LEAN PROCESSES AND THE DIGITAL FACTORY

LEAN TRANSFORMATION: FROM TOYOTA PRODUCTION SYSTEM (TPS) TO INDUSTRY 4.0

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BOSCH BARI

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Agile and connected

Manufacturing innovation function (MFI) leads the continuous evolution of a connected and lean plant

Industry 4.0, Information Technology in Manufacturing, Bosch Production System, Lean Administration are integrated in the same function (MFI, BPS, ADM)

Lean evolution (BPS for direct processes, ADM for indirect processes) supported by the opportunities of the connected industry, with strong focus about standard and sustainability.

Development of key solutions in the whole value stream based on sustainability and profitability criteria

Lean processes and the digital factory
Topics

1. I4.0: background, importance and value of data

2. New technologies in the connected industry

3. Opportunities and challenge of the «connected world», digital Twin

4. BOSCH Bari: approach and use cases

Lean processes and the digital factory

The concept

Industry 1.0

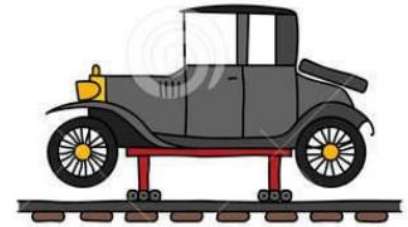
The Industrial Revolution begins. Mechanization of manufacturing with the introduction of steam and water power

1 Mechanization, Steam industry machines

1782

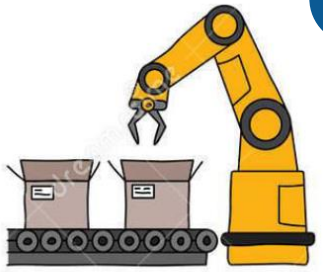
2 Electrification, mass production

1913



Industry 2.0

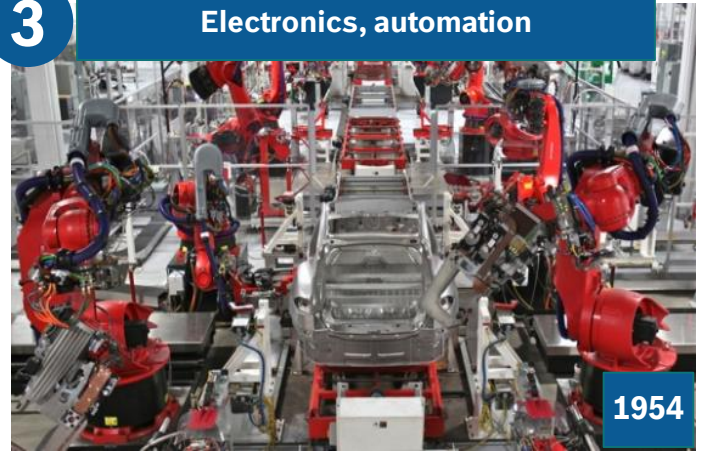
Mass production assembly lines using electrical power



Industry 3.0

Automated production using electronics, programmable logic controllers (PLC), IT systems and robotics

3 Electronics, automation



1954

4 Interconnection, Internet

- Robot e sse e intellige
- Sistemi one tra mondo f uale

2015

Industry 4.0

The 'Smart Factory'. Autonomous decision making of cyber physical systems using machine learning and Big Data analysis. Interoperability through IoT and cloud technology.

Lean processes and the digital factory
I4.0 ?

When: 2011

Where: Hannover

Who:

German government

University

Main industrial companies

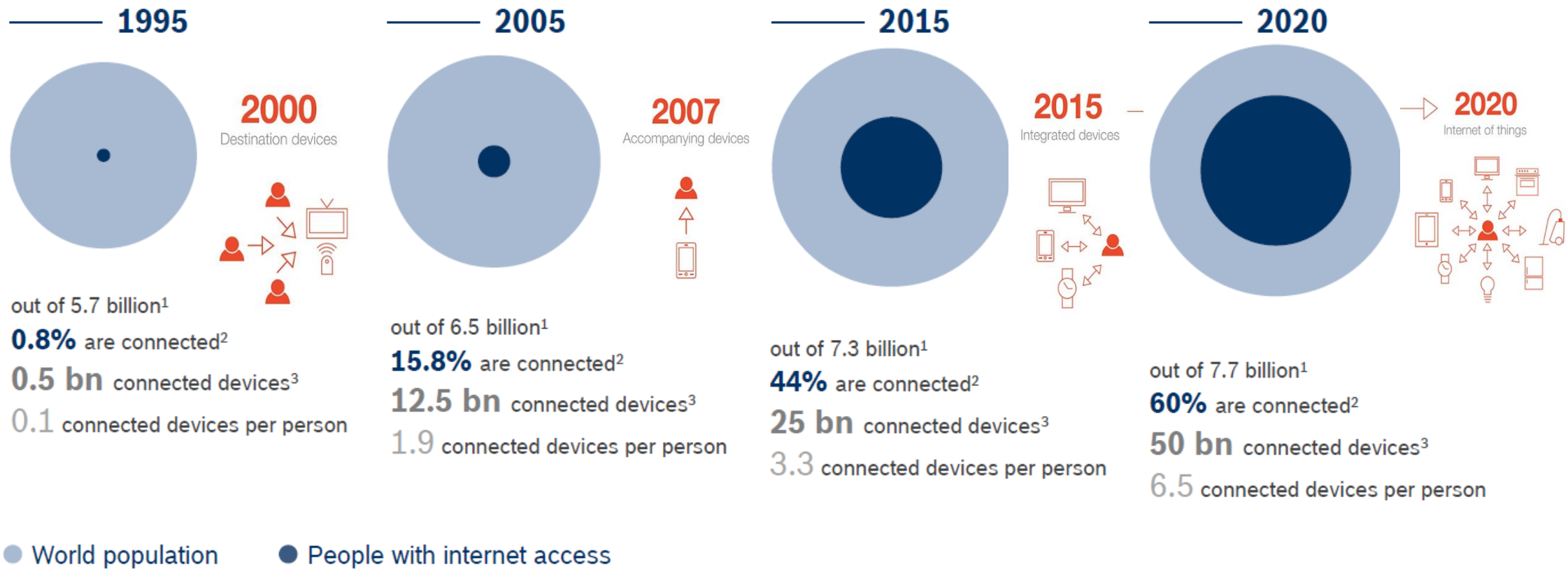
Why:

Support the leadership of the german manufacturing industry

Plan the transformation of the industrial world and its growing complexity

Lean processes and the digital factory

Background: more and more a connected world

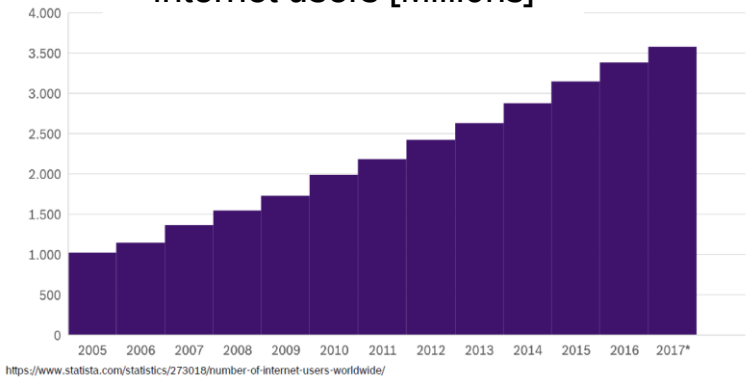


Sources:
United NationsPopulation Division (2) Source: Internet live stats, International TelecommunicationUnion (ITU) (3) Source: Cisco IBSG April 2011

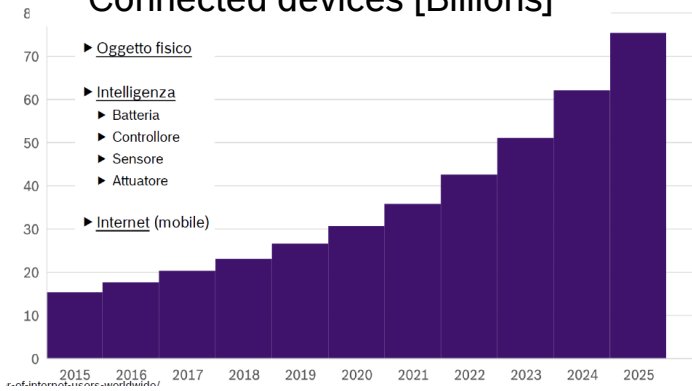
Lean processes and the digital factory

Background: more and more a connected world

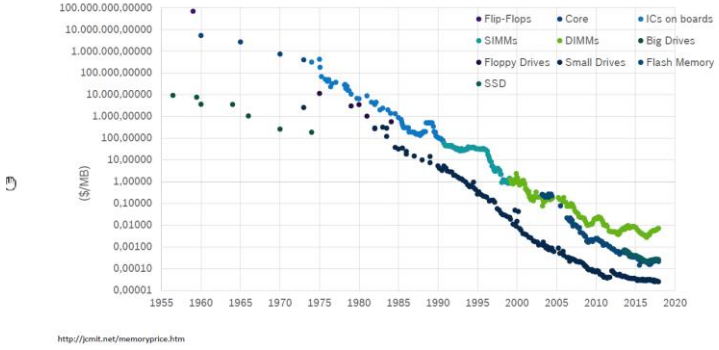
Internet users [Millions]



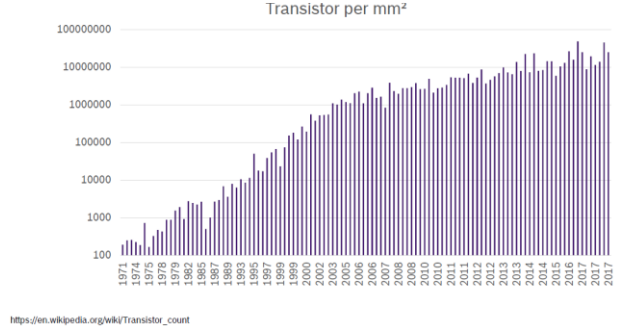
Connected devices [Billions]



Memory cost [$/MB]



Processor dimension [transistor/mm^2]



