A 4ª Revolução Industrial

Rui Rosa

A 4ª Revolução Industrial

1. Como chegámos aqui
   – os pressupostos
2. Onde estamos
   – o fim da 3ª revolução industrial
3. O que estamos a fazer
   – 4ª revolução industrial
4. O impacto e valor da 4ª RI
   – o que muda, valor económico
5. O que falta e os perigos
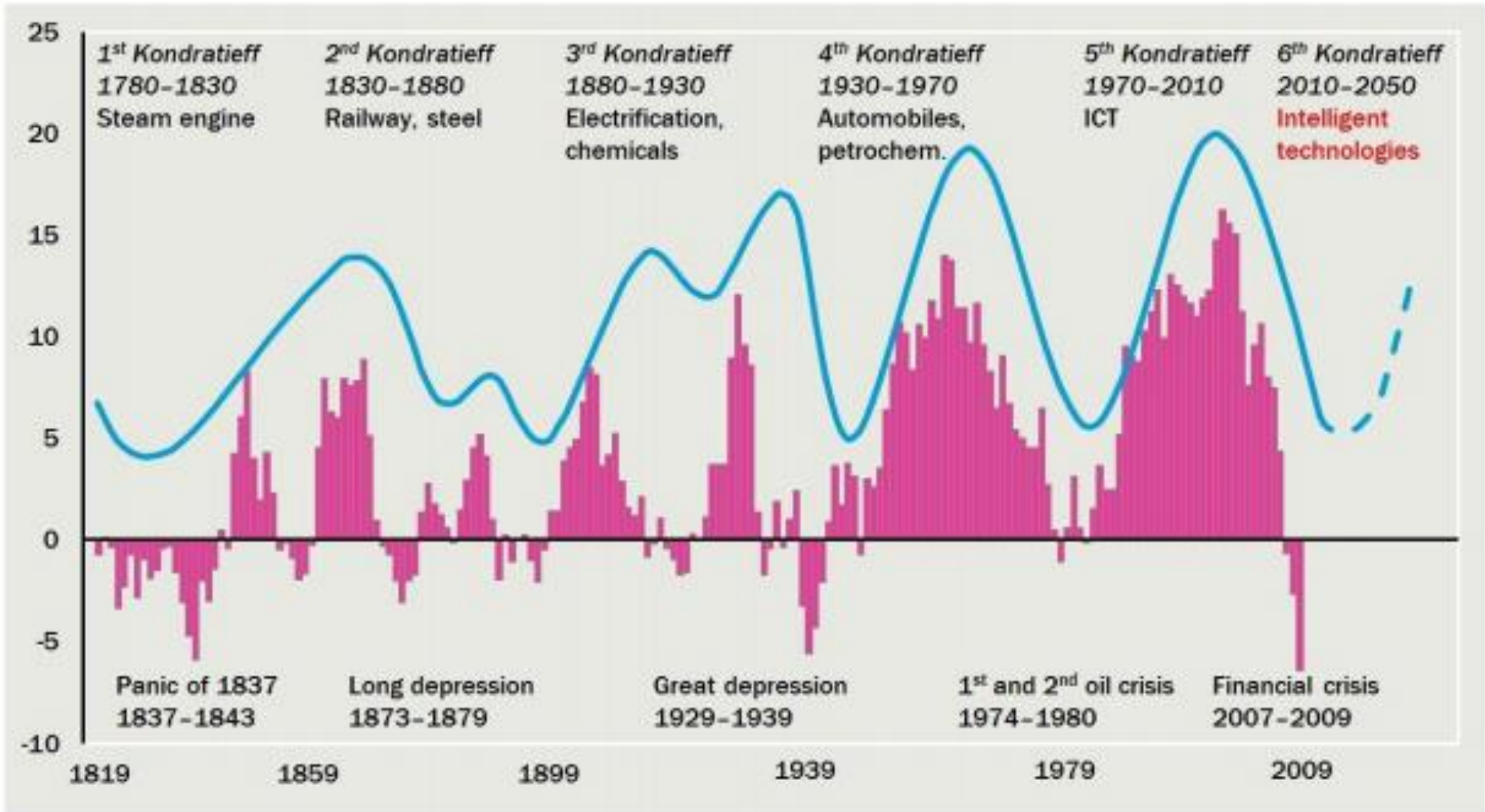   – investimento, maturação, energia, legislação, economia
6. Conclusão

Foco no desenvolvimento e impacto da tecnologia

COMO CHEGÁMOS AQUI
A HISTÓRIA REPETE-SE

Surtos de desenvolvimento
e tecnologia – Teoria das ondas de Kondratieff

1st Kondratieff 1780–1830 Steam engine
2nd Kondratieff 1830–1880 Railway, steel
3rd Kondratieff 1880–1930 Electrification, chemicals
4th Kondratieff 1930–1970 Automobiles, petrochem.
5th Kondratieff 1970–2010 ICT
6th Kondratieff 2010–2050 Intelligent technologies

Panic of 1837 1837–1843
Long depression 1873–1879
Great depression 1929–1939
1st and 2nd oil crisis 1974–1980
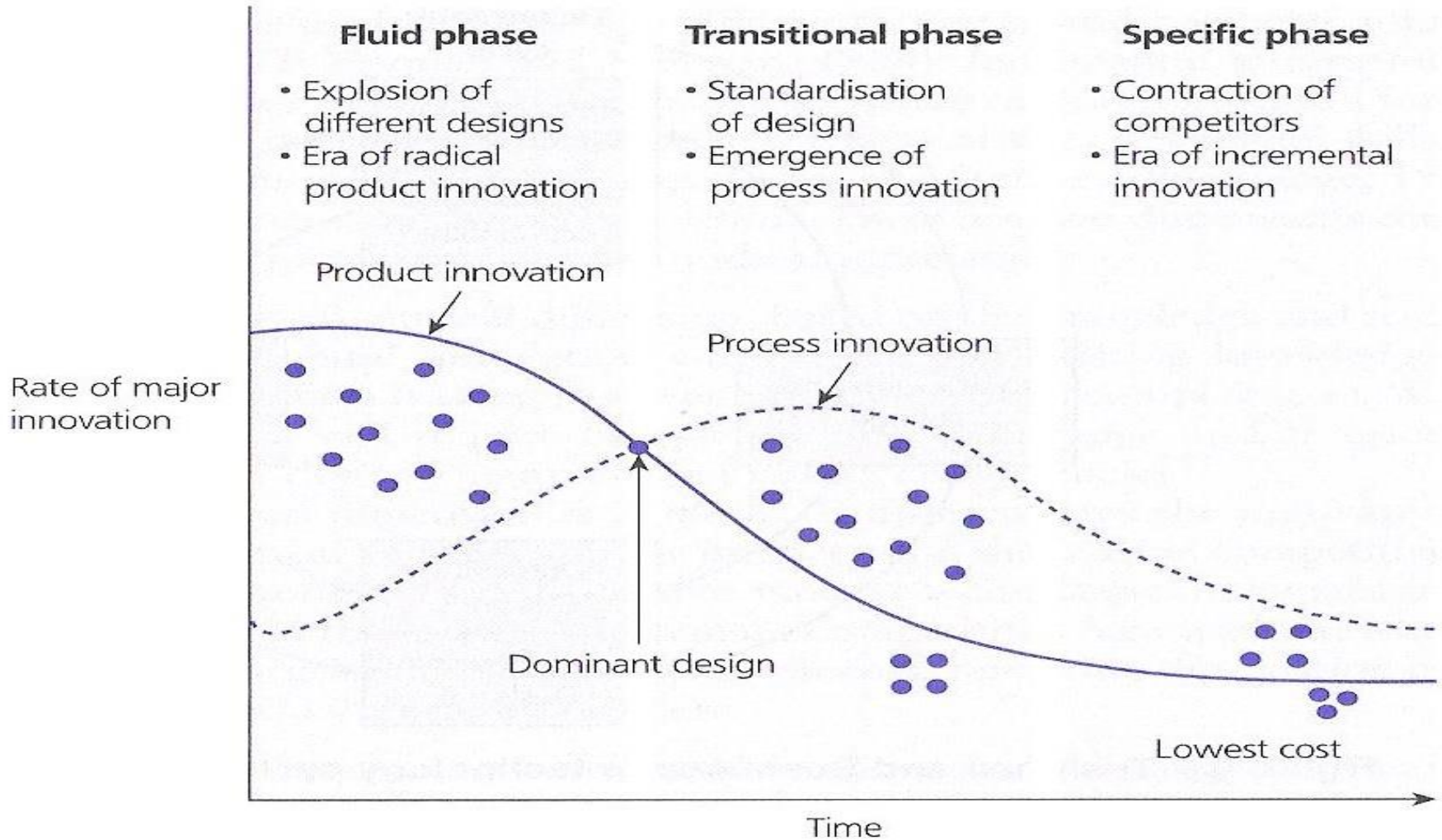Financial crisis 2007–2009

SURFING THE SIXTH WAVE
Exploring the next 40 years of global change   Markku Wilenius and Sofi Kurki

Difusão, assimilação e domínio
tecnológico

Fluid phase
- Explosion of different designs
- Era of radical product innovation

Transitional phase
- Standardisation of design
- Emergence of process innovation

Specific phase
- Contraction of competitors
- Era of incremental innovation

Product innovation

Process innovation

Rate of major innovation

Dominant design

Lowest cost

Time

Abernathy and Utterback's three phases of innovation

Source: Utterback (1994).

Combinação de fatores
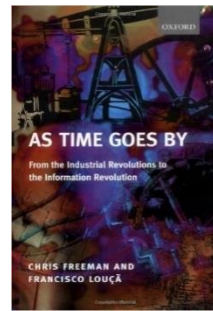
TABLE II.1. Condensed summary of the Kondratiev waves

Constellation of technical and organizational innovations	Examples of highly visible, technically successful, and profitable innovations	'Carrier' branch and other leading branches of the economy	Core input and other key inputs	Transport and communication infrastructure	Managerial and organizational changes	Approx. timing of the 'upswing' (boom) / 'downswing' (crisis of adjustment)
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1. Water-powered mechanization of industry	Arkwright's Cromford mill (1771) / Henry Cort's 'puddling' process (1784)	Cotton spinning Iron products Water wheels Bleach	Iron Raw cotton Coal	Canals Turnpike roads Sailing ships	Factory systems Entrepreneurs Partnerships	1780s–1815 / 1815–1848
2. Steam-powered mechanization of industry and transport	Liverpool–Manchester Railway (1831) / Brunel's 'Great Western' Atlantic steamship (1838)	Railways and railway equipment Steam engines Machine tools Alkali industry	Iron Coal	Railways Telegraph Steam ships	Joint stock companies Subcontracting to responsible craft workers	1848–1873 / 1873–1895
3. Electrification of industry, transport, and the home	Carnegie's Bessemer steel rail plant (1875) / Edison's Pearl St. New York Electric Power Station (1882)	Electrical equipment Heavy engineering Heavy chemicals Steel products	Steel Copper Metal alloys	Steel railways Steel ships Telephone	Specialized professional management systems 'Taylorism' Giant firms	1895–1918 / 1918–1940
4. Motorization of transport, civil economy, and war	Ford's Highland Park assembly line (1913) / Burton process for cracking heavy oil (1913)	Automobiles Trucks Tractors, tanks Diesel engines Aircraft Refineries	Oil Gas Synthetic materials	Radio Motorways Airports Airlines	Mass production and consumption 'Fordism' Hierarchies	1941–1973 / 1973–
5. Computerization of entire economy	IBM 1401 and 360 series (1960s) Intel microprocessor (1972)	Computers Software Telecommunication equipment Biotechnology	'Chips' (integrated circuits)	'Information Highways' (Internet)	Networks; internal, local, and global	??

