POLITECNICO DI MILANO

# Industry 4.0:
# la rivoluzione dell'industria?

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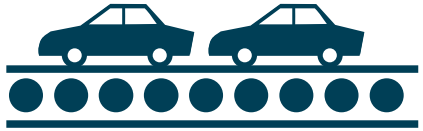
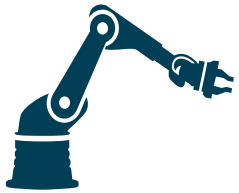
# La Quarta Rivoluzione Industriale

| Prima Rivoluzione Industriale | Seconda Rivoluzione Industriale | Terza Rivoluzione Industriale | Quarta Rivoluzione Industriale |
|---|---|---|---|
| Introduzione di strumenti meccanici di produzione | Organizzazione del lavoro e produzione di massa grazie all'utilizzo dell'energia elettrica | Produzione ulteriormente automatizzata grazie all'utilizzo in fabbrica di sistemi IT ed elettronici | Prodotti e processi interconnessi grazie all'utilizzo in fabbrica dell'Internet delle Cose e delle nuove tecnologie digitali |





1780 — Primo telaio a vapore

1870 — Prima catena di montaggio (1870)

1970 — Primo PLC (1969)

oggi

**TEMPO**

# L'Italia nel manifatturiero mondiale

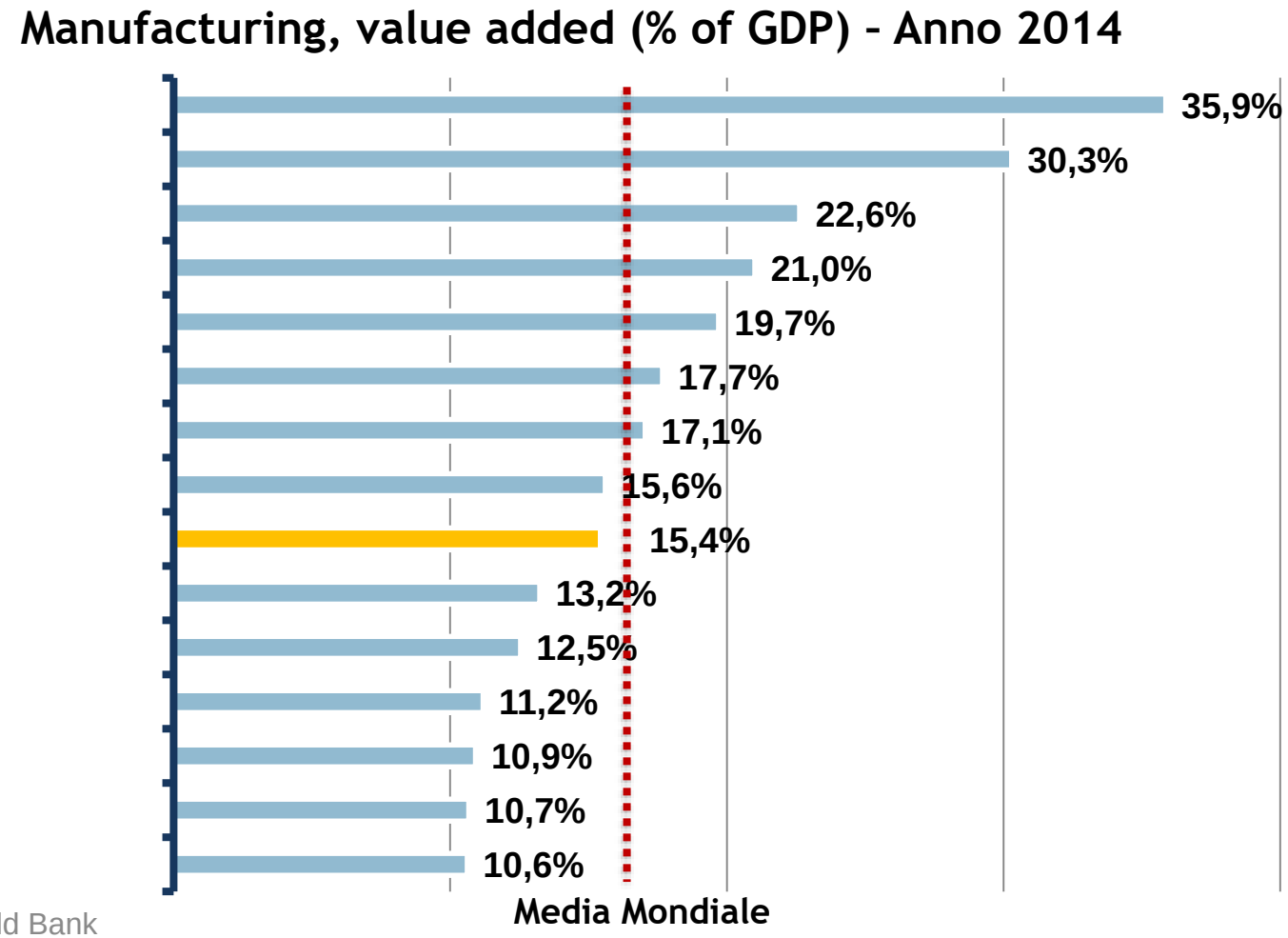
**Le Top 13 potenze manifatturiere nel Mondo**