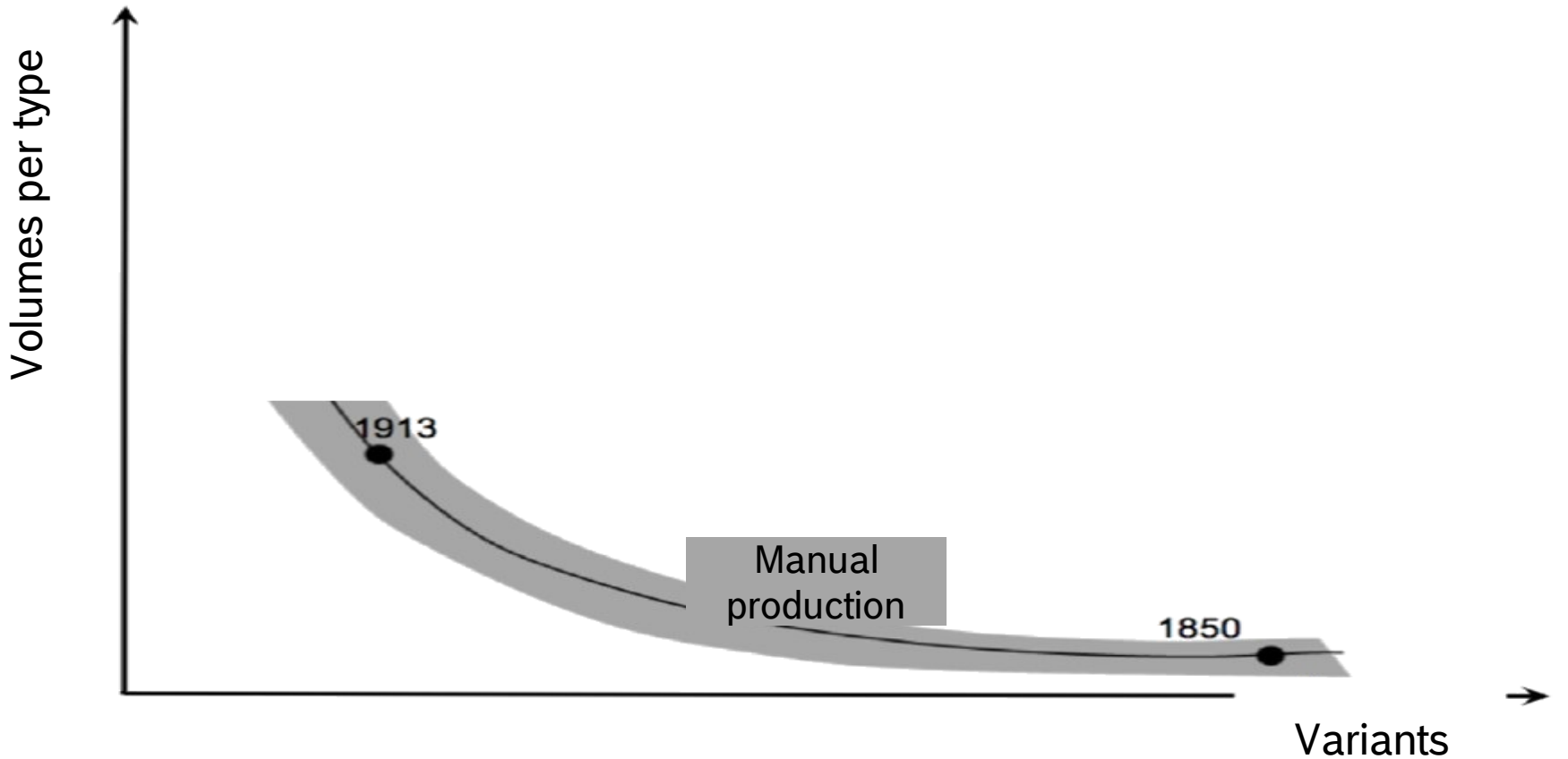
Sources:
https://www.statista.com/statistics/273018/number--ofof--internetinternet--usersusers--worldwide/worldwide/