AS TIME GOES BY
From the Industrial Revolutions to the Information Revolution
CHRIS FREEMAN AND FRANCISCO LOUÇÃ

ONDE ESTAMOS

A Infraestrutura - As inovações base

A 3ª Revolução industrial

1st	2nd	3rd
Mechanization, water power, steam power	Mass production, assembly line, electricity	Computer and automation
Mecanização (músculo)	Industrialização (músculo)	Digitalização (cérebro)
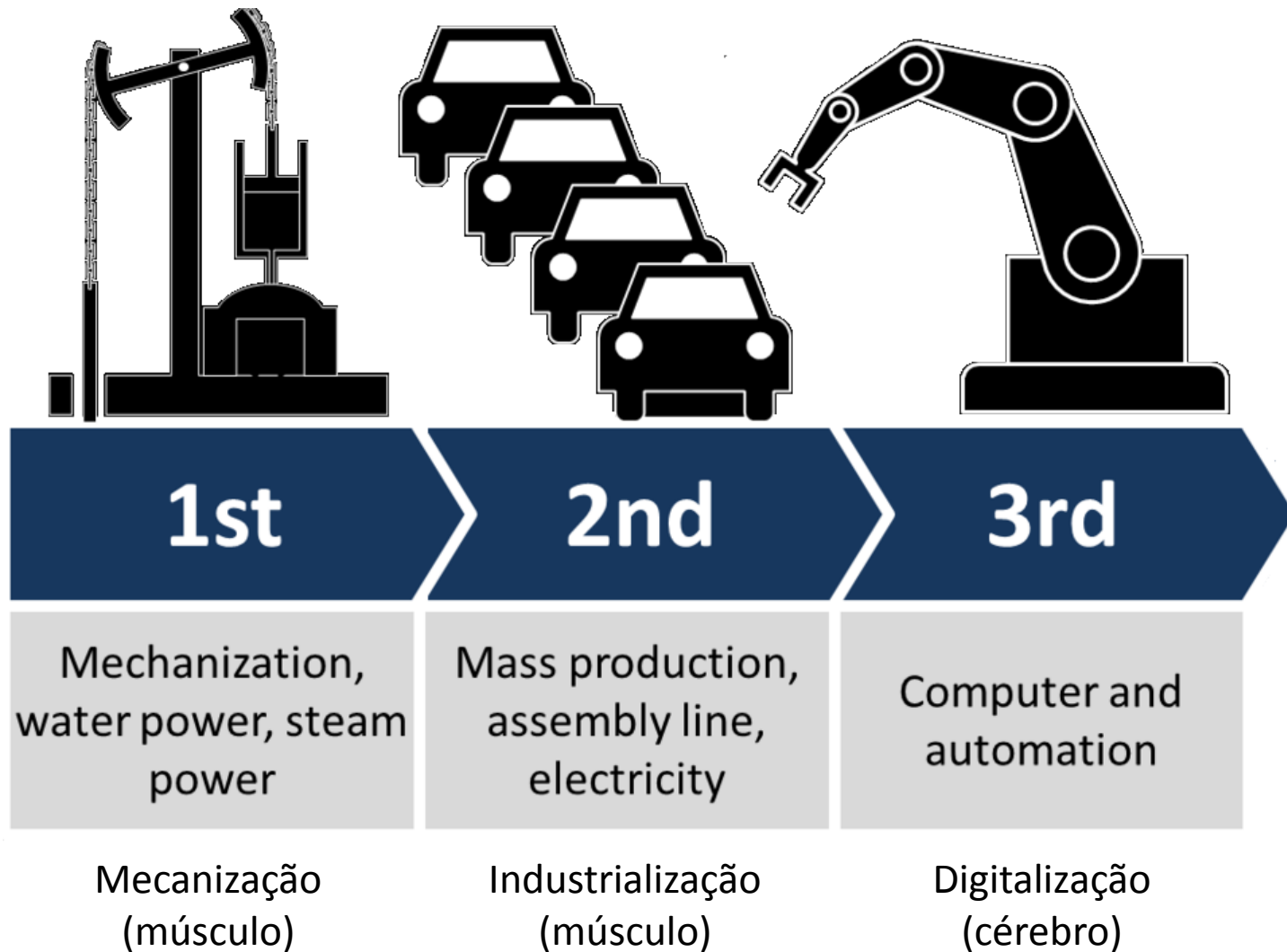
Onde estamos
Fase 1 – A era das TIC (Y2K Bug)

Computador
Comunicações
Telemóvel

Internet
World Wide Web
Aplicações Informáticas

Onde estamos
Fase 1 – A era das TIC

Global IP Traffic & Service Adoption Drivers

By 2019:

IP Broadband Growth Projections

	2014	2019
More Internet Users	2.8 Billion	3.9 Billion
More Devices & Connections	14.2 Billion	24.4 Billion
Faster Broadband Speeds	20.3 Mbps	42.5 Mbps
More Video Viewing	67% of Traffic	80% of Traffic

Source: Cisco VNI Global IP Traffic Forecast, 2014–2019

Onde estamos
Fase 2 – "Big Data & Analytics"

THE BIG DATA ERA

VOLUME
VARIETY
VELOCITY
VALUE

DATA SIZE

BIG DATA

INFORMATION OVERLOAD

RELEVANT DATA

TODAY

THE FUTURE

2009 **0.8** ZETTABYTES

2020 **35.2** ZETTABYTES

44 x

Harvard Business Review
Big Data: The Management Revolution (Out 2012)

McKinsey&Company
Big data: The next frontier for innovation, competition, and productivity (Mai 2011)
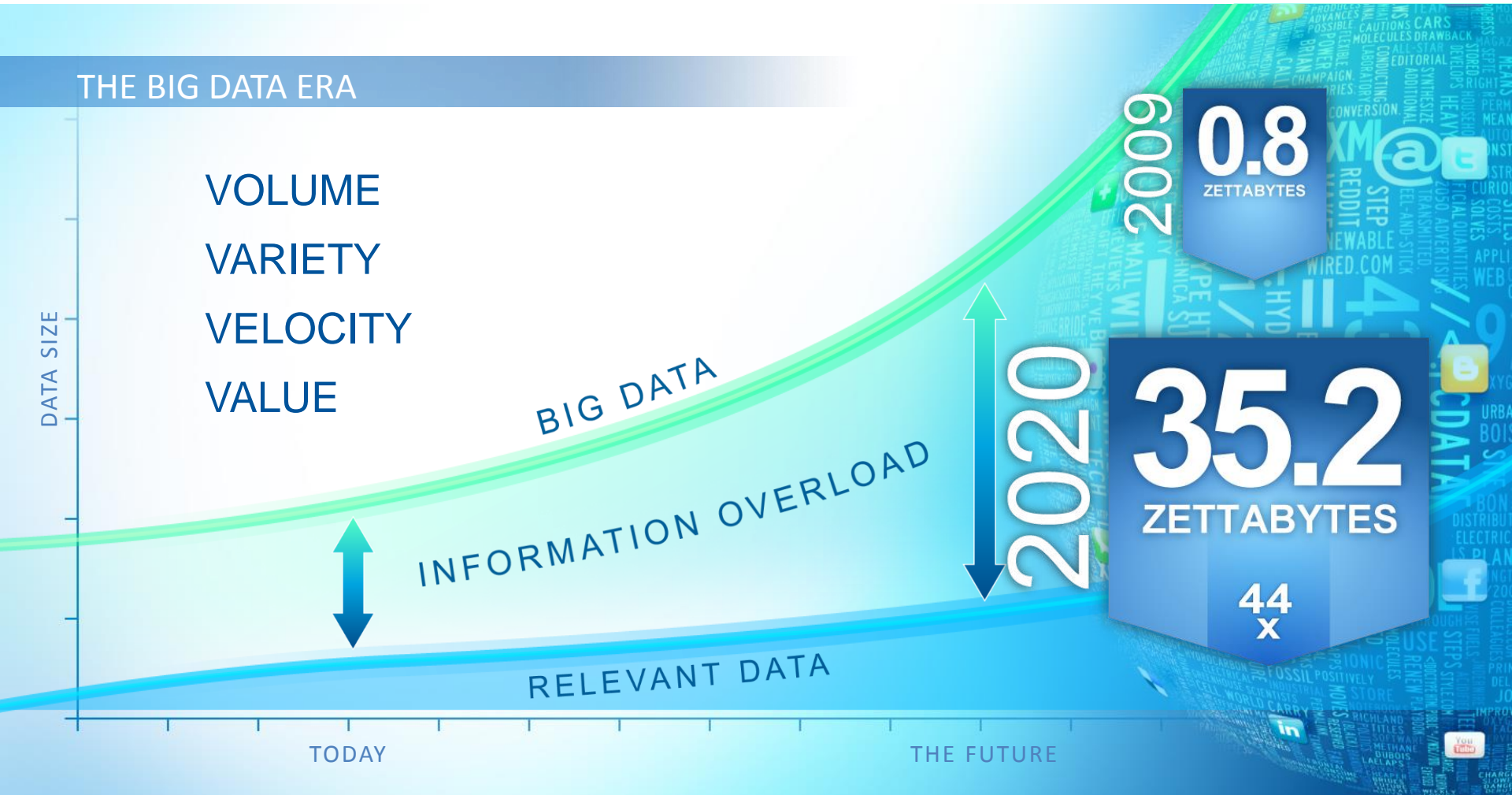
Onde estamos
Fase 2 – "Big Data & Analytics"

- "We create as much information in two days now as we did from the dawn of man through 2003."
  Eric Schmidt at Techonomy (2010); http://techcrunch.com/2010/08/04/schmidt-data/

- "Every day, we create 2.5 quintillion (Eb) bytes of data"
  IBM (2013); http://www-01.ibm.com/software/data/bigdata/what-is-big-data.html

- "A full 90% of all the data in the world has been generated over the last two years."
  SINTEF (2013); http://www.sintef.no/home/Press-Room/Research-News/Big-Data--for-better-or-worse/

- "From now until 2020, the digital universe will about double every two years."
  IDC (2012); http://www.emc.com/collateral/analyst-reports/idc-the-digital-universe-in-2020.pdf

- "One Out of Two in Internet "
  Internet World Stats (2016); http://www.internetworldstats.com/

Onde estamos
Fase 3 – A 3ª plataforma de TIC

THE THIRD PLATFORM

The Third Platform is described by IDC as the next-generation compute platform that is accessed from mobile devices, utilizes Big Data, and is cloud based.

