



LISBON  
SCHOOL OF  
ECONOMICS &  
MANAGEMENT  
UNIVERSIDADE DE LISBOA

# A 4ª Revolução Industrial

Rui Rosa

Aula ISEG  
19-Nov-2018

# 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, legislação, economia

6. Conclusão



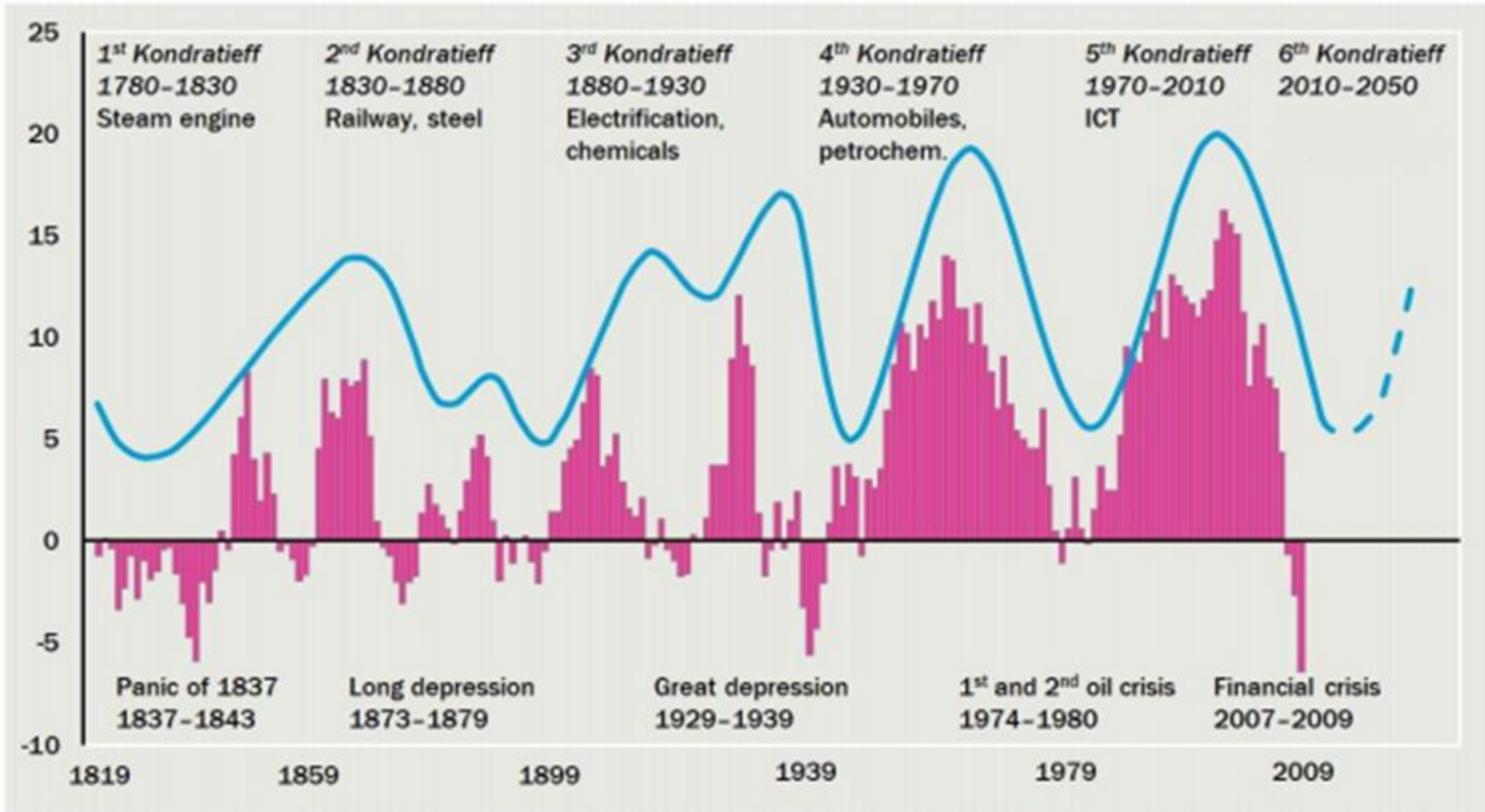
Foco no desenvolvimento e impacto da tecnologia

# COMO CHEGÁMOS AQUI

*PADRÕES DE DESENVOLVIMENTO*

# Surtos de desenvolvimento

*e tecnologia – Teoria das ondas de Kondratieff*



SURFING THE SIXTH WAVE

Exploring the next 40 years of global change

Markku Wilenius and Sofi Kurki

# Combinação de fatores

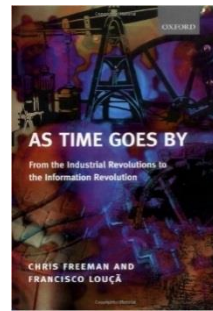


TABLE II.1. Condensed summary of the Kondratiev waves

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)
(1)	(2)	(3)	(4)	(5)	(6)	'downswing' (crisis of adjustment) (7)
1. Water-powered mechanization of industry	Arkwright's Cromford mill (1771)	Cotton spinning Iron products Water wheels	Iron Raw cotton Coal	Canals Turnpike roads Sailing ships	Factory systems Entrepreneurs Partnerships	1780s–1815
	Henry Cort's 'puddling' process (1784)	Bleach				1815–1848
2. Steam-powered mechanization of industry and transport	Liverpool–Manchester Railway (1831)	Railways and railway equipment Steam engines	Iron Coal	Railways Telegraph Steam ships	Joint stock companies Subcontracting to responsible craft workers	1848–1873
	Brunel's 'Great Western' Atlantic steamship (1838)	Machine tools Alkali industry				1873–1895
3. Electrification of industry, transport, and the home	Carnegie's Bessemer steel rail plant (1875)	Electrical equipment Heavy engineering Heavy chemicals	Steel Copper Metal alloys	Steel railways Steel ships Telephone	Specialized professional management systems 'Taylorism'	1895–1918
	Edison's Pearl St. New York Electric Power Station (1882)	Steel products			Giant firms	1918–1940
4. Motorization of transport, civil economy, and war	Ford's Highland Park assembly line (1913)	Automobiles Trucks Tractors, tanks	Oil Gas Synthetic materials	Radio Motorways Airports Airlines	Mass production and consumption 'Fordism'	1941–1973
	Burton process for cracking heavy oil (1913)	Diesel engines Aircraft Refineries			Hierarchies	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	??

# Inovação tecnológica e criação de valor

Ideias - R&D

Inovação produto

Inovação processo

Inovação Modelos Negócio / Organizacional / Social

Alteração massificada de padrões de comportamento e gestão com redução estrutural de custos e aumento de valor