Valore aggiunto del settore manifatturiero sul GDP Mondiale

Fonte Dati: The World Bank
*Proiezione anno 2013

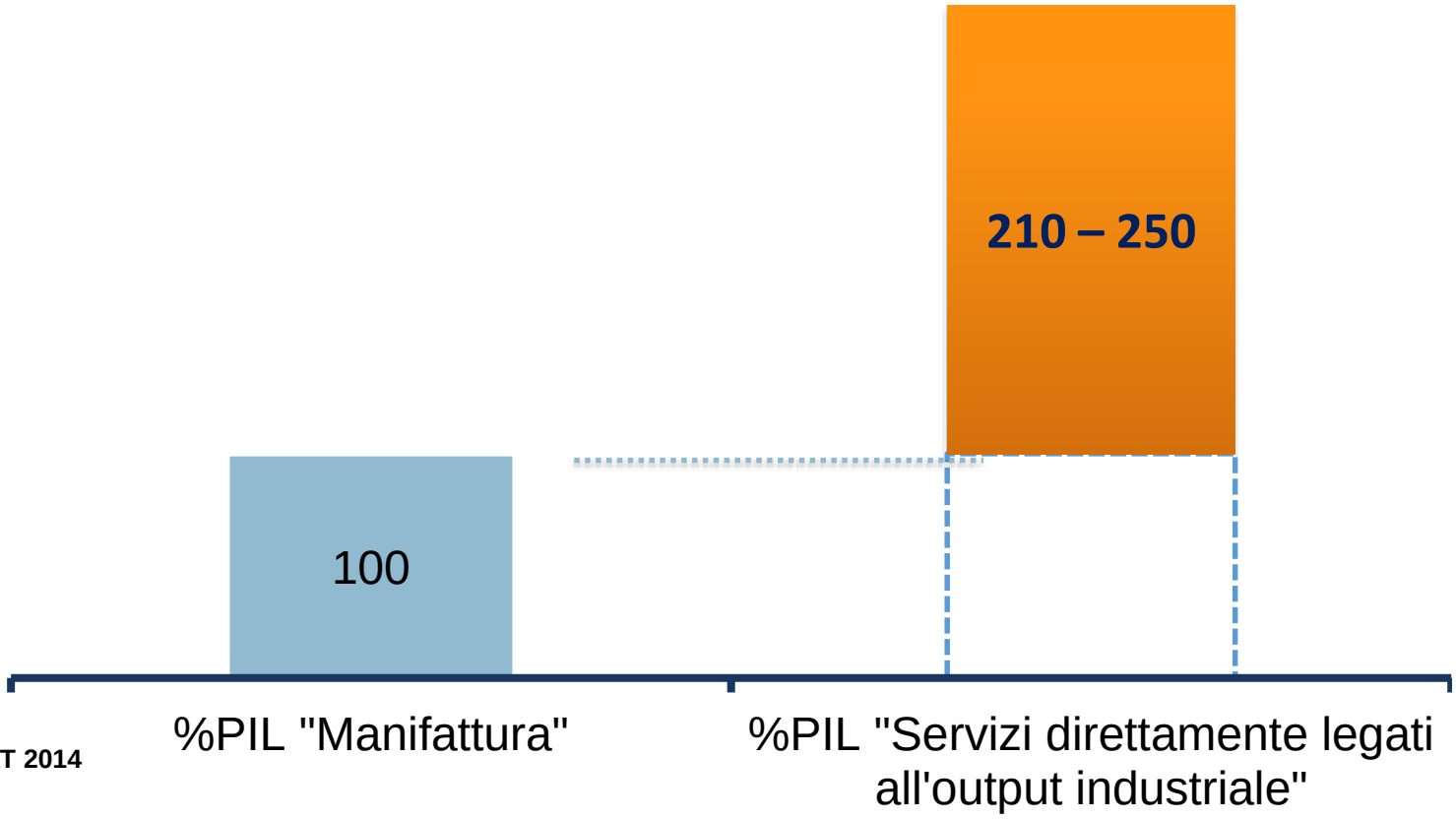
| Rank | 1990 | 2000 | 2010 | 2014 |
|---|---|---|---|---|
| 1 | Giappone | USA | Cina | Cina |
| 2 | Italia | Giappone | USA | USA* |
| 3 | Francia | Cina | Giappone | Germania |
| 4 | Regno Unito | Germania | Germania | Giappone* |
| 5 | Cina | Regno Unito | Korea, Rep. | Korea, Rep. |
| 6 | Korea, Rep. | Italia | Italia | India |
| 7 | Olanda | Francia | Brasile | Italia |
| 8 | Messico | Korea, Rep | Francia | Regno Unito |
| 9 | Svezia | Messico | India | Francia |
| 10 | Svizzera | Spagna | Regno Unito | Russia |
| 11 | India | Brasile | Russia | Brasile |
| 12 | Australia | India | Spagna | Messico |
| 13 | Argentina | Olanda | Messico | Indonesia |

# L'importanza del Manufacturing nelle economie mondiali




Fonte Dati: The World Bank
*Ultimo anno con informazione disponibile (2013)

# Il settore manifatturiero anche come motore dell'economia dei servizi




Dati ISTAT 2014

# ICT Megatrends - Technology Push Perspective

## Collaboration

- OEM – subcontractor collaboration through cloud paradigm
- Trends of contract manufacturing and ‘product as a service’
- Customer involvement in product design

## Mobility

- Proliferation of mobile devices
- ‘On-the-go’ and ‘Always-on’ users
- New businesses (manufacturing apps & manufacturing app store)