Lean processes and the digital factory

Background: more and more a connected world

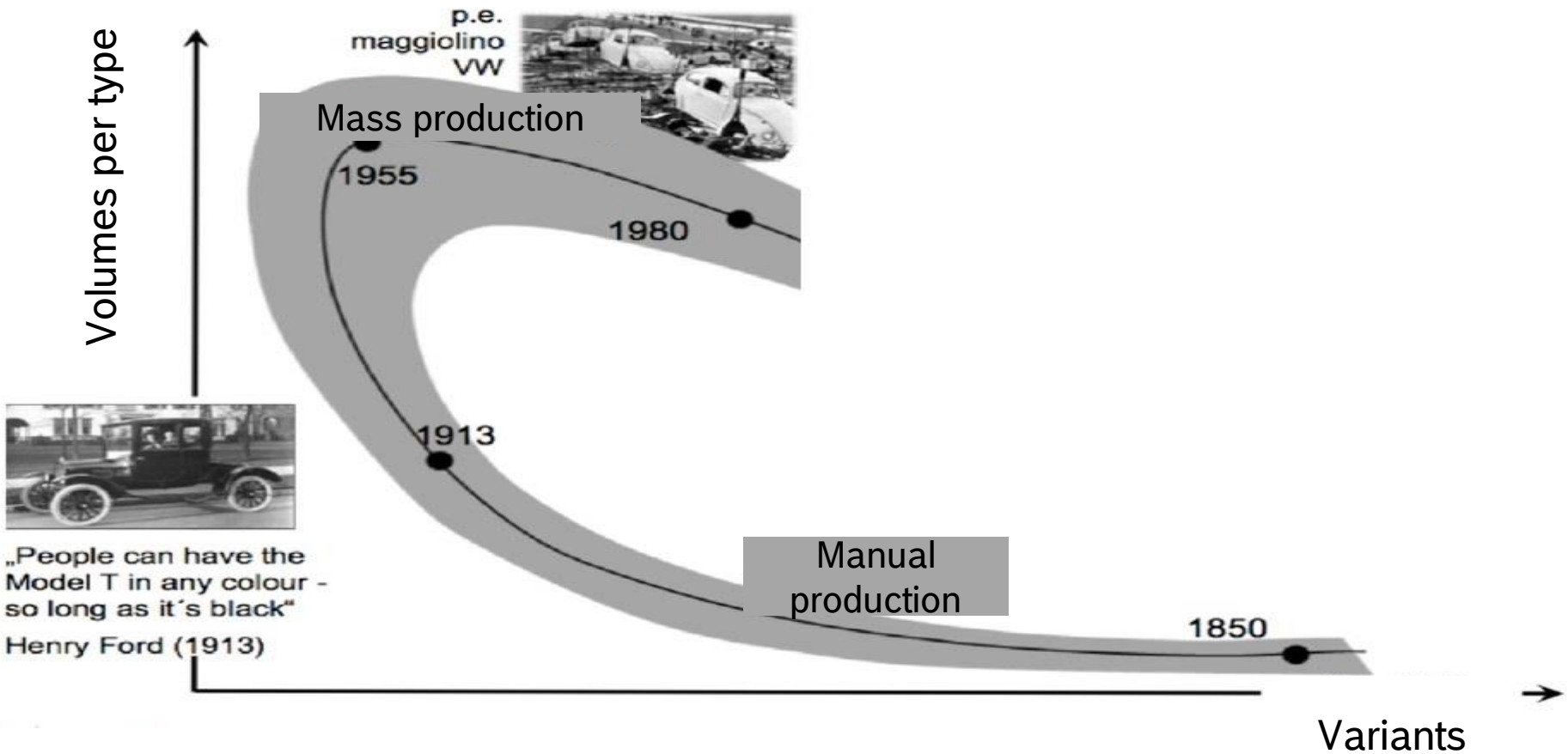
Lean processes and the digital factory

The «mass customization», importance and value of data



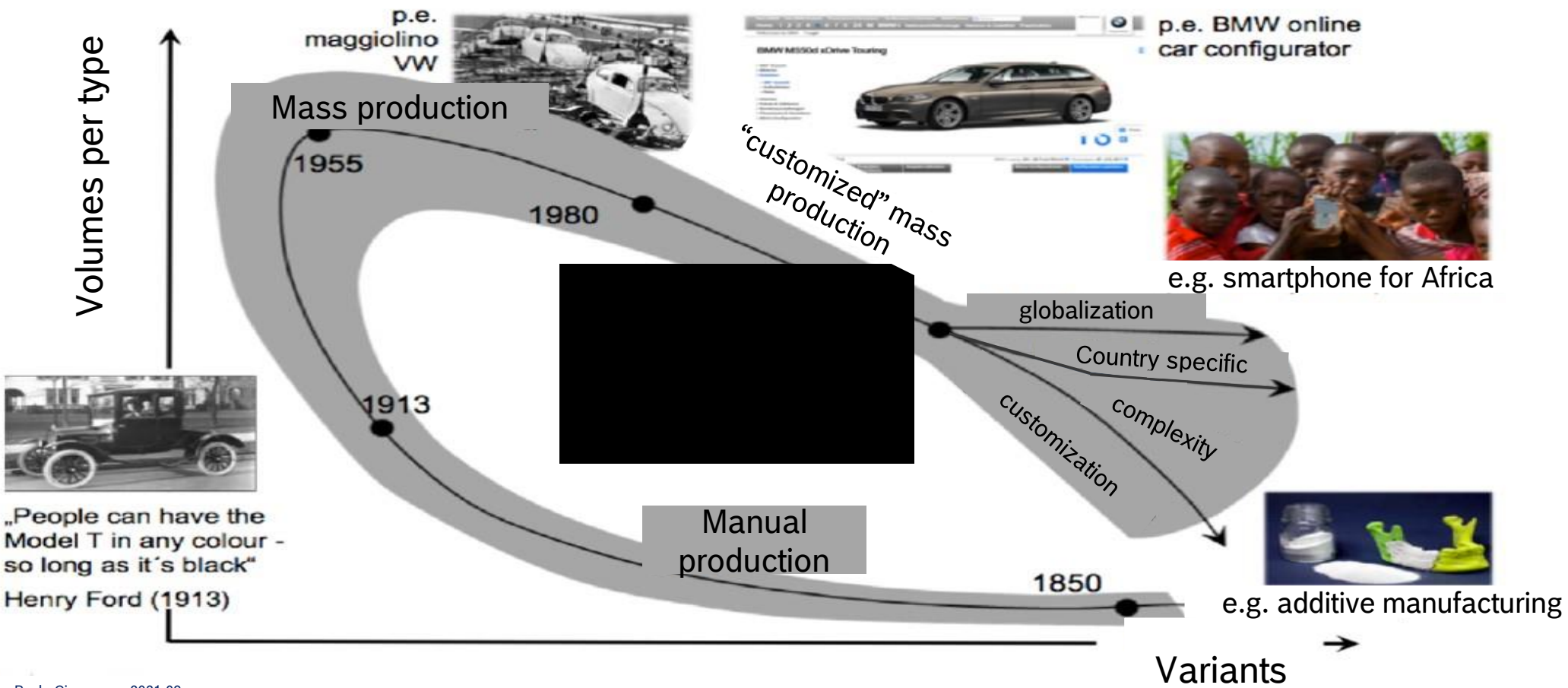
Lean processes and the digital factory

The «mass customization», importance and value of data

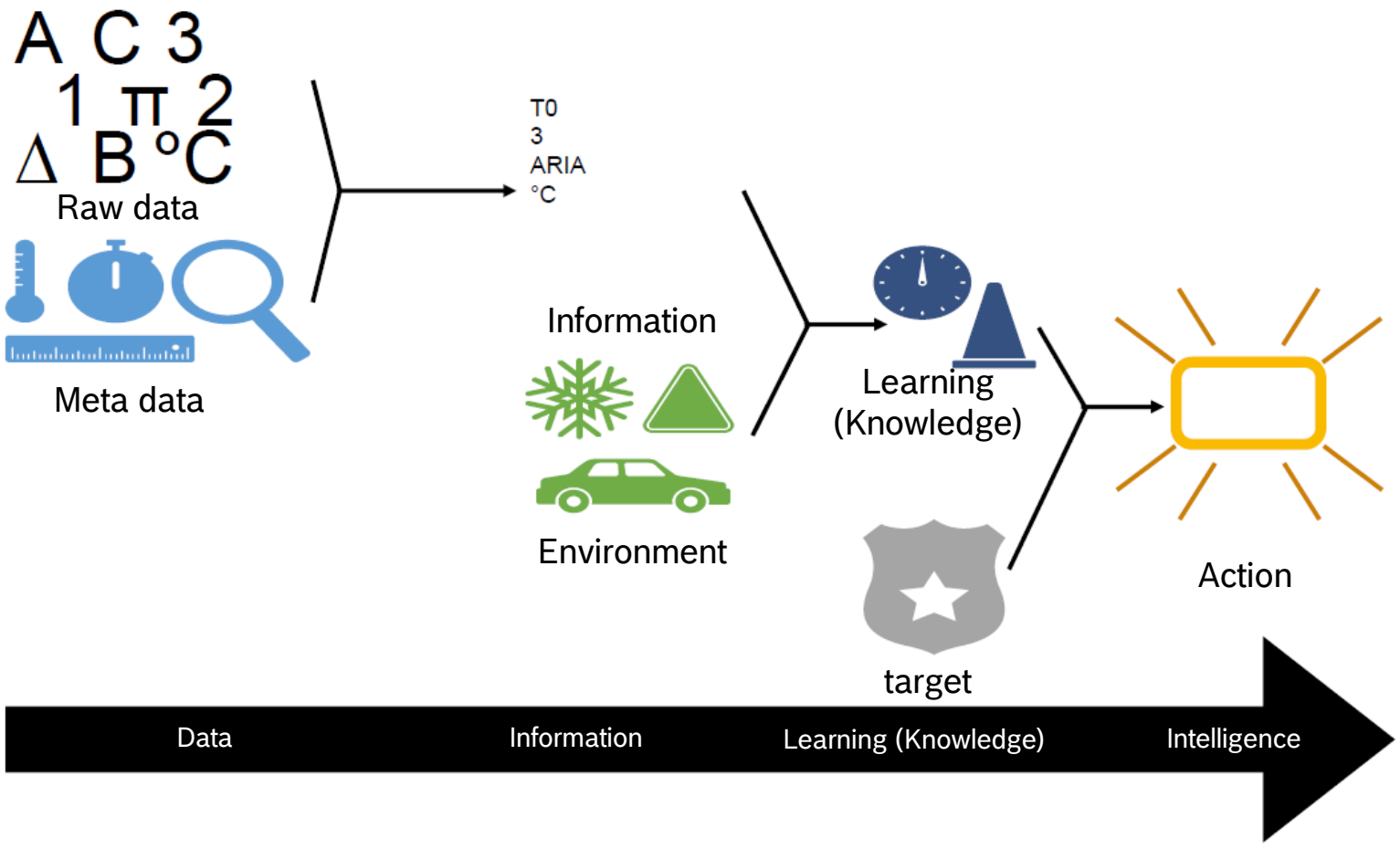


Lean processes and the digital factory

The «mass customization», importance and value of data



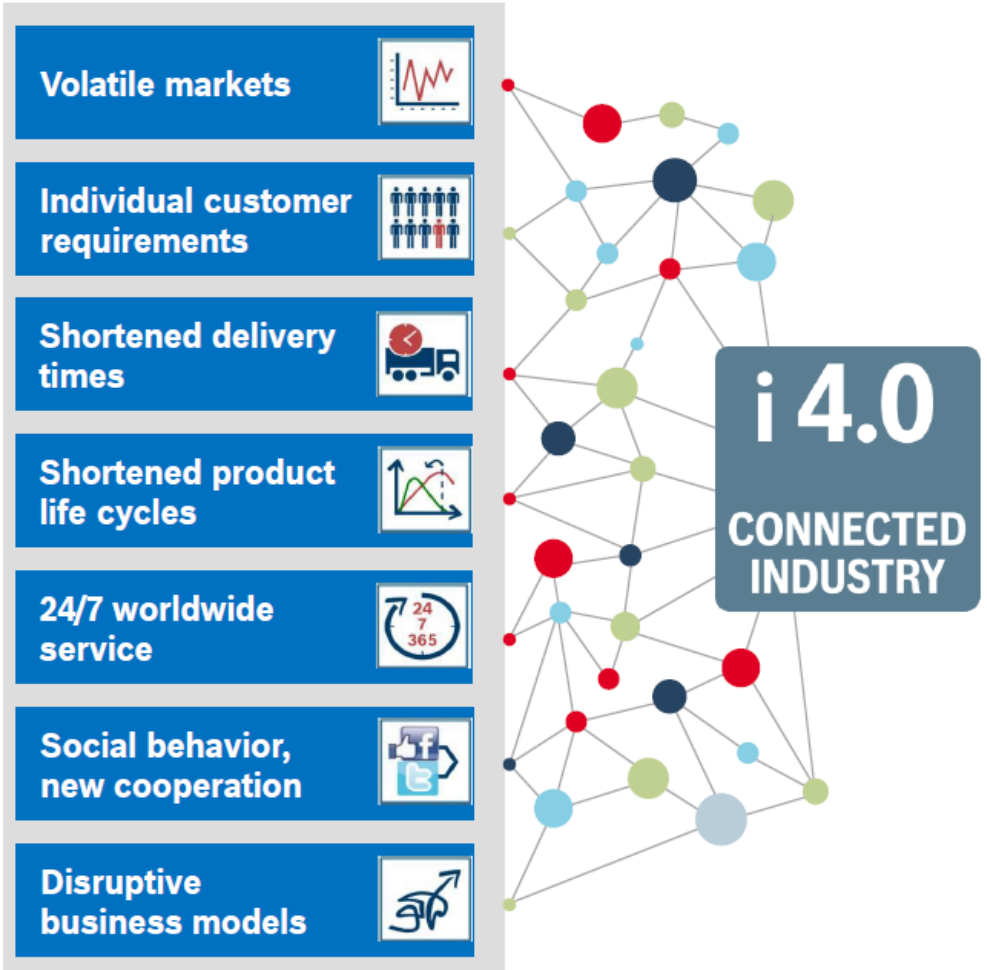
Lean processes and the digital factory
Data as a key value



Lean processes and the digital factory
Opportunities of the «connected world»

- Satisfy specific (single) customer requests
- Flexibility
- New (optimized) decision tools
- Productivity and efficency
- Servitization
- Answer to demographic change
- Work-life balancing

*servitization: company producing goods transform their products and sell (also) data as added value



Lean processes and the digital factory
Opportunities of the «connected world»

Both!

Technical evolution

- Continuous development of products
- Continuous improvement of products
- More and more connected products

…but it's more a evolution rather than a revolution ….

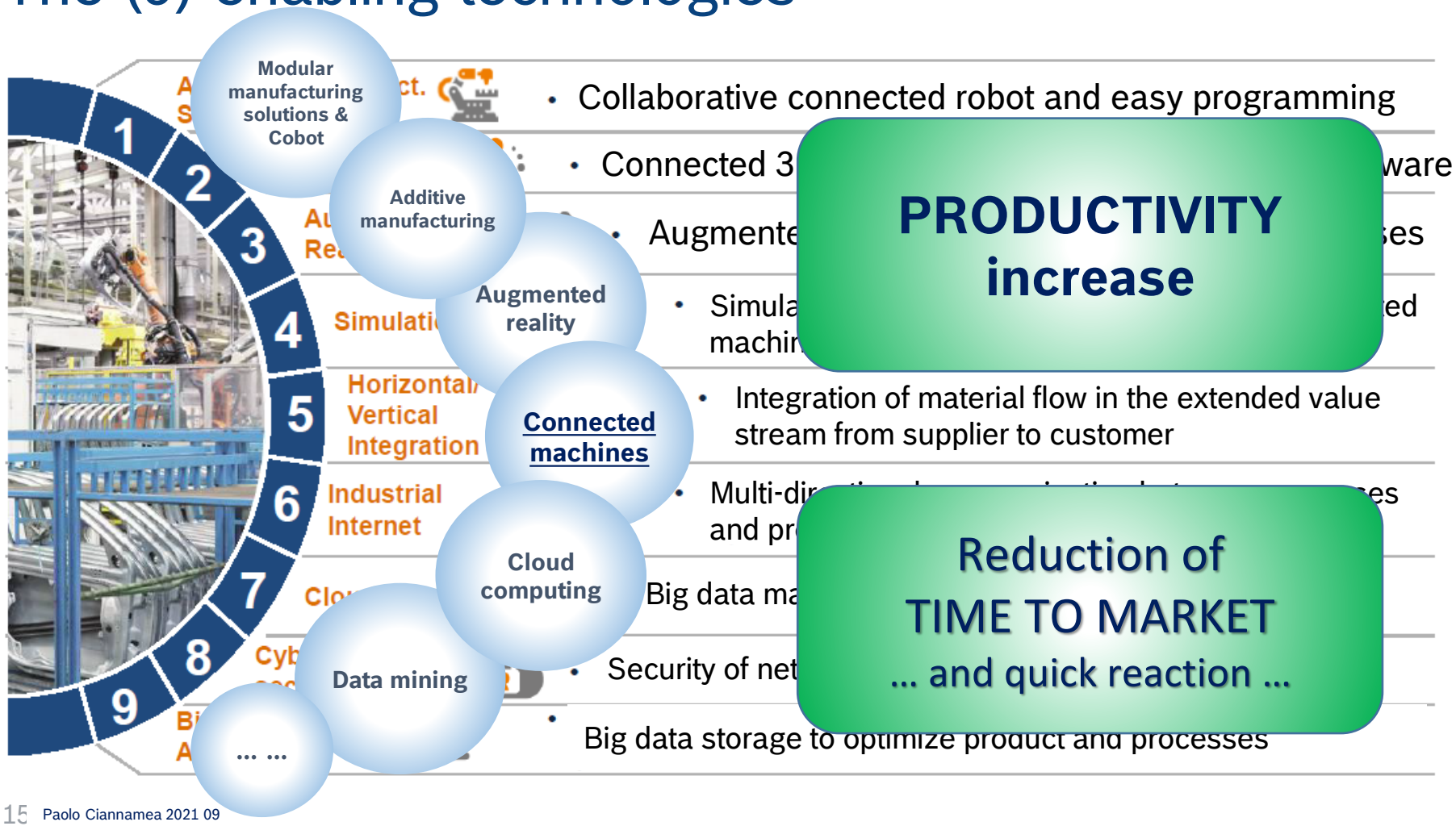
Business revolution

- The way to produce
- The daily work of associates
- The way to sell "products"

…production and sell of "products" (services) is already (completely) changed…

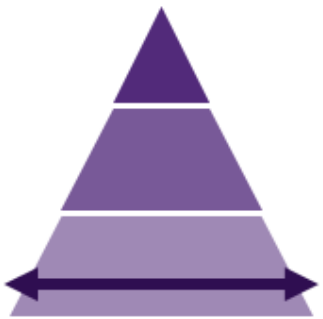
Lean processes and the digital factory

The (9) enabling technologies



Lean processes and the digital factory
Internet of things

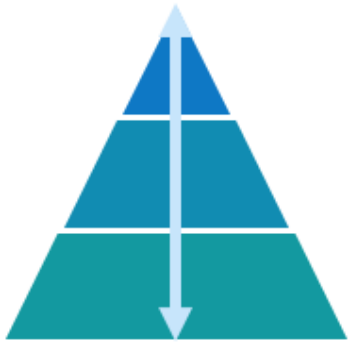
Lean processes and the digital factory
The connected factory



