



# Digital Earth: Future Challenges

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European Commission – Joint Research Centre

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Joint Research Centre

The European Commission's science and knowledge service



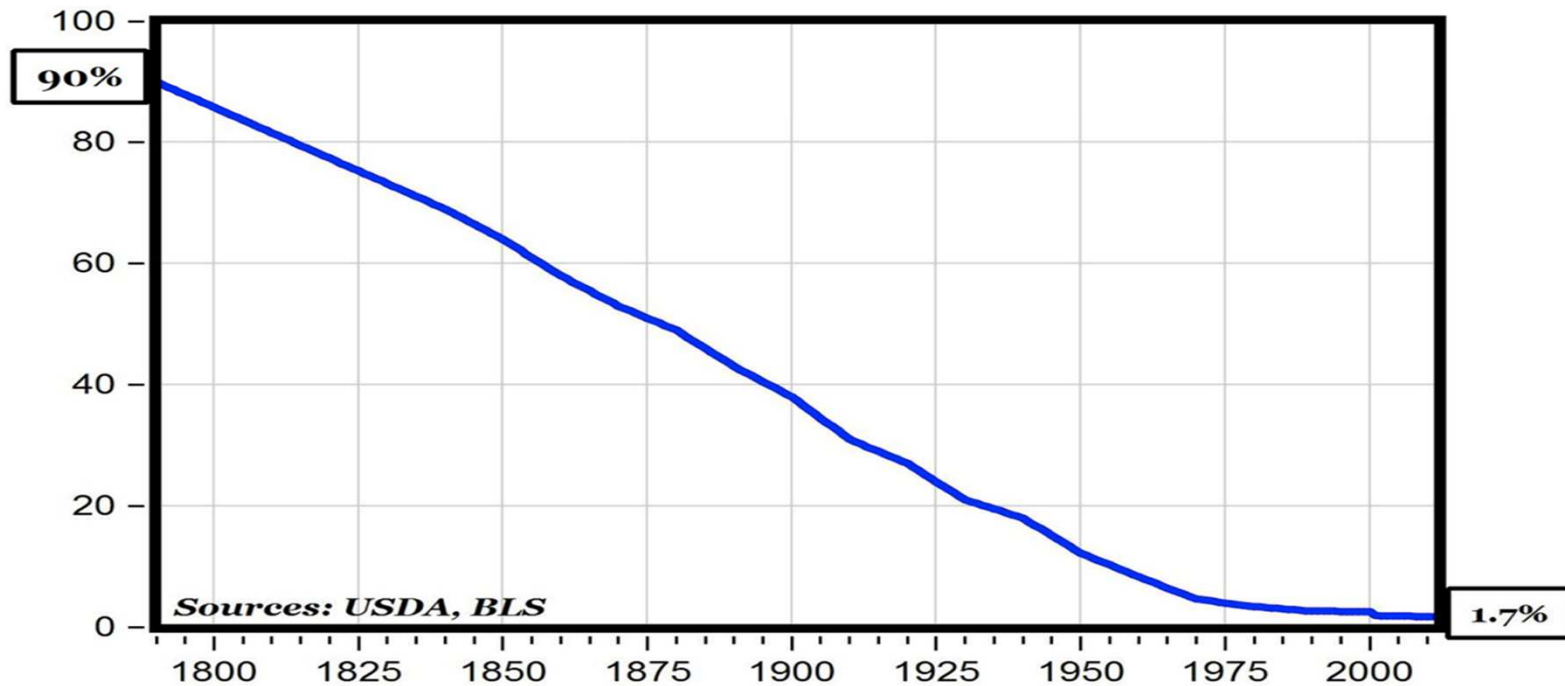
# Farm Automation



Courtesy Jerry Kaplan, Stanford University

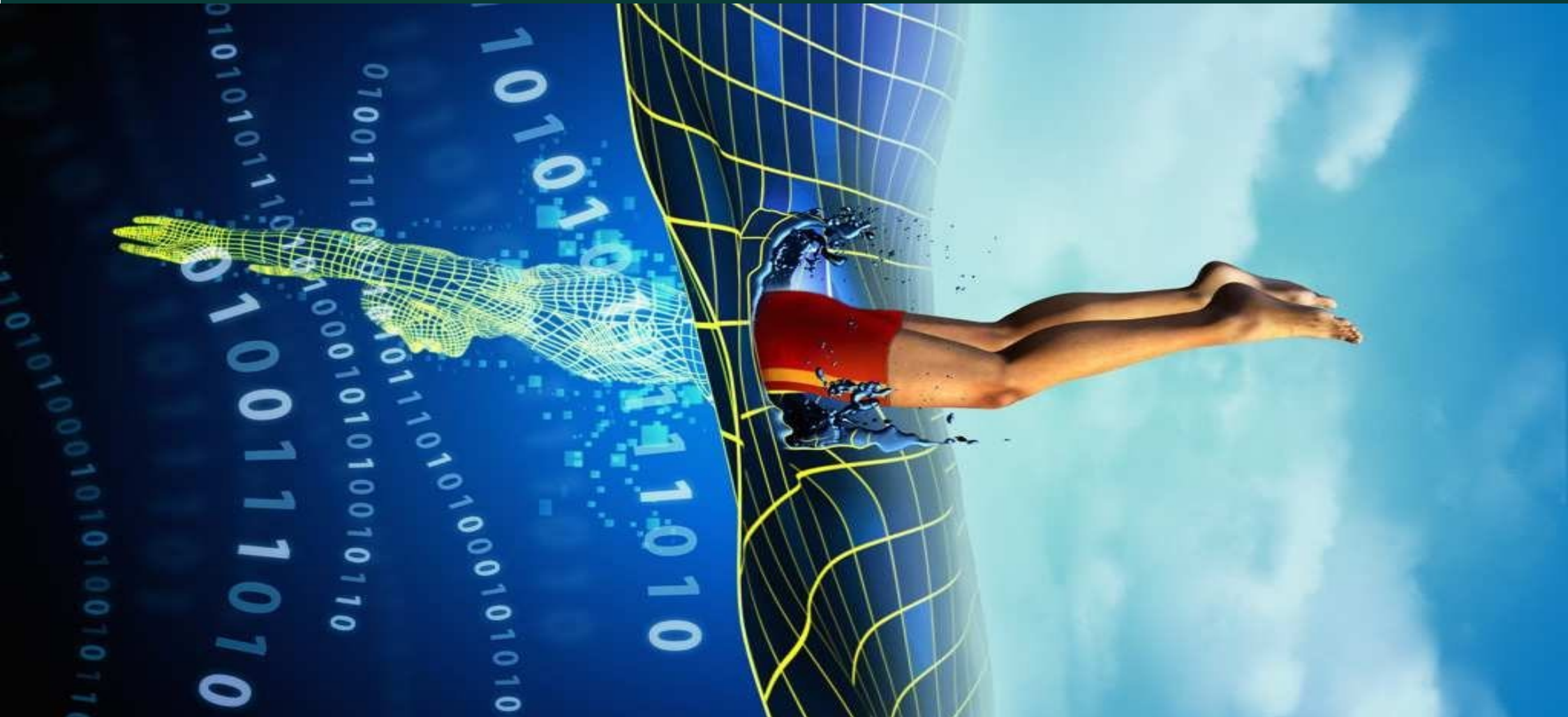
# Farm % of Total US Employment

## Farm Jobs, % of Total U.S. Jobs 1790 to 2011



Courtesy Jerry Kaplan, Stanford University

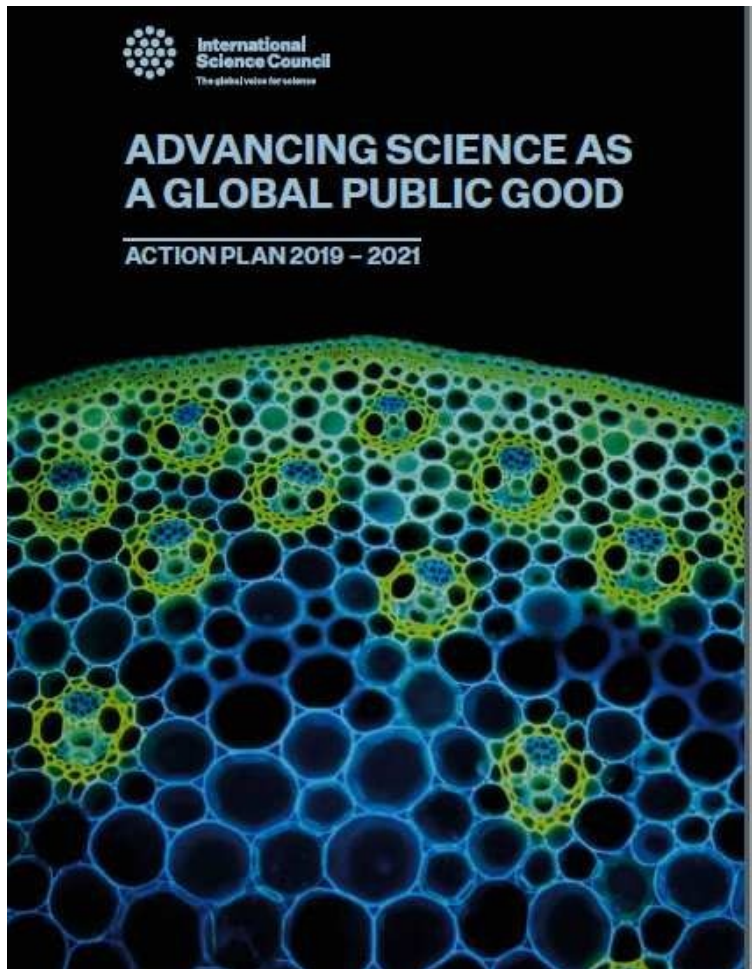
**Digital transformation** refers to the profound changes taking place in the economy and society as a result of the uptake and integration of digital technologies in every aspect of human life.