## Connectivity

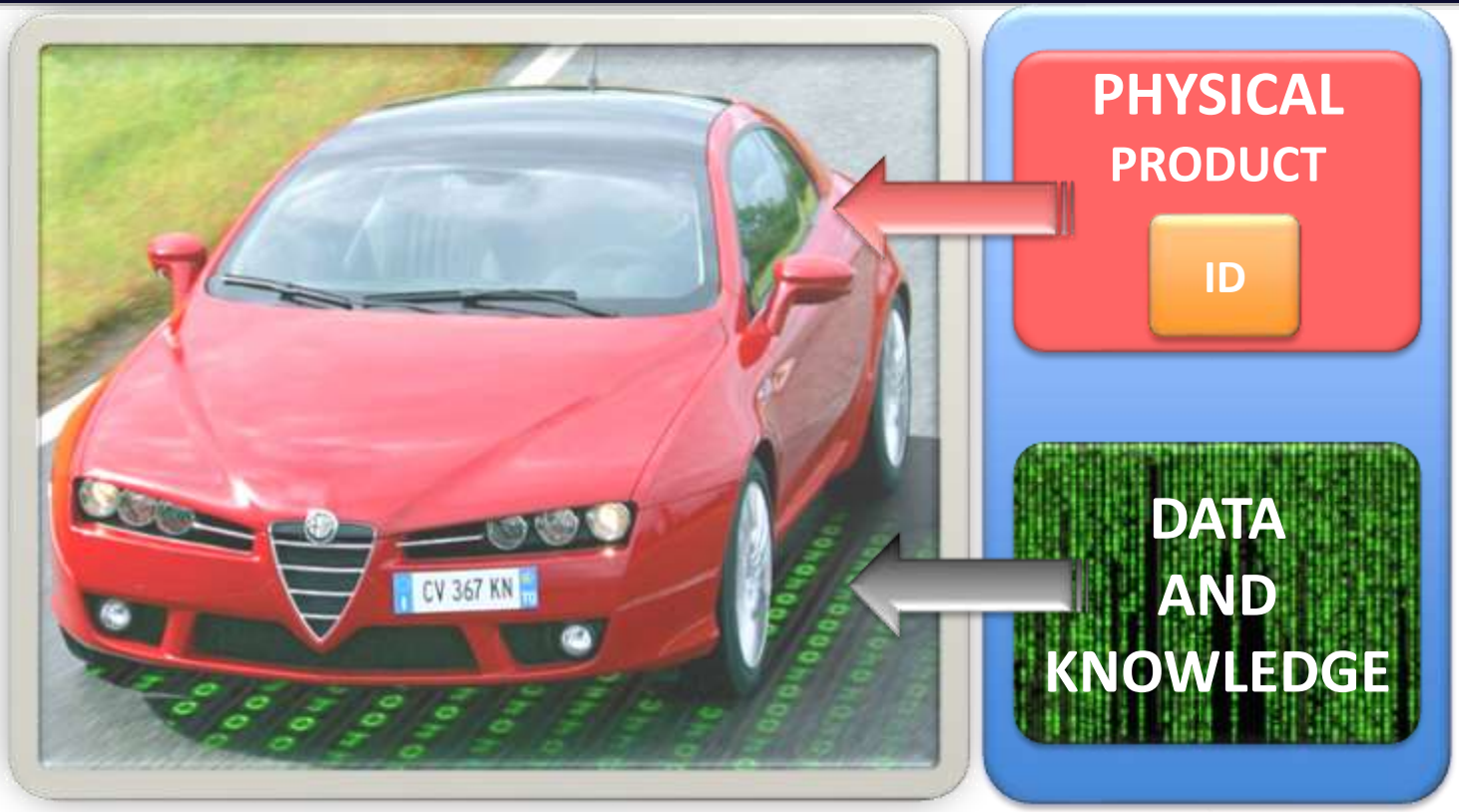
- Sensors, controllers, embedded devices a commonplace
- ‘Intranet of Things’ to ‘Internet of Things’
- Bidirectional interaction with real-world objects

## Intelligence

- Data analytics and forecasting on-the-fly
- Leveraging cheaper storage and low cost processors
- Better visualization & intelligence on manufacturing data