3RD PLATFORM

Mobile   Big Data   Social

CLOUD

BILLIONS OF USERS

MILLIONS OF APPS

2ND PLATFORM

LAN/Internet   Client/Server

DISTRIBUTED

HUNDREDS OF MILLIONS OF USERS

TENS OF THOUSANDS OF APPS

1ST PLATFORM

Mainframe, Mini Computer

MAINFRAMES

MILLIONS OF USERS

THOUSANDS OF APPS
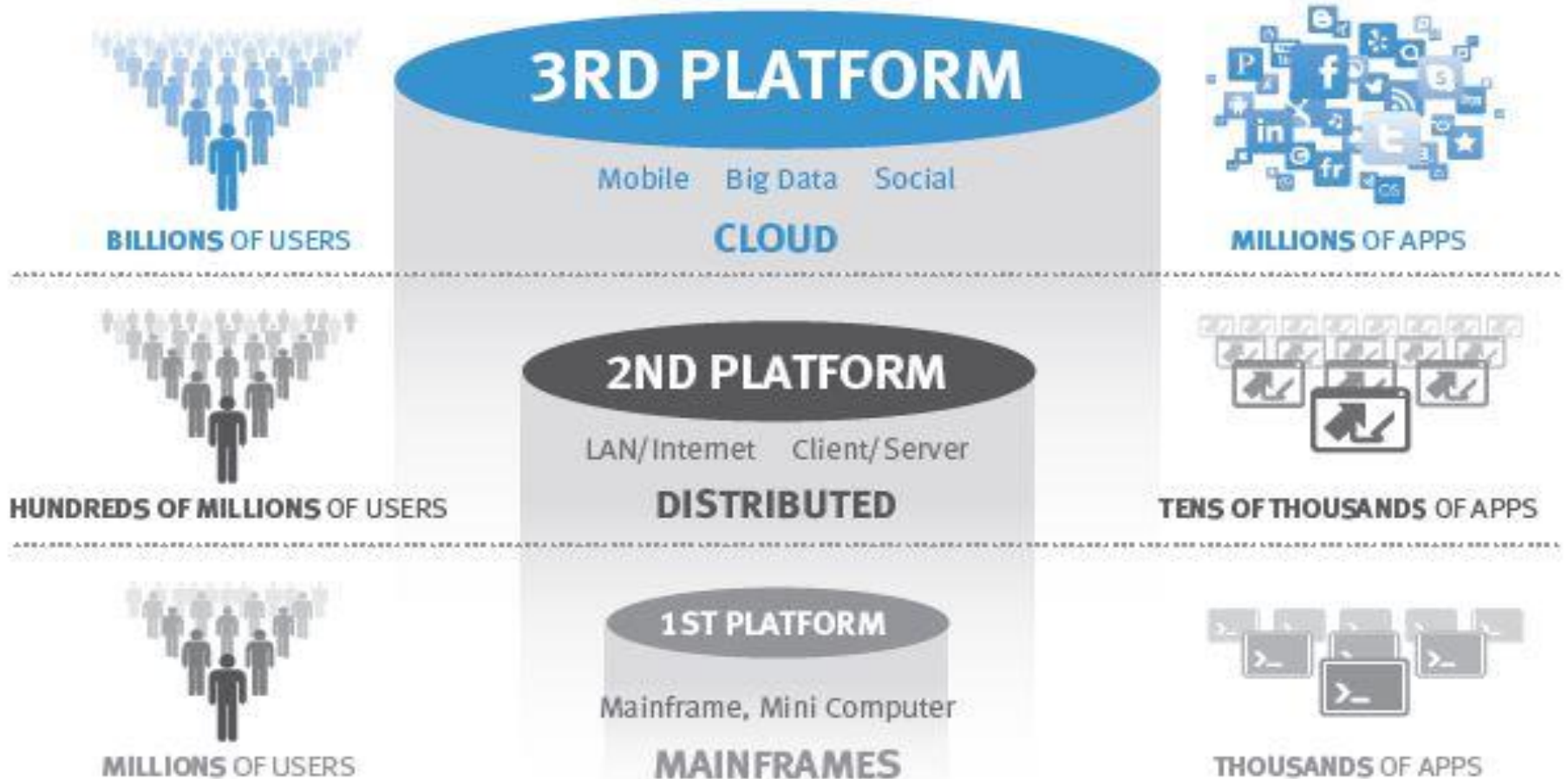
Onde estamos

Fase 4 – Internet das Coisas e Aceleradores

Low cost processors
and sensors

Low cost
communications

Onde estamos
Fase 4 – Internet das Coisas

ACCORDING TO **ABI RESEARCH** MORE THAN 30 BILLION DEVICES WILL BE WIRELESSLY CONNECTED TO THE INTERNET BY 2020.

	2003	2010	2015	2020
World Population	6.3 Billion	6.8 Billion	7.2 Billion	7.6 Billion
Connected Devices	500 Million	12.5 Billion	25 Billion	50 Billion
Connected Devices Per Person	0.08	1.84	3.47	6.58

More connected devices than people
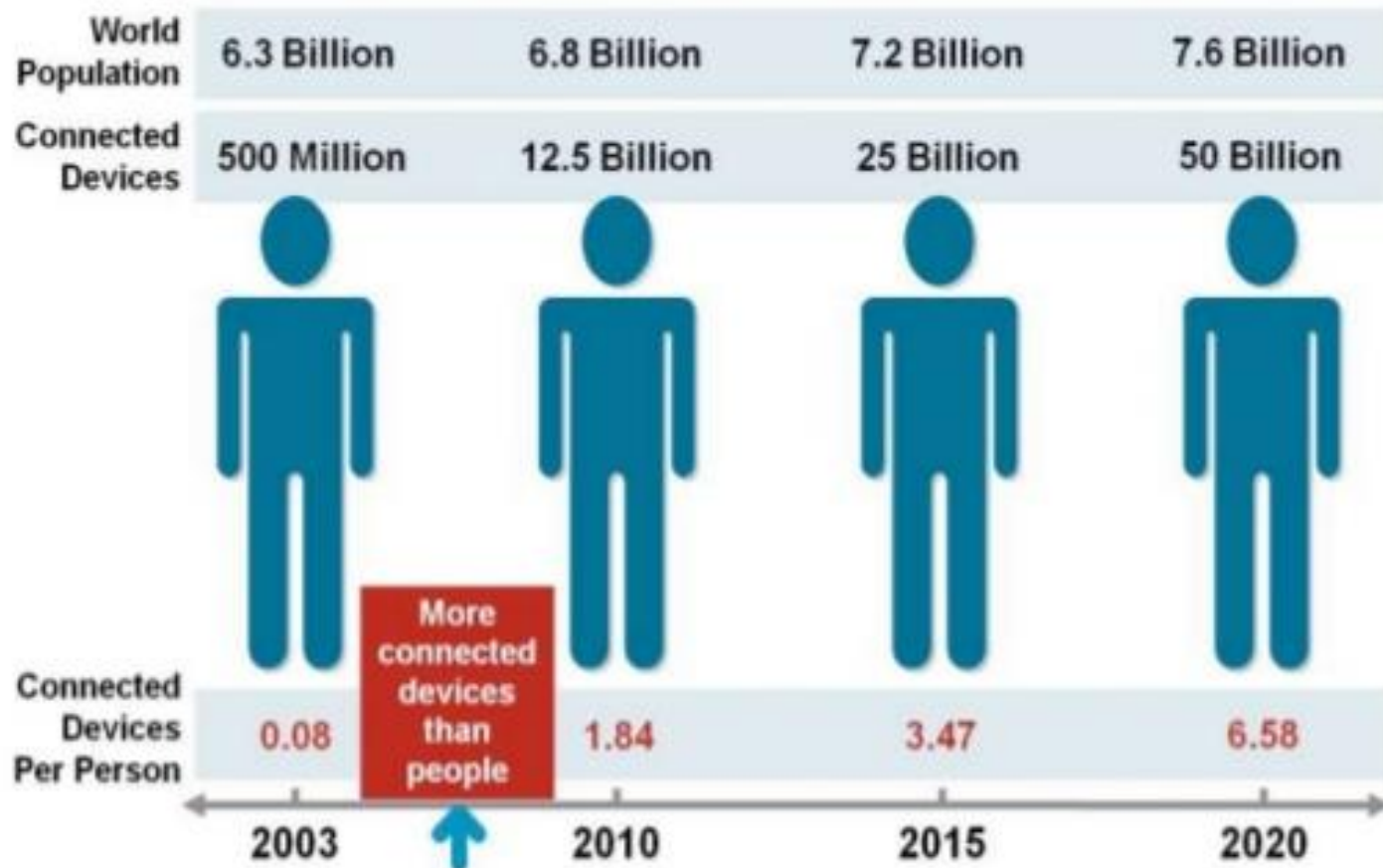
Onde estamos