# MAJOR CHALLENGES FOR SOCIETY TO WHICH SCIENCE SHOULD RESPOND

International Science Council: Action Plan 2019-2021



Today's digital technologies are a good example of a '**general-purpose technology**' that **continually transforms itself**, progressively **penetrating almost all domains of private and public life**.

It **disrupts existing patterns** of behaviour, organization and production and boosts productivity across all sectors and industries because of its cost effectiveness, with profound economic and social implications.

It has ushered in a new era of **data driven science**, with concomitant pressures for change in the social organization of science.

# The Digital Revolution

## *Domain 2 in the ISC Action Plan 2019-21*



Global society is in the throes of a **digital revolution that has transformed the way in which information and knowledge are acquired, stored, communicated and used.**

This revolution is distinguished by its **speed**, its **global pervasiveness** and its **disruptive consequences.**

There are few areas of individual, commercial, social or political action that are unaffected.

It poses **powerful opportunities and radical challenges both to science and to society to adapt in ways that maximise beneficial and minimise negative outcomes.**

Two Projects as priority

- **Data-driven interdisciplinarity**
- **Global data resources and governance**



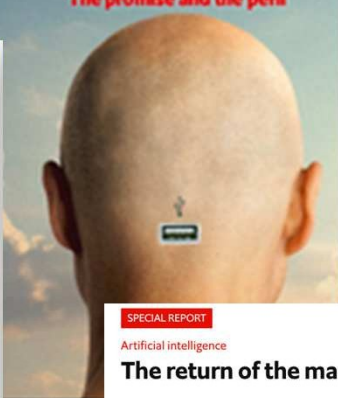
# Most important technologies contributing to Digital Transformation

Table 2: Top 15 technologies of 2025

1	Artificial intelligence
2	Internet of Things/Smart Things
3	Robotics/Automation
4	Cybersecurity
5	Big data/analytics
6	Energy storage/Batteries
7	Blockchain
8	5G
9	Cloud
10	FinTech
11	Battery-less/energy harvesting
12	Augmented/mixed reality
13	Voice assistants/VPA
14	3D printing
15	Virtual reality



Artificial intelligence  
**Difference Engine: Luddite legacy**  
*Is smart technology now destroying more jobs than it creates?*



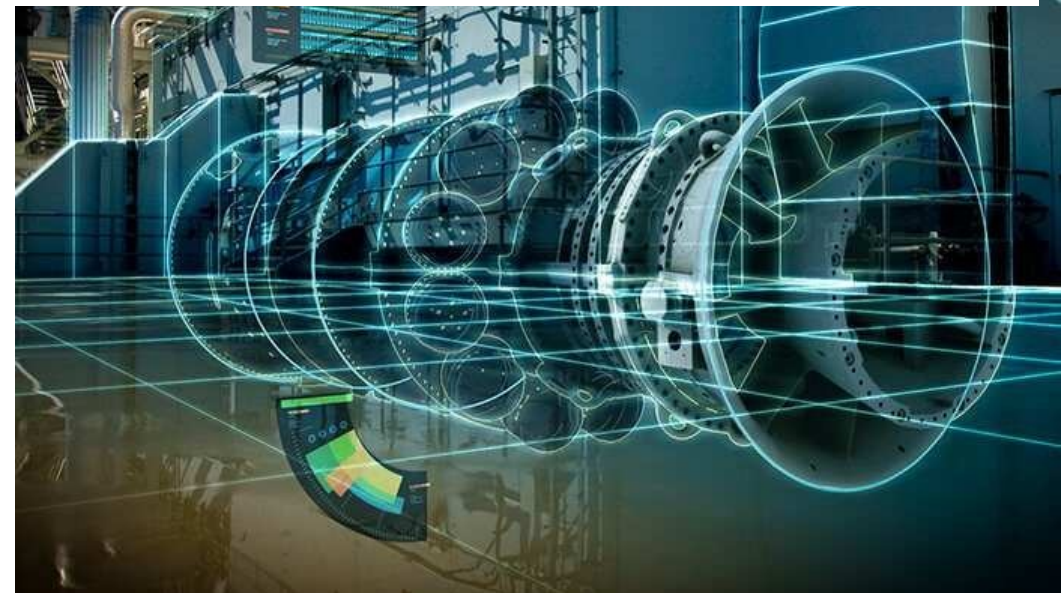
SPECIAL REPORT  
Artificial intelligence  
**The return of the machinery question**  
*After many false starts, artificial intelligence has taken off. Will it cause mass unemployment or even destroy mankind? History can provide some helpful clues, says Tom Standage*



Source: IDATE DigiWorld

# Digital Earth vs Digital Twin

**Digital twins are virtual replicas of physical devices that data scientists and IT pros can use to run simulations before actual devices are built and deployed. They are also changing how technologies such as IoT, AI and analytics are optimized.**

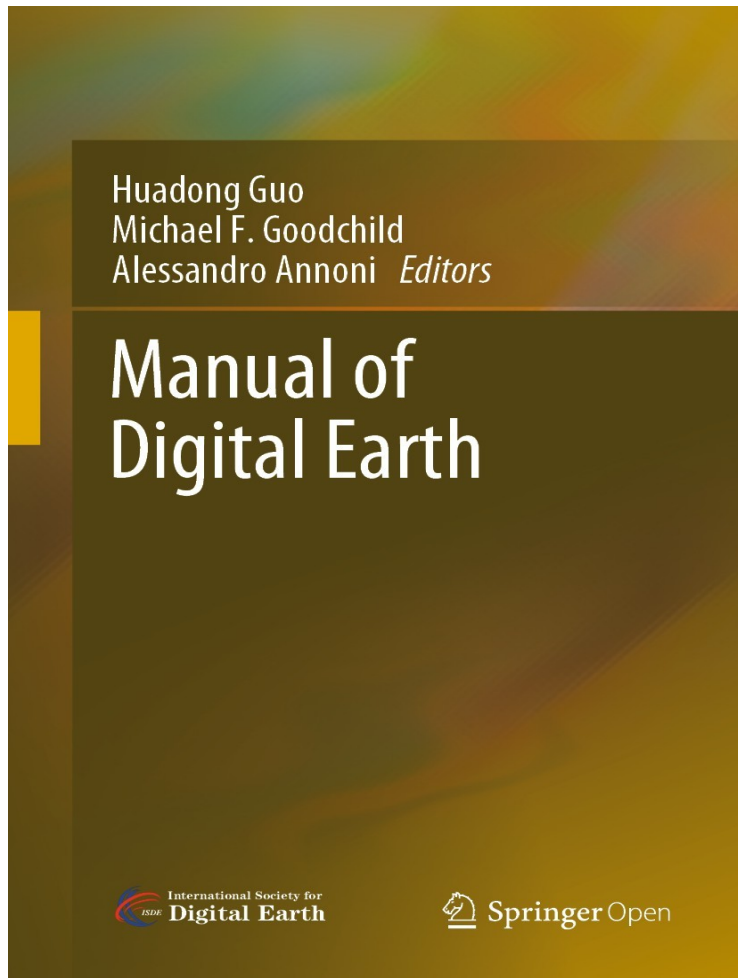


<https://www.networkworld.com/article/3280225/what-is-digital-twin-technology-and-why-it-matters.html>

<https://blog.eduonix.com/internet-of-things/digital-twin-new-big-strategic-rise-iot/>