**Human–centric Manufacturing**

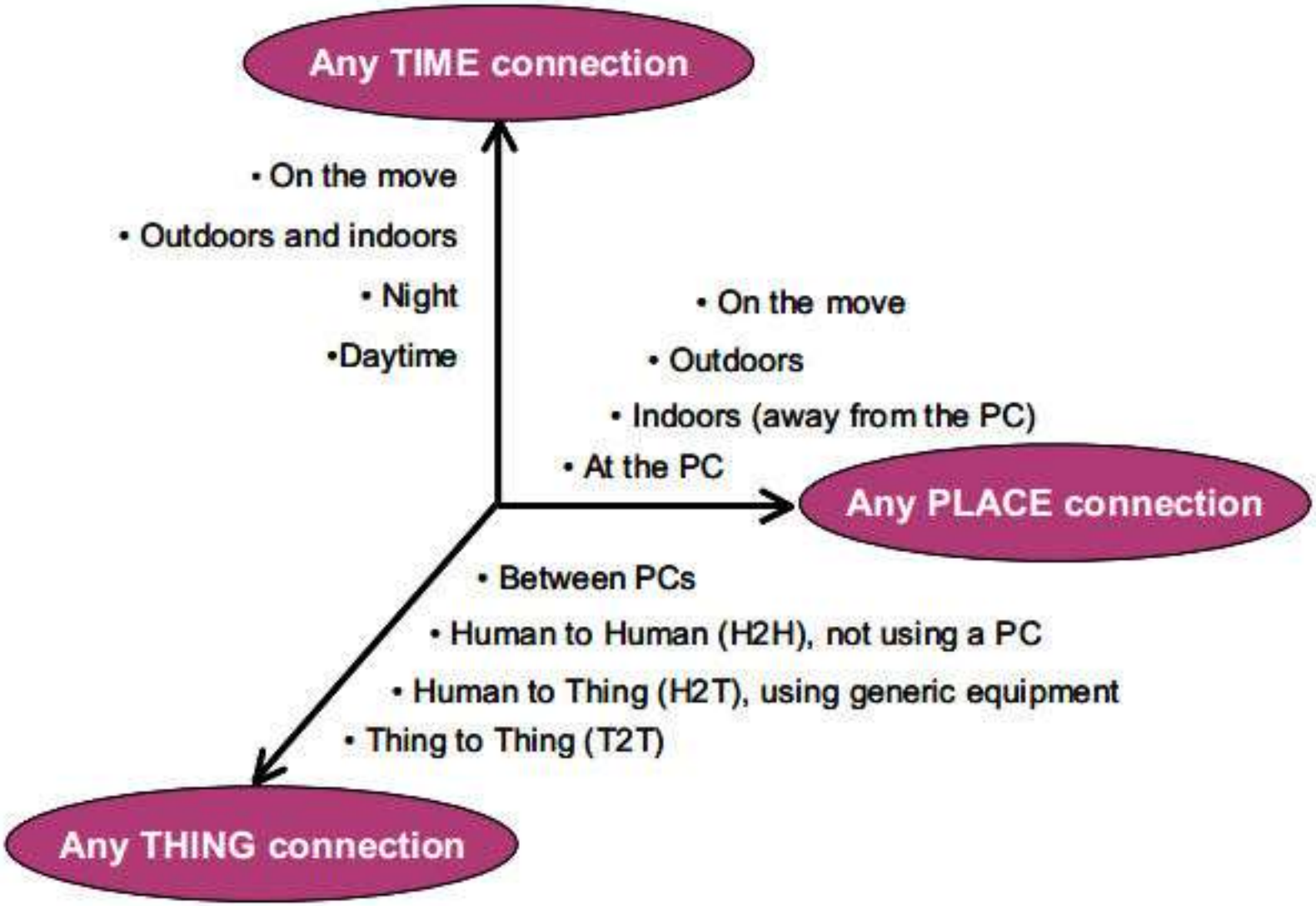
# Internet of Things: Avatar



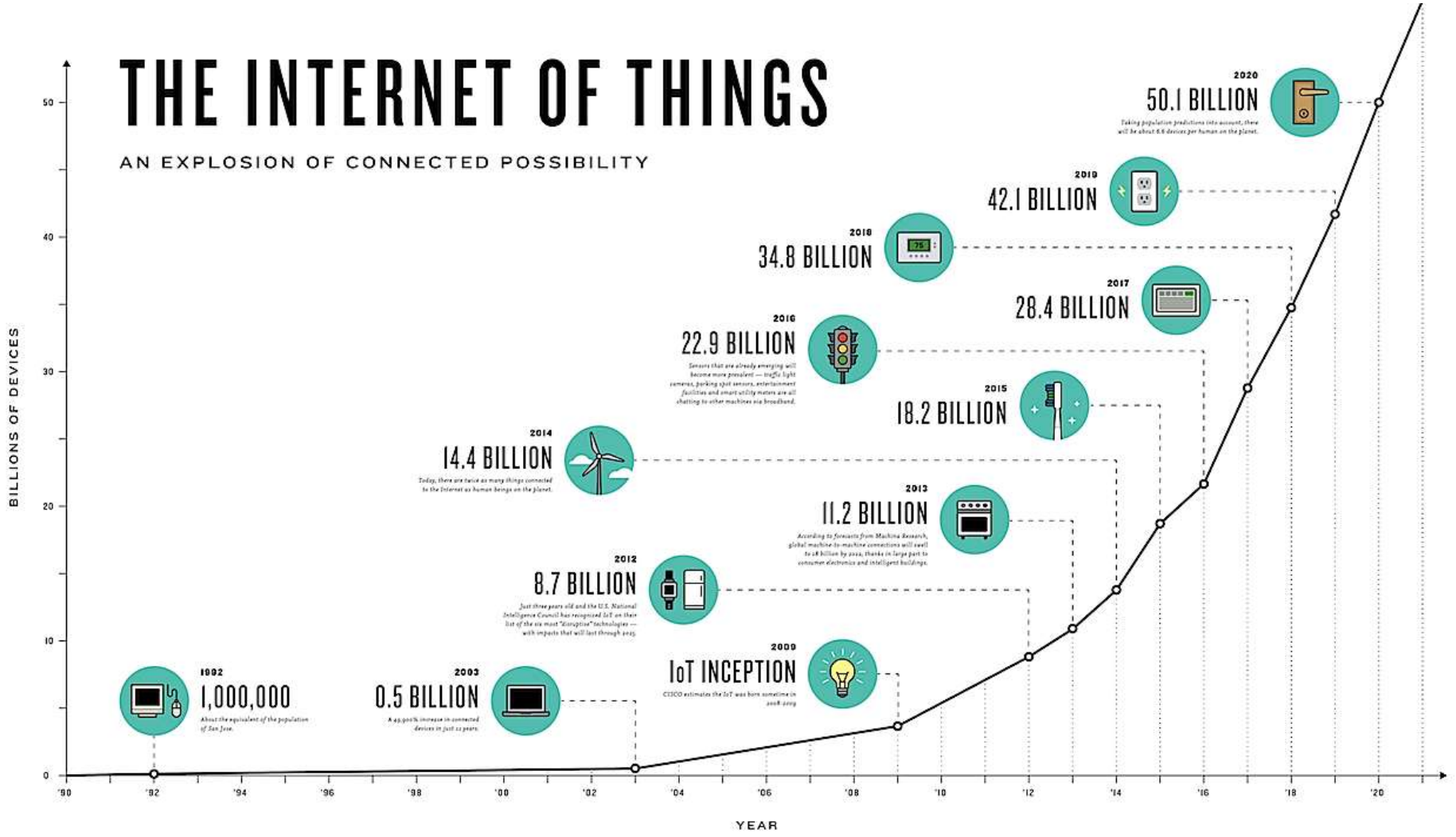

- According to some estimates there will be 50 billion mobile wireless devices connected to the Internet across the globe by 2020
- The total number of devices connected to the Internet in some way could reach 500 billion.

OECD (2012), "Machine-to-Machine Communications: Connecting Billions of Devices", *OECD Digital Economy Papers*, No. 192, OECD Publishing.