Horizontal integration

Unification of IT systems used in the different production (and business) processes

+



Vertical integration

Integration of different IT systems between different levels

=

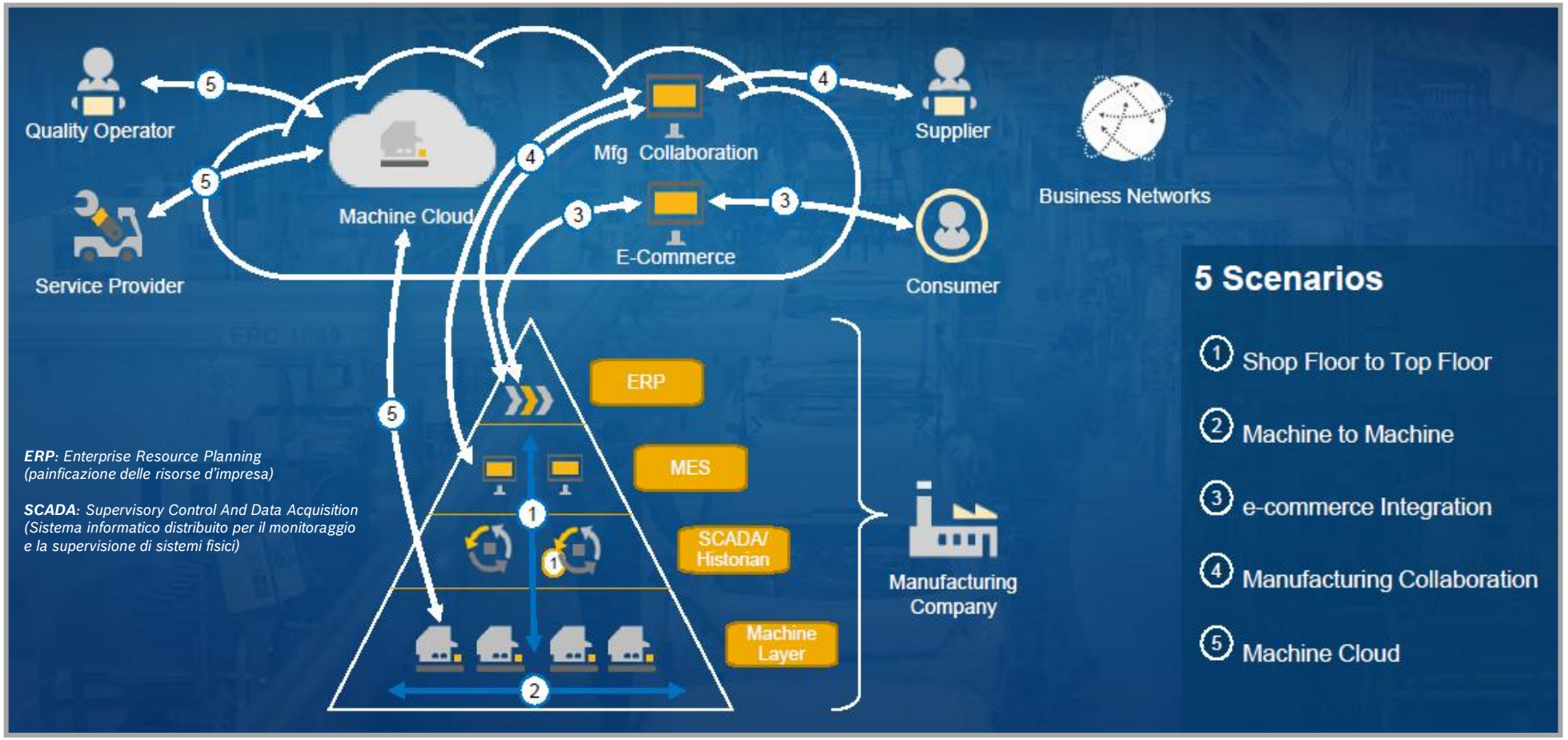
End-to-end integration

The complete value stream is covered

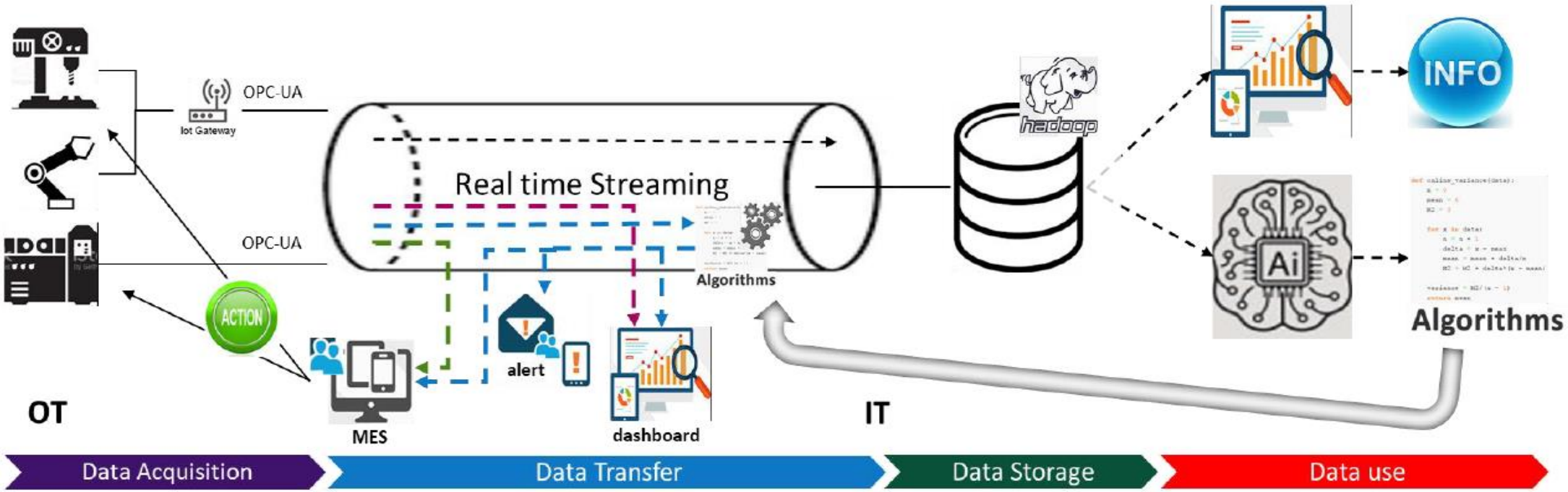
Physical world fusion with virtual world in a real-time communication, in the complete extended value stream.
Flexibility, sustainability, quality, optimal allocation of resources to approach market customization