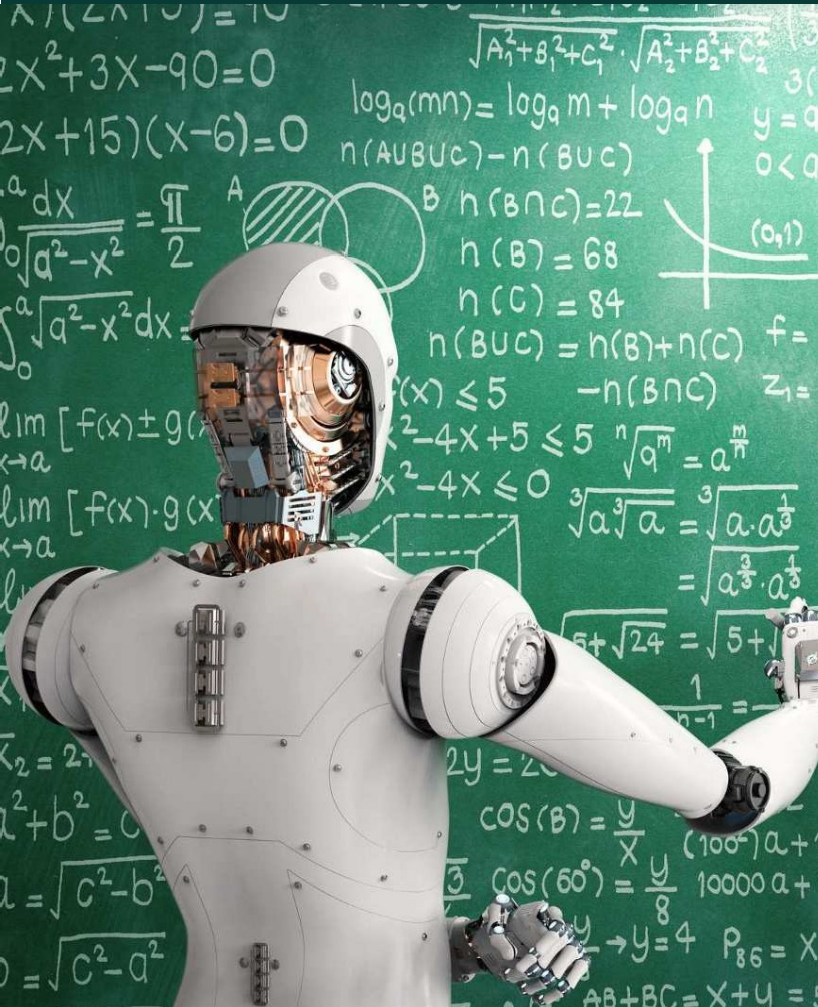


# Major Challenges for Digital Earth

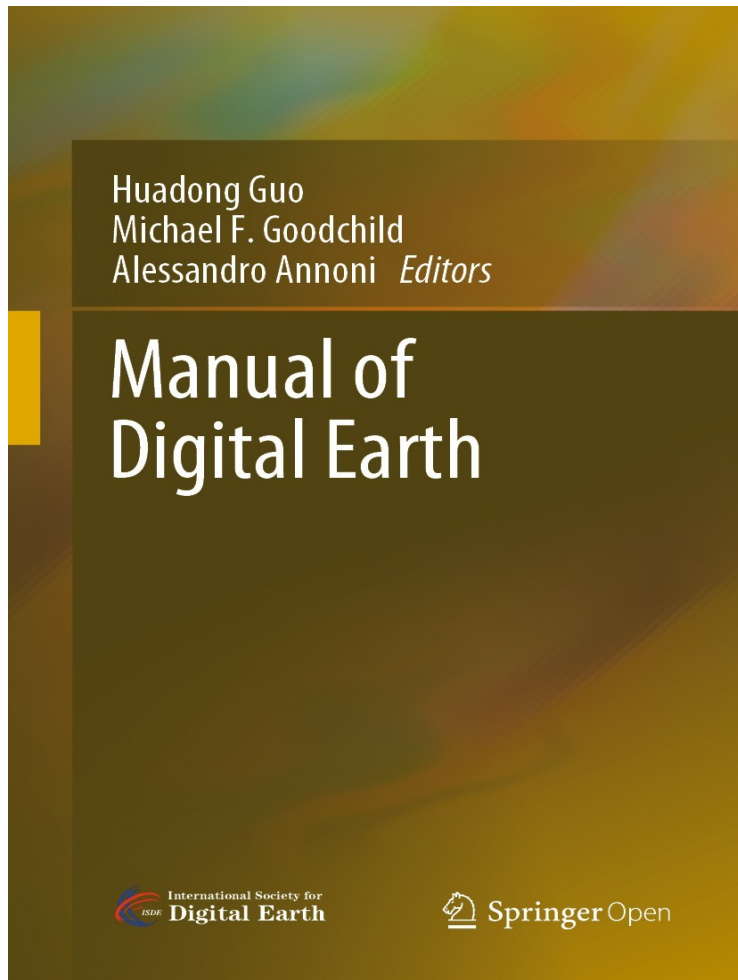


- Big Data Management
- DE Platforms implementation and construction
- Developing an Ecosystem for DE
- Addressing Social Complexities
- Diversified curricula toward DE Education

# Education



# Technologies relevant for Digital Earth



- IoT
- Block Chain
- Virtual Reality / Augmented Reality
- Artificial Intelligence
- Hyper Connectivity
- 5G, Fog/Edge computing
- Progress in computing and microelectronics
- In memory computing...



# Data Explosion

**BY 2020**

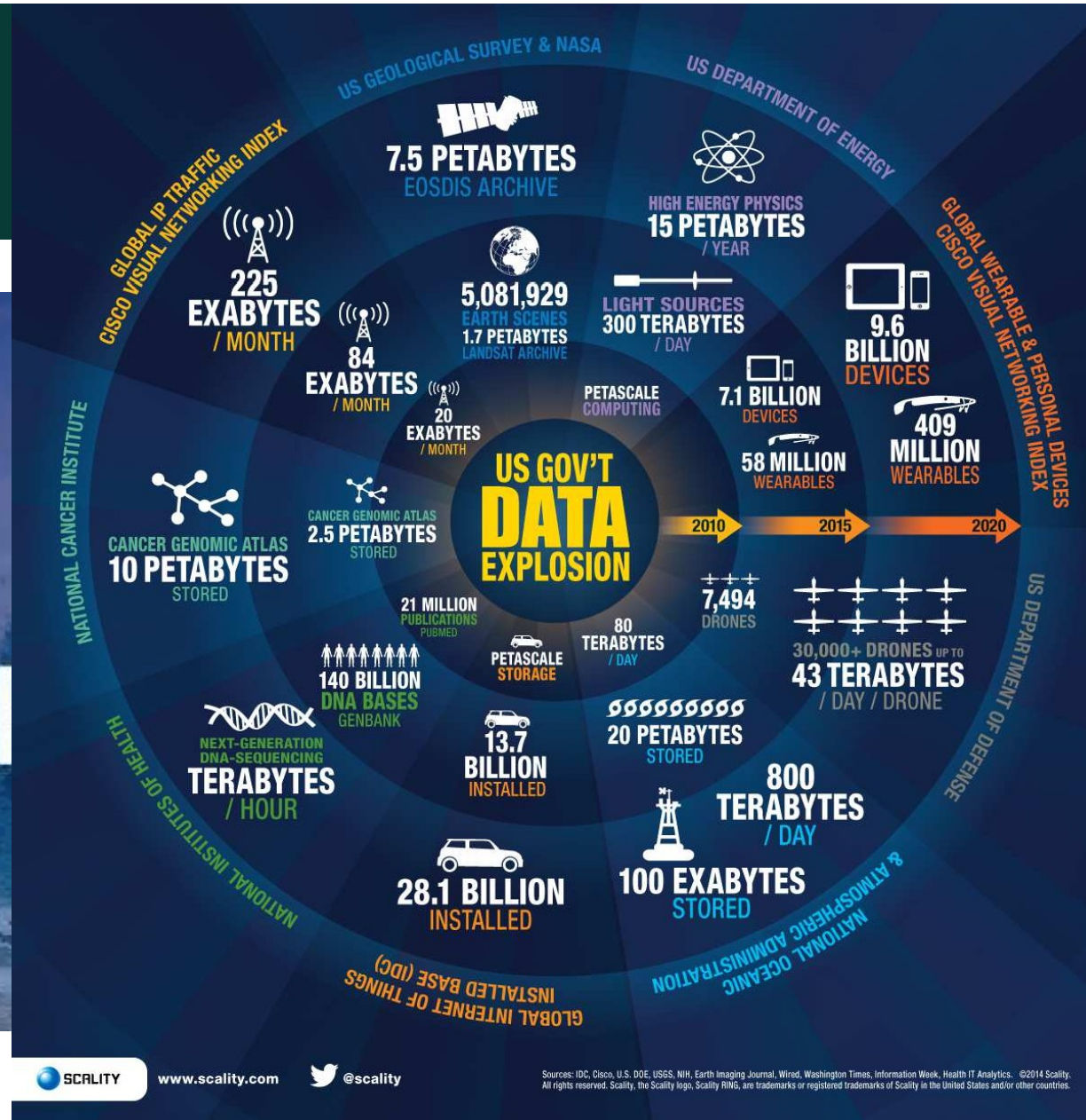
AVG. INTERNET USER **1.5 GB** OF TRAFFIC / DAY

AUTONOMOUS VEHICLES **4 TB** OF DATA / DAY

CONNECTED AIRPLANE **5 TB** OF DATA / DAY

SMART FACTORY **1 PB** OF DATA / DAY

CLOUD VIDEO PROVIDERS **750 PB** OF VIDEO / DAY



<https://www.semiconwest.org/consumer-industrial-data-explosion-hits-supply-chain>

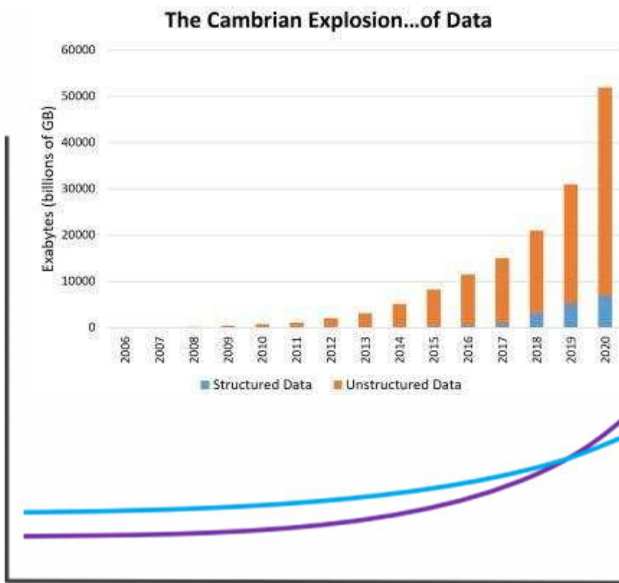


www.scality.com



Sources: IDC, Cisco, U.S. DOE, USGS, NIH, Earth Imaging Journal, Wired, Washington Times, Information Week, Health IT Analytics. ©2014 Scality. All rights reserved. Scality, the Scality logo, Scality RING, are trademarks or registered trademarks of Scality in the United States and/or other countries.