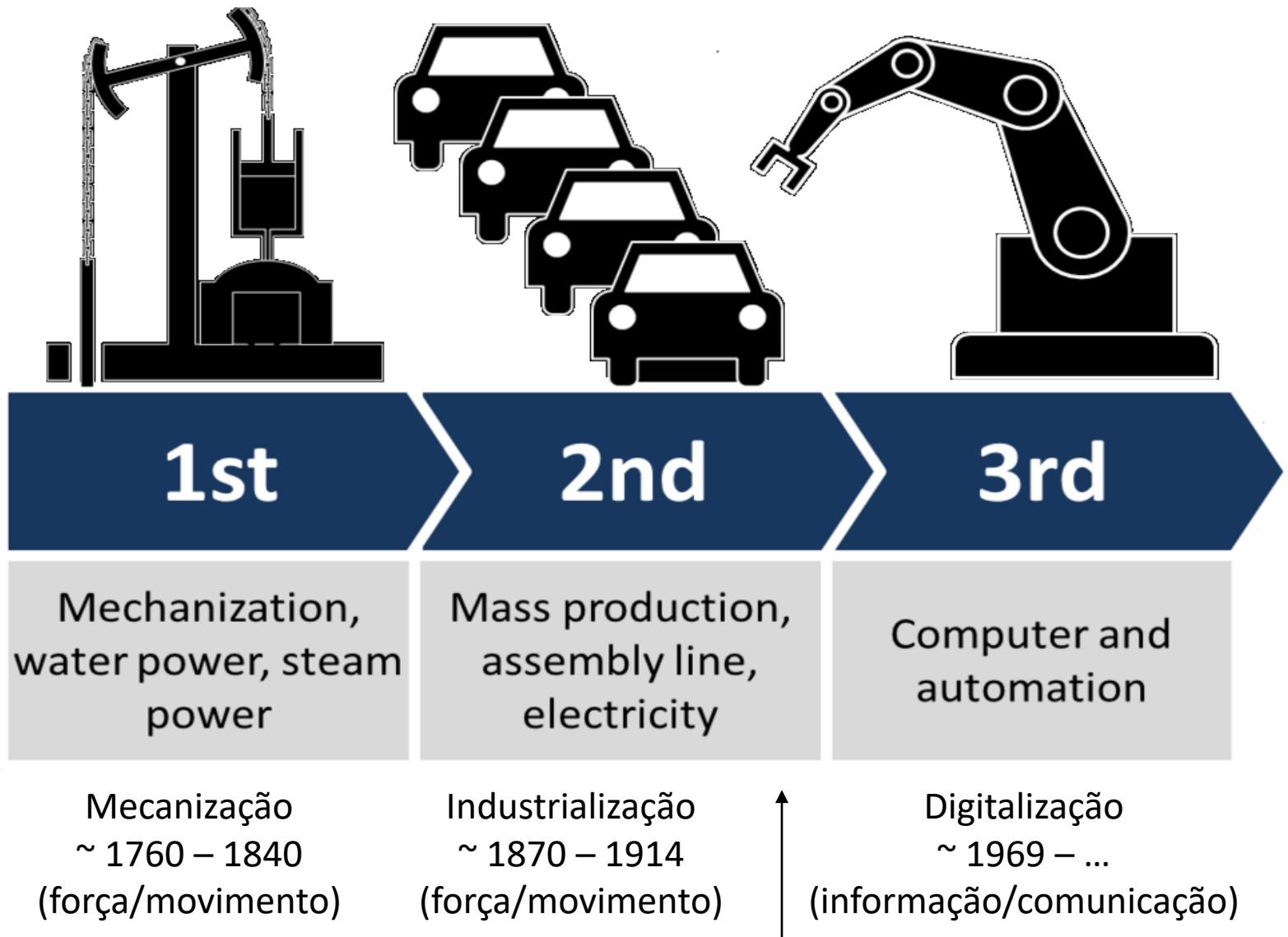
**Processo Combinatório**

**Processo Incremental**

**Produto - Processo - Gestão**

**Vários caminhos. Um sentido!**

# A 3ª Revolução industrial



# ONDE ESTAMOS

*A Infraestrutura - As inovações base*



# Onde estamos

*Fase 1: A era das TIC - Digitalização*

Computador  
Comunicações  
Telemóvel

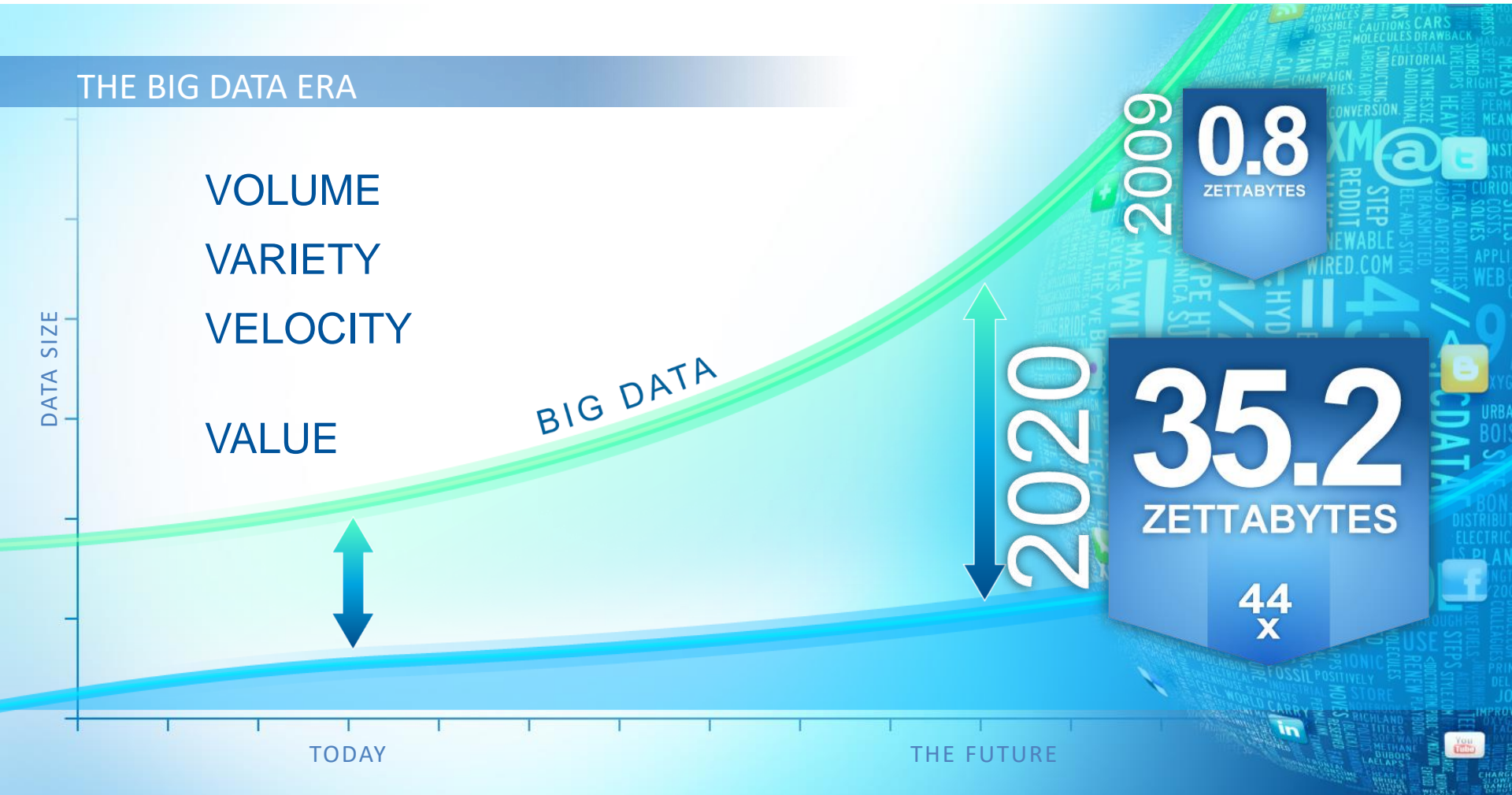


Internet  
World Wide Web  
Aplicações Informáticas



# Onde estamos

## Fase 2: "Big Data & Analytics"



# Onde estamos

## *Fase 2: “Big Data & Analytics”*

- “One Out of Two in Internet ”

Internet World Stats (2016); <http://www.internetworldstats.com/>

- “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>

# Onde estamos

*Fase 2: “Big Data & Analytics”*

## **The second economy**

**W. Brian Arthur**

Digitization is creating a second economy that's vast, automatic, and invisible—thereby bringing the biggest change since the Industrial Revolution.

# Onde estamos

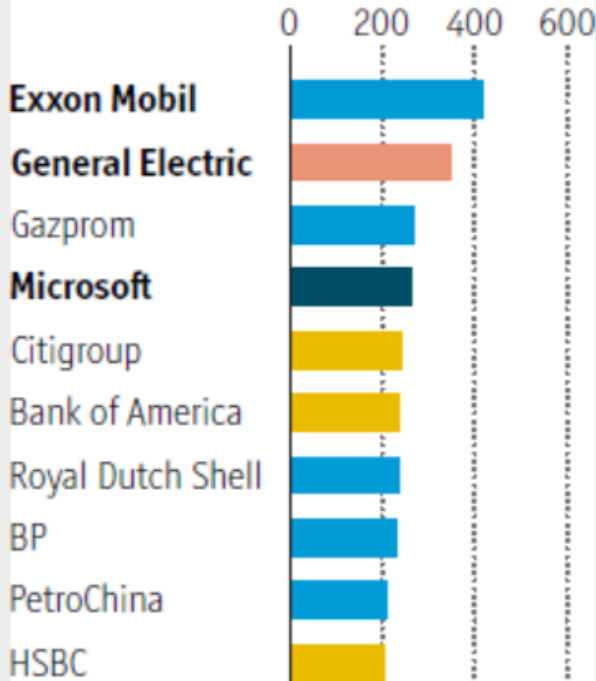
## Fase 2: "Big Data & Analytics"

### A virtually new world

World, largest listed companies by market capitalisation, \$bn

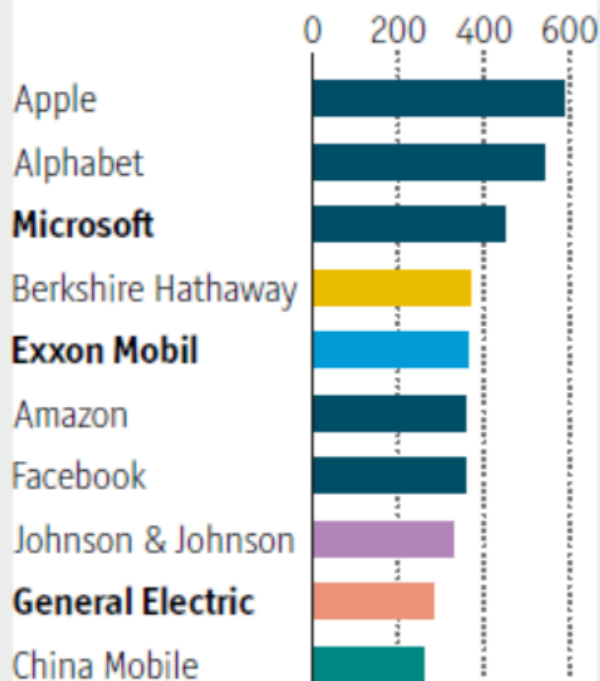
Sector: ■ Energy ■ Financials ■ Health care  
■ Industrials ■ IT ■ Telecoms