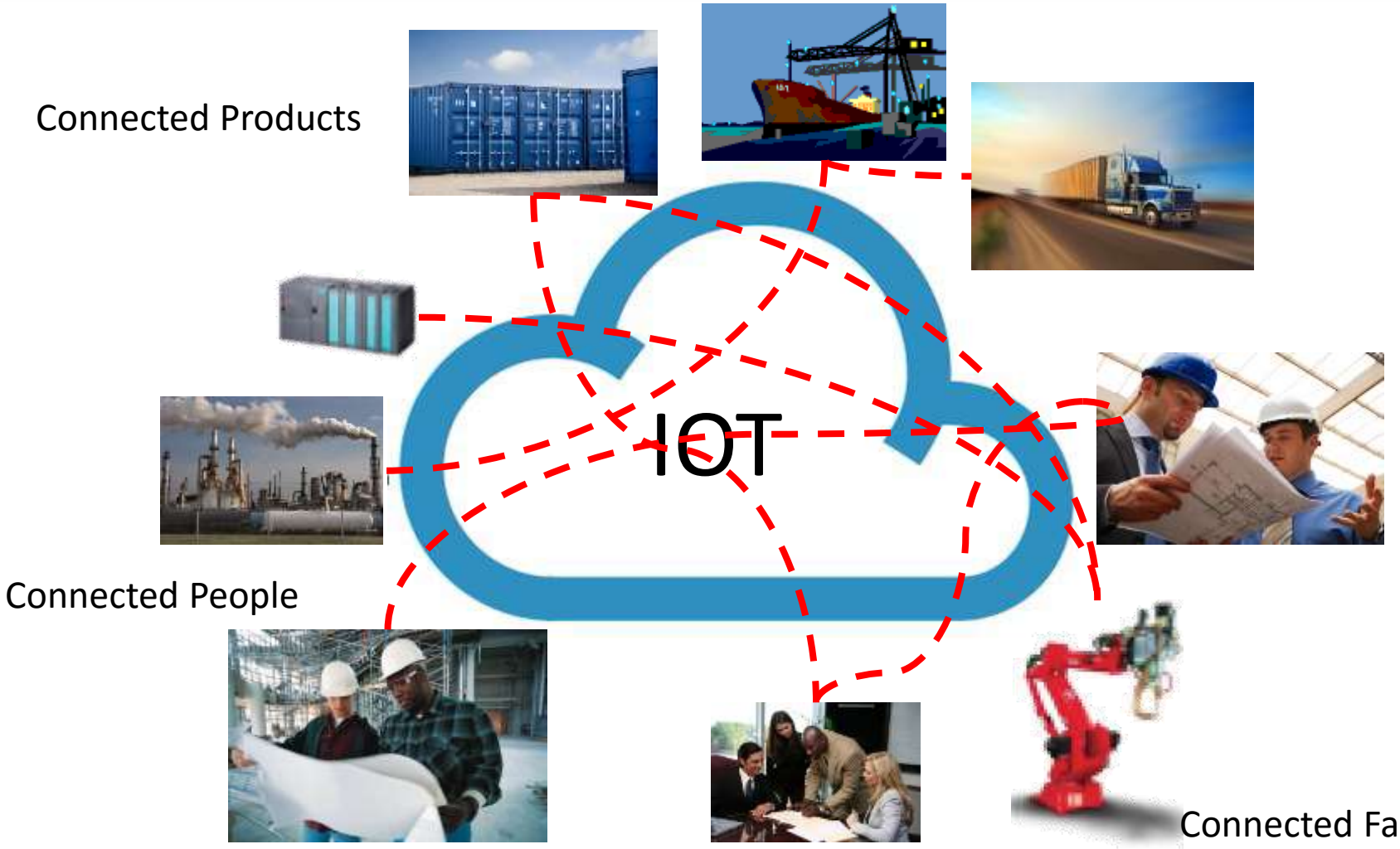
# Internet of Things



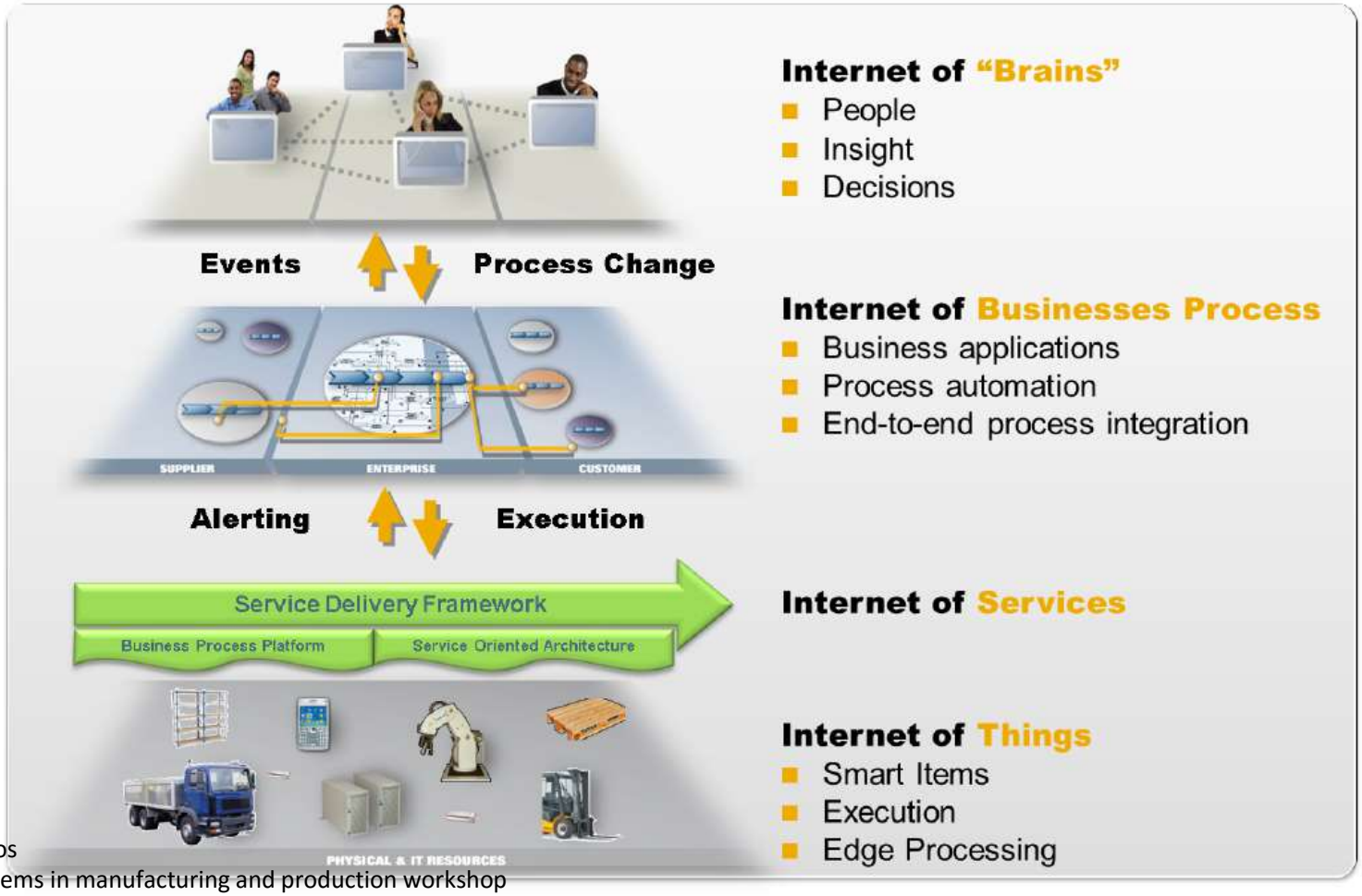
# IoT growth


THE INTERNET OF THINGS
AN EXPLOSION OF CONNECTED POSSIBILITY
BILLIONS OF DEVICES
YEAR
1992
1,000,000
2003
0.5 BILLION
2009
IoT INCEPTION
2012
8.7 BILLION
2013
11.2 BILLION
2014
14.4 BILLION
2015
18.2 BILLION
2016
22.9 BILLION
2018
34.8 BILLION
2019
42.1 BILLION
2017
28.4 BILLION
2020
50.1 BILLION