# Data Vs Computing Power



Data Growth  
40% per year

CPU Processing Power  
20% per year

COMPUTING  
POWER

## Technological solutions emerge

- New powerful chips
- Edge and Fog computing
- Quantum computing ...

Dedicated AI  
accelerators +  
smart sensors

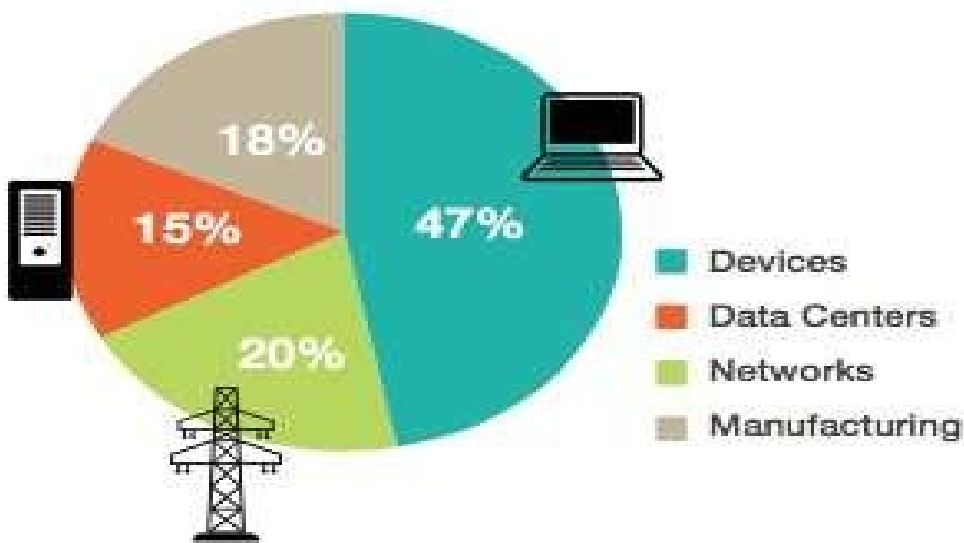
General Purpose  
Microcontrollers  
+ sensors

Silicon-Born-  
AI on single  
Chip

# Energy consumption

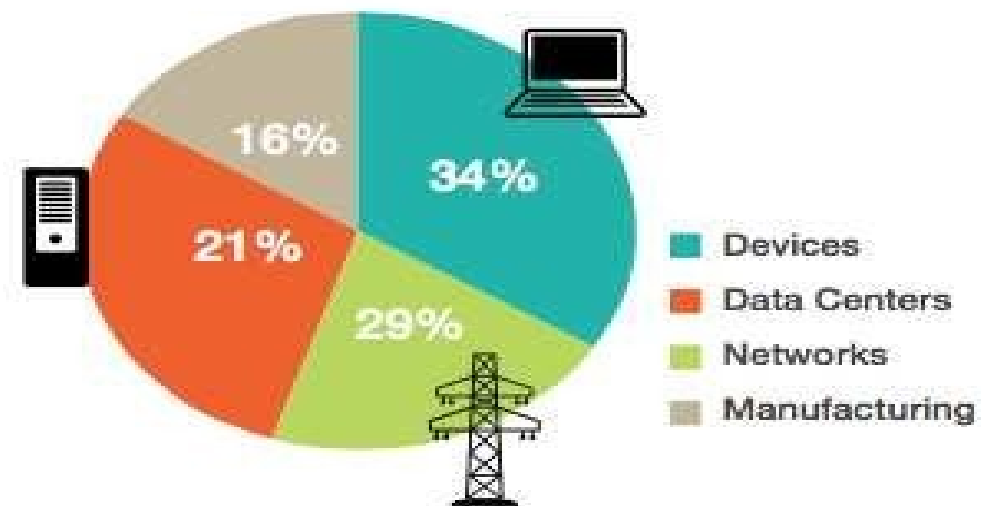
## Main components of electricity consumption for the ICT sector

2012



Main components of electricity consumption for the IT sector, 2012. From "Emerging Trends in Electricity Consumption for Consumer ICT"

2017

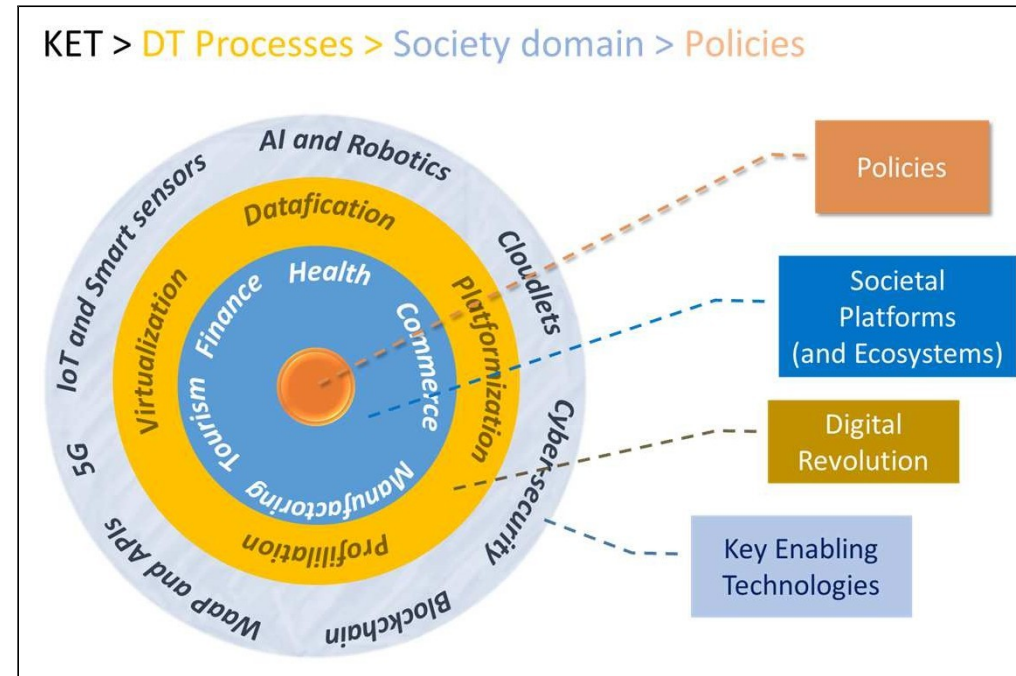
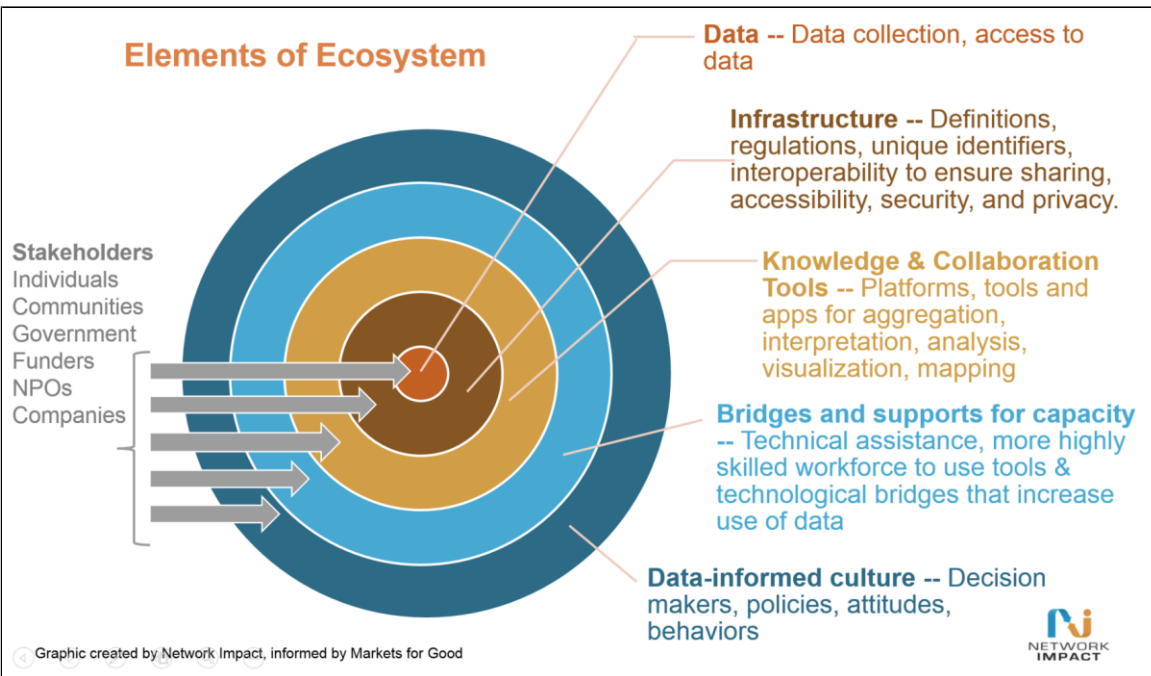