End 2006



Source: Bloomberg

2016\*



\*At August 24th 2016

The largest companies in the world are digital natives

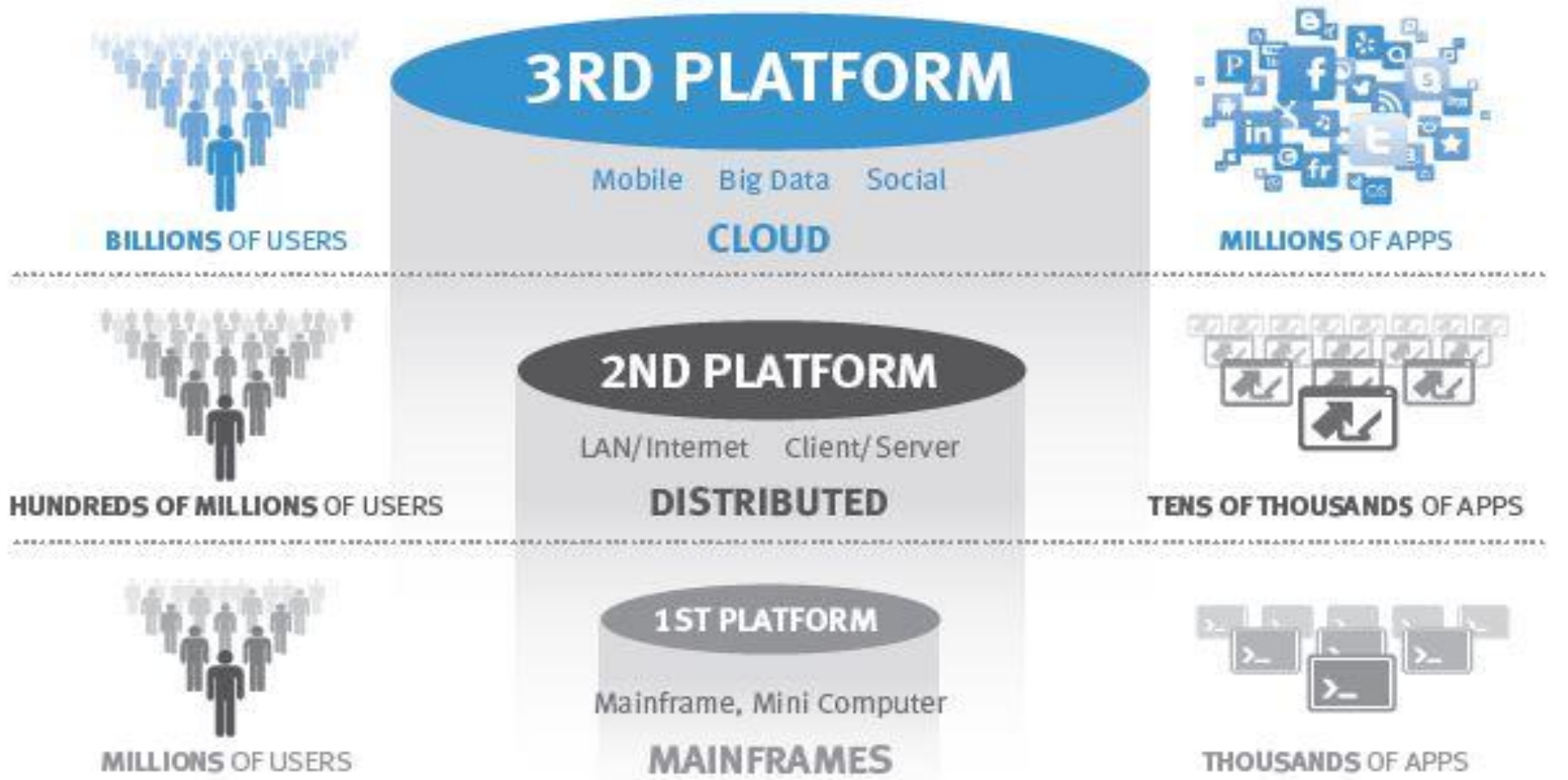
# Onde estamos

*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.



# Onde estamos

## *Fase 4: Internet das Coisas e Aceleradores*

Low cost processors  
and sensors

Low cost  
communications

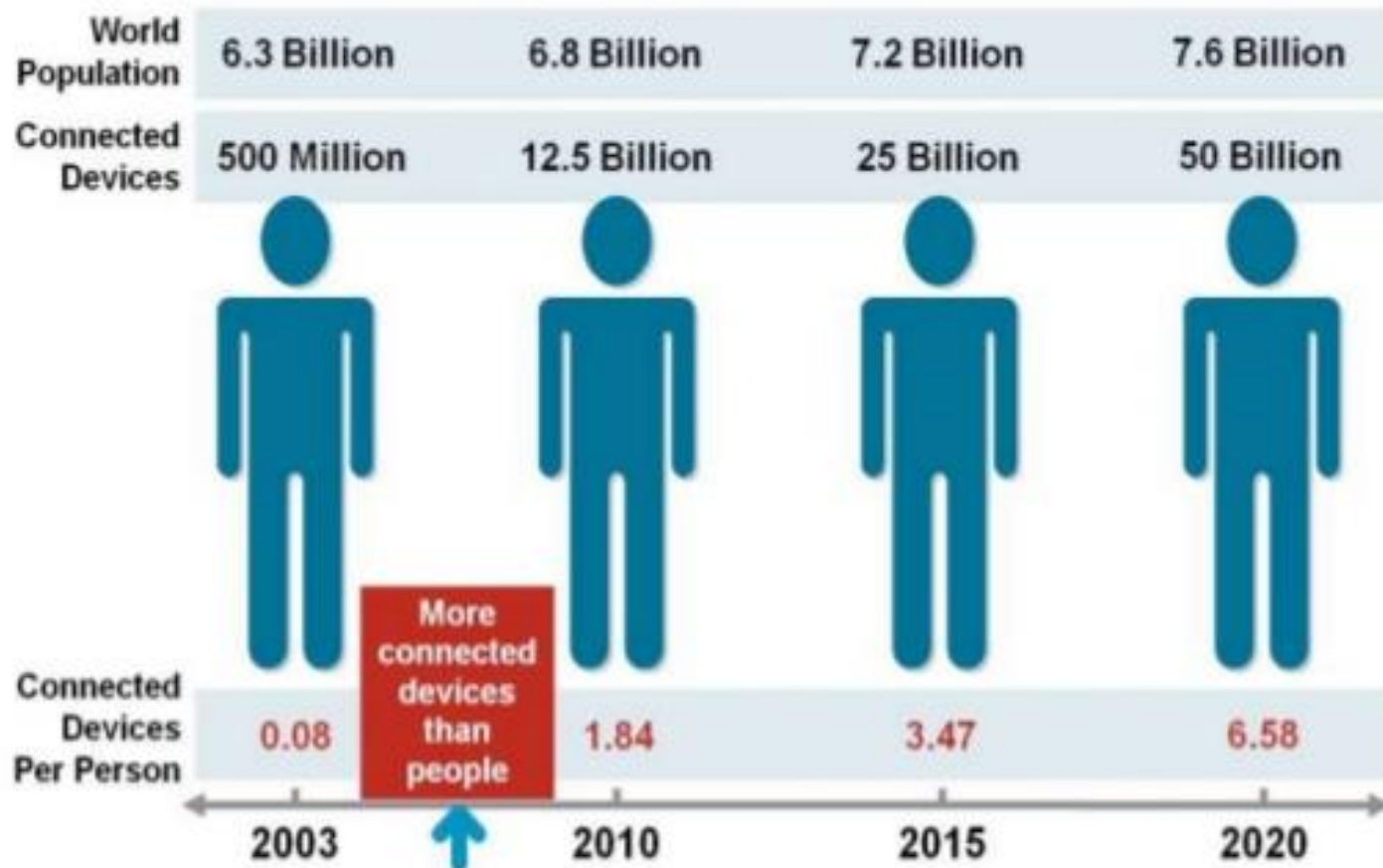




# Onde estamos

## *Fase 4: Internet das Coisas*

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



# Onde estamos

## *Fase 4: Internet das Coisas*

- “Since 2013, 650 million new physical objects have come online; ... 10 percent of automobiles became connected; ... In 2015, all of these things will double again.”

Gartner (2014) <http://www.gartner.com/newsroom/id/2865519>

- “The number of mobile-connected devices exceeded the world’s population in 2014” (1.5 in 2019)

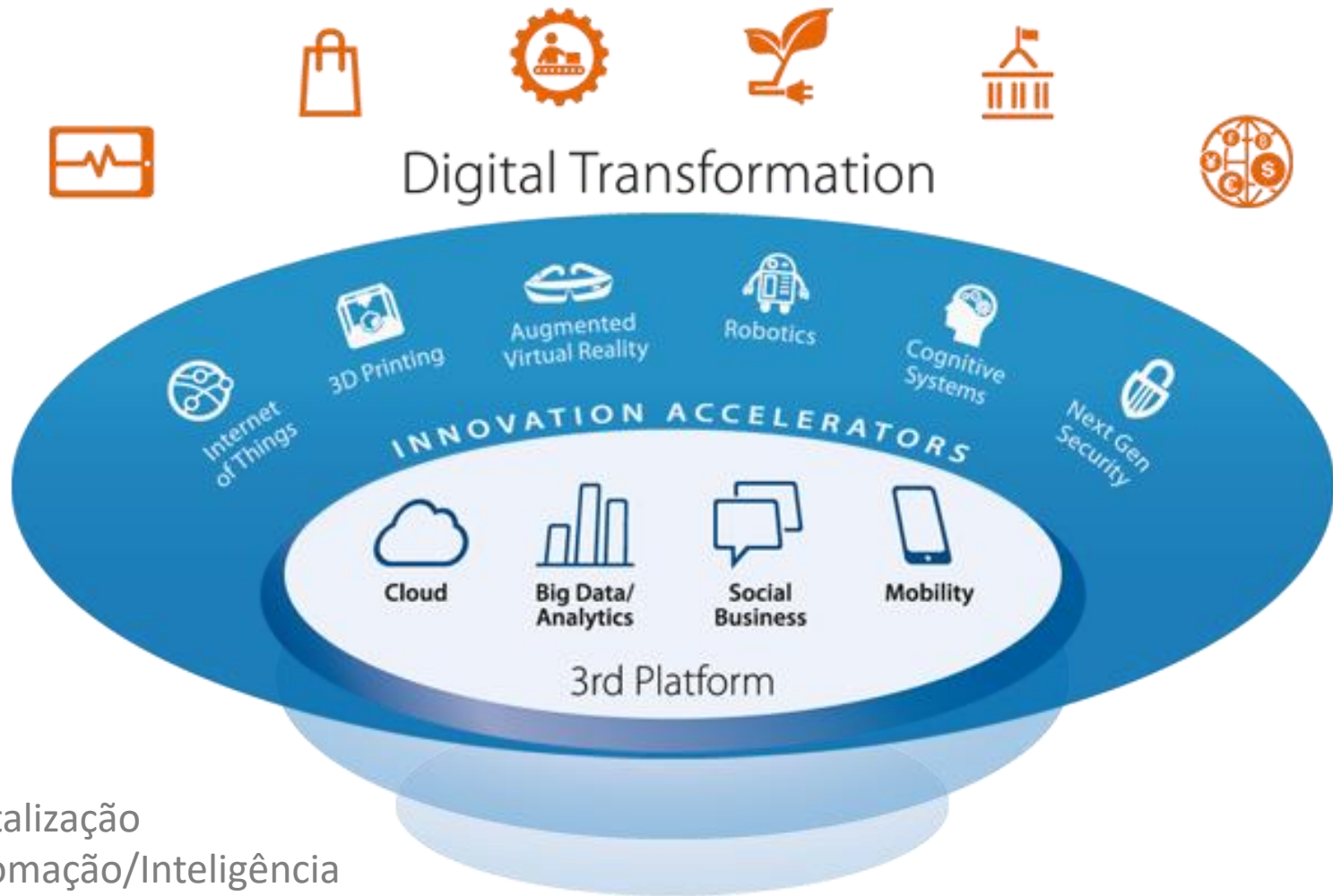
Cisco (2013); [http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white\\_paper\\_c11-520862.html](http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white_paper_c11-520862.html)