# Interconnected Manufacturing

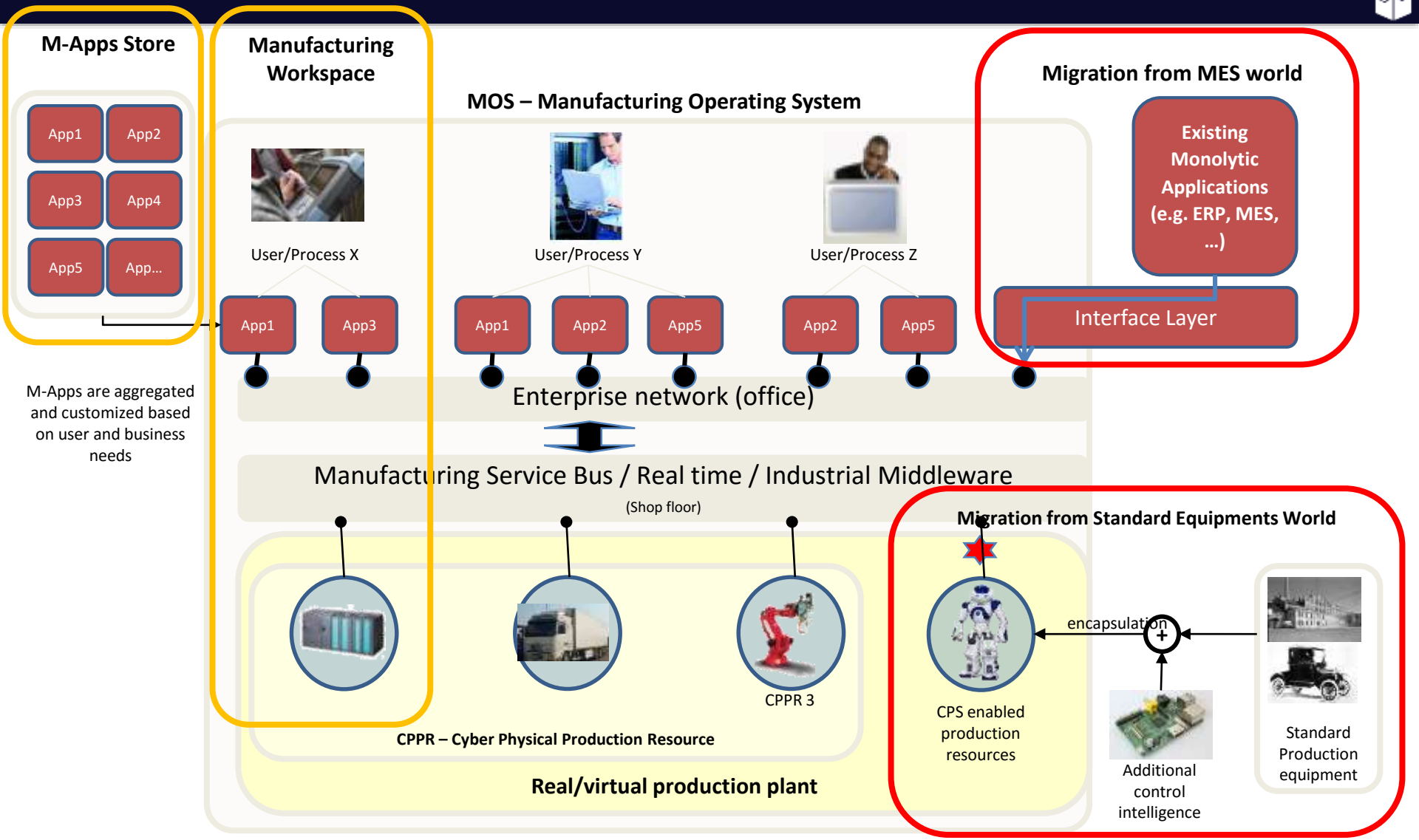


# Interconnected Manufacturing



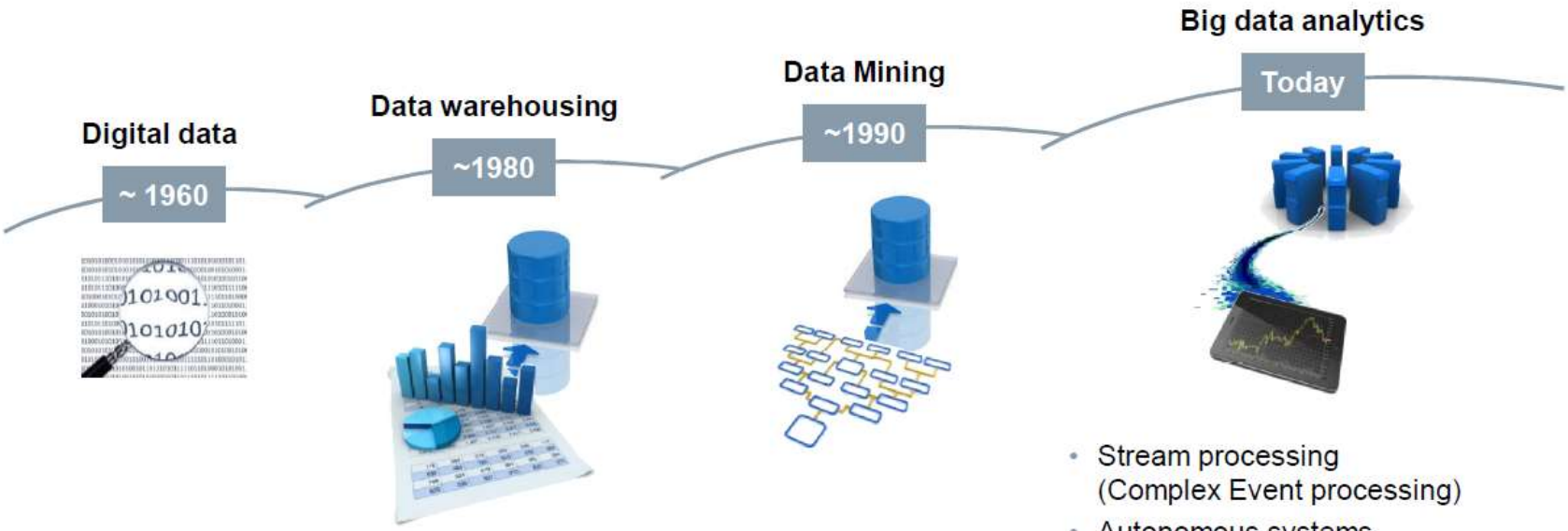

Stamatis Karnouskos
Cyber-Physical Systems in manufacturing and production workshop
Brussels 30th October 2013

# From MES to MOS (Mfg Operating System)



# Big Data

Innovation waves lifting Business Intelligence / Data Analytics




- Digital data collection
- First databases

➡ **Documentation**

- Data cubes
- Relational databases
- Financial data

➡ **Enterprise mgmt.**

- Statistics
- Artificial intelligence
- Machine learning
- Knowledge discovery
- Unstructured data

➡ **Process optimization**

- Stream processing (Complex Event processing)
- Autonomous systems
- Collective intelligence
- Massively distributed analytics
- NoSQL databases
- Heterogeneous data and knowledge
- Petabytes of data

➡ **Real-time decision support and control**

*** Cyber Physical Systems for Manufacturing and Production
Thomas Runkler, Siemens Corporate Technology