Fase 4 – Crescimento dos dispositivos conectados

GSM Association
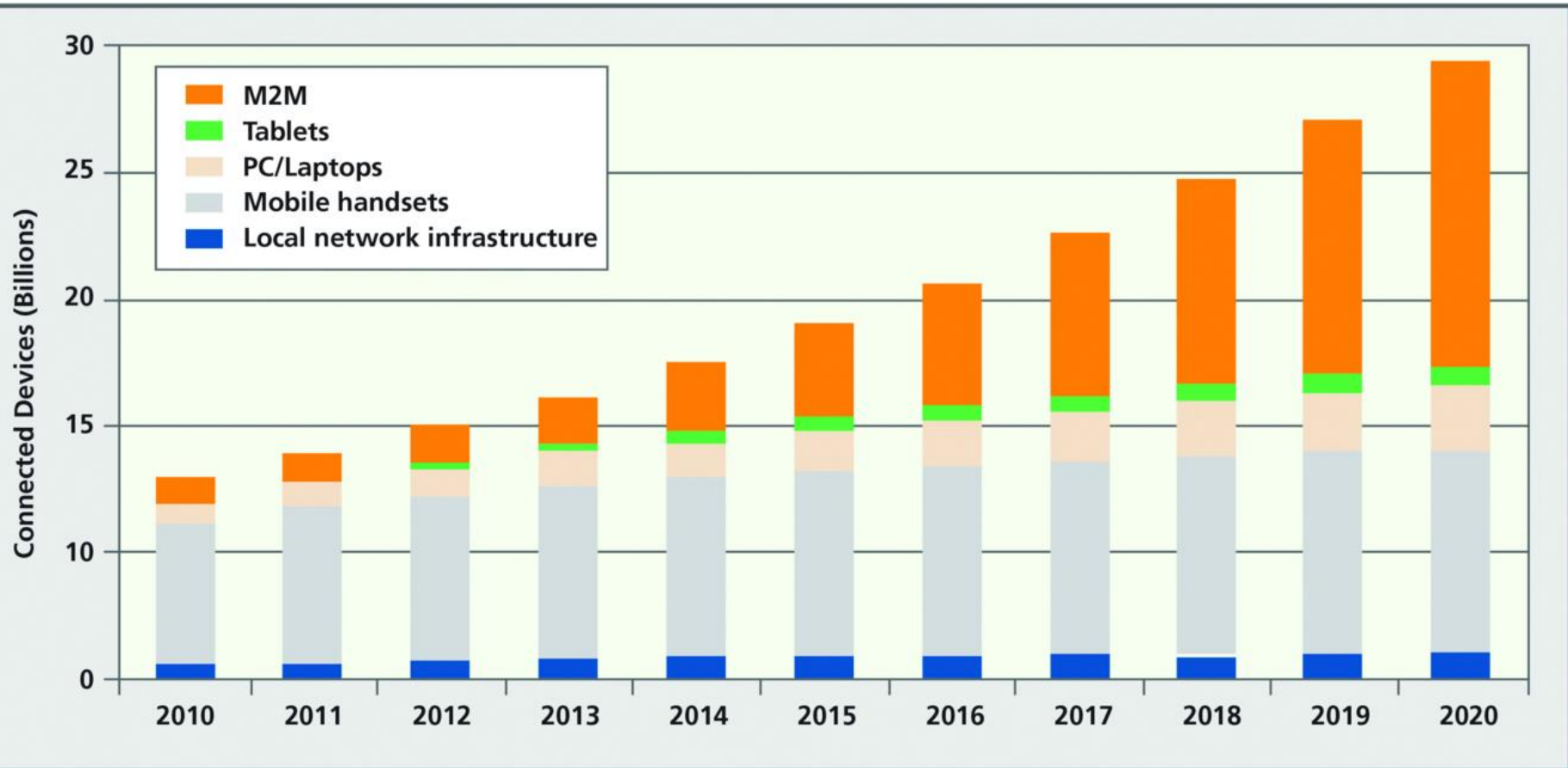
Onde estamos

Fase 4 – Os aceleradores (interfaces físico e digital)
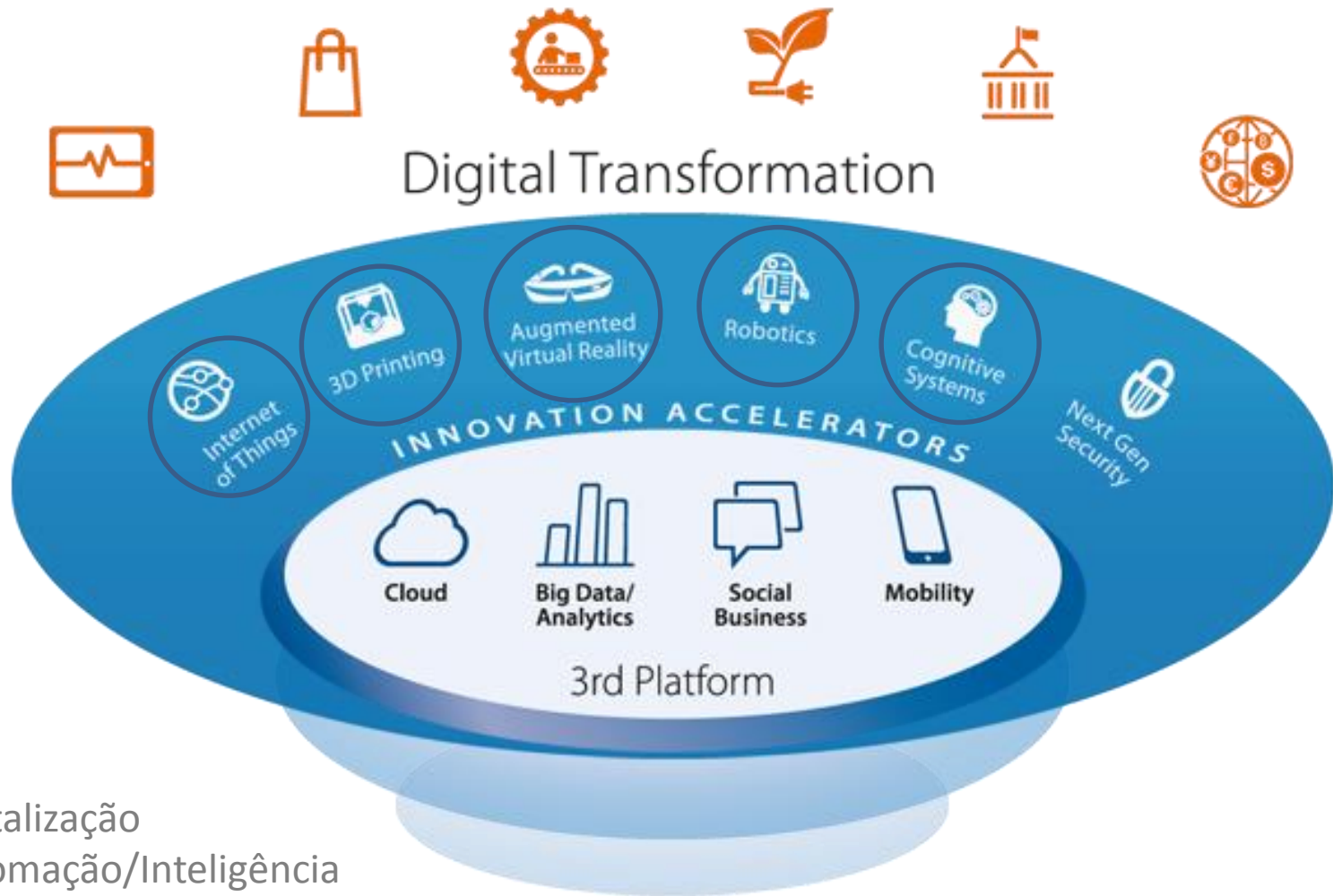
- Digitalização
- Automação/Inteligência
- Interfaces físico/digital

IDC's 3rd Platform 2016

O QUE ESTAMOS A FAZER

A estrutura - ligando as peças

O que estamos a fazer
Fase 5 – Empresa 2.0
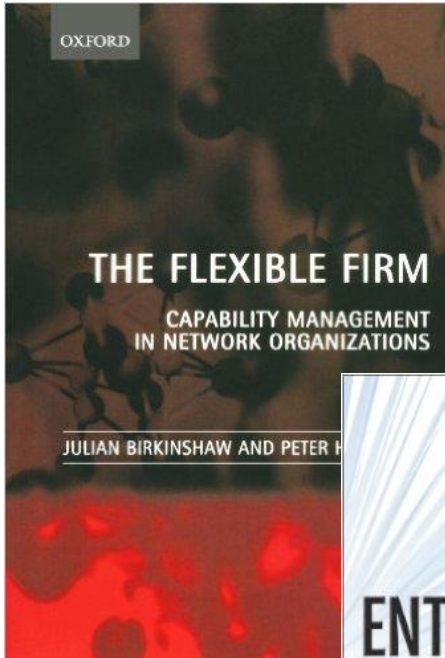
Network-like organizational forms *that firms are adopting to make themselves more flexible and responsive to changing technologies and customer demands*
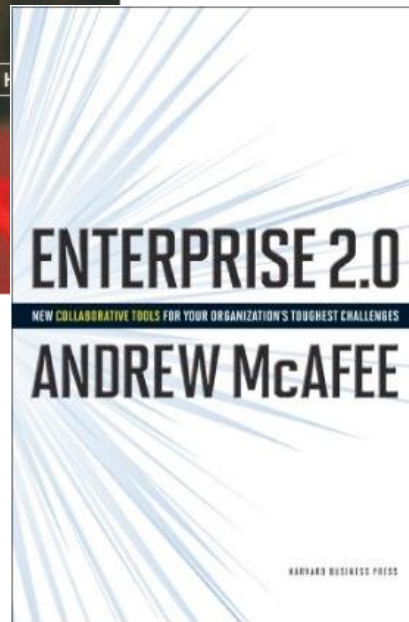
Enterprise 2.0 *is the use of emergent social software platforms within companies, or between companies and their partners or customers*
- *Group editing*
- *Authoring*
- *Broadcast Search*
- *Collective Intelligence*
- *Self-organization*

The Flexible Firm – Birkinshaw, Hagstrom (2010)
Enterprise 2.0: The Dawn of Emergent Collaboration – McAfee (2009)

O que estamos a fazer
Fase 5 – Máquina 2.0, iterativa e autónoma
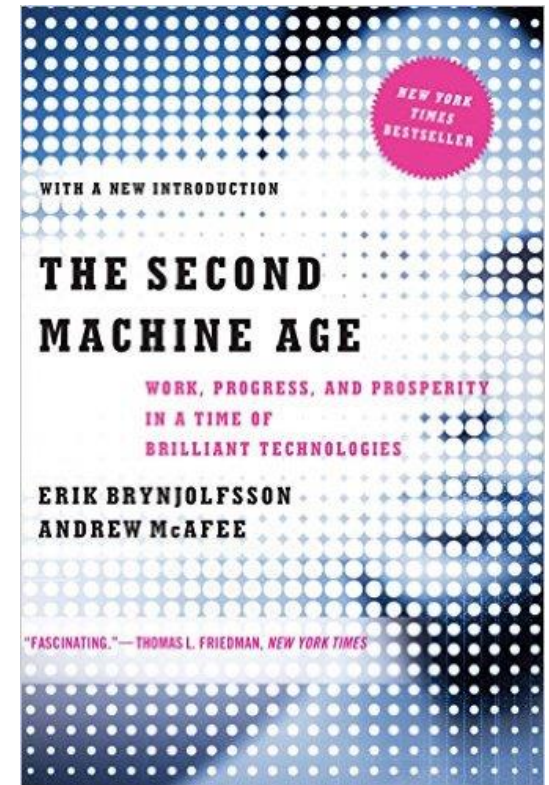
Useless robot waiters fired for incompetence in China
The Telegraph, April 2016

O que estamos a fazer
Fase 5 – Máquina 2.0, iterativa e autónoma

Figure 12: Worldwide Consumer Robotics Product Shipments and Revenue

(Source: ABI Research)

O que estamos a fazer
Fase 5 – Dispositivos 2.0, ligados ao mundo

O que estamos a fazer
Fase 5 – Dispositivos 2.0, ligados ao mundo

Harvard
Business
Review

MANAGING ORGANIZATIONS

How Smart, Connected Products Are Transforming Companies

by Michael E. Porter and James E. Heppelmann

FROM THE OCTOBER 2015 ISSUE

"How the nature of smart, connected products substantially changes the work of virtually every function within the manufacturing firm. The core functions - product development, IT, manufacturing, logistics, marketing, sales, and after-sale service - are being redefined, and the intensity of coordination among them is increasing. Entirely new functions are emerging, including those to manage the staggering quantities of data now available"

Harvard
Business
Review

O que estamos a fazer
Fase 5 – Industria 4.0

4th
Cyber Physical Systems

Industry Internet of Things
Smart Factories
Digital Value Chain Integration
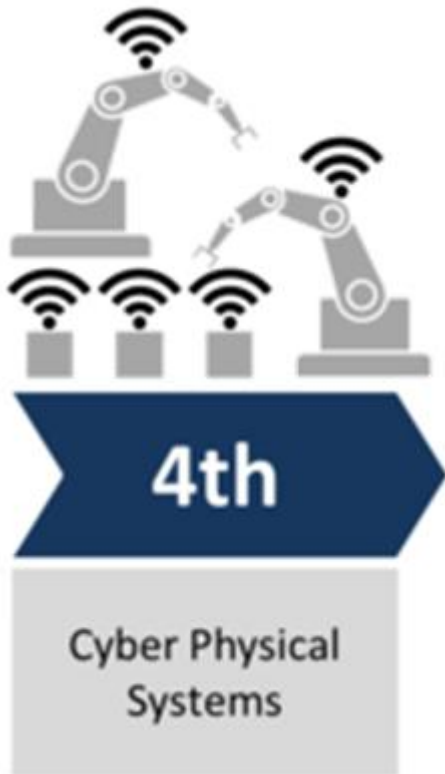
Industry 4.0 - *Digitalization of Manufacturing The transformations in design, manufacture, operation and service of manufacturing systems and products*

- *Aplicação TIC: digitalização, internet, cloud, IA*
- *Sistemas ciber-físicos: IoT, robots, drones*
- *Automação: CAD, ERP, BPM (desenho, operação, monitorização)*