- “In 2013, connected “things” were 7% of the total. By 2020, that will grow to 15%”

EMC (2014); <http://www.emc.com/collateral/analyst-reports/idc-digital-universe-2014.pdf>

# Onde estamos

*Fase 4: Os aceleradores (interfaces)*



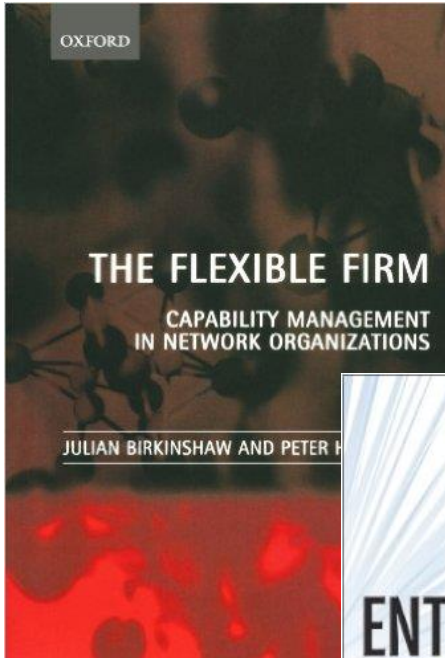
- Digitalização
- Automação/Inteligência
- Interfaces físico/digital

# O QUE ESTAMOS A FAZER

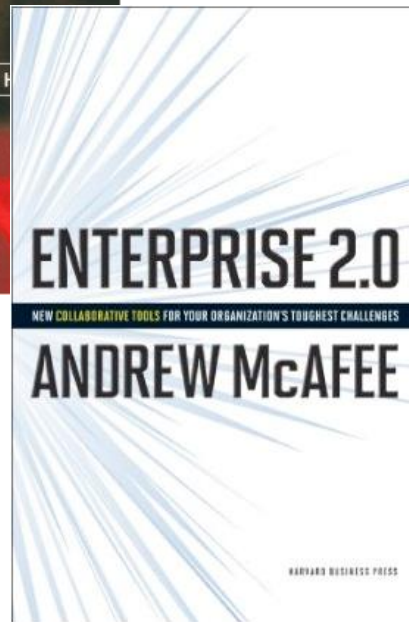
*A estrutura - ligando as peças*

# 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

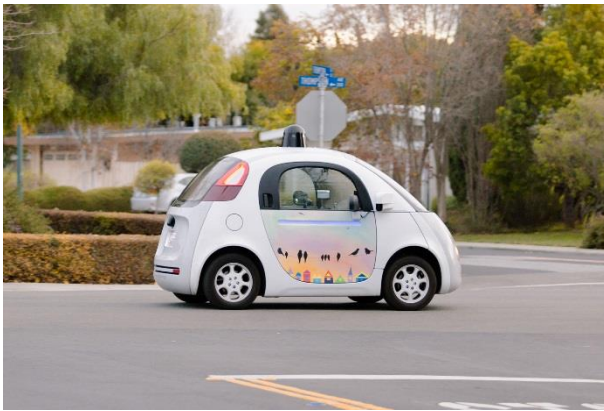
- *Group editing*
- *Authoring*
- *Broadcast Search*
- *Collective Intelligence*
- *Self-organization*

The Flexible Firm – Birkinshaw, Hagstrom (2010)

Enterprise 2.0: The Dawn of Emergent Collaboration – McAfee (2009)

# O que estamos a fazer

## Fase 5: Dispositivos 2.0, ligados ao mundo

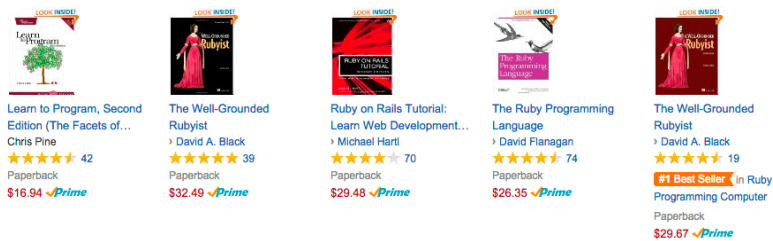


### Frequently Bought Together



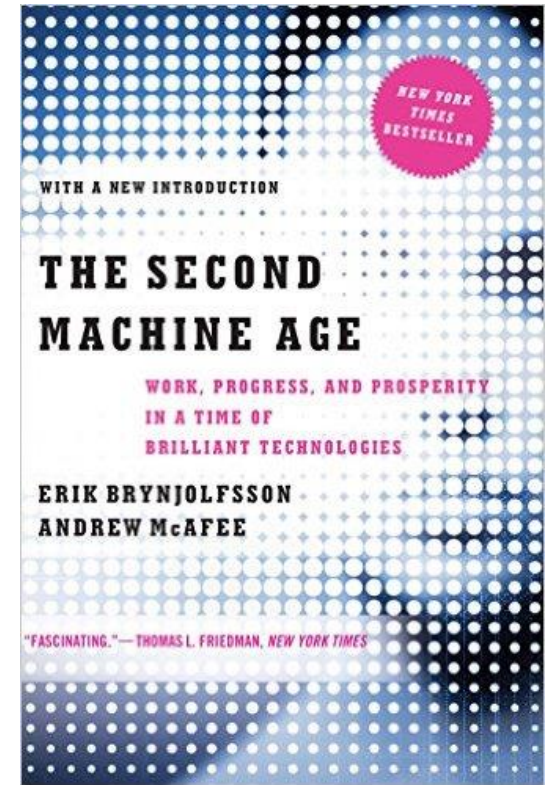
- This item:** Beginning Ruby: From Novice to Professional (Expert's Voice in Open Source) by Peter Cooper Paperback \$27.78
- Learn to Program, Second Edition (The Facets of Ruby Series) by Chris Pine Paperback \$16.94
- Ruby on Rails Tutorial: Learn Web Development with Rails (2nd Edition) (Addison-Wesley Professional Ruby ... by Michael Hartl Paperback \$29.48