Main components of electricity consumption for the IT sector, 2017 estimate. From "Emerging Trends in Electricity Consumption for Consumer ICT"

[source: IEEE STC on Sustainable Computing](#)



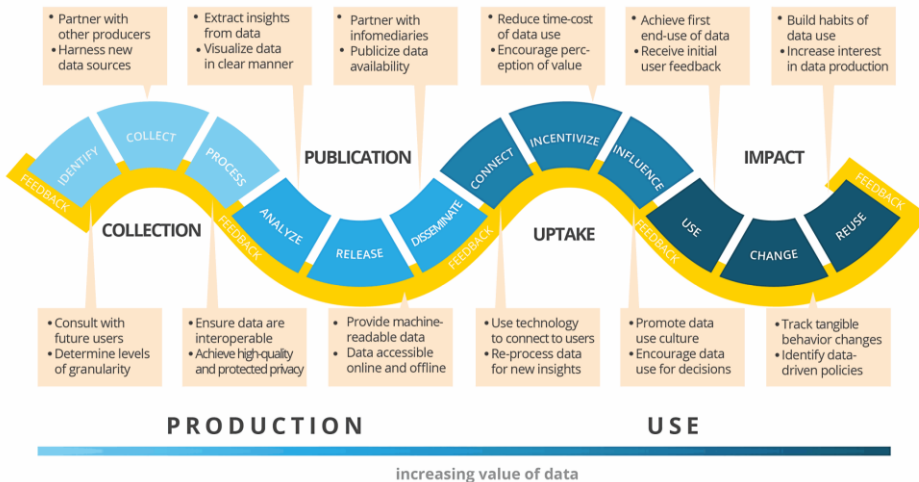
# Data ecosystem (economic vs technological view)



# Data value chain vs Datafication paradigm



## DATA VALUE CHAIN

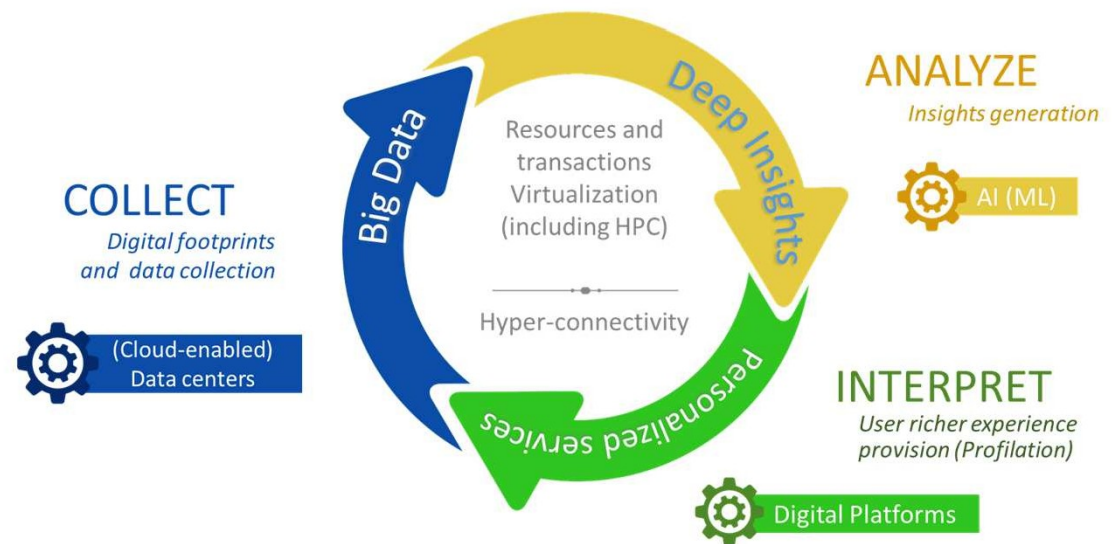


**MARKERS** Potential achievements within each process of the value chain mark progress towards data impacts.

**Roadblocks for production** include lack of financial, human, and technological resources; low data literacy; lack of trust between users and data collectors; blind-spots in data gaps; lack of country ownership; and lack of government desire for transparency.

**Roadblocks for use** include low political support; lack of data relevance to decisions; poor quality; lack of trust in government data use; no rewards or results of data use; financial constraints; corruption; data silos; and lack of partnerships between infomediaries.

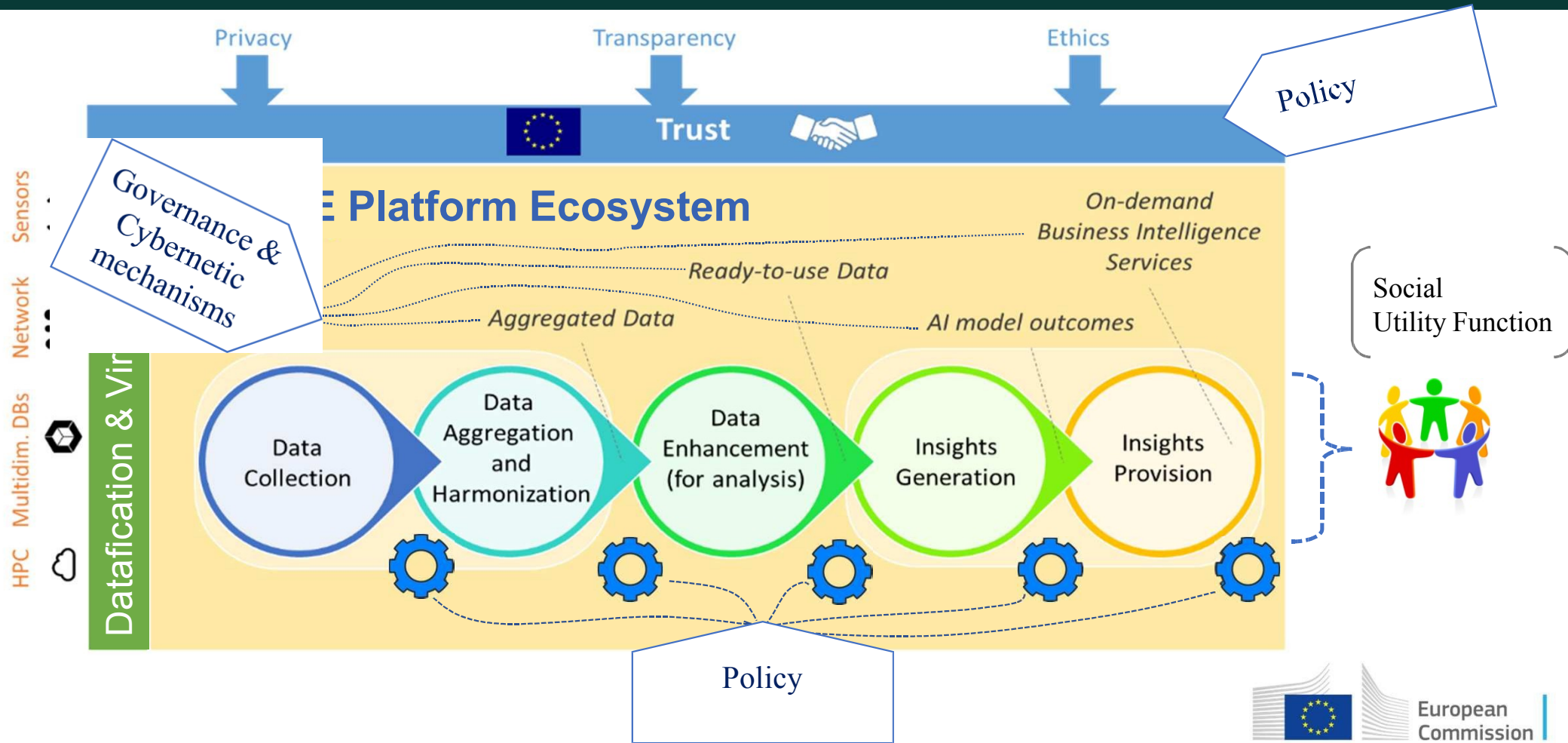
## Datafication Paradigm



Source: <https://opendatawatch.com/publications/the-data-value-chain-moving-from-production-to-impact/>