O que estamos a fazer
Fase 5 – Cidades Inteligentes

O IMPACTO DA 4ª RI

O que muda

O impacto da 4ª RI

Digitalização, Conetividade, Tempo-real, IA, Social

O impacto da 4ª RI
Desmaterialização e Desintermediação

Digitalização de produtos e serviços

Desintermediação da cadeia de valor

O impacto da 4ª RI
Sistemas ciber-físico e Automação

Redução custos, eficiência recursos   **"No humans allowed"**
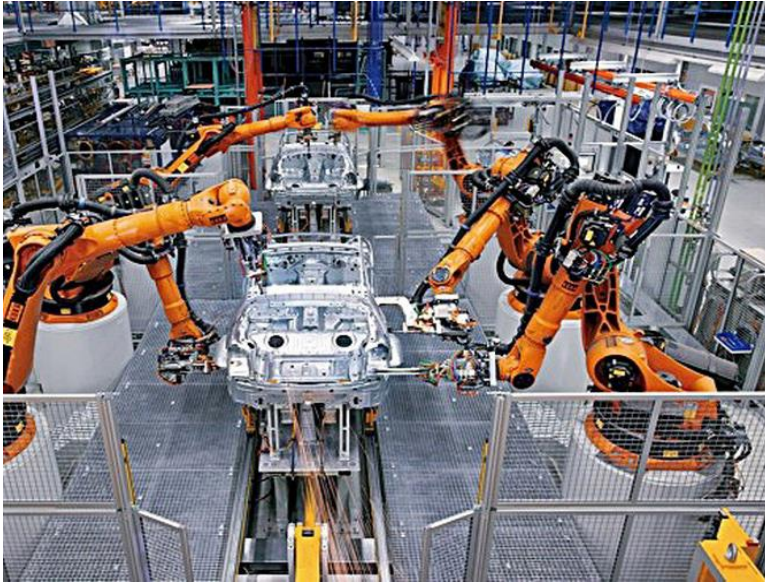
O impacto da 4ª RI
Industria 4.0

The adoption and impact path of the Industrial Internet

Near-term

Long-term

1. Operational Efficiency
- Asset utilization
- Operational cost reduction
- Worker productivity

2. New Products & Services
- Pay-per-use
- Software-based services
- Data monetization

3. Outcome Economy
- Pay-per-outcome
- New connected ecosystems
- Platform-enabled marketplace

4. Autonomous, Pull Economy
- Continuous demand-sensing
- End-to-end automation
- Resource optimization & waste reduction

Sources : World Economic Forum 2015

Industrial Internet of Things:
Unleashing the Potential of Connected Products and Services

O impacto da 4ª RI
Personalização

MAIN BENEFITS OF PERSONALISATION TO RETAILERS

46%
Customer en-
gagement

5%
Potential increase in
upselling/average order
values

1%
Impulse purchases

19%
Customer loyalty and re-
peat business

18%
Conversion rate
improvement

11%
Revenue growth
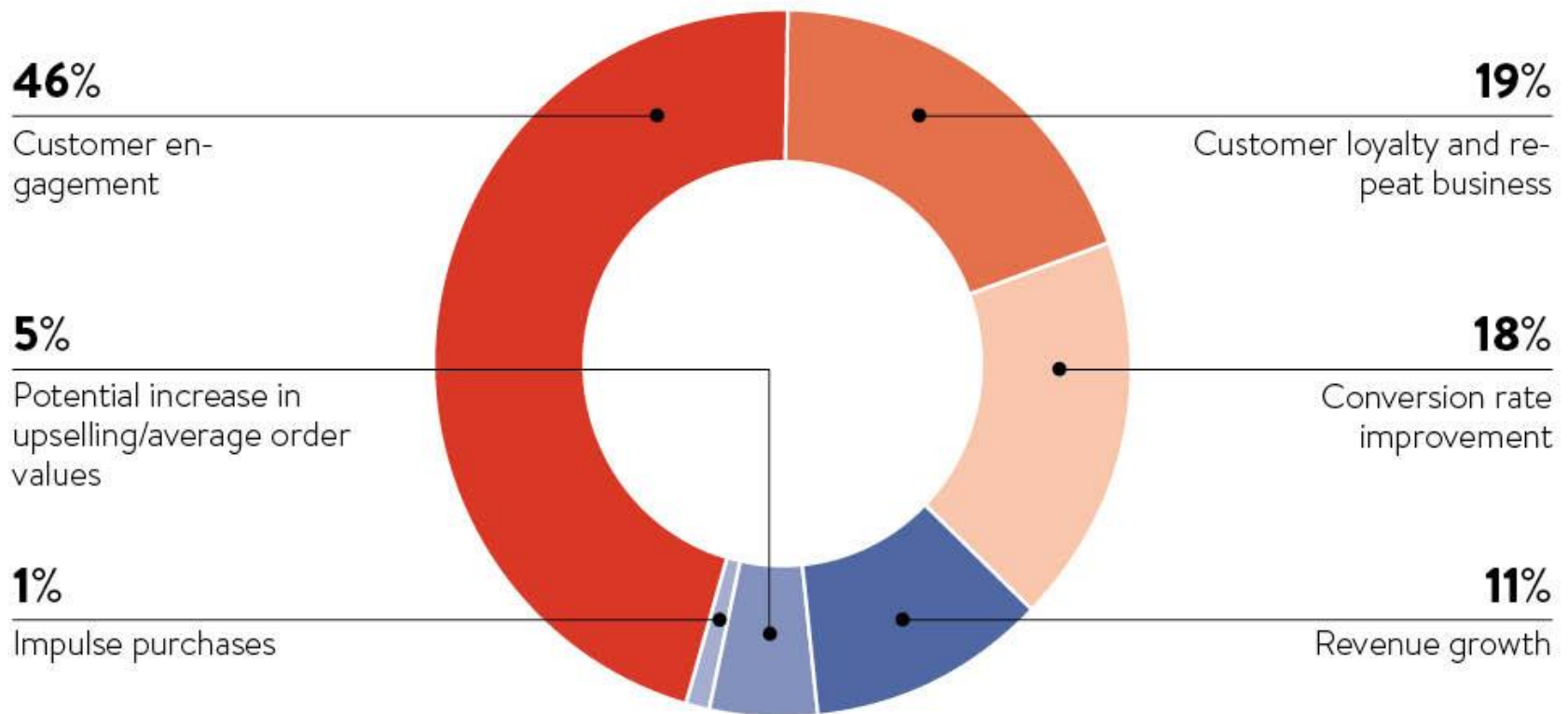
Source: *Retail Week* 2015

O impacto da 4ª RI
Novos modelos de negócio (digitais)

Plataformas

Social

Colaboração e cocriação

O impacto da 4ª RI
Plataformas, Colaboração e Cocriação
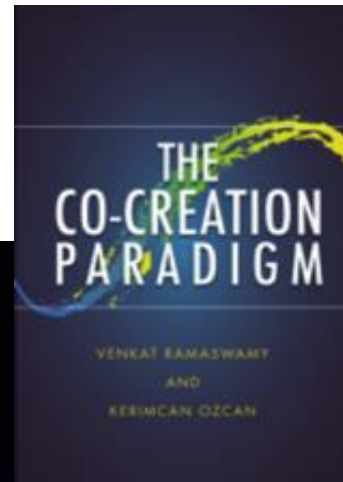
The Co-Creation Paradigm of Value Creation

Source: Venkat Ramaswamy and Kerimcan Ozcan, *The Co-Creation Paradigm* (2014)
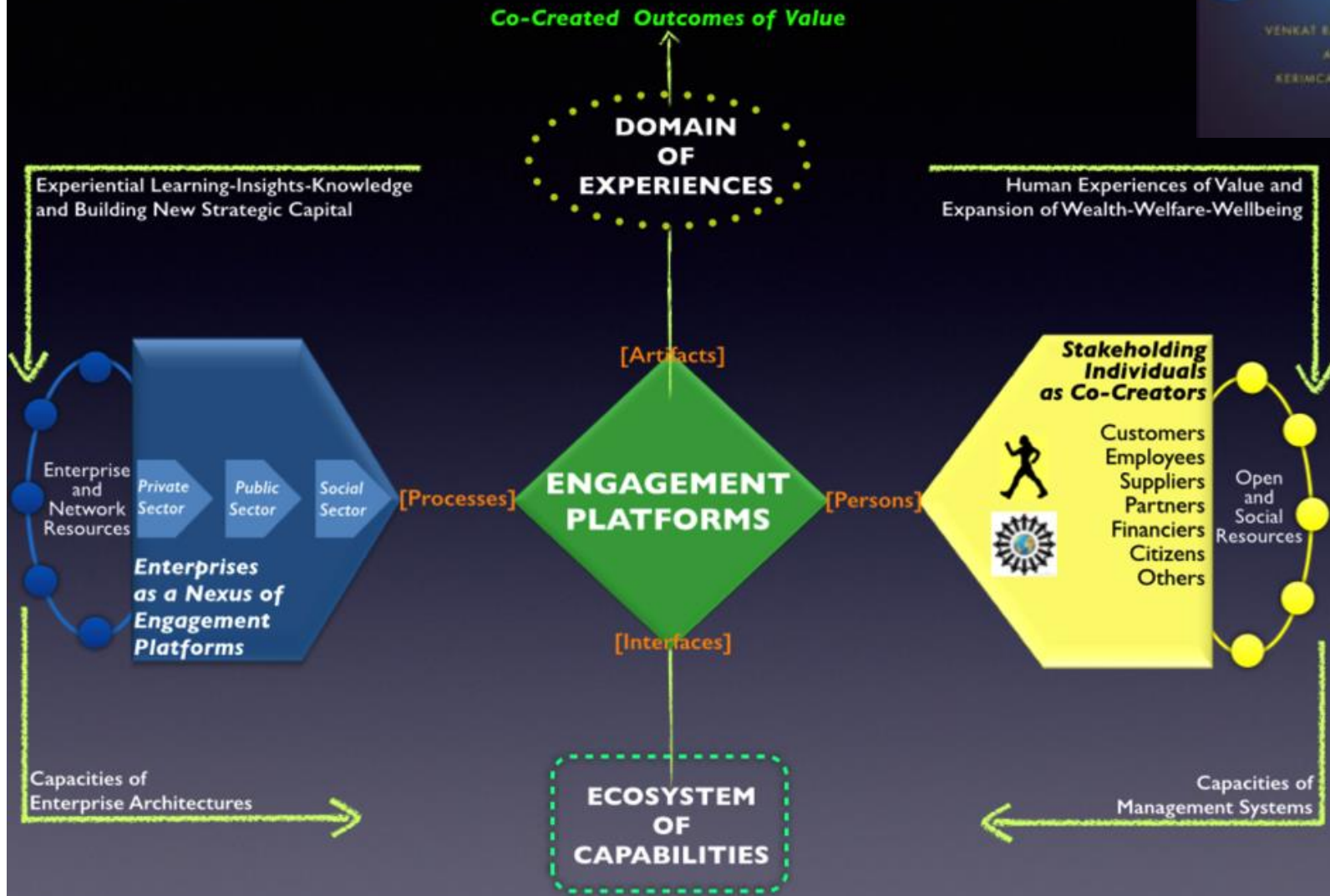
O valor da 4ª RI
Valor (triliões!)

O valor da 4ª RI
Valor (IoT)

"Total economic value-add from IoT across industries will reach $1.9 trillion worldwide in 2020"

Gartner

"Fifty billion devices will be connected to the Internet by 2020"

CISCO

"Cities will spend $41 trillion in the next 20 year on infrastructure upgrades for IoT"

intel

"The utility smart grid transformation is expected to almost double the customer information system market, from $2.5 billion in 2013 to $5.5 billion in 2020"

NAVIGANT RESEARCH

"The industrial Internet could add $10-15 trillion to global GDP, essentially doubling the US economy"

GE

"Wide deployment of IoT technologies in the auto industry could save $100 bn annually in accident reductions"

McKinsey&Company

"IoT developers to total 3 million in 2019"

ABIresearch
technology market intelligence

"75% of global business leaders are exploring the economic opportunities of IoT"

The Economist

"The UK government recently approved 45 million pounds (US$76.26 million) in research funding for Internet of Things technologies"

theguardian

O valor da 4ª RI
Valor (Industria 4.0)

- Industry 4.0 can deliver estimated annual efficiency gains in manufacturing of between 6% and 8%

- The Boston Consulting Group predicts that in Germany alone, Industry 4.0 will contribute 1% per year to GDP over ten years, creating up to 390 000 jobs

- Globally, the Industrial Internet will grow from US$20 billion in 2012 to more than US$500 billion in 2020, and that value added will surge from $US23 billion in 2012 to US$1.3 trillion in 2020

- The United States has established a National Network for Manufacturing Innovation with a proposed US$1 billion of public funding

- Companies in the Asia/Pacific were expected to invest US$10 billion in the Industrial IoT in 2012, with that figure rising to nearly US$60 billion by 2020

Industry 4.0
Digitalisation for productivity and growth

O impacto e valor da 4ª RI

- Empresa
- Trabalho
- Educação
- Saúde
- Energia
- Liberdade

Ler
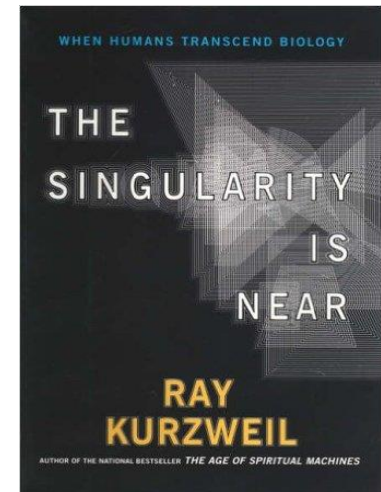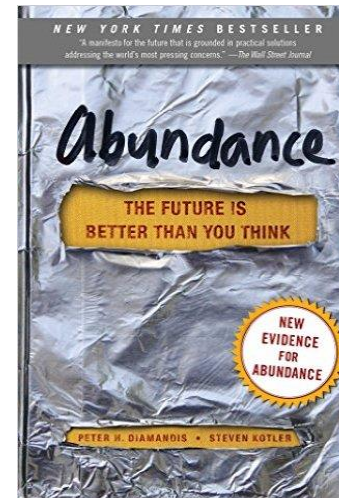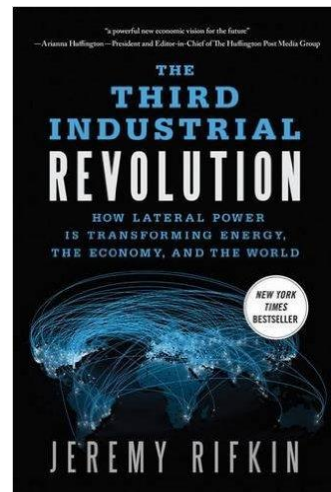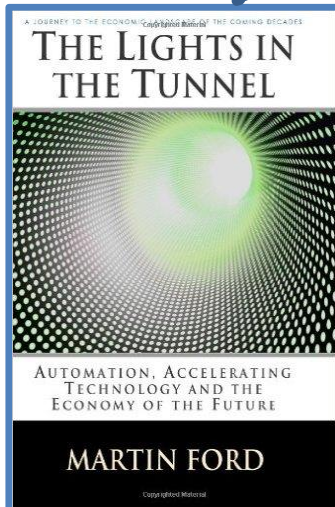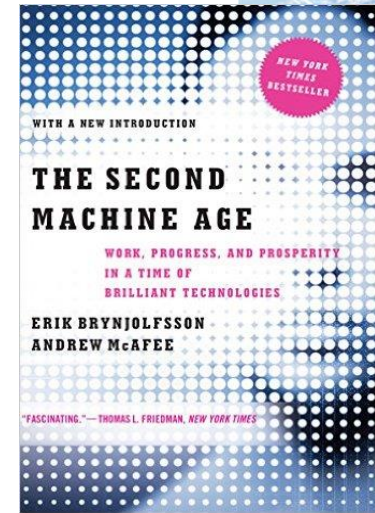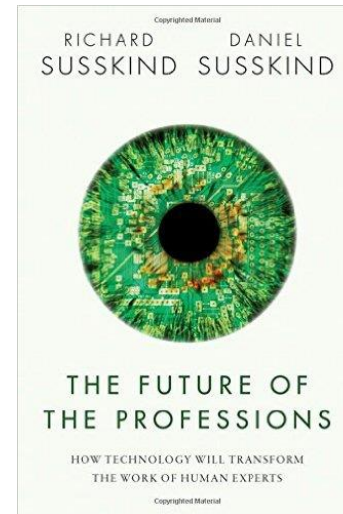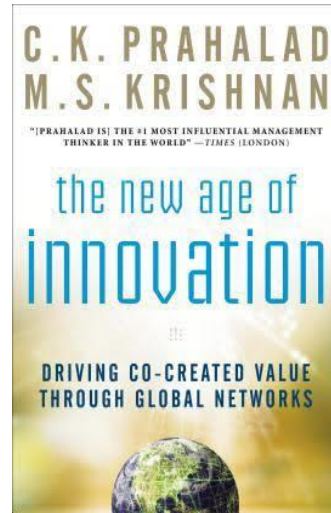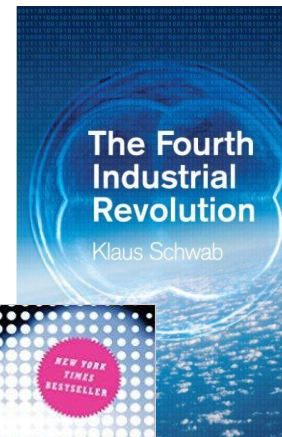
O QUE FALTA E OS PERIGOS

O que falta

As ligações, investimento e mudança

Gestão
(Rede)

Pessoas
(Geração Z)

Tecnologia
(Digital)

Negócio
(Plataformas relacionamento)

€

Os pilares já existem

Falta:
- *Reforçar as ligações*
- *Mudar as organizações*
- *Refazer infraestruturas*
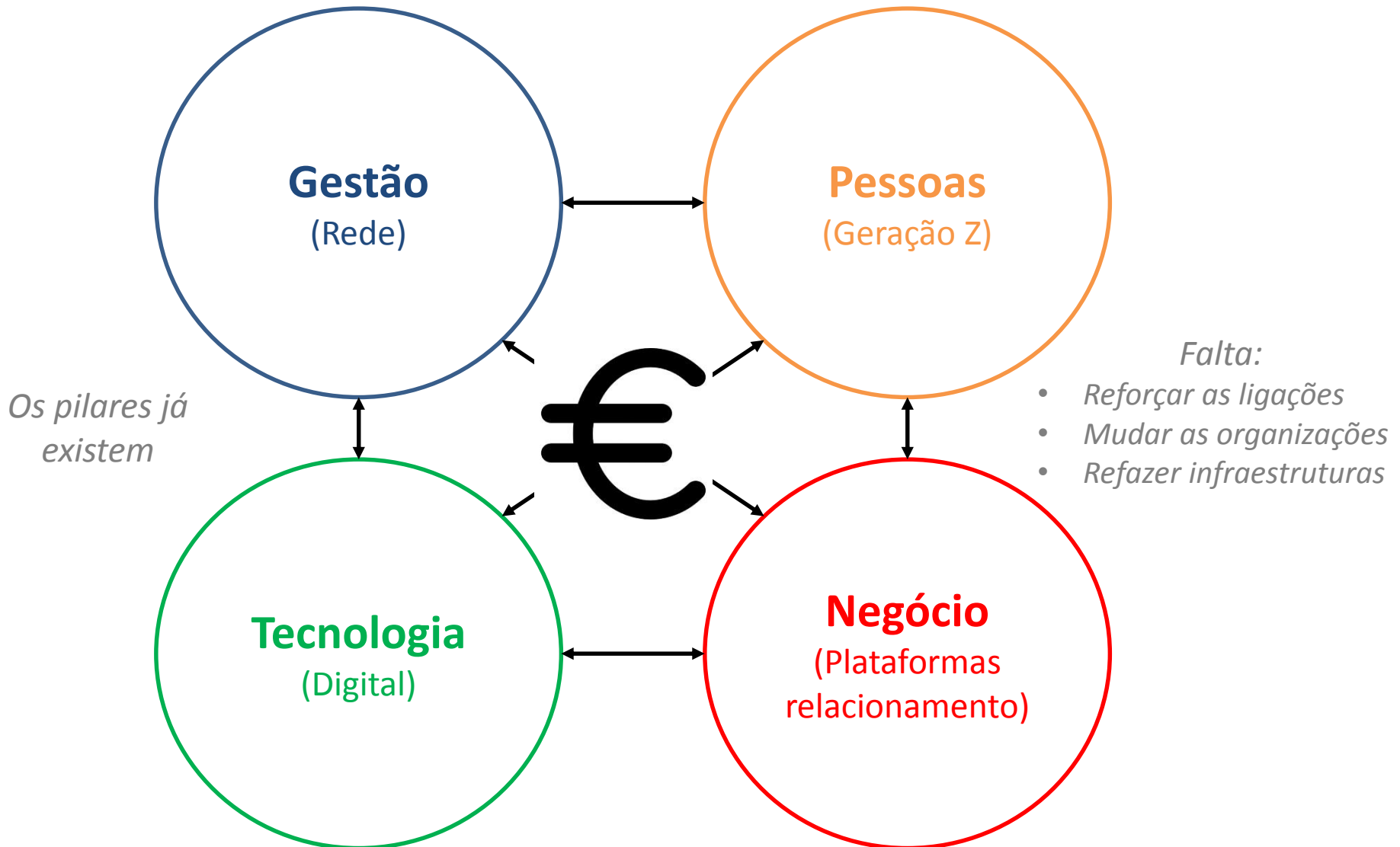
O que falta
Maturação, difusão e adoção tecnológica (tempo!)

Gartner's 2015 Hype Cycle for Emerging Technologies Maps the Journey to Digital Business
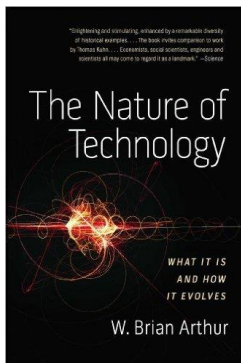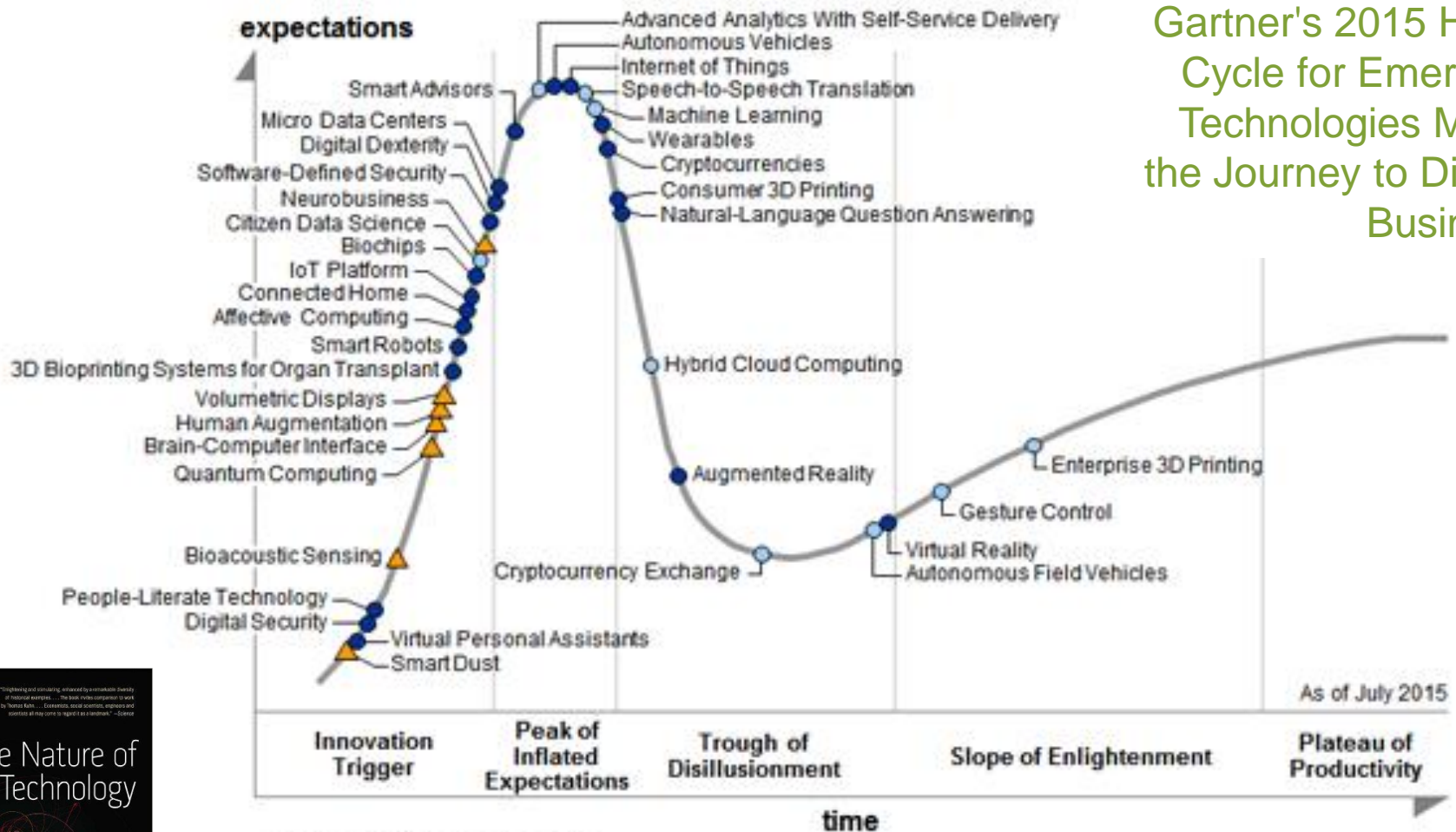
Estamos prontos mas ... vai levar tempo (Abernathy e Utterback)!

O que falta
Standards - A guerra já começou

How will standards facilitate new production systems in the context of EU innovation and competitiveness in 2025? (2014)

Digitising European Industry - Reaping the full benefits of a Digital Single Market (2016)

European Commission

IoT SDOs and Alliances Landscape (Technology and Marketing Dimensions)

Source: AIOTI WG3 (IoT Standardisation) – Release 2.0

O que falta

Integração das TIC e Industria – A fábrica inteligente
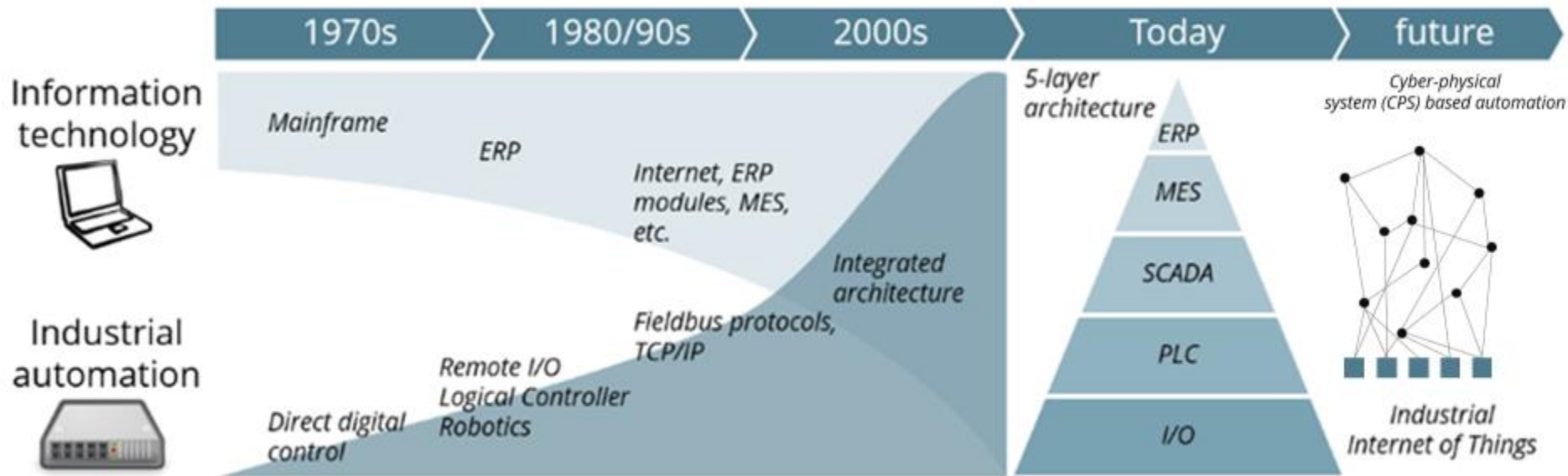
O que falta
A fábrica inteligente - Produtividade
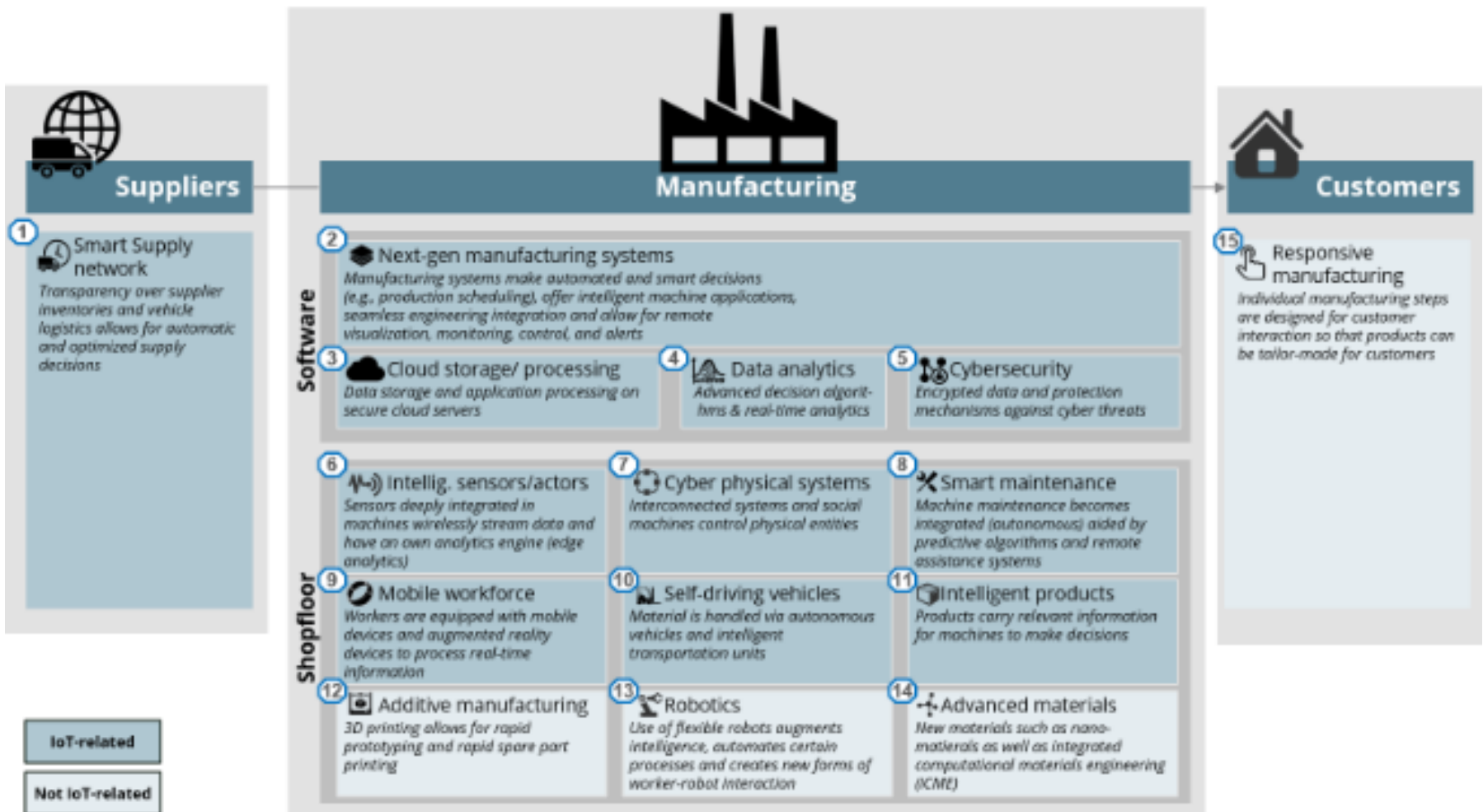
O que falta
Energia barata, muita!
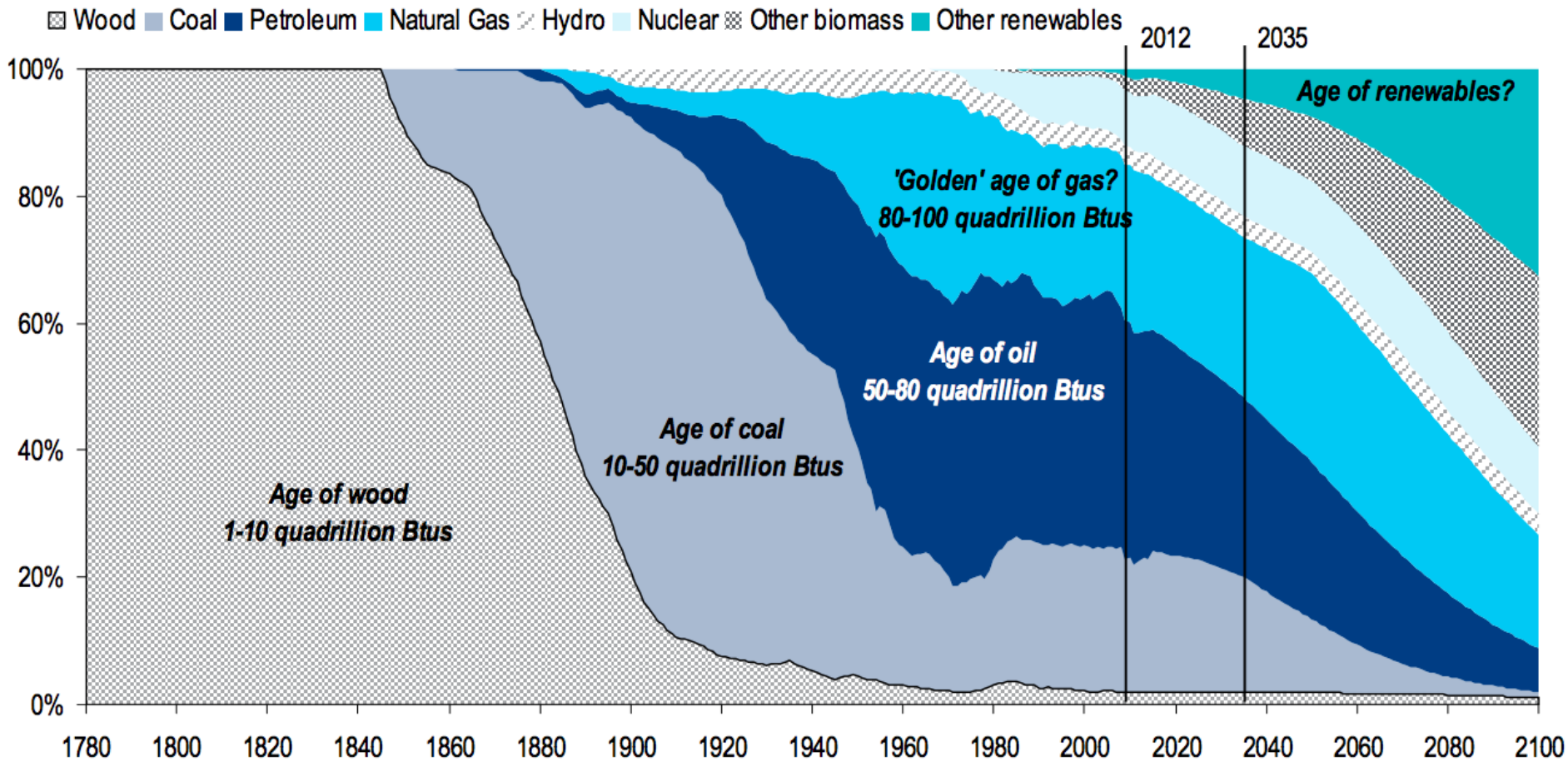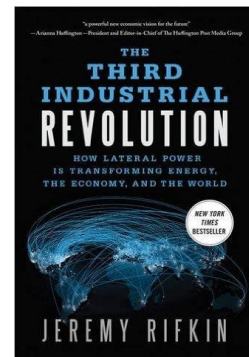
O que falta
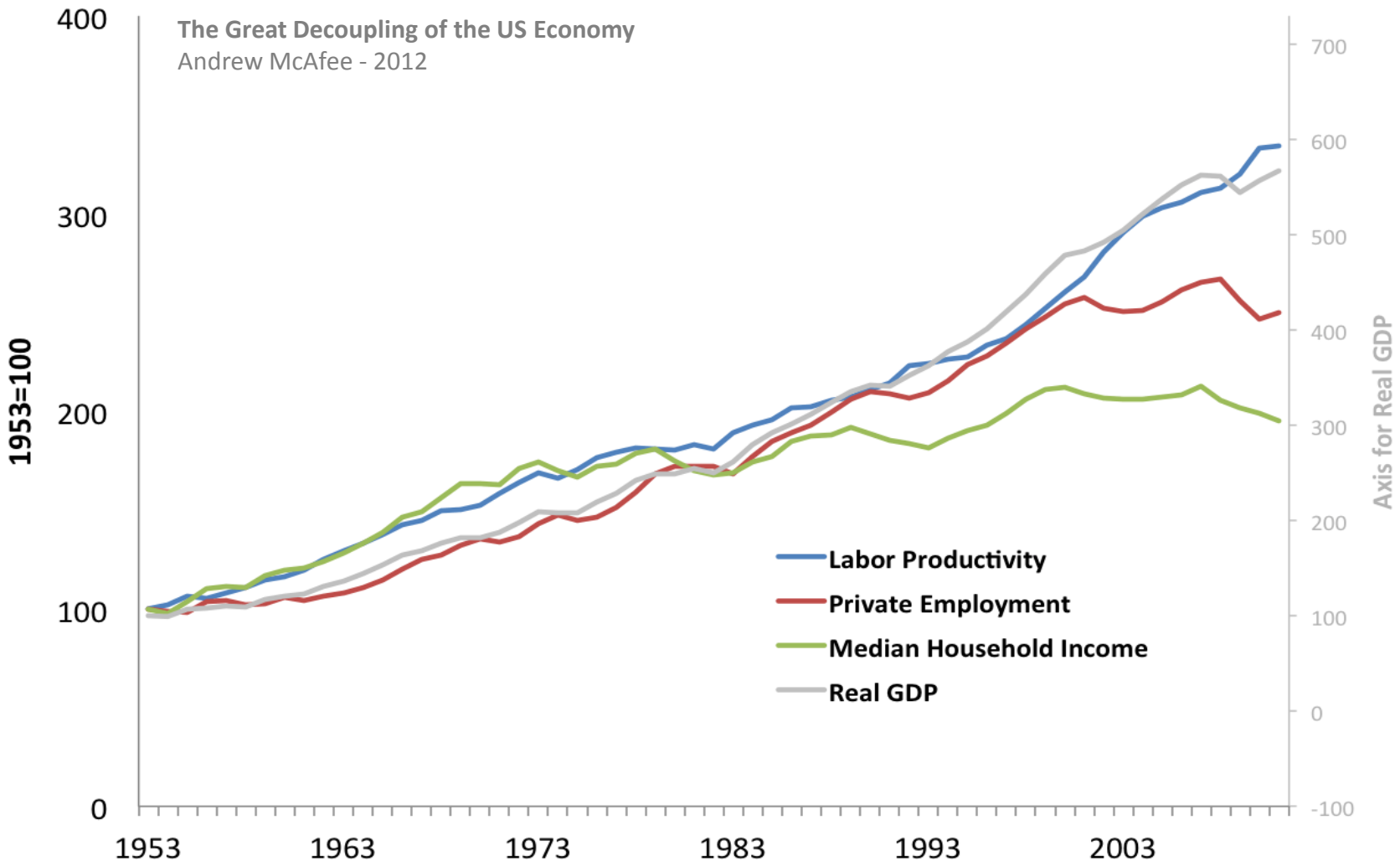*Legislação, Politicas e Economia*

Legislação

- Segurança dos dados
- Proteção pessoal
- Supervisão
- Responsabilidade
- Propriedade intelectual
- Emprego e desenvolvimento pessoal
- Incentivos à industria e indivíduos

O que falta


US Productivity, GDP, Employment, and Income: 1953-2011

The Great Decoupling of the US Economy
Andrew McAfee - 2012

Legend:
- Labor Productivity
- Private Employment
- Median Household Income
- Real GDP

Sources: Census Bureau, Bureau of Labor Statistics

O que falta
Legislação, Politicas e Economia

Cenário 1 – curto prazo

- As máquinas automatizam tarefas simples
- São eliminados muitos empregos
- O que fazer com os trabalhadores nesta situação?
- E com os jovens a entrar no mercado trabalho?

Cenário 2 – longo prazo

- A Industria 4.0 elimina a maioria dos empregos
- O que fazer com o mercado do trabalho?
- Se não há trabalhadores, vai haver consumidores?
- O que fazer com a remuneração extra das empresas?
- Que economia para:
  - Desenvolver as pessoas
  - Distribuir riqueza e ajustar desigualdades
  - Criar infraestruturas e sistemas comuns
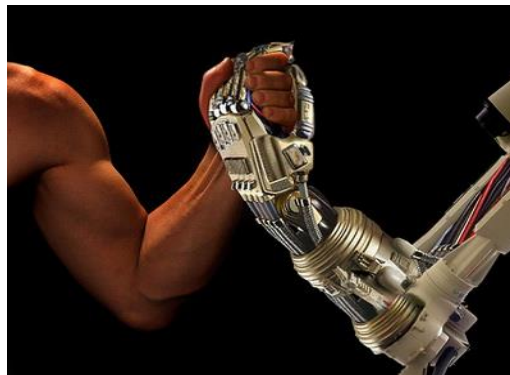 - Desenvolver novo conhecimento e inovação
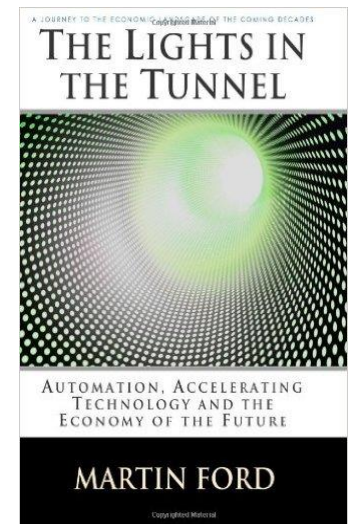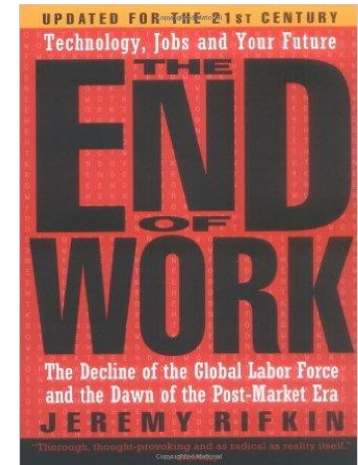
Os perigos

Desemprego

Recessão

Homem vs. Máquina

CONCLUSÕES

Conclusões
A 4ª Revolução Industrial

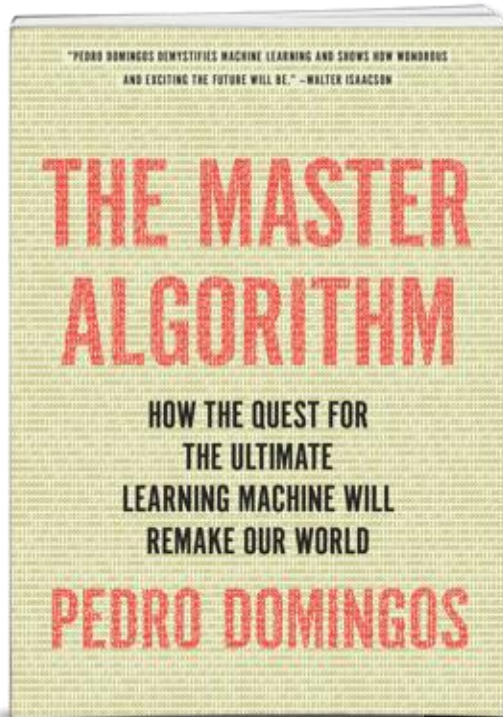Estamos a construir um "novo mundo" - digital

- Tudo tem um rasto digital

- Tudo tem "iteratividade" e está conectado

- Automação e "Inteligência Artificial"

- **Integração mundo físico e digital, homem e máquina**

- Aumento da **produtividade**, **mais recursos**, **crescimento**

- Precisamos de tempo, investimento e mudança processos

- **Relação trabalho vs consumo –> Nova Economia?**

Estamos a construir as bases para:
a industria sem trabalhadores, o homem-cyborg

A 4ª e/ou 5ª Revolução Industrial
Os investigadores Portugueses

A 4ª Revolução Industrial