### Customers Who Bought This Item Also Bought



# 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

**Sophia, the first robot to be granted citizenship**

Independent, October 2017

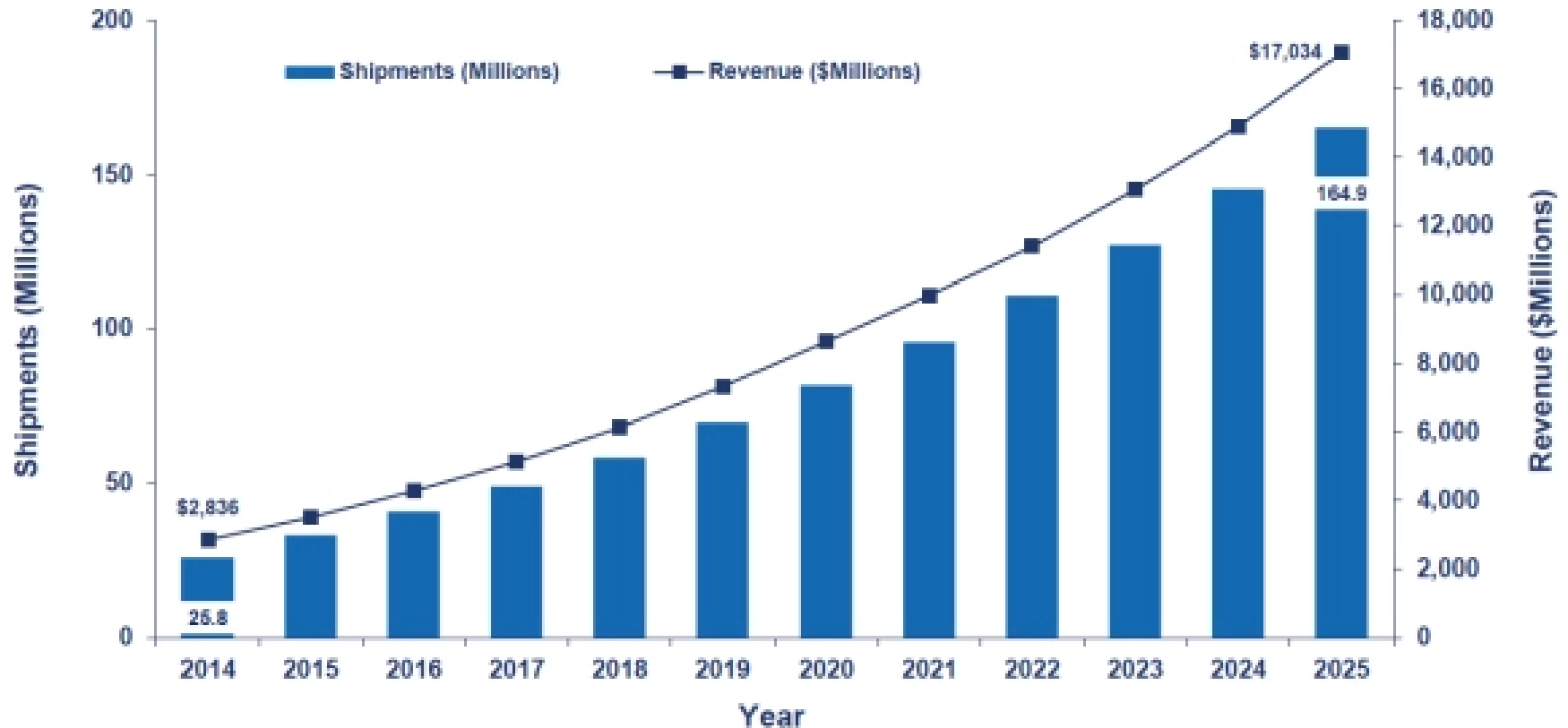


# O que estamos a fazer

*Fase 5: Máquina 2.0, iterativa e autónoma*

**Figure 12: Worldwide Consumer Robotics Product Shipments and Revenue**

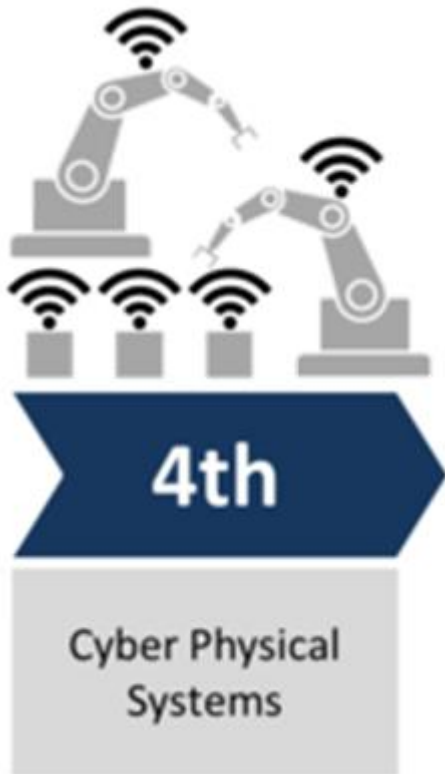
*(Source: ABI Research)*





# O que estamos a fazer

## *Fase 5: Industria 4.0*



***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)*

Industry Internet of Things  
Smart Factories  
Digital Value Chain Integration

## Industry 4.0

Digitalisation for productivity and growth

EPRS | European Parliamentary Research Service

Author: Ron Davies

September 2015

# O que estamos a fazer

## *Fase 5: Industria 4.0*

What is new? The way in which the IoT promises to take smart factory automation to a whole new level by intelligently connecting all phases of the product life cycle, from sourcing to delivery and right into the customer's home.

# To make a new kind of shoe, adidas had to change everything

adidas's South Asian factories churn out 720 million shoes a year, but production is slow and inflexible. In Bavaria, robots can make every pair unique. Welcome to the Speedfactory

**WIRED**

By ROWLAND  
MANTHORPE

—  
Wednesday 4 October 2017

# O que estamos a fazer

*Fase 5: Industria 4.0 – Em desenvolvimento*

## Tesla's wild 2017 ride

Model 3 news creates some peaks and troughs



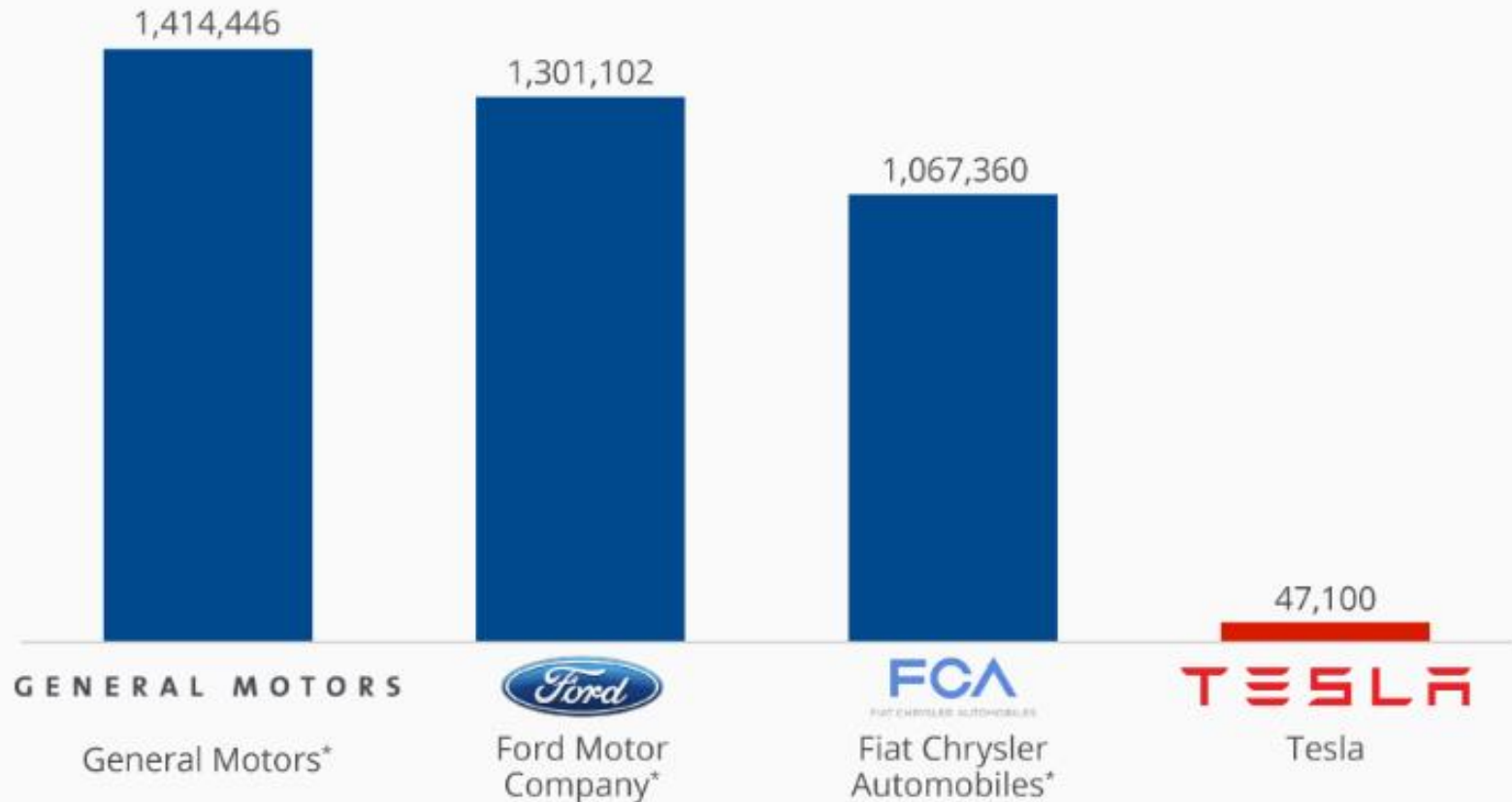
Source: MarketWatch

# O que estamos a fazer

*Fase 5: Industria 4.0 – Em desenvolvimento*

## How Tesla's Vehicle Deliveries Measure Up With the Big 3

Vehicle deliveries in the first half of 2017



 \* figures for GM, Ford and FCA are U.S. sales only  
@StatistaCharts Source: Company data

# O que estamos a fazer

## *Fase 5: Cidades Inteligentes*



European Innovation Partnership on Smart Cities and Communities  
**ROADMAP 2016**  
Supporting European Smart Cities

### What?

To overcome market fragmentation and achieve scale in building a market for smart city innovations

-  Quality of life
-  Business
-  Job creation
-  Low carbon
-  Sustainability

---

### How?

 Public partners +  Private partners →  Co-creating +  Sharing risk

---

### Who?

At least **100** cities to collaborate on bundling demand,  
**100** industries cooperate and develop solutions

-  **100** cities
-  **100** industry partners
- with the support of:
-  Governments
-  Civil society
-  Academia

# O IMPACTO DA 4ª RI

*O que muda*

# O impacto da 4ª RI

*Conetividade, Mobilidade, Tempo-real, Integração Físico-Digital, IA*



# O impacto da 4ª RI

*Alteração dos padrões de referência e escala*





# O impacto da 4ª RI

## *Desmaterialização e Desintermediação*



*Digitalização de produtos e serviços*

*Desintermediação da cadeia de valor*

# O impacto da 4ª RI

## Automação e Personalização

*Redução custos, eficiência recursos*

“No humans allowed”



# O impacto da 4ª RI

*Novos modelos de negócio (plataformas digitais)*



UBER



airbnb

eCooltra

citydrive



threadless



coursera



KHAN  
ACADEMY



fintech



bitcoin

You Tube

NETFLIX

Digitais

Plataformas

Colaboração e cocriação

# O impacto da 4ª RI

*“Inteligência Artificial”*



# O valor da 4ª RI

*Valor (triliões!)*

## IoT Market Size

(by 2025)

McKinsey&Company

**\$6.1T**



**\$7.1T**



**CISCO**

**\$14.4T**

## Connected Devices

(by 2020)

Gartner

**26B**



**32B**



**CISCO**

**50B**

## Data Growth

(2013 vs 2020)