# (networked) Supply chain ecosystem



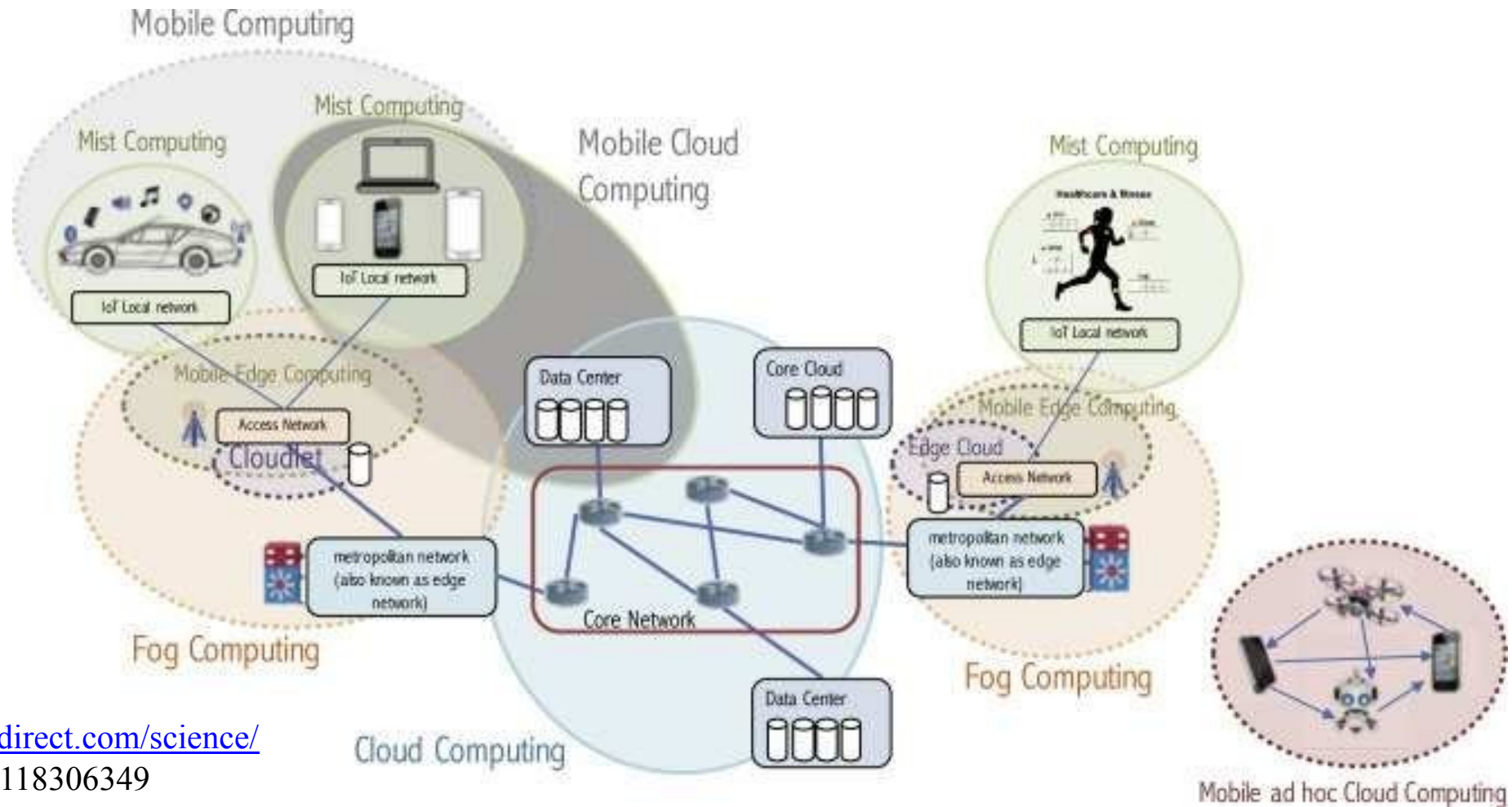


# Blockchain



**Blockchain** — just like **data science** — is gradually transforming the way several industries operate. And while **data science** focuses on harnessing **data** for proper administration, **blockchain** ensures trust of **data** by maintaining a decentralized ledger.

# Fog and Edge computing



<https://www.sciencedirect.com/science/article/pii/S1383762118306349>

# Opportunities: e.g. Artificial Intelligence

AI is automation



Quality of work will improve

Better decision making

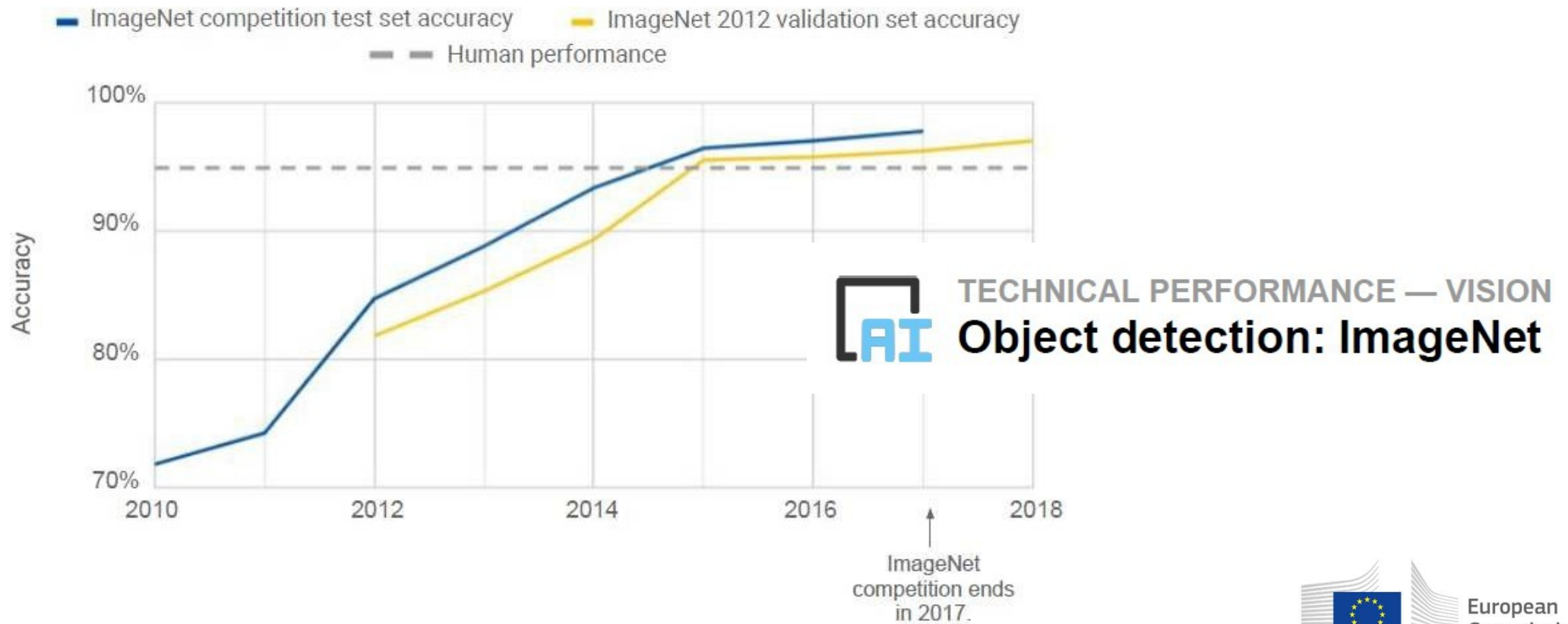




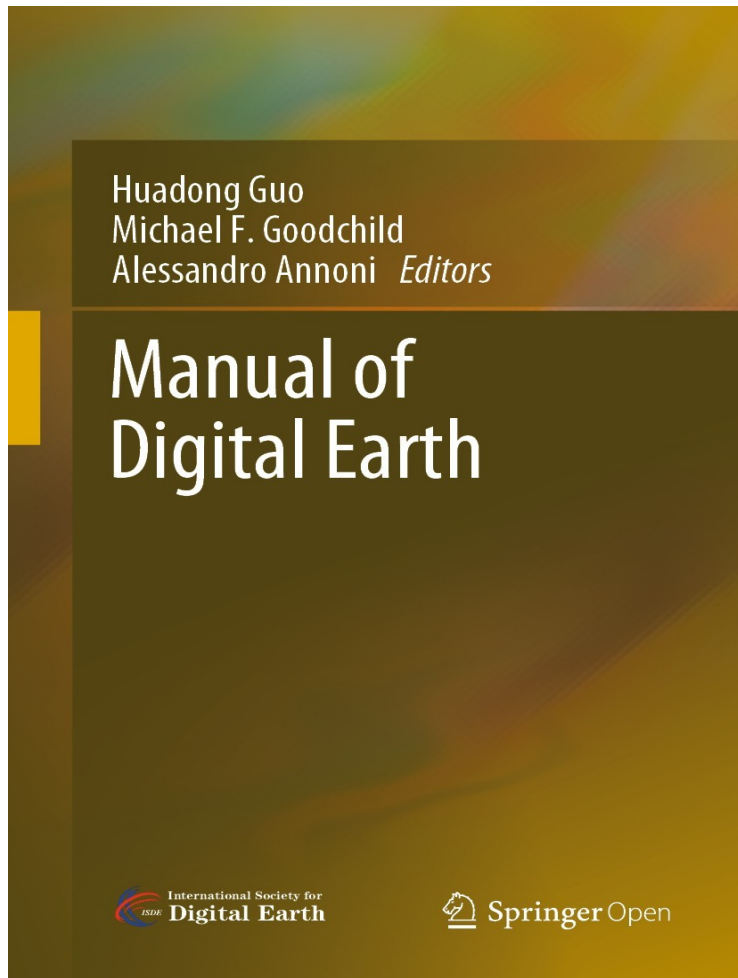
# Readiness and Maturity of the technologies

