



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



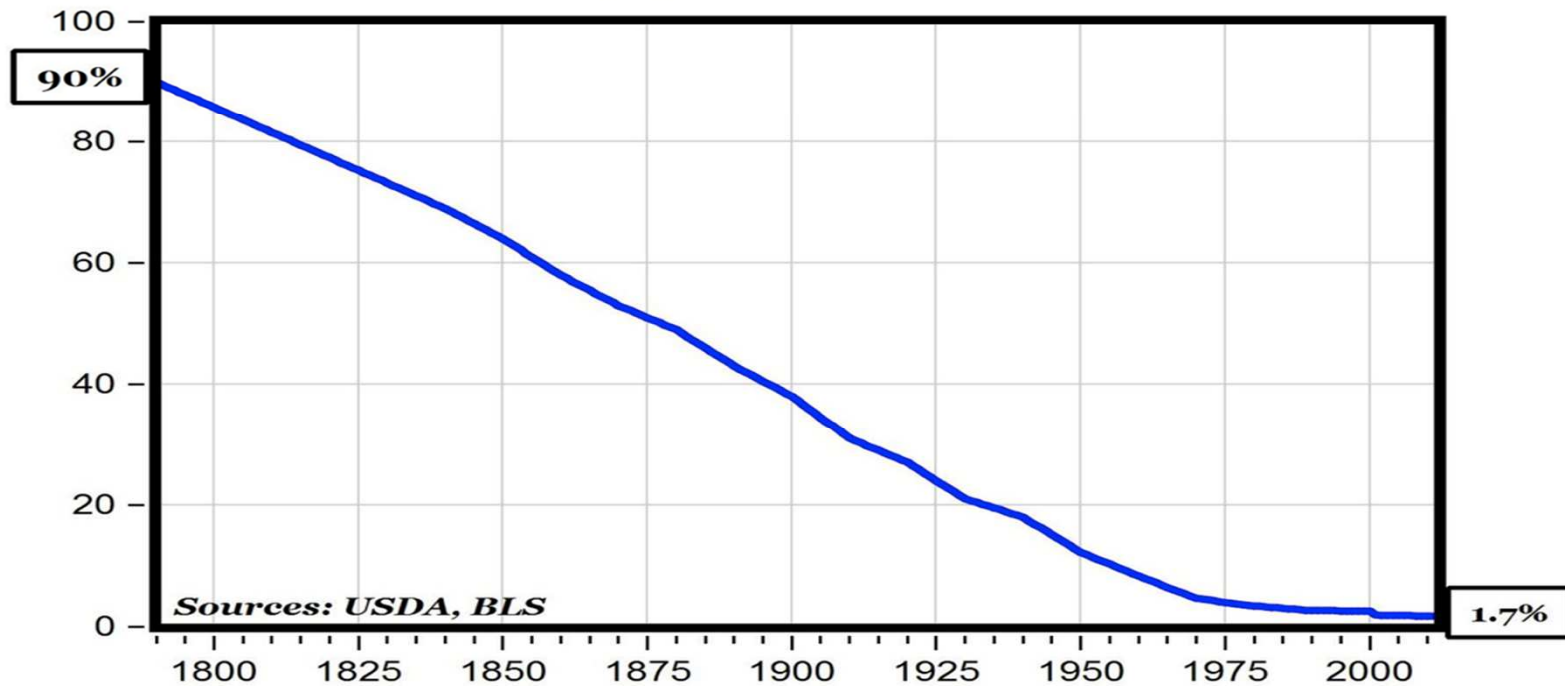
Farm Automation



Courtesy Jerry Kaplan, Stanford University

Farm % of Total US Employment

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

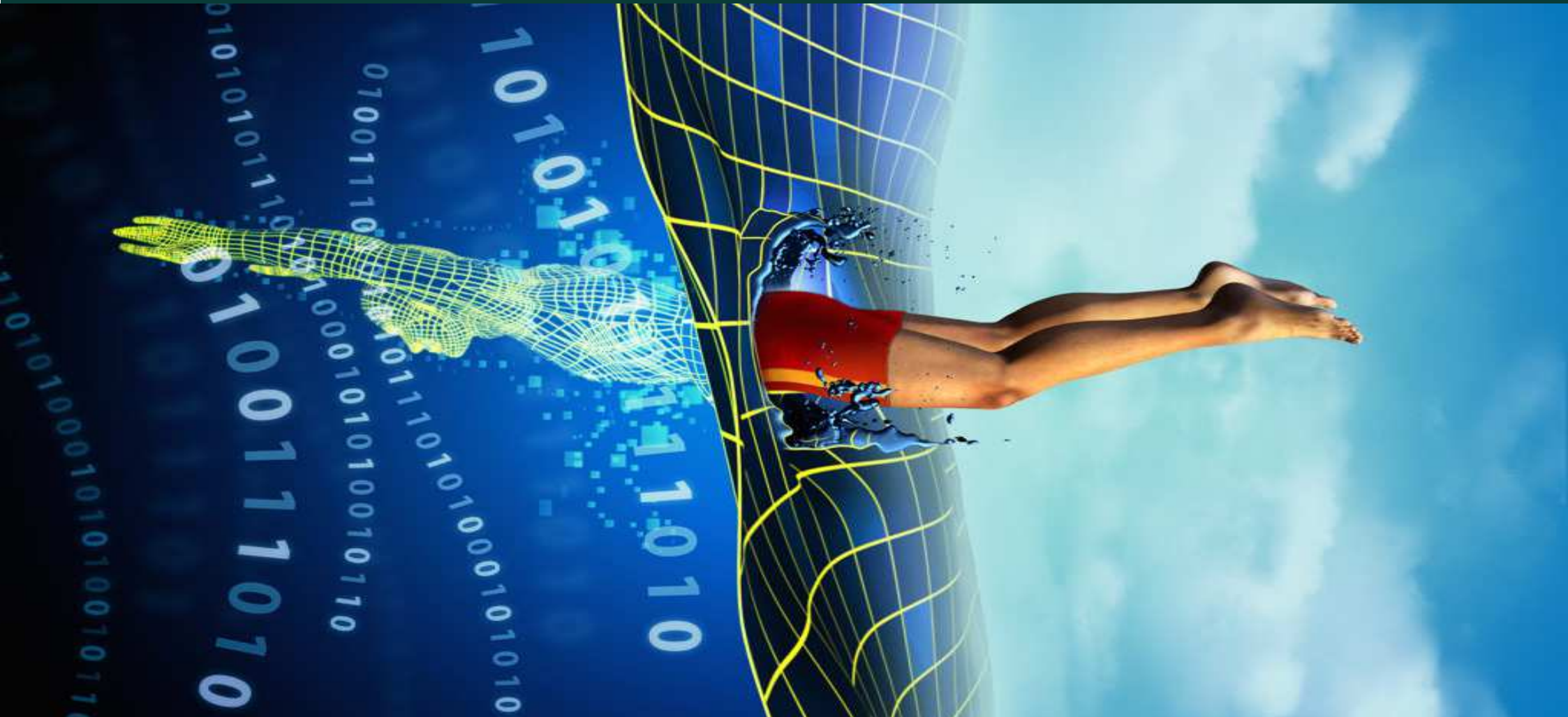


Courtesy Jerry Kaplan, Stanford University



European
Commission

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

Source: IDATE DigiWorld



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

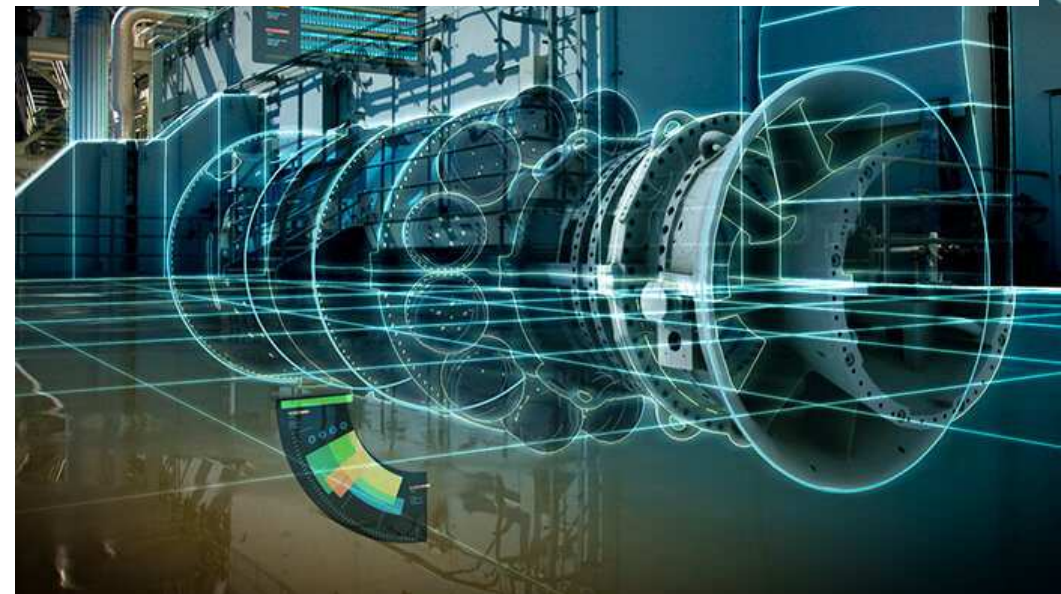
Abby

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

Michael Margreiter

Digital Earth vs Digital Twin

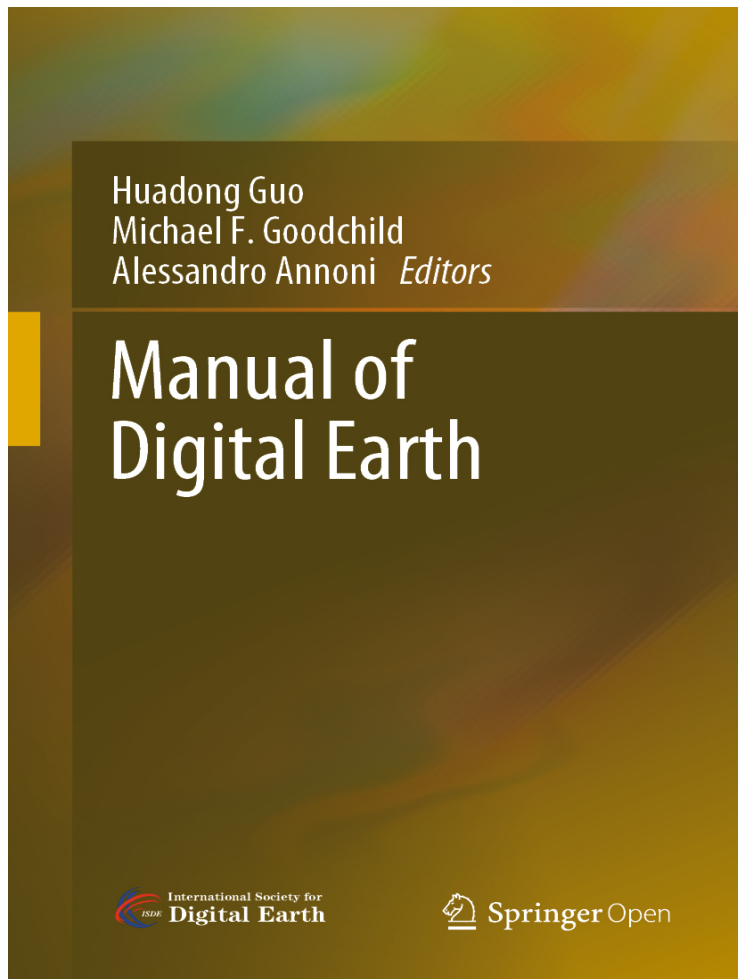
Digital twins are virtual replicas of physical devices that data scientists and IT pros can use to run simulations before actual devices are built and deployed. They are also changing how technologies such as IoT, AI and analytics are optimized.



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

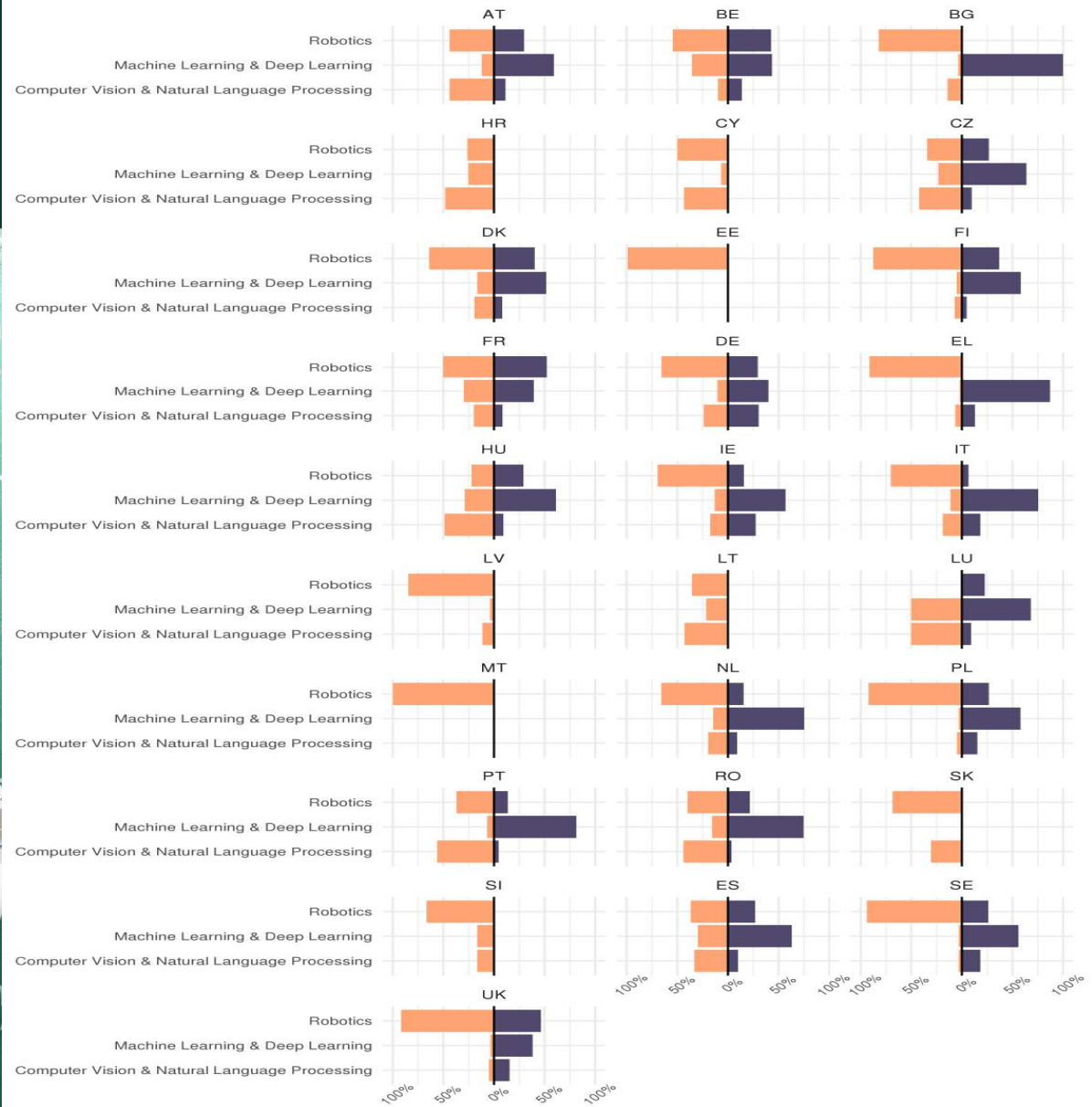
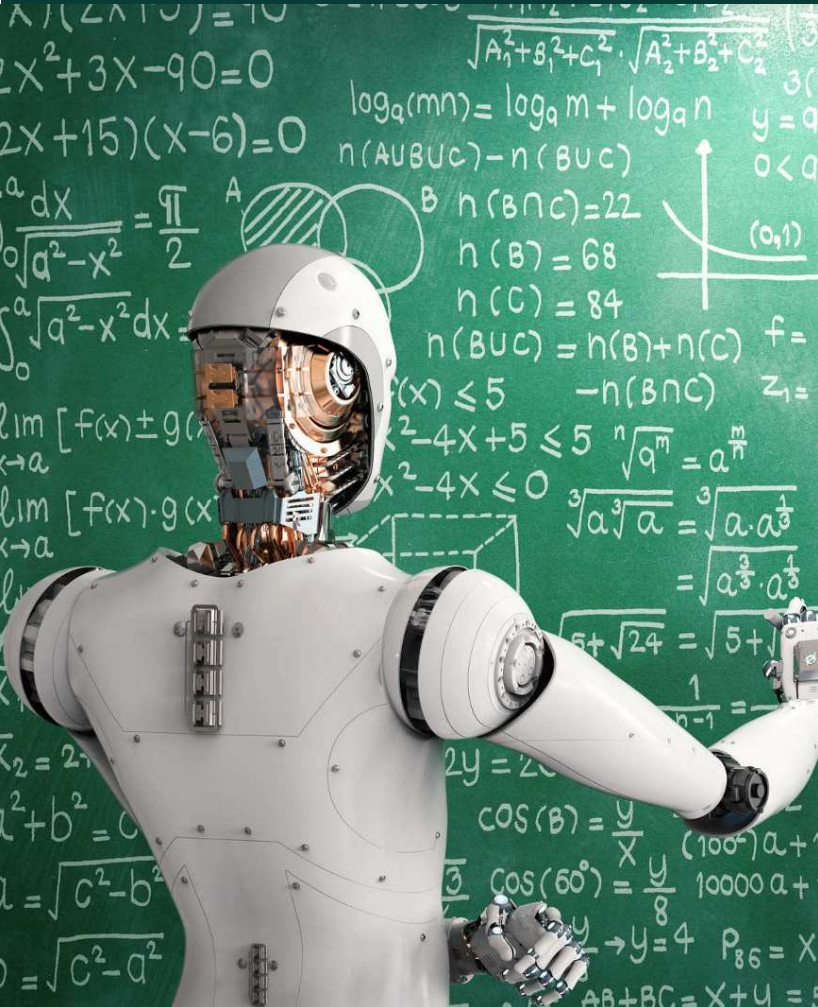
<https://blog.eduonix.com/internet-of-things/digital-twin-new-big-strategic-rise-iot/>

Major Challenges for Digital Earth



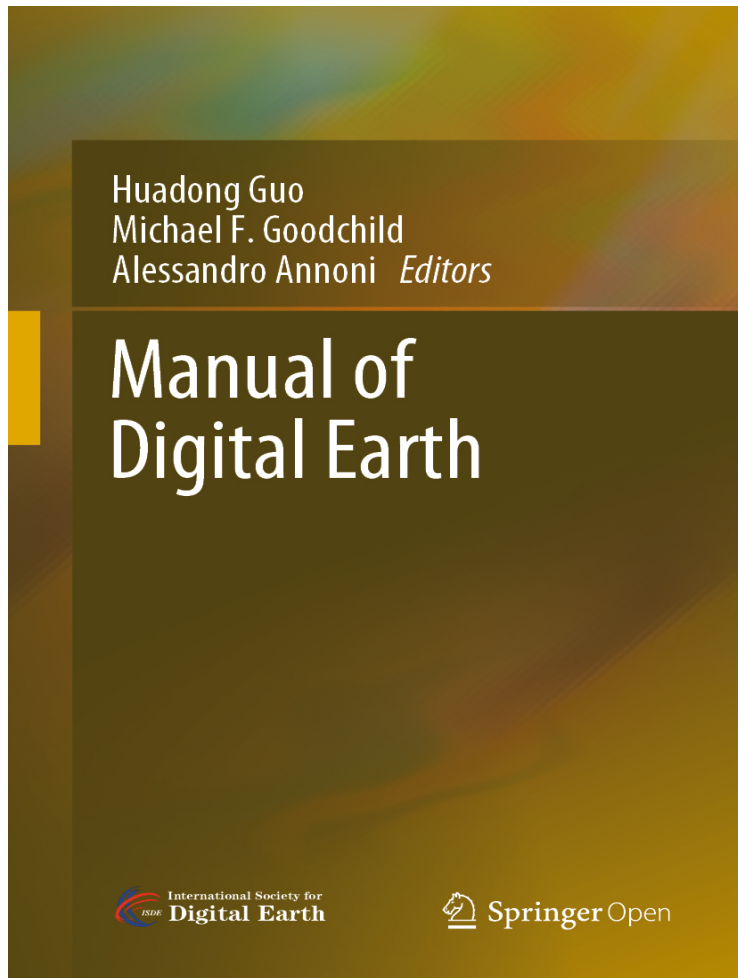
- Big Data Management
- DE Platforms implementation and construction
- Developing an Ecosystem for DE
- Addressing Social Complexities
- Diversified curricula toward DE Education

Education



Legenda
■ Academic offer
■ Industry demand

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

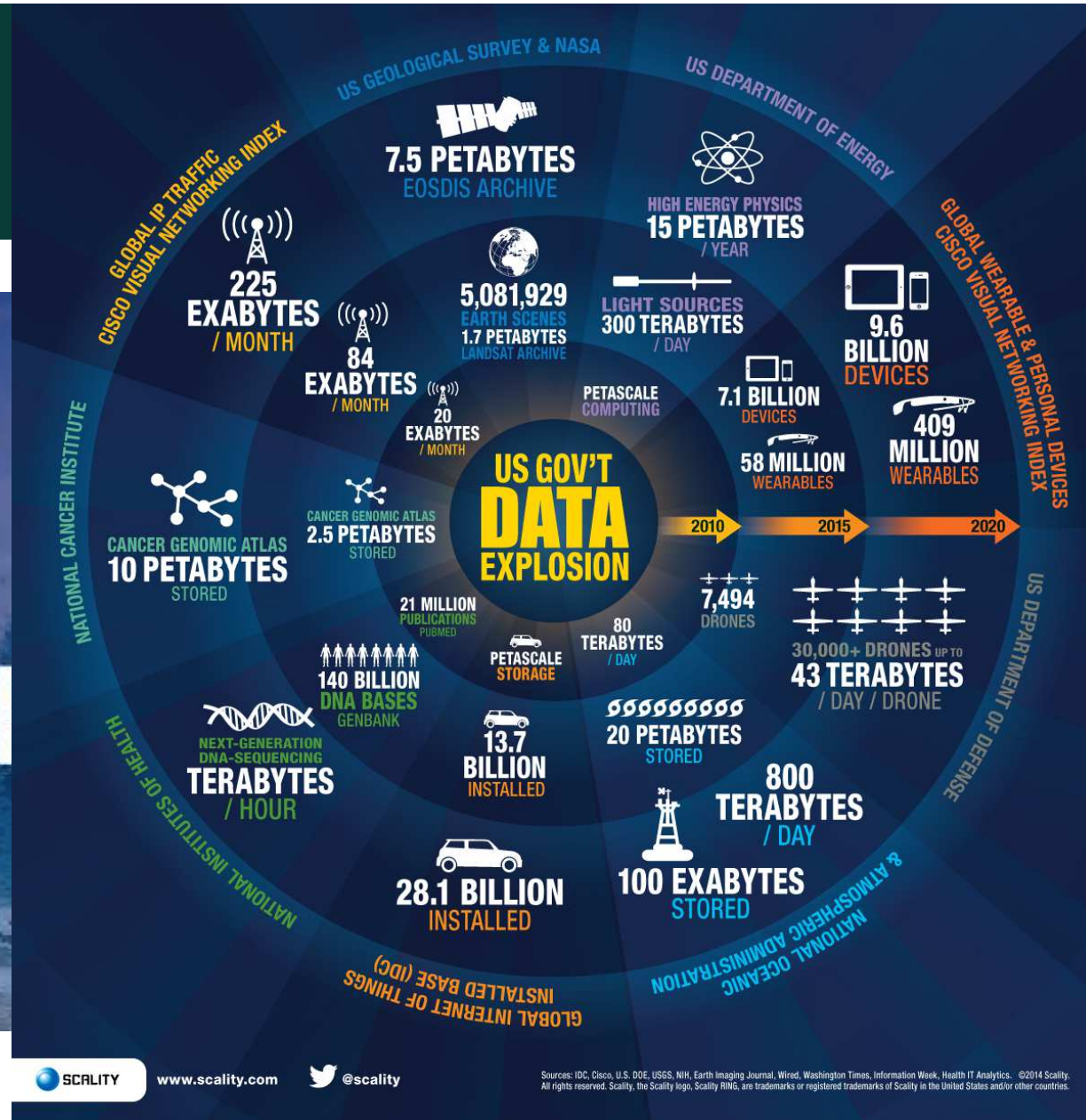
AVG. INTERNET USER **1.5 GB** OF TRAFFIC / DAY

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



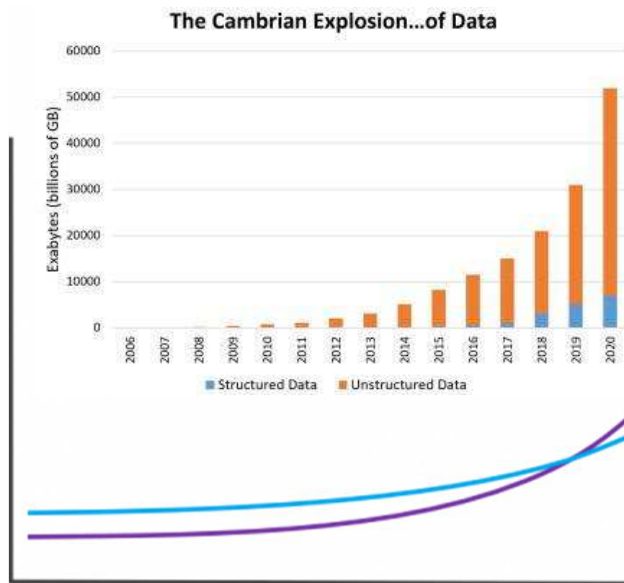
www.scality.com



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.

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

Data Vs Computing Power



COMPUTING
POWER

Technological solutions emerge

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

General Purpose
Microcontrollers
+ sensors

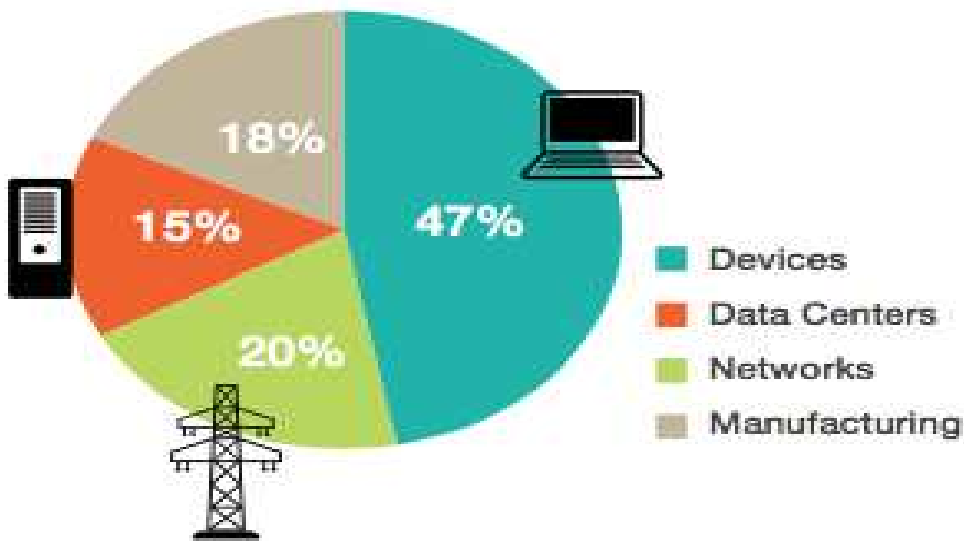
Dedicated AI
accelerators +
smart sensors

Silicon-Born-
AI on single
Chip

Energy consumption

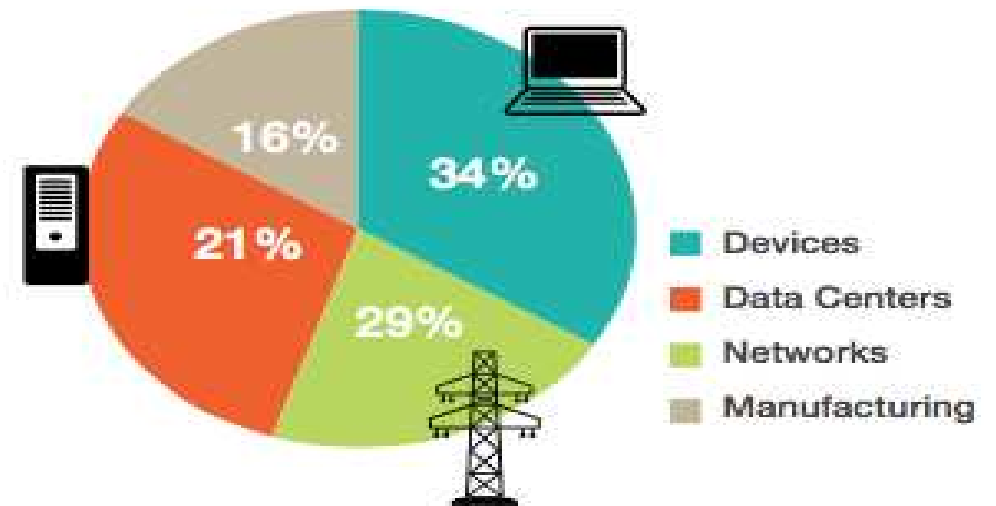
Main components of electricity consumption for the ICT sector

2012



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

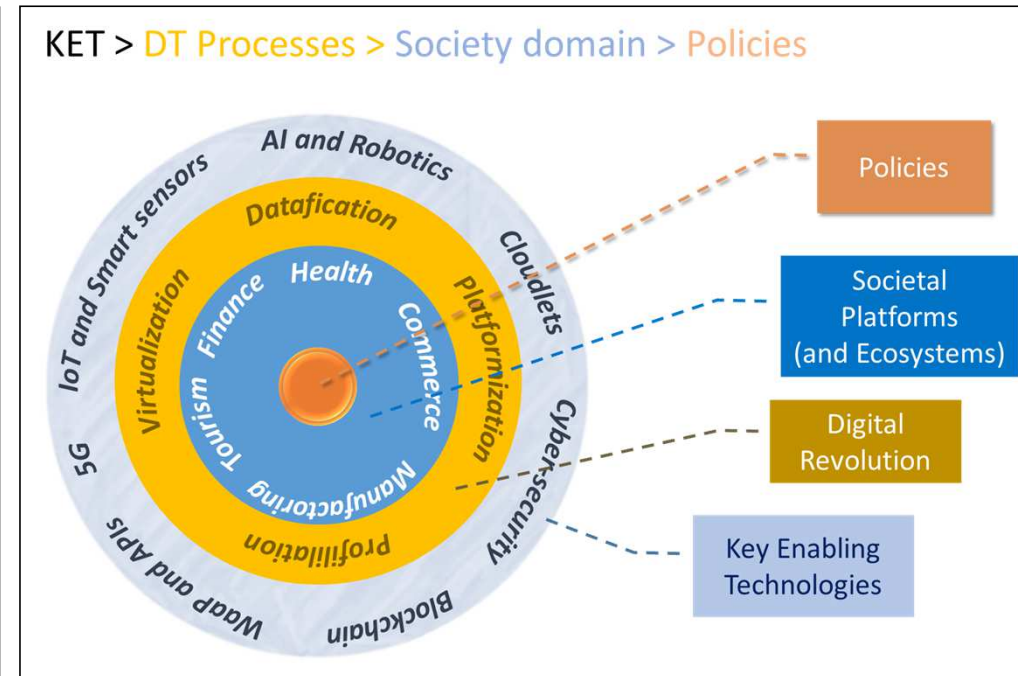