Lean processes and the digital factory

The connected factory: from the pyramid to the cloud

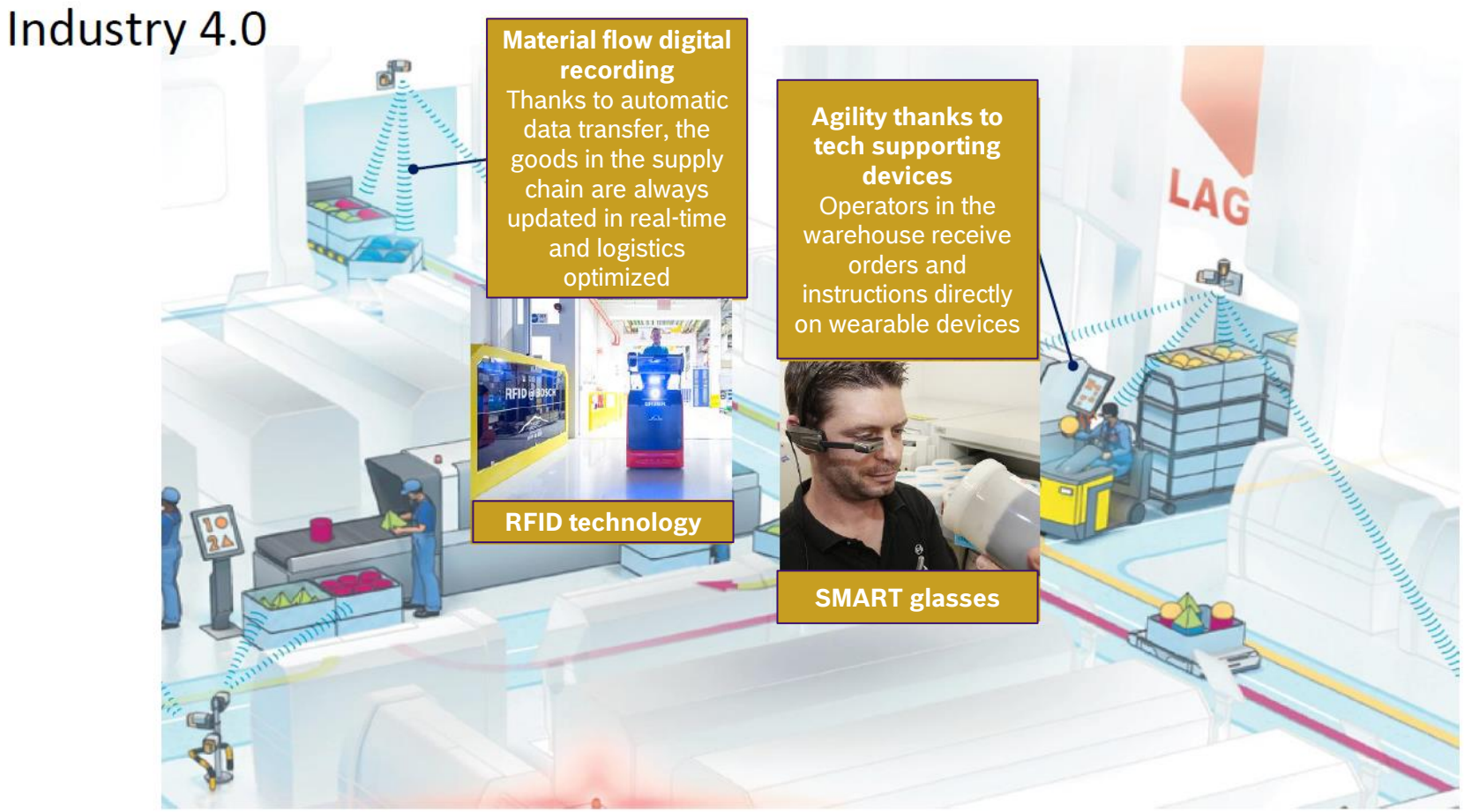


Lean processes and the digital factory
The connected factory: data architecture



Lean processes and the digital factory
The connected factory: applications

Lean processes and the digital factory
The connected factory: applications



Lean processes and the digital factory
The connected factory: applications

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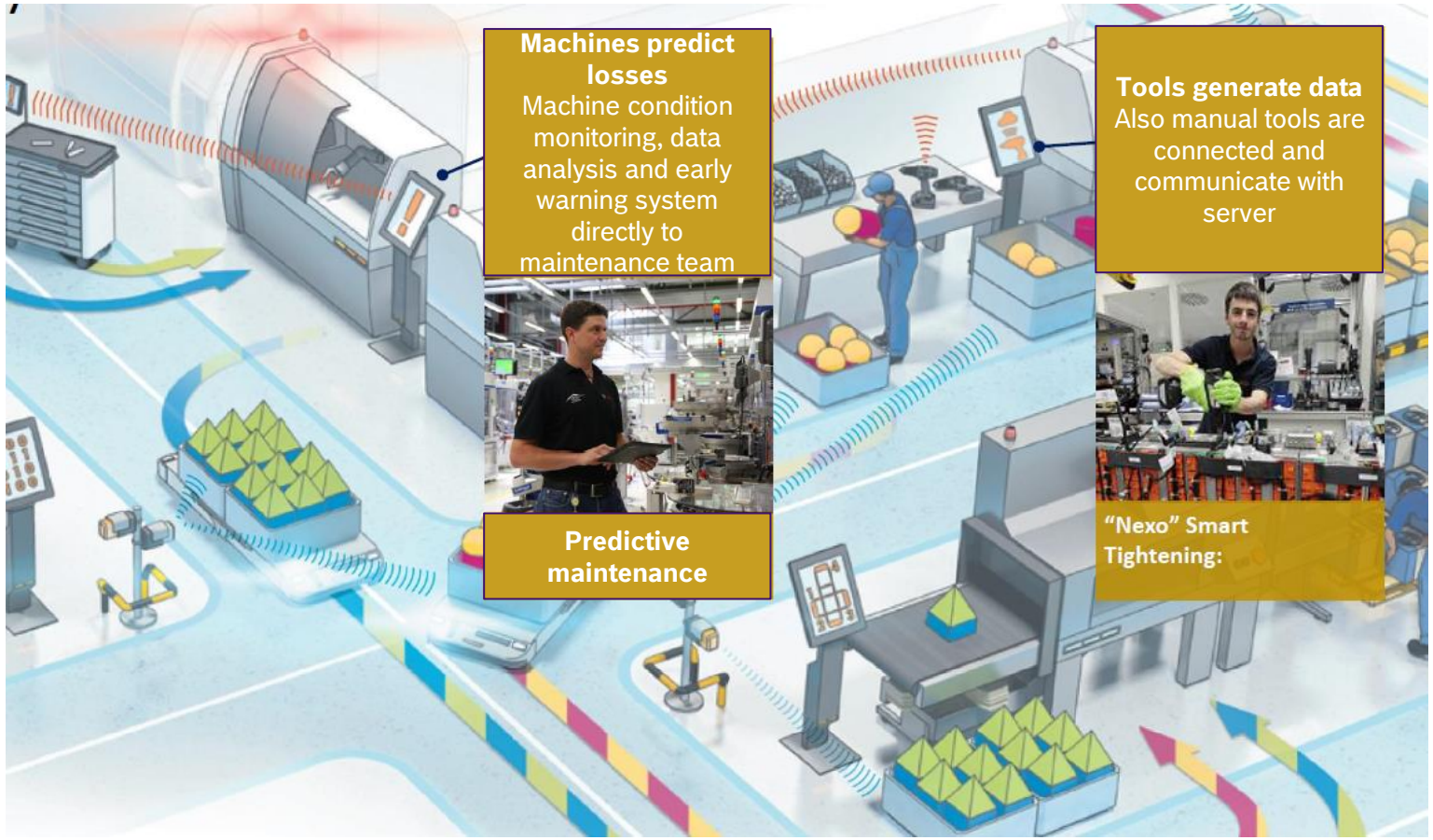
The connected factory: applications



Lean processes and the digital factory
The connected factory: needs and applications

Cost reduction!

Minimize waste / errors!

Avoid downtime!

Minimize stock!

Faster and easier Service!

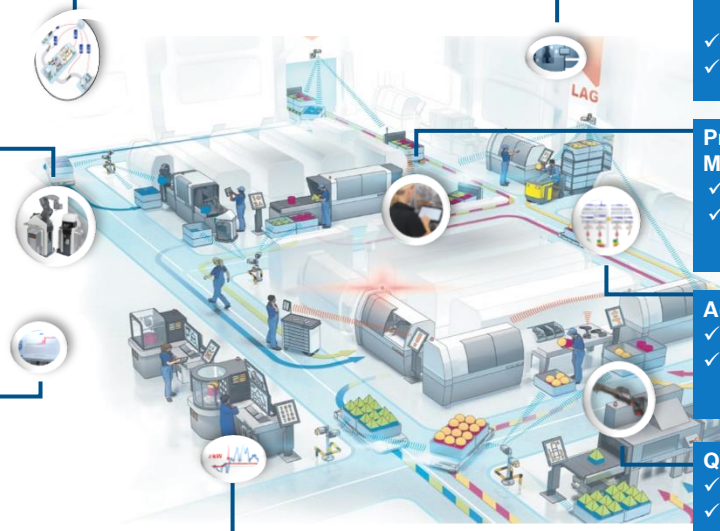
Lean value stream!

Digital Supply Chain
- ✓ stock saving
- ✓ efficiency increase
- ✓ transparency along supply chain

Convertible Equipment
- ✓ fix cost reduction
- ✓ efficient M2H collaboration
- ✓ human relief of heavy load / repetitive tasks

Shop Floor Mgmt. Information
- ✓ real time data
- ✓ fast escalation
- ✓ paperless

Power / Energy Management
- ✓ peak reduction
- ✓ energy cost saving



Operator Support
- ✓ agility & quick reaction
- ✓ quality increase
- ✓ efficiency increase

Predictive Maintenance
- ✓ improve OEE
- ✓ no sudden breakdown

Adaptive Testing
- ✓ increase efficiency
- ✓ less invest

Quality Improvement
- ✓ instant feedback
- ✓ fast identification of error sources

Optimizing and improving productivity!

Eliminate bottlenecks!

Increase product quality!

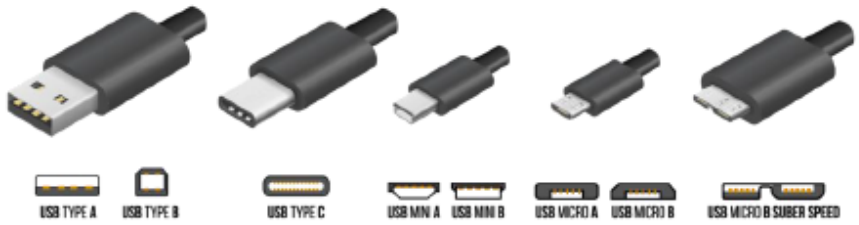
Full traceability of parts and products for the entire life cycle!

Lean processes and the digital factory
The connected factory: collaboration man-machine (APAS)

Lean processes and the digital factory
The connected factory: Boston Dynamics Robot

Lean processes and the digital factory
The connected factory: challenges

Standardization

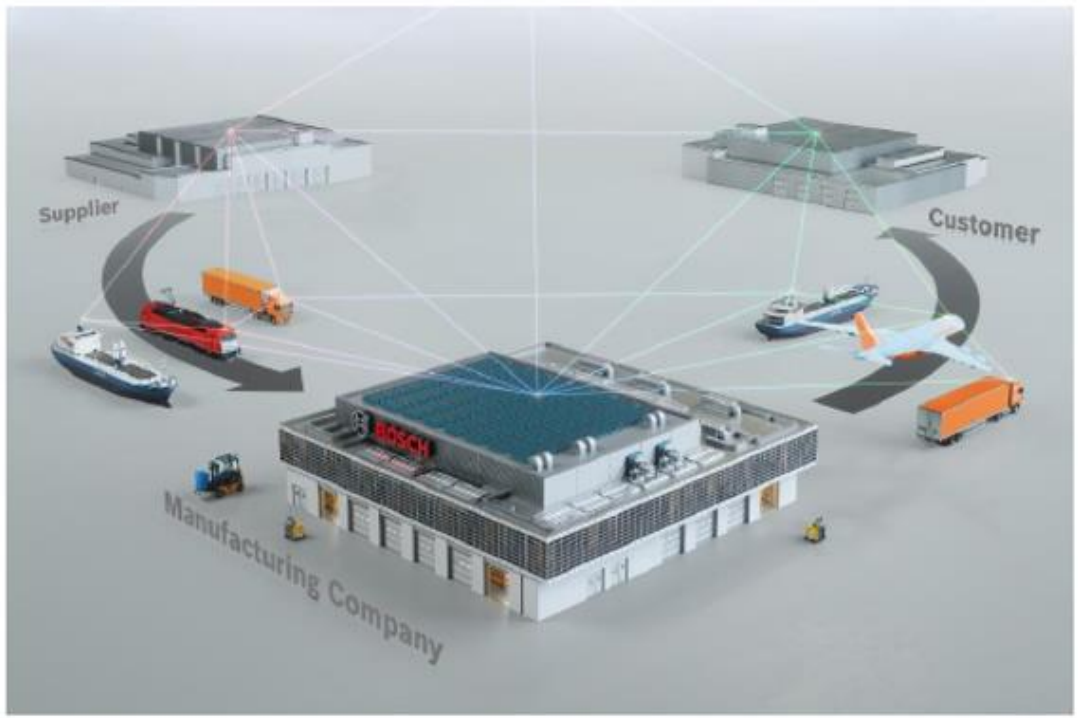


OPC UA™

ISO International Organization for Standardization

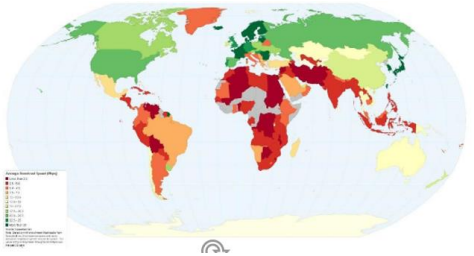
Lean processes and the digital factory
The connected factory: challenges