ImageNet (2010 –2018)

Source: ImageNet; see appendix



# New challenges



- Sustainability
- Ethics and Security
- Digital Governance

# Societal and ethical impact

DEC 2014

## MOBILE CONNECTIONS vs. PEOPLE

ACTIVE MOBILE SUBSCRIPTIONS



**7.324**  
BILLION

vs

TOTAL WORLD POPULATION



**7.280**  
BILLION

we are social

We Are Social - Sources: GSMA Intelligence, Worldometers

<http://wearesocial.sg> @wearesocial

JAN 2019

## INTERNET USE: DEVICE PERSPECTIVE

BASED ON ACTIVE INTERNET USER DATA, AND ACTIVE USE OF INTERNET-POWERED MOBILE SERVICES

TOTAL NUMBER OF ACTIVE INTERNET USERS



**4.388**  
BILLION

we are social

INTERNET USERS AS A PERCENTAGE OF TOTAL POPULATION



**57%**

global web index

TOTAL NUMBER OF ACTIVE MOBILE INTERNET USERS



**3.986**  
BILLION

we are social

MOBILE INTERNET USERS AS A PERCENTAGE OF TOTAL POPULATION



**52%**

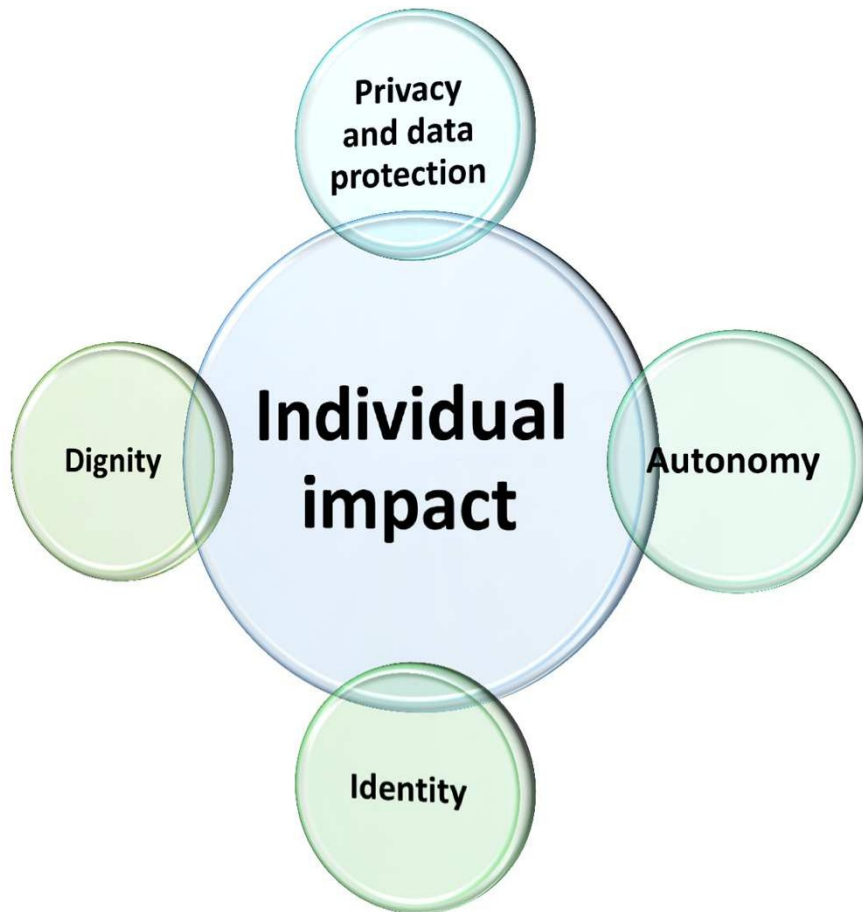
32

SOURCES: INTERNETWORLDSTATS; ITU; WORLD BANK; CIA WORLD FACTBOOK; EUROSTAT; LOCAL GOVERNMENT BODIES AND REGULATORY AUTHORITIES; MIDEASTMEDIA.ORG; REPORTS IN REPUTABLE MEDIA. MOBILE SHARE DATA: A COMBINATION OF DATA FROM GLOBALWEBINDEX (Q2 & Q3 2018) AND EXTRAPOLATED DATA FROM THE SELF-SERVE ADVERTISING TOOLS OF VARIOUS SOCIAL NETWORKS (JANUARY 2019). DATA FROM GLOBALWEBINDEX REPRESENT THE FINDINGS OF A BROAD SURVEY OF INTERNET USERS AGED 16-64.

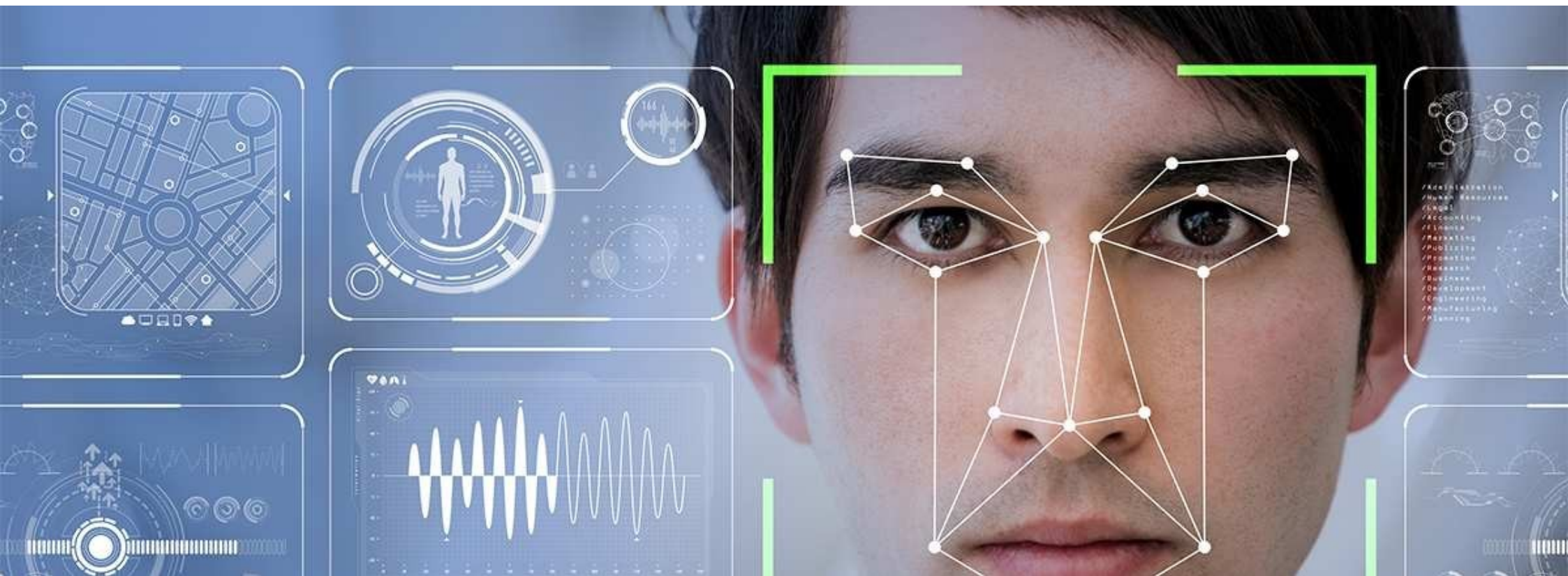
Hootsuite we are social



# Societal and ethical impact



# Face Recognition



<https://newsroom.cisco.com/feature-content?type=webcontent&articleId=1938827>

# Tecnolgy my raise ethical concern

**BBC** Sign in News Sport Reel Worklife Travel Future

**NEWS**

Home Video World UK Business Tech Science Stories Entertainment & Arts

Technology

## San Francisco is first US city to ban facial recognition

By Dave Lee  
North America technology reporter

15 May 2019

f     Share



Legislators in **San Francisco** have voted to ban the use of **facial recognition**, the first US city to do so.

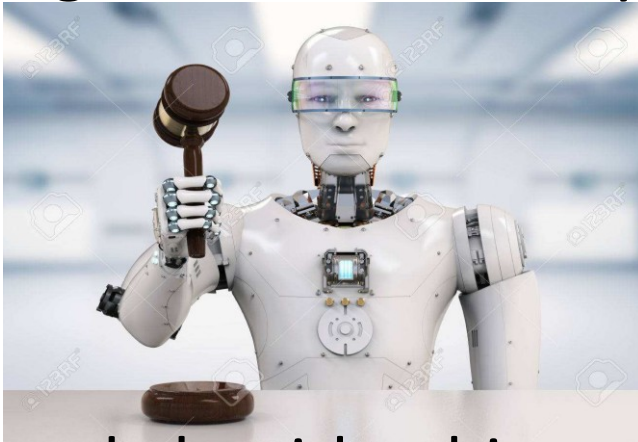
The emerging technology will not be allowed to be used by local agencies, such as the city's transport authority, or law enforcement.