Total Data

**4.4ZB → 44.4ZB**

**10x**

IoT Data

**.09ZB → 4.4ZB**

**49x**

# 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

EPRS | European Parliamentary Research Service

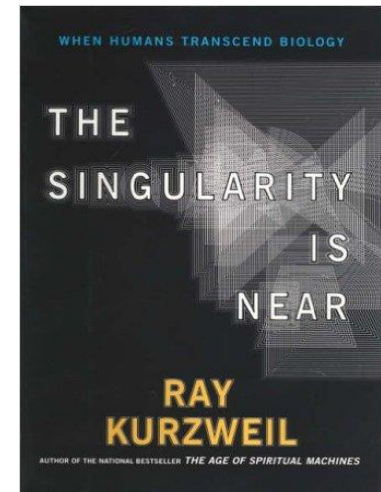
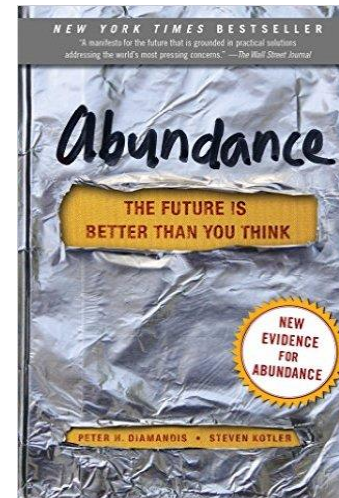
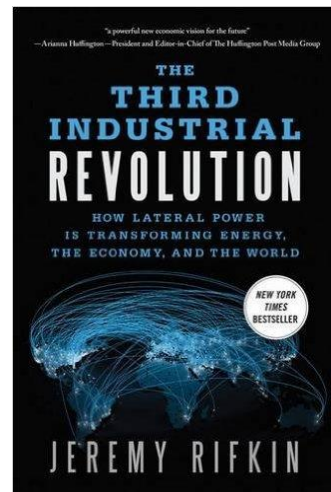
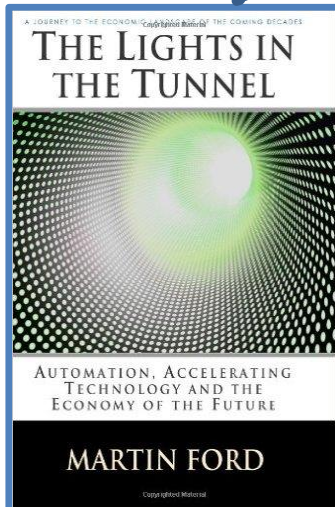
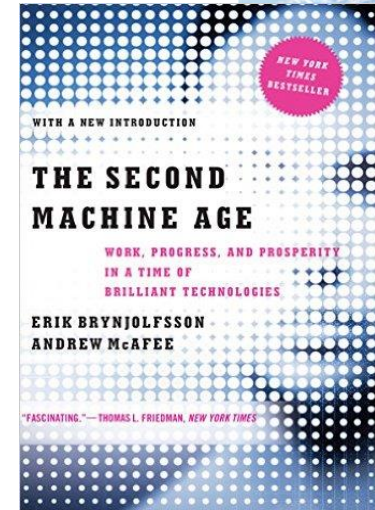
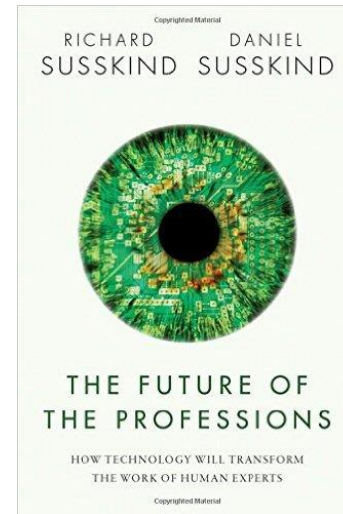
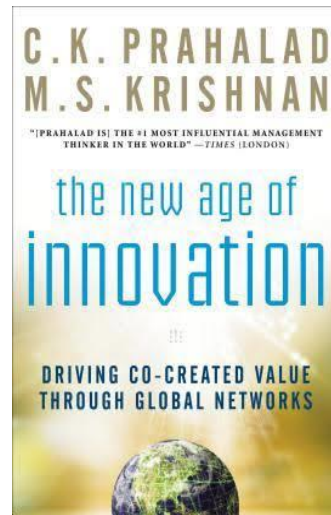
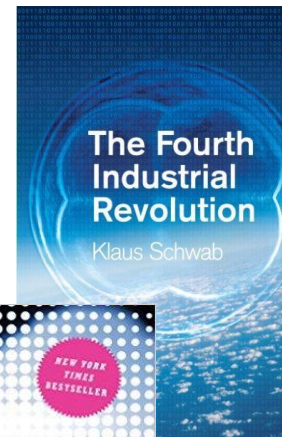
Author: Ron Davies