Complex system integration

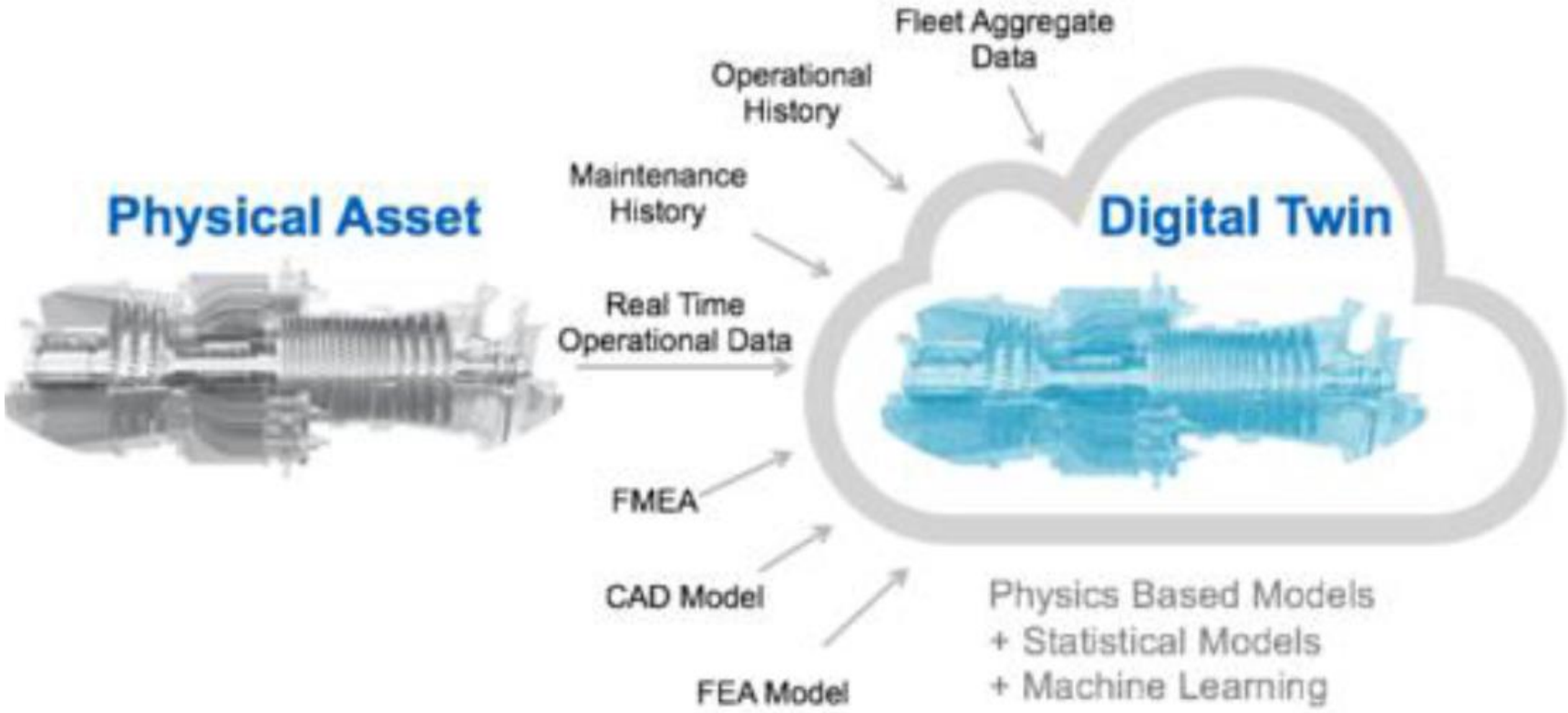


Lean processes and the digital factory
The connected factory: challenges

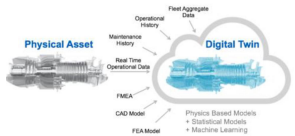
- **Standardization**
- **Complex system integration**
- **Reliable network**
- **Safety and Security**
- **Company organization**
- **Legal norms**
- **Energetic efficency**
- **Competence development and professional opportunities**

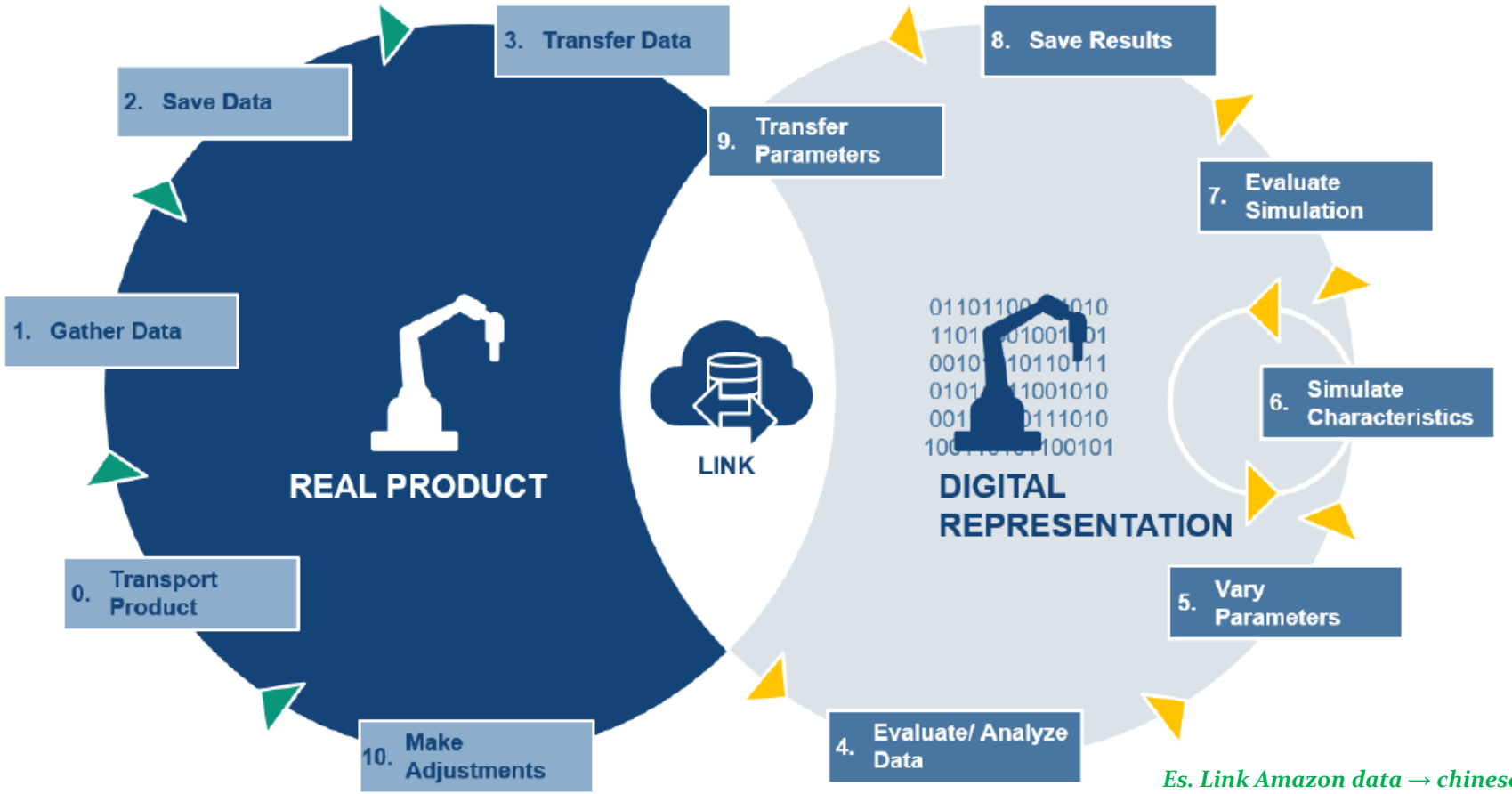


Lean processes and the digital factory
Digital twin



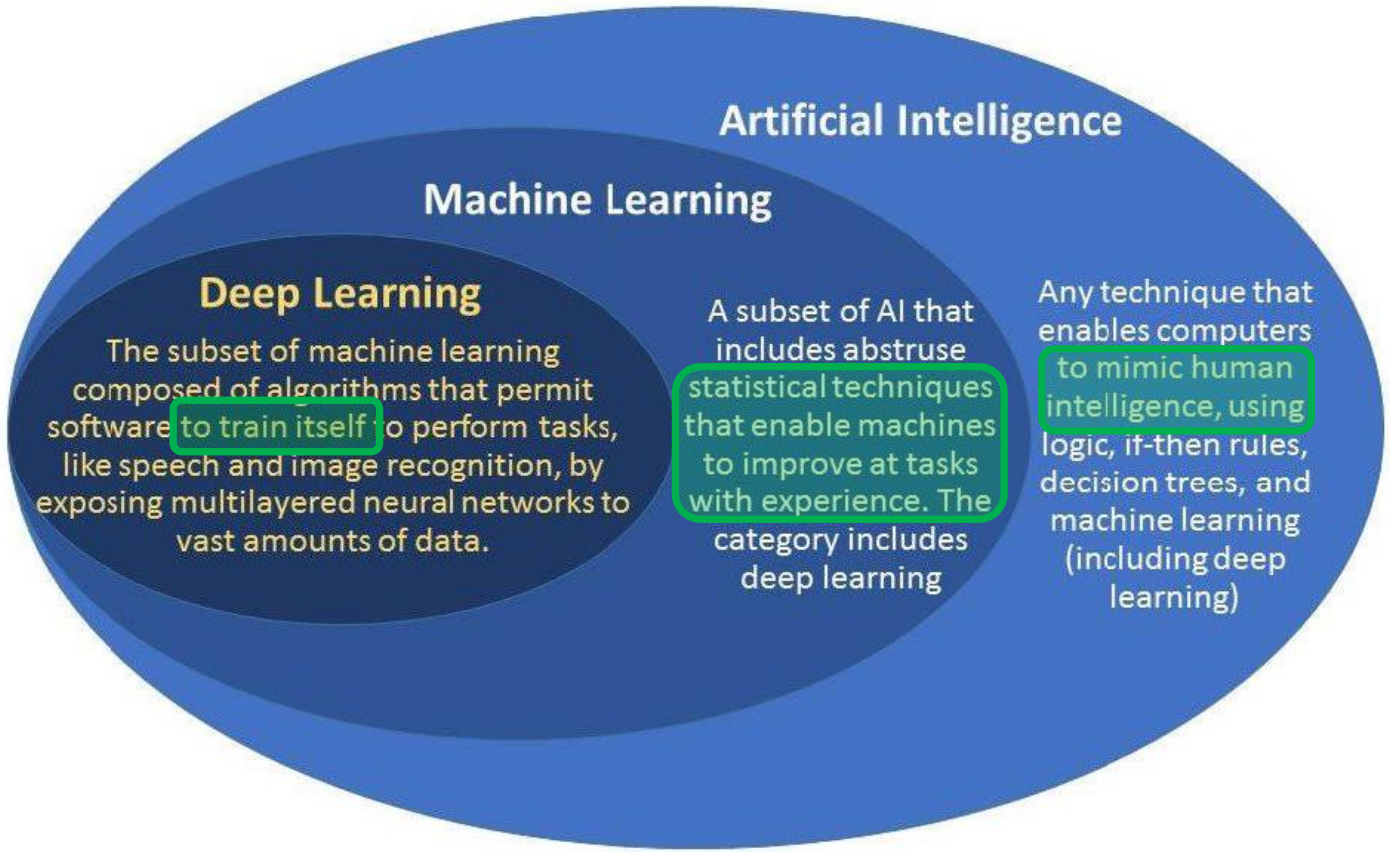
Lean processes and the digital factory
Digital twin





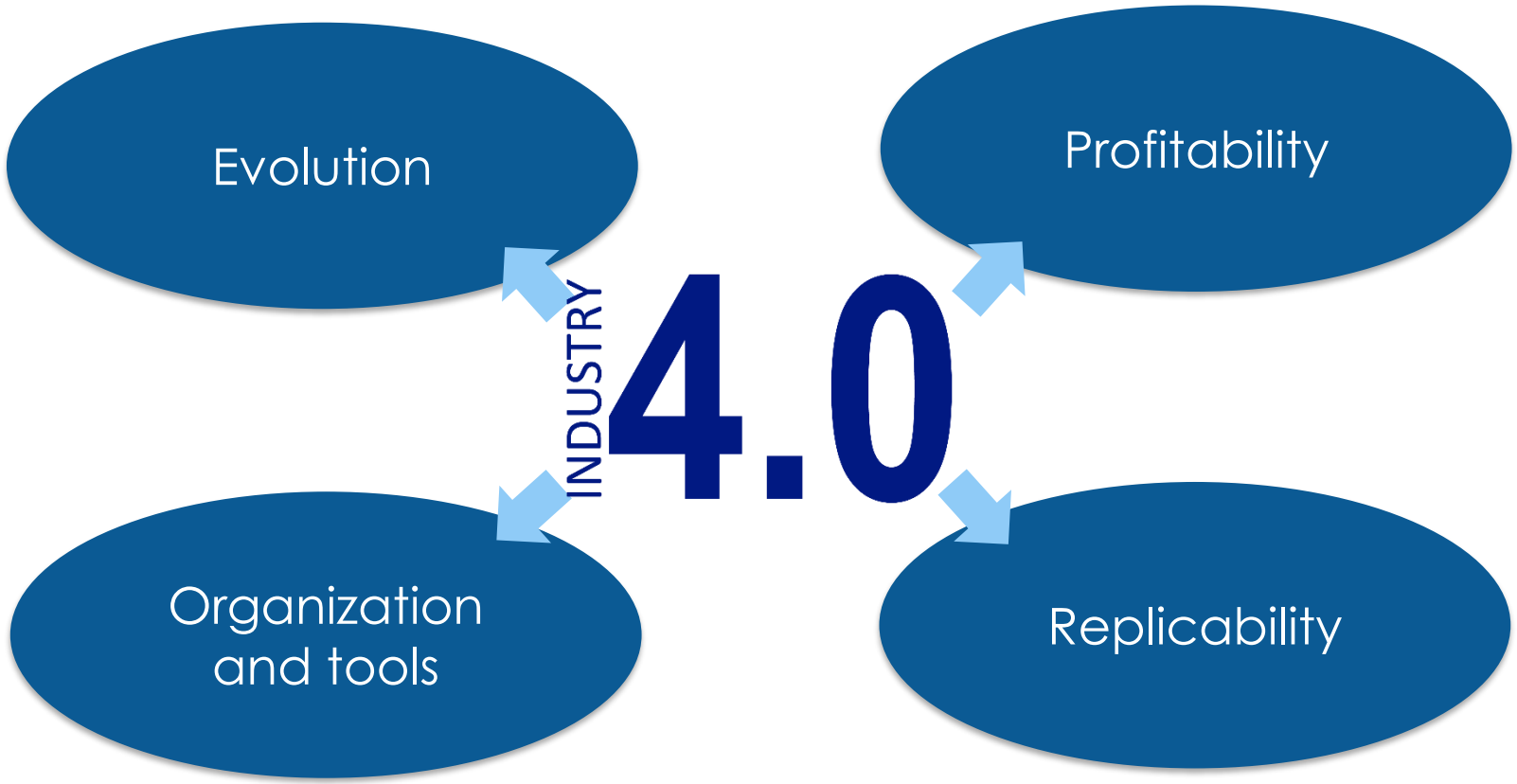
Es. Link Amazon data → chinese producers
Es. Tesla (electric car → digital car)

Lean processes and the digital factory
Artificial intelligence



Lean processes and the digital factory
Artificial intelligence

Lean processes and the digital factory
Approach



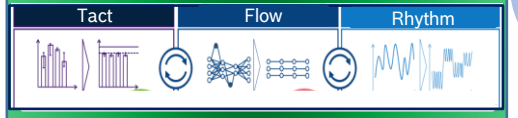
Lean processes and the digital factory

BOSCH Bari approach: think big, start small

What	Why
DIGITALIZATION	TRANSPARENCY
AUTOMATION FAST IMPROVEMENTS	PRODUCTIVITY
DIAGNOSIS	FOCUS
PREDICTION	FAILURE PREVENTION
A.I.	AUTONOMOUS RESPONSE

Where

BPS meets I4.0: Identification of focus topics



"The right investment at the right time at the right place"

More specific

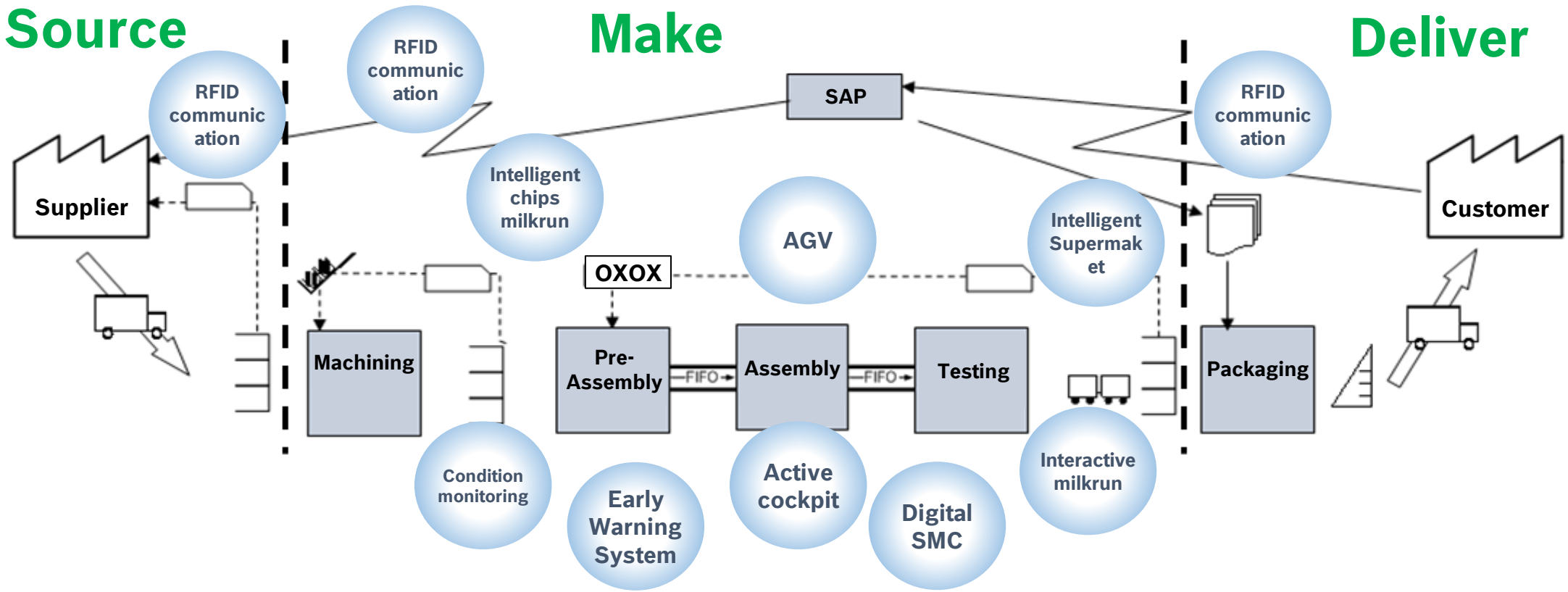
- Machine data are available
- Data are analyzed
- high OEE for old machines
- No manual "no-adding value" operations
- No waiting times / stock
- Improve productivity and inventory
- Process data are available
- High speed and focused reaction
- Safe and cheap (new) processes
- Automatic closed loop of reaction
- Competitive costs

How

- "small steps" way
  Pilot projects in focus areas
- QUALIFICATION and ENABLING by doing
  Learn & build competence
- Co-create industrial STANDARD solutions

Transparent approach by derivation, target and gap definition

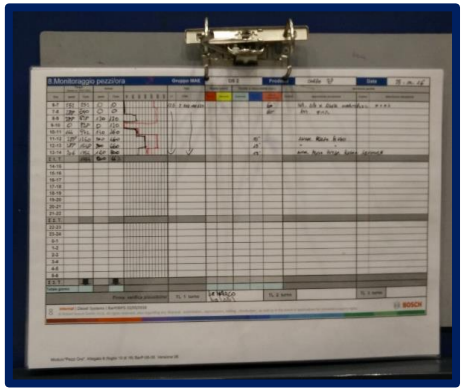
Lean processes and the digital factory
BOSCH Bari approach: think big, start small

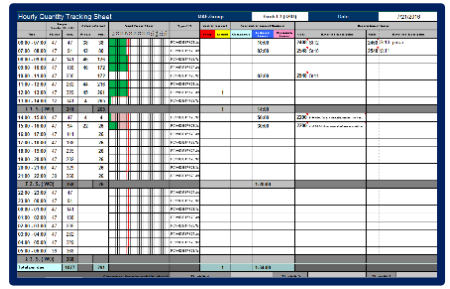


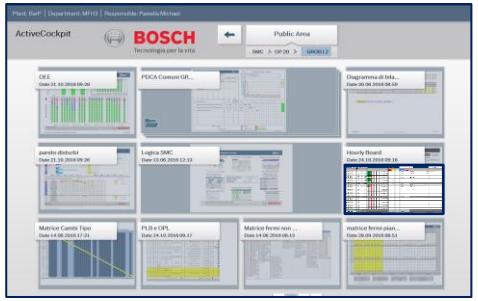
Il flusso di valore esteso .. inizia dai fornitori e si conclude ai clienti