With this vote, San Francisco has declared that face surveillance technology is incompatible with a healthy democracy and that residents deserve a voice in decisions about high-tech surveillance,"

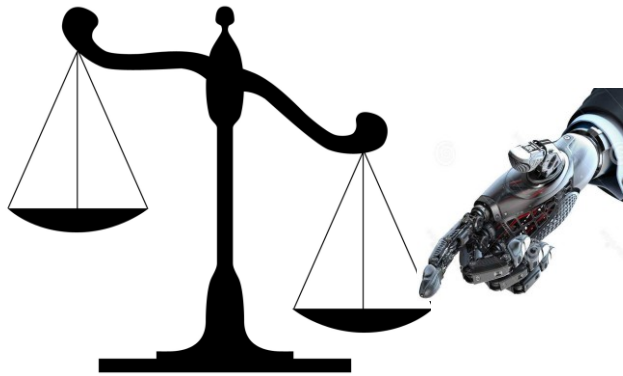


# Trust in technologies

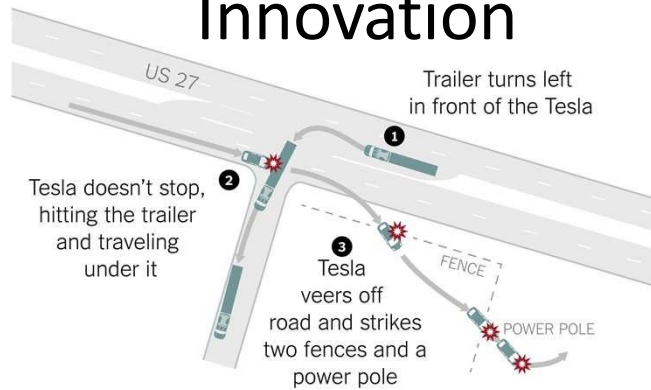
## Algorithmic Authority



and algorithm bias



## Regulation vs Innovation



Volvo admits its self-driving cars are confused by kangaroos

Swedish company's animal detection system can identify and avoid deer, elk and caribou, but is yet to work against the marsupials' movements



▲ Kangaroos are responsible for about 90% of collisions between vehicles and animals in Australia – although most are not serious. Photograph: Paul Kane/Getty Images

# Technological Determinism: Technological Neutrality

- It is one of the commonly held views that the computer, like all pieces of technology is neutral it's only a tool it might be argued. Or we could rebut this point with the statement that **technology is not neutral because it determines the course of society through history**. Technological determinism argues that throughout history, technology has been the main cause for changes in society.

<https://www.scss.tcd.ie/tangney/ComputersAndSociety/99/StdPapers/P3-Revisited/doc.html>

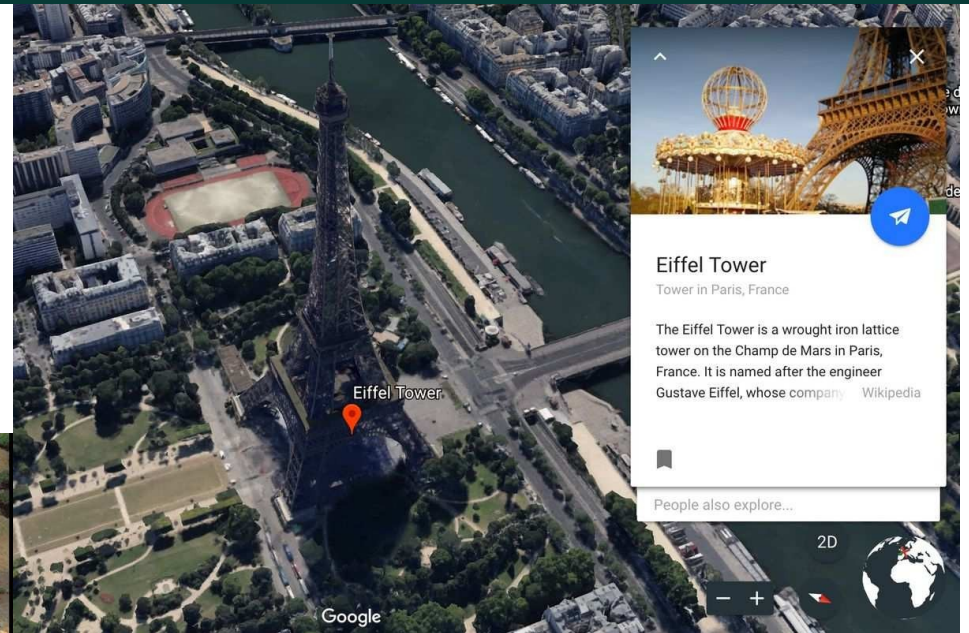




# Virtual Reality / Augmented Reality



Google Earth



# Virtual Reality / Augmented Reality

## PLAYERUNKNOWN'S BATTLEGROUNDS

Unofficial PLAYERUNKNOWN'S BATTLEGROUNDS Interactive Maps



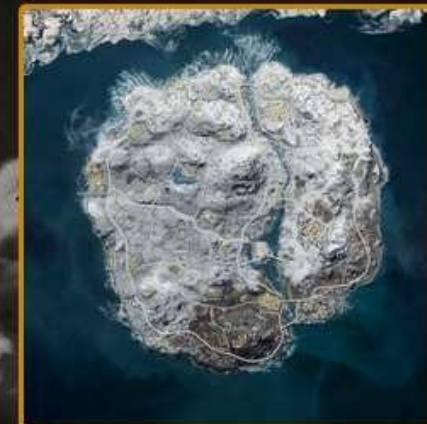
ERANGEL



MIRAMAR



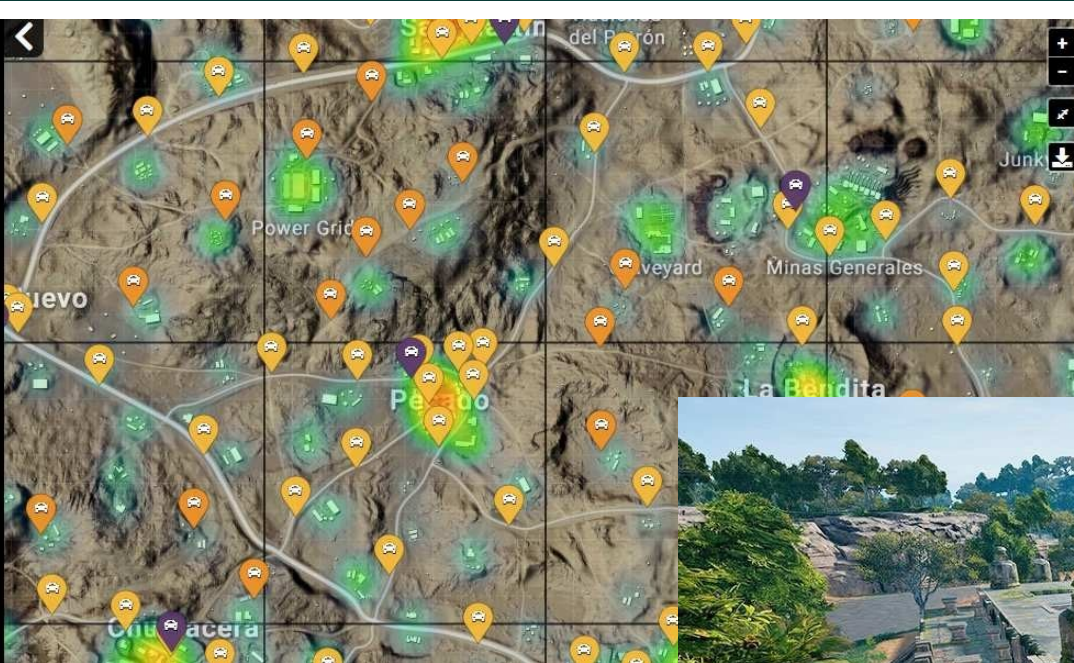
SANHOK



VIKENDI



# Virtual Reality / Augmented Reality and Collaborative Platform





# Big challenges for DE scientists – wrap up

- **Mastering Technologies** and try to **use them for good** (e.g. to address sustainability issues). Bad examples could be of inspiration (e.g. use of profiles to better target people needs)
- Identify and **address ethical and security challenges** when they emerge (e.g being ethic and secure by design)
- Provide solutions (e.g. platforms) that are **Multidisciplinary, Collaborative and Inclusive** always considering environmental and socio-economic impacts of human actions
- Understand impact of digital transformation and contribute to define the right **digital governance**

# Conclusions

- No single definition of Digital Earth. **DE is an evolving concept** to adapt to social and technological changes
- Its main characteristic is to promote the use of digital the technology to study and safeguard our planet and the people that live in
- Mastering Technologies, Understanding social changes and Addressing societal challenges should be the raison d'etre of the DE community
- Advances in science will be relevant if and only if we can demonstrate their value for big issues of our society

# Thanks



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YouTube: [EU Science Hub](https://www.youtube.com/EU_Science_Hub)