Session: The role of Cyber-Physical Systems (CPS) for manufacturing
Cyber-Physical Systems in manufacturing and production workshop Brussels 30th October 2014

# Cloud computing

# Cyber-physical systems (CPS) enable the future of Manufacturing

## Communication everywhere and every time

- Future infrastructure will support the access to information everywhere and every time without any specific installation / parameterization needs

## Production and products will be intelligent

- Production resources will be autonomic and will connect to each other (M2M)
- Products know their own production systems

## Digital and real world will merge

- Each real object will have a digital shadow, which reflects the characteristics of the real object

*** Cyber Physical Systems for Manufacturing and Production
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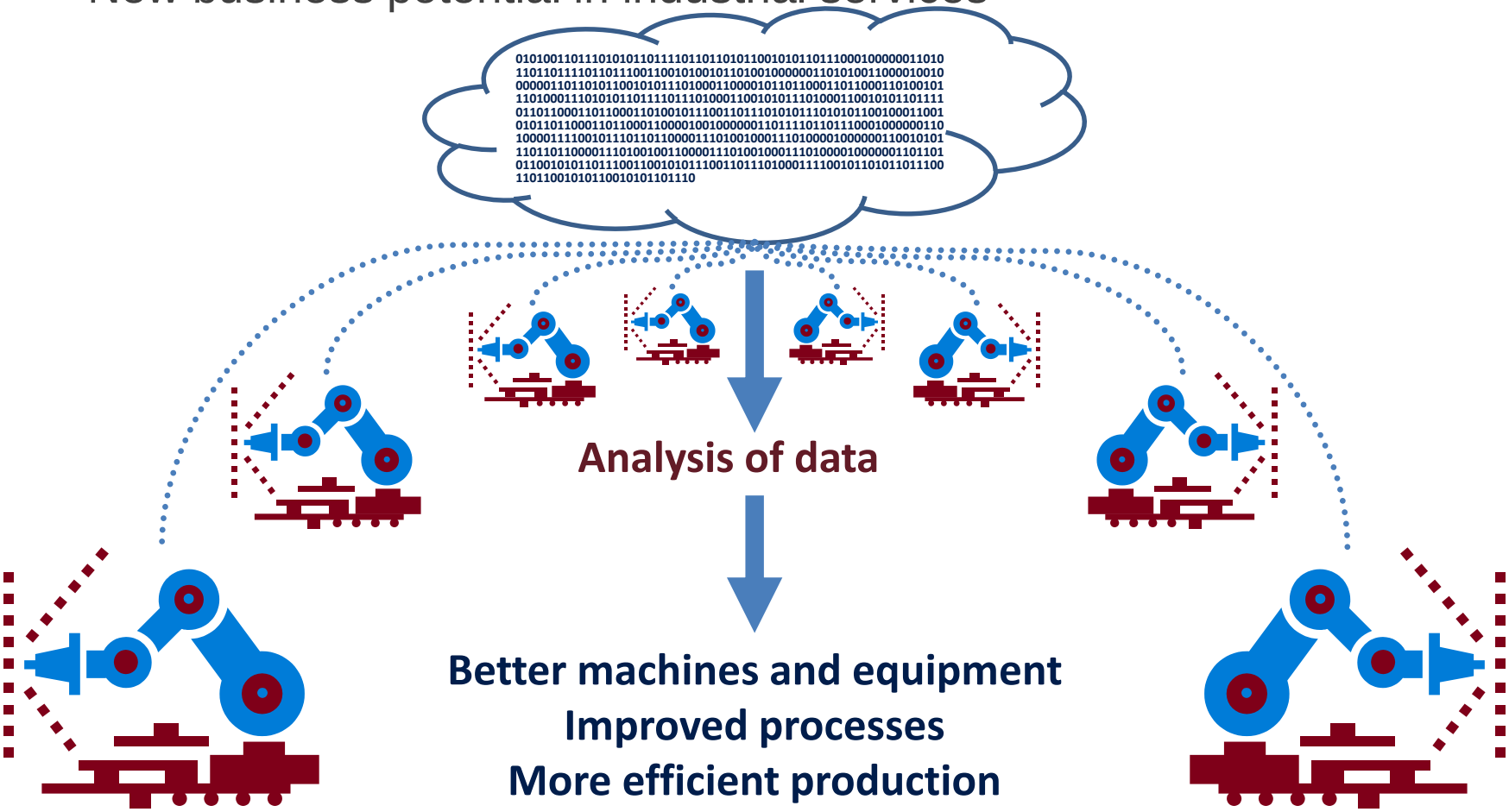
# Cognitive Automation