Lean processes and the digital factory

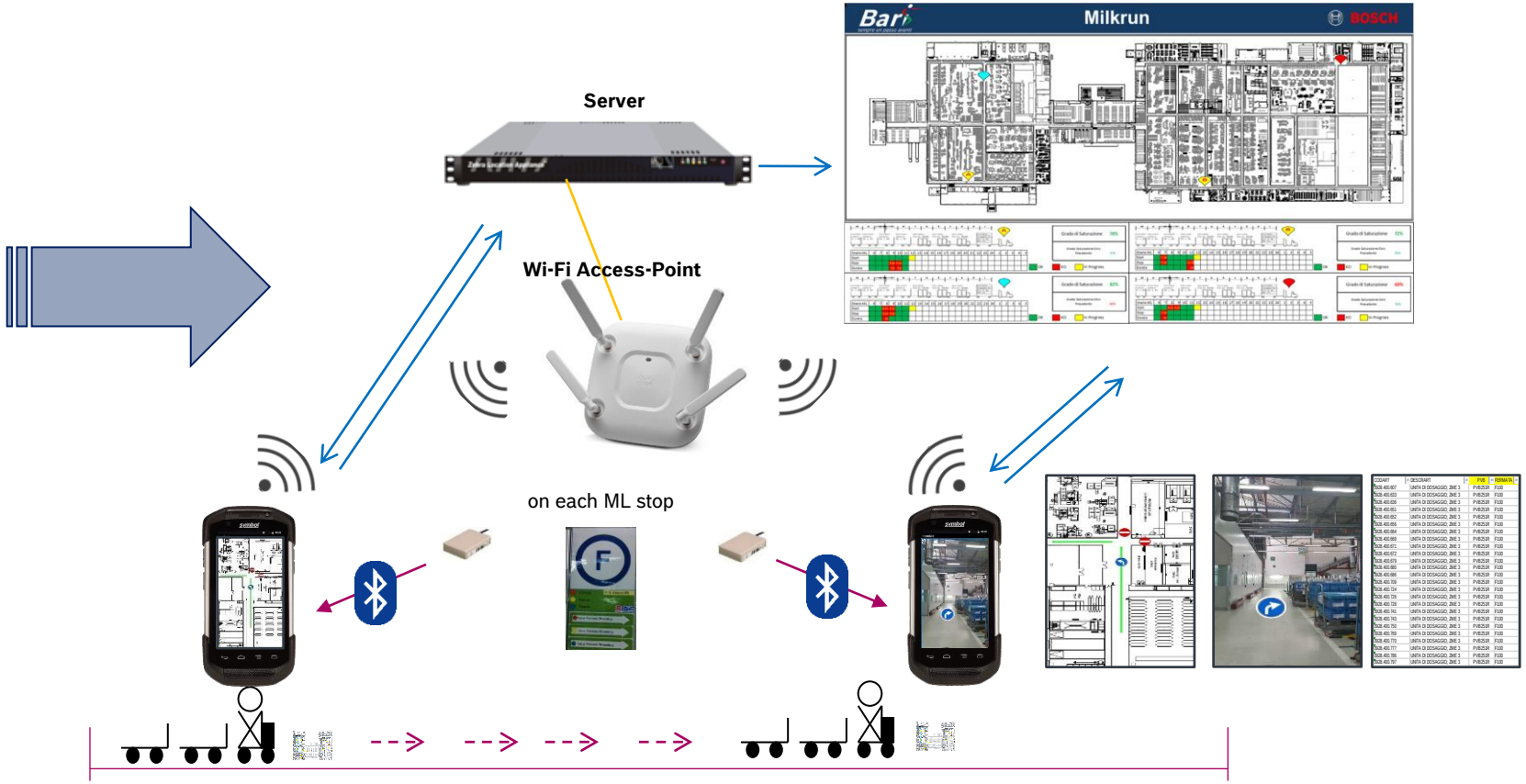
Application: Active cockpit





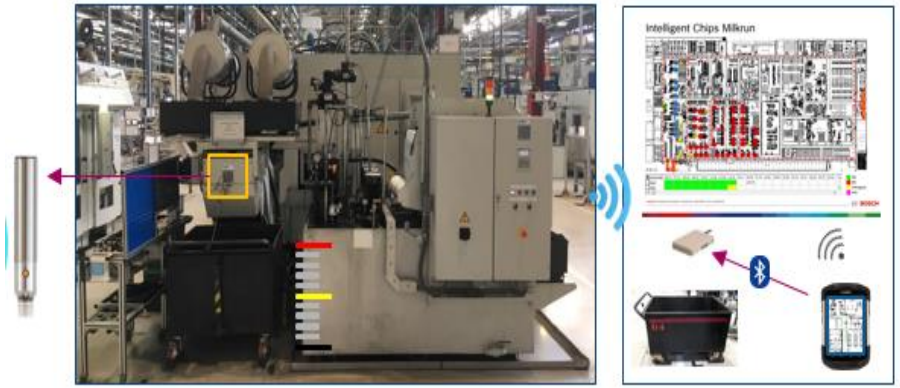


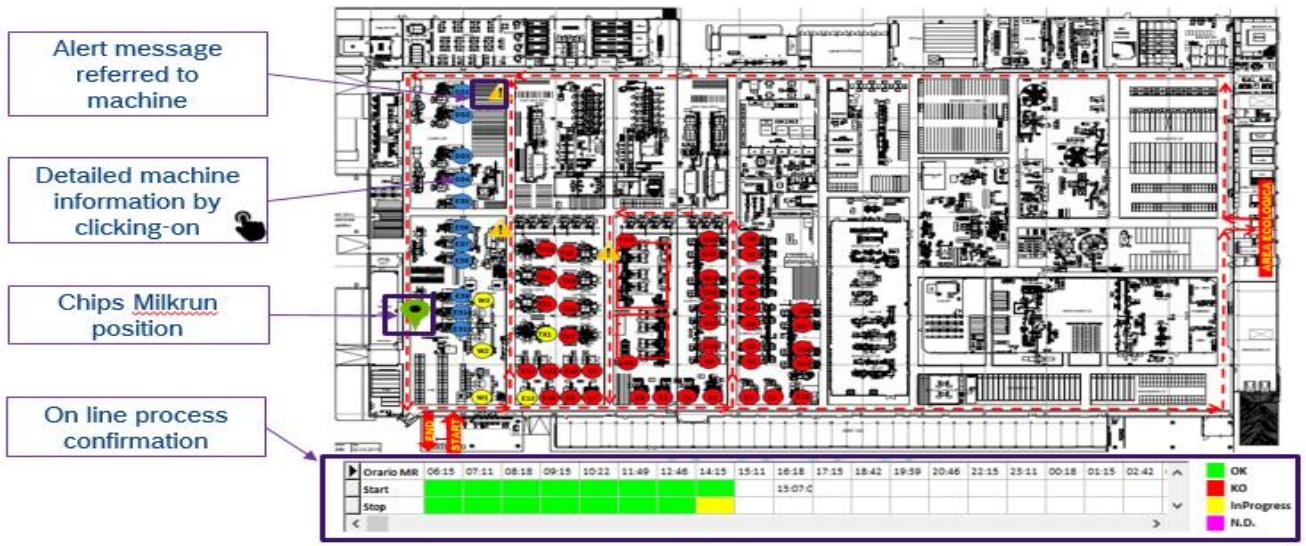
Lean processes and the digital factory
Application: Interactive milkrun



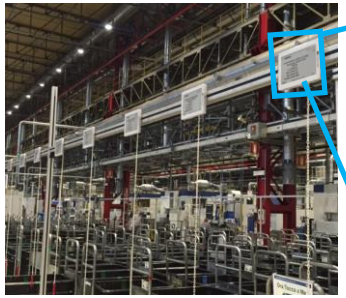
Lean processes and the digital factory

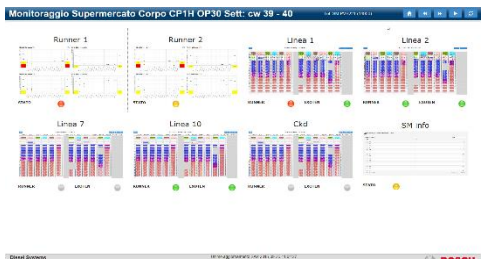
Application: interactive chips milkrun

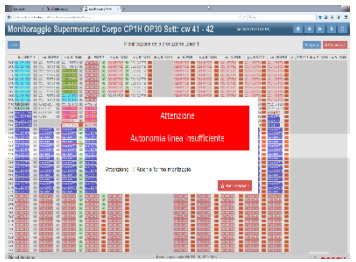




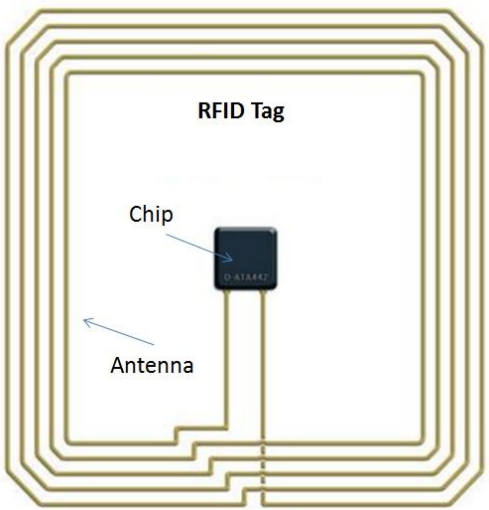
Lean processes and the digital factory
Application: Intelligent supermarket

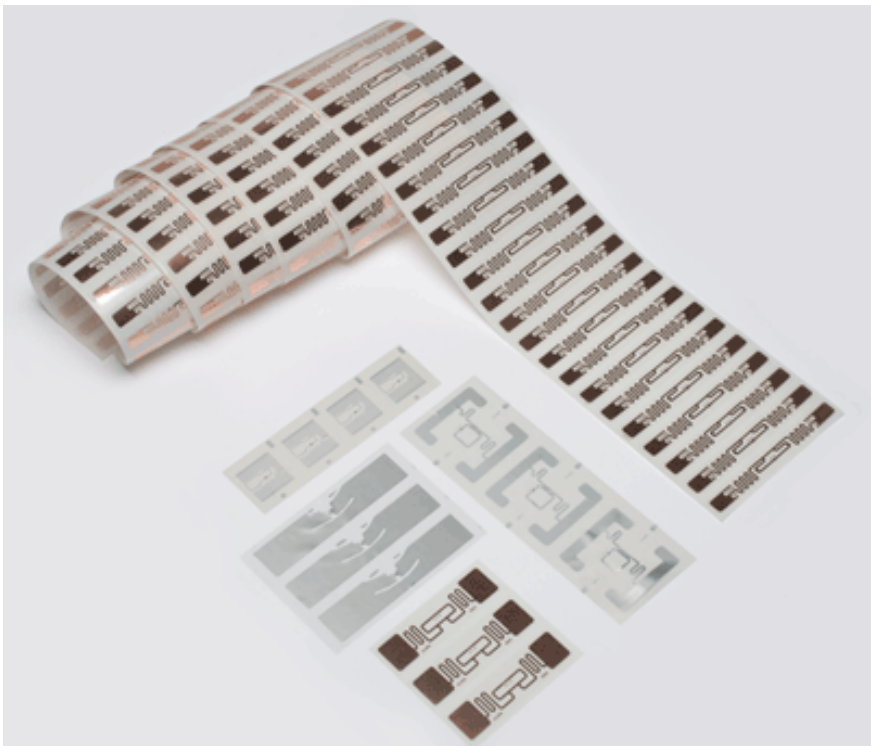






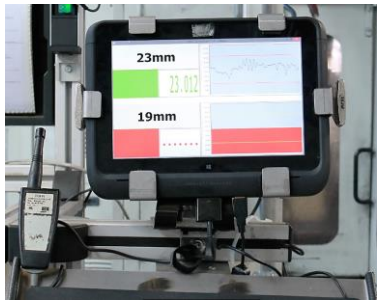
Lean processes and the digital factory
Application: RFID TAG

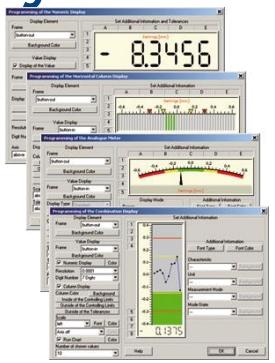


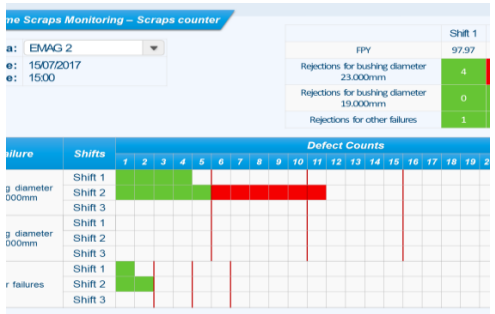


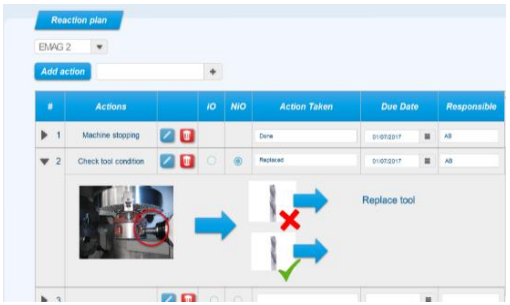
Lean processes and the digital factory

Application: early warning system









Measures feedback

- Quick support for operator
- Real-time scrap and trend visualization

Scrap-matrix

- Quick reaction to failures
- Real-time alert to team coordinators and quality team

Dashboard

- FPY and failure data available for Daily management
- Transparency and visual management

Problem Solving

- Reaction plan and problem solving tools connected