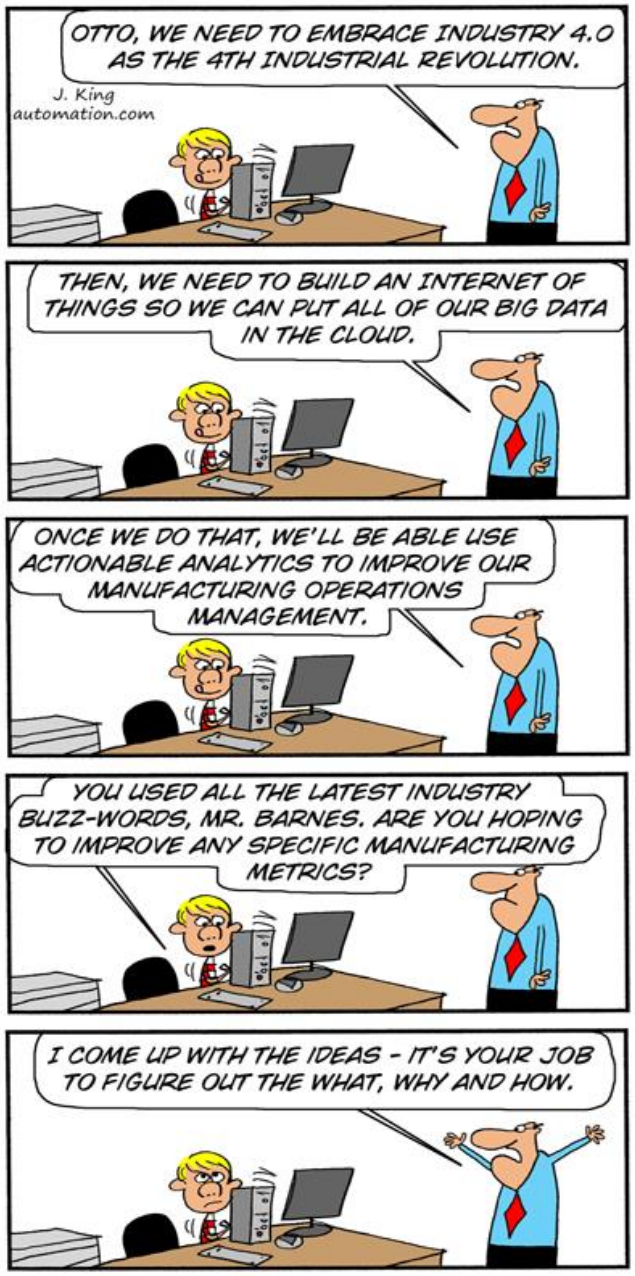


Production Planning

- ✚ *Reduce energy cost* using time varying energy prices
- ✚ *Increase flexibility* / agility wrt. energy availability
- ✚ Connect to *existing environment*
- ✚ Steel/TMP mills: *3-20% energy cost savings*

Hadera et al. (2015). *Computers and Chemical Engineering. DOI: 10.1016/j.compchemeng.2015.02.004*

Summary



For more examples of Otto Mation see www.automation.com

Conclusions
Interesting Journey ahead for Academia & Industry

- Intranet of Things – Internet of Things
  - Intelligent devices equipped with sensors are providing large amounts of data that is today used in the automation system
  - Today's essential requirements remain valid (safety, reliability), cyber security and data privacy become even more important
- Internet of people
  - People will not be obsolete. They are still the decision makers.
- Internet of Services
  - Business model is key. Monitoring and analytics natural first step, but operations will follow.
- More complex systems need to become simpler to manage
  - Smartphone a good example of this…
- Revolution or Evolution?
  - The answer lies still in the future… depends on you!

Conclusions
Interesting Journey ahead for Academia & Industry

Academia: What is theoretically possible?

Industry: What is commercially realistic?

Acknowledgements

- The speaker is grateful to numerous colleagues at ABB for discussions and slides
- In particular to Rainer Drath, Iiro Harjunkoski, Christopher Ganz, Rüdiger Franke and Susanne Timsjö

Power and productivity
for a better world™