# Industrial Internet creates opportunities

- New business potential in industrial services



# Cyber Security in Manufacturing


The Washington Post

Washington, DC May 28, 2013 Edition: U.S. Regional Make us your

**Weapons designs compromised by Chinese hackers**

Ellen Nakashima 10:54 PM ET





**Cyber Security**

**German jitters over cyber attacks**

**W32.Stuxnet Dossier**

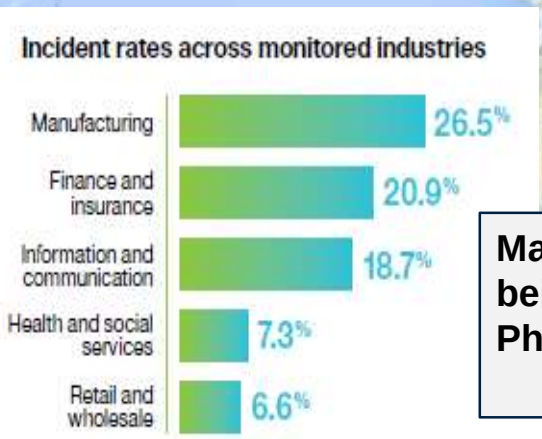
Version 1.4 (February 2011)

Symantec Security Response

MANDIANT

WHO'S SPYING ON YOU?

No business is safe from cyber-espionage




Security Intelligence Index 2014

**Manufacturing: a 1 in 3 chance of being targeted by at least one Spea Phishing attack in 2013**

Symantec Internet Security Report 2014

verizon 2014 DATA BREACH INVESTIGATIONS REPORT

KASPERSKY

# Advanced Manufacturing Processes

Advanced manufacturing processes that will be focused on by the 'Factories of the Future' partnership are:

- Additive manufacturing (i.e. 3D Printing)
- Photonics-based materials processing technologies
- Shaping technology
- High productivity & 'self-assembly' technologies (see video)
- Methods for the handling parts, metrology & inspection
- Flexible sheet-to-sheet & roll-to-roll
- Innovative physical, chemical & physiochemical processes
- Replication equipment for flexible, scalable production
- Integration of non-convention technologies

## Table 3b: Global CEO Survey: Global drivers of manufacturing competitiveness index ranking

*Executives rank key drivers that impact a country's ability to compete in manufacturing*

| Overall rank (1–10) | Overall index score | Main driver | Most important sub-components | Sub-component rank (1-40) |
|---|---|---|---|---|
| 1 | 10.00 | Talent-driven innovation | Quality and availability of researchers, scientists, and engineers<br>Quality and availability of skilled labor | 1<br>2 |
| 2 | 8.42 | Economic, trade, financial and tax system | Tax rate burden and system complexity<br>Clarity and stability of regulatory, tax and economic policies | 3<br>5 |
| 3 | 8.07 | Cost and availability of labor and materials | Cost competitiveness of materials<br>Availability of raw materials | 11<br>21 |
| 4 | 7.76 | Supplier network | Cost competitiveness of local suppliers<br>Ability of supply base to innovate in products and processes | 8<br>9 |
| 5 | 7.60 | Legal and regulatory system | Stability and clarity in legal and regulatory policies<br>Labor laws and regulations | 7<br>13 |
| 6 | 6.47 | Physical infrastructure | Quality and efficiency of electricity grid, IT and telecommunications network<br>Quality and efficiency of roads, airports, ports, and railroad networks | 4<br>16 |
| 7 | 6.25 | Energy cost & policies | Cost competitiveness of energy<br>Ongoing investments to improve and modernize energy infrastructure | 14<br>20 |
| 8 | 3.99 | Local market attractiveness | Size and access of the local market<br>Intensity of local competition | 27<br>36 |
| 9 | 2.48 | Healthcare system | Cost of quality healthcare for employee and society<br>Regulatory policies (e.g., pollution, food safety, etc.) that are enforced to protect public health | 26<br>33 |
| 10 | 1.00 | Government investments in manufacturing and innovation | Government investments in R&D: science, technology, engineering and manufacturing<br>Private and public sector collaboration for long-term investments in R&D: science, technology, engineering and manufacturing | 29<br>30 |

Source: Deloitte Touche Tohmatsu Limited and U.S. Council on Competitiveness, 2013 Global Manufacturing Competitiveness Index
Note: See Appendix B1 for full list of 40 sub-components and associated ranking

# Knowledge Workers

Factories of the future are expected to create a large amount of employment opportunities for citizens. Factory workers are key to competitiveness but challenges such as changing demographics & news skills must be addressed.

Policies should address the following items:

- New approaches to accommodate different demographics
- New technical, educational & organisational ways to increase attractiveness of factory work
- New approaches to development of skills & competences
- New ways to organise factories: Human-centred work environments
- Ways to integrate future factory work into social patterns

# Llotja de Mar, Barcelona 3-4 May 2016

*"From Global Challenges to Grand Manufacturing Opportunities"*

High-level speakers from Bosch, COMAU, Dassault Systemès, IBM, KUKA, McKinsey, PTC, Schneider Electric, SAP, Siemens and many more.

**Panel "Digitalizing Manufacturing"**
Policy makers and key industry players will discuss strategies such as Industry 4.0 and the Internet of Things

WMF 2016 BARCELONA
World Manufacturing Forum

| www.worldmanufacturingforum.org |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# Who am I

- Professor of Advanced and Sustainable Manufacturing @ Politecnico di Milano
- 40-people group on Manufacturing Engineering and Management
- Member of the Board of the Factory of the Future cPPP
- Technology Foresight expert
  - Coordination of 4 Technological Foresight Roadmaps on Manufacturing over the last 10 years
- 25 EU Funded projects for a total amount of 12,9 M€ funding since Jan 2009
- Scientific Chairman of the World Manufacturing Forum
- Consultant and advisor to large Italian Enterprises

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