September 2015

# O impacto e valor da 4ª RI

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

Ler

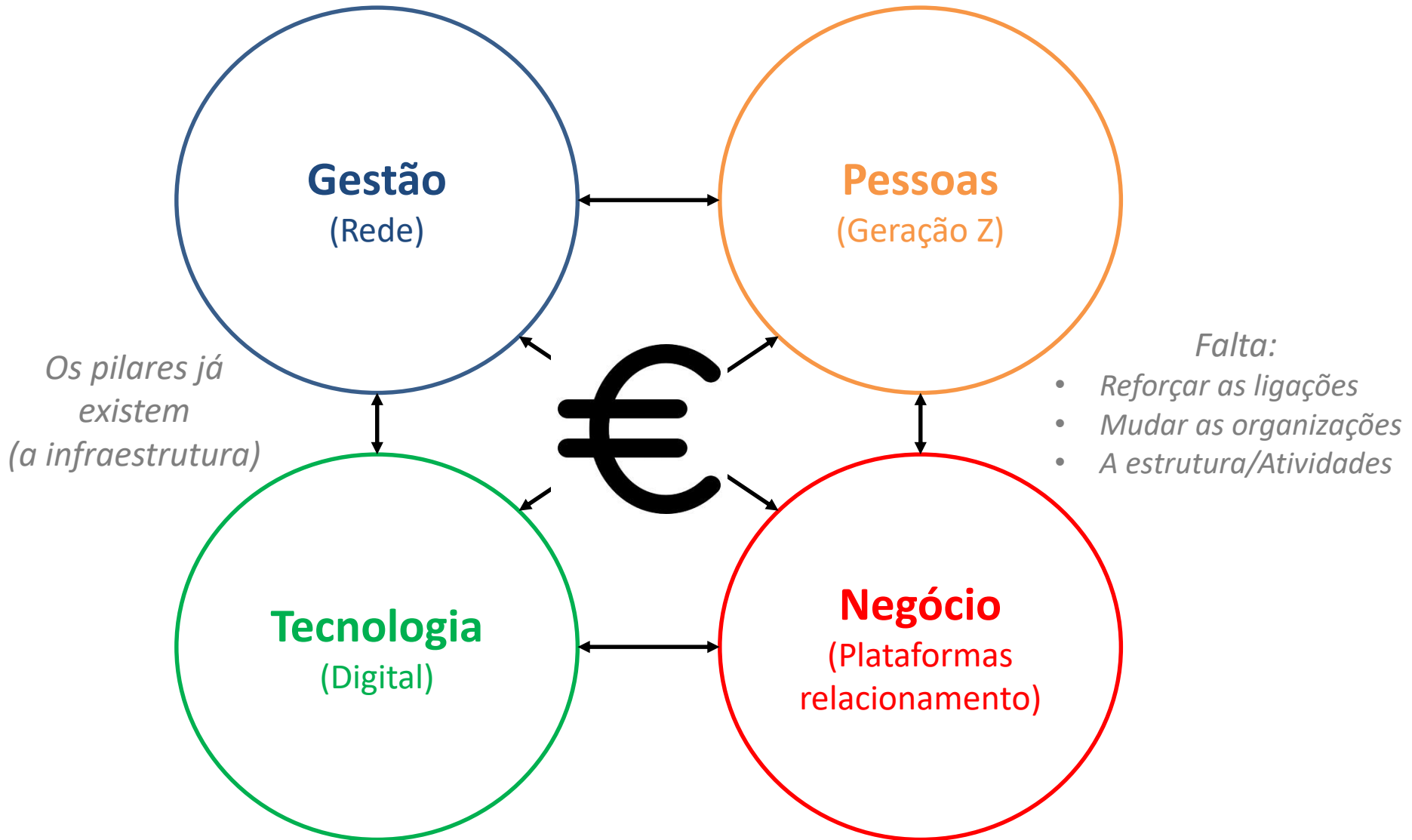


**O QUE FALTA E OS PERIGOS**



# O que falta

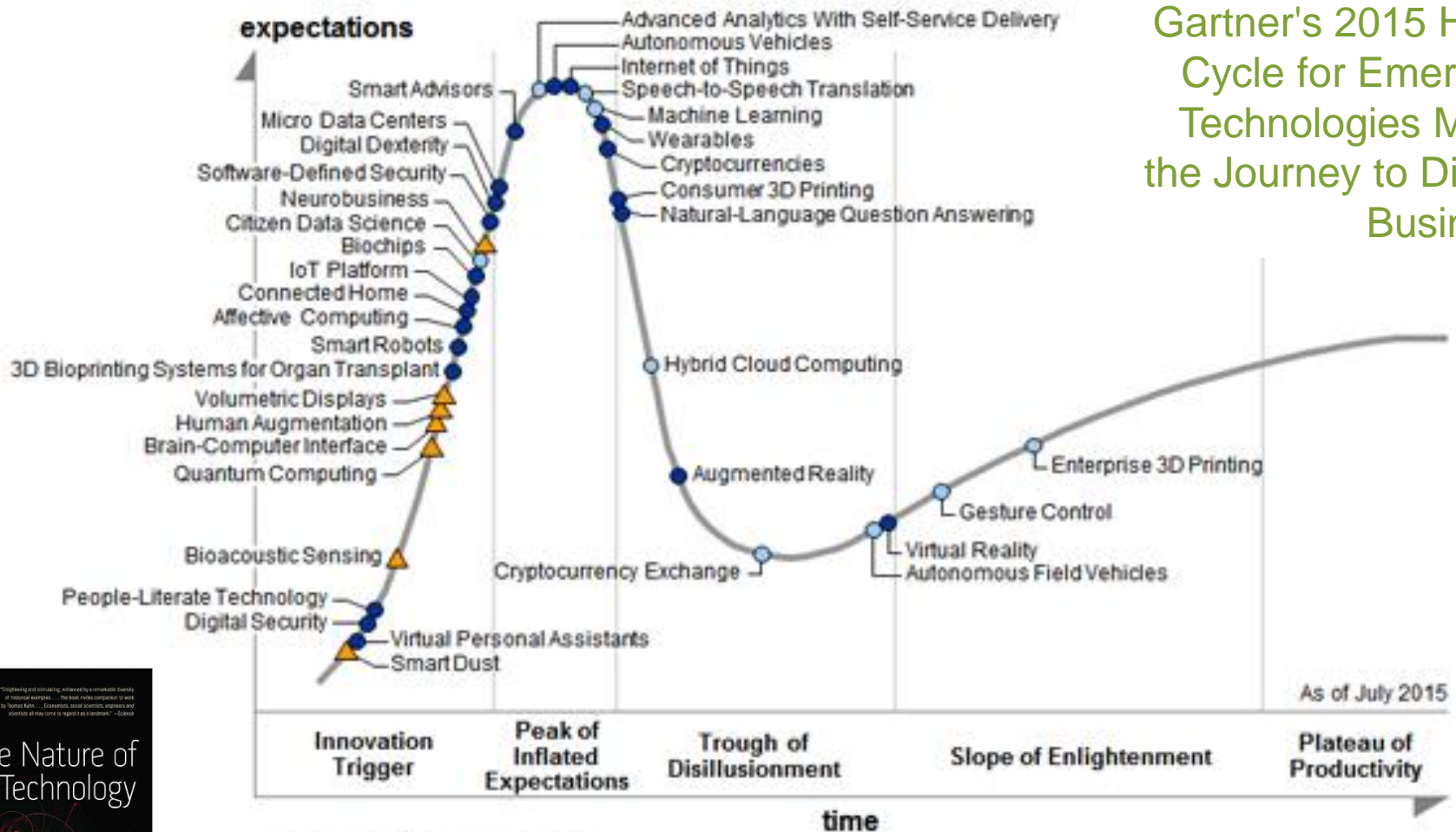
*As ligações, investimento e mudança*



# O que falta

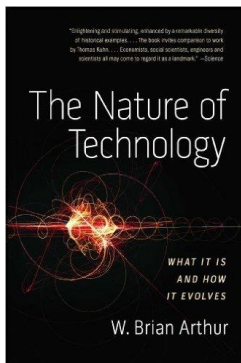
*Maturação, difusão e adoção tecnológica (tempo!)*

Gartner's 2015 Hype Cycle for Emerging Technologies Maps the Journey to Digital Business



Plateau will be reached in:

- less than 2 years
- 2 to 5 years
- 5 to 10 years
- ▲ more than 10 years
- ⊗ obsolete before plateau



*Estamos prontos mas ... vai levar tempo (Abernathy e Utterback)!*

# O que falta

## Standards - A guerra já começou



European  
Commission

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

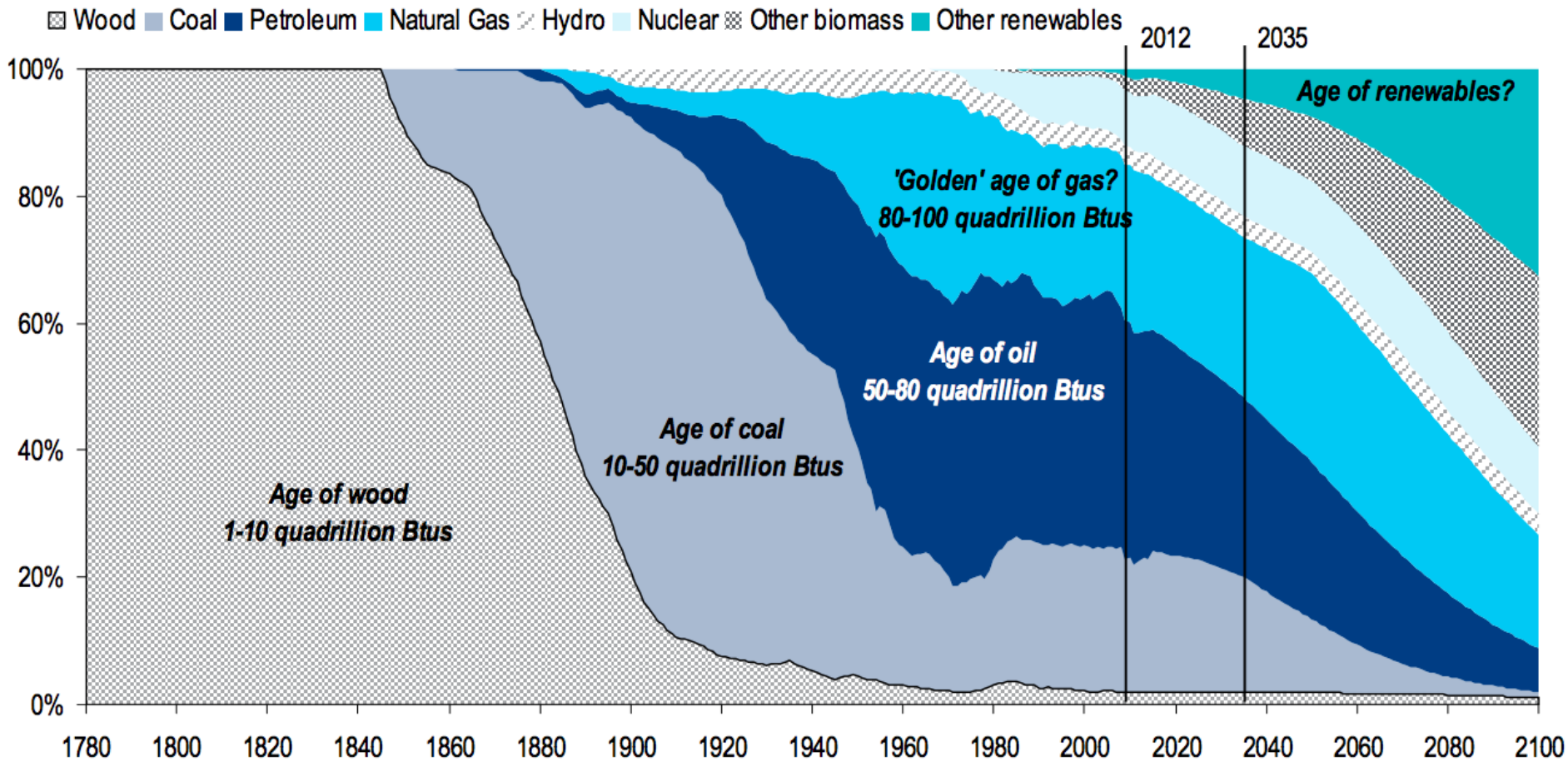
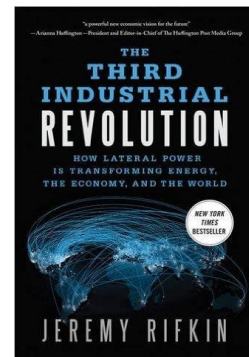
Digitising European Industry - Reaping the full benefits of a Digital Single Market (2016)

### IoT SDOs and Alliances Landscape (Technology and Marketing Dimensions)



# O que falta

## Energia barata, muita!



# O que falta

*Legislação, Políticas e Economia*

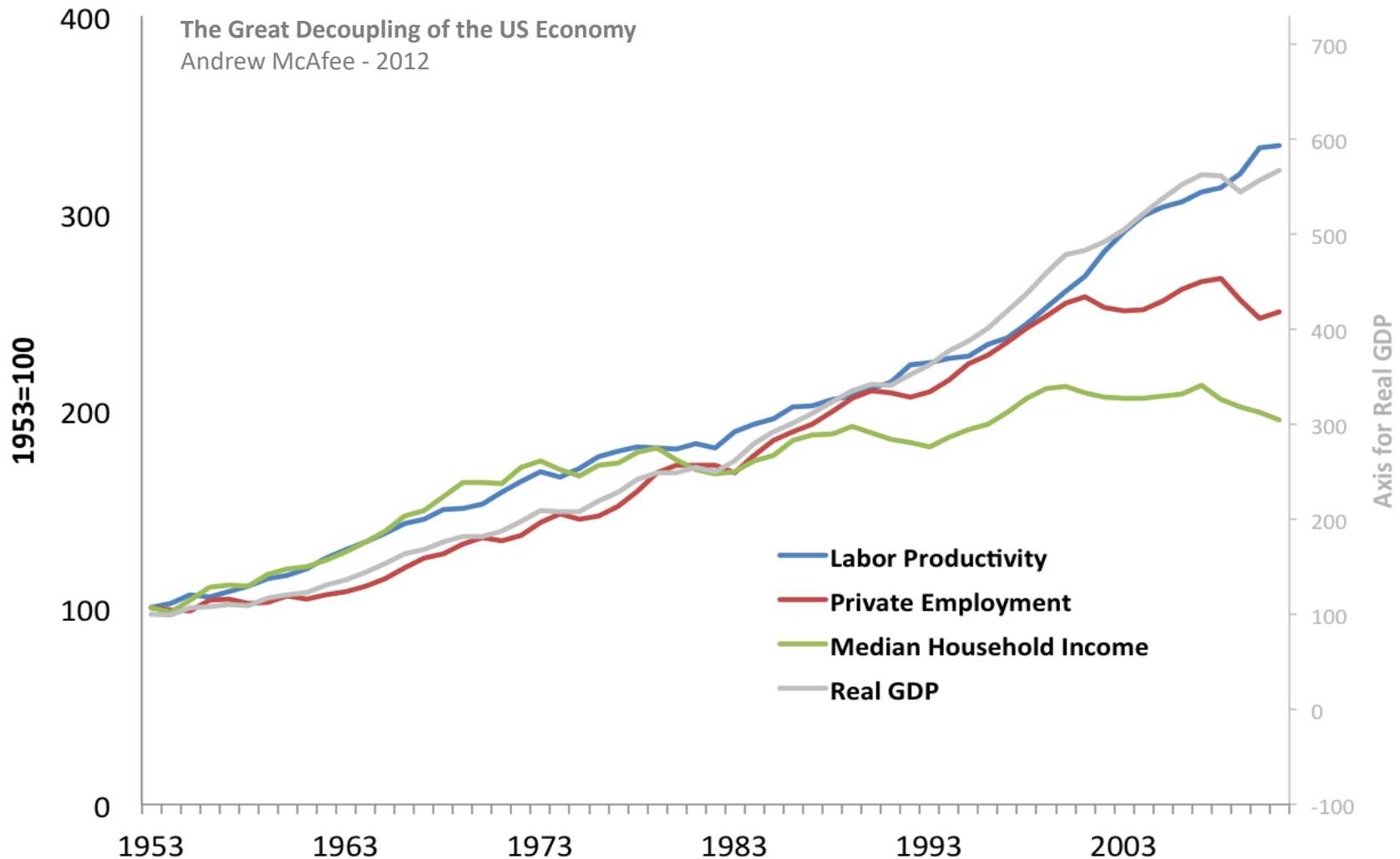
## Legislação

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



# O que falta

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



# O que falta

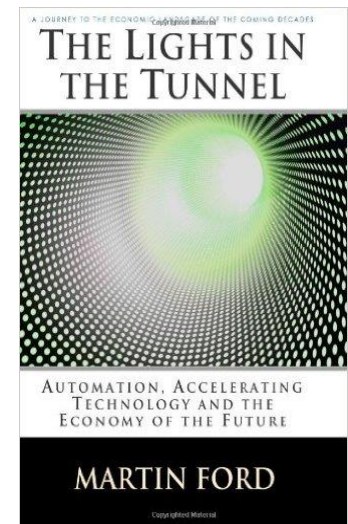
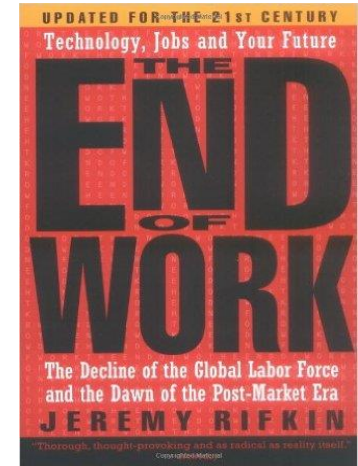
## *O fim do trabalho?*

### 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?

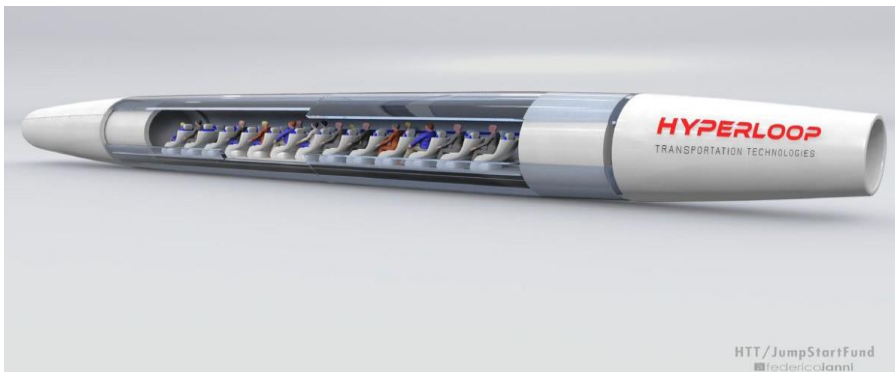
### Cenário 2 – longo prazo

- A Indústria 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



# O que falta

*Está tudo por fazer!*





# Os perigos

Desemprego  
Desigualdade



Recessão  
Polarização



Homem vs. Máquina



# CONCLUSÕES

# Conclusões

## *A 4ª Revolução Industrial - IA*

### Construímos um “novo mundo” - Digital

- Tudo está conectado e tem “iteratividade”
- Tudo tem um rasto digital
- Os dados são fonte de diferenciação e valor

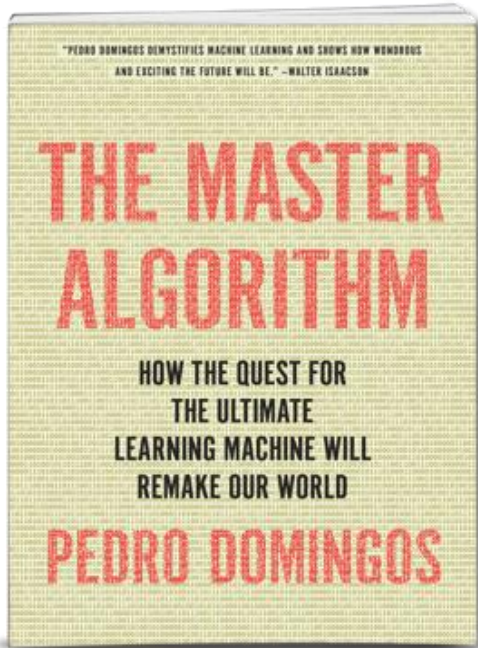
- **“Inteligência Artificial”**
- **Integração mundo físico e digital, homem e máquina**

- Aumento significativo da **produtividade e crescimento**
- Precisamos de tempo, investimento e mudança processos

- **Relação Trabalho vs Consumo → Nova Economia!**

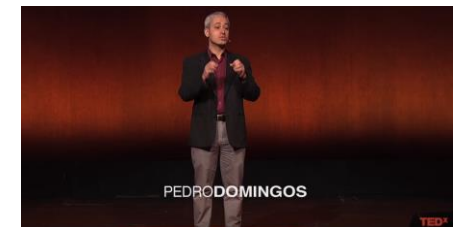
# A 4ª Revolução Industrial - IA

*Alguns investigadores Portugueses*



**Recomendo que vejam:**

The Next Hundred Years of Your Life | Pedro Domingos | TEDxLA



“People worry that computers will get too smart and take over the world, but the real problem is that they're too stupid and they've already taken over the world.”

— Pedro Domingos

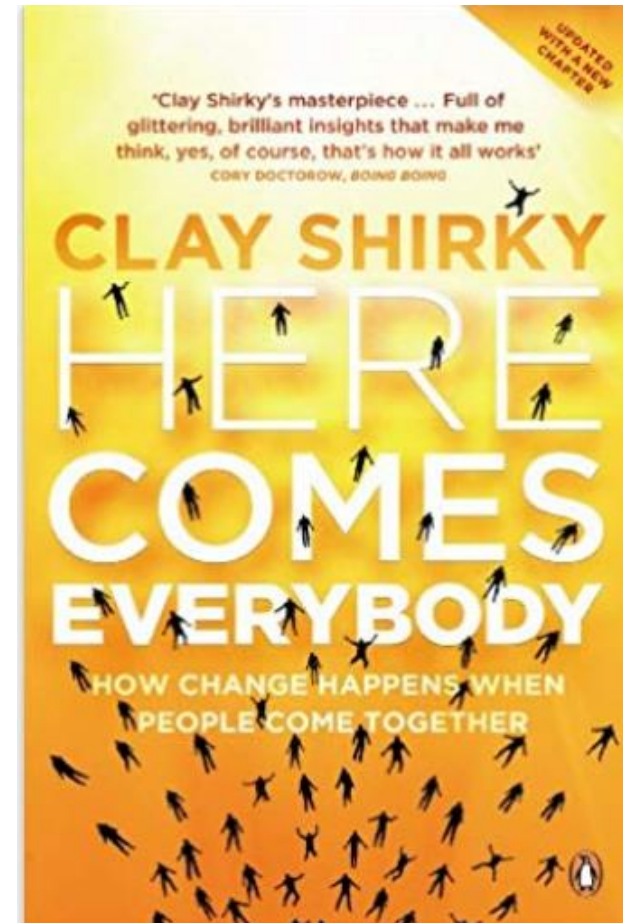
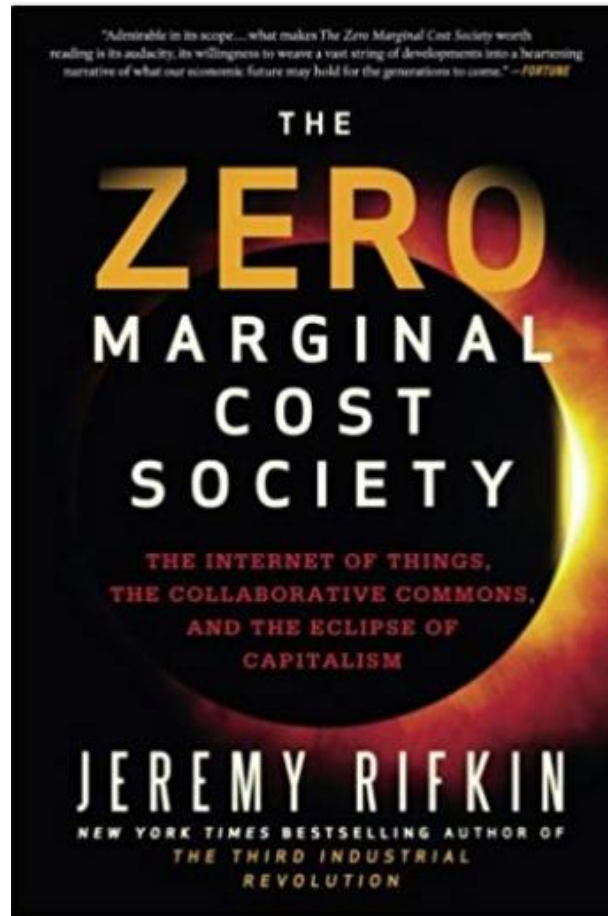
# A 4ª Revolução Industrial



LISBON  
**SCHOOL OF  
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UNIVERSIDADE DE LISBOA

# “The sharing economy”

(livros que prometi partilhar no fim da aula)



# “The sharing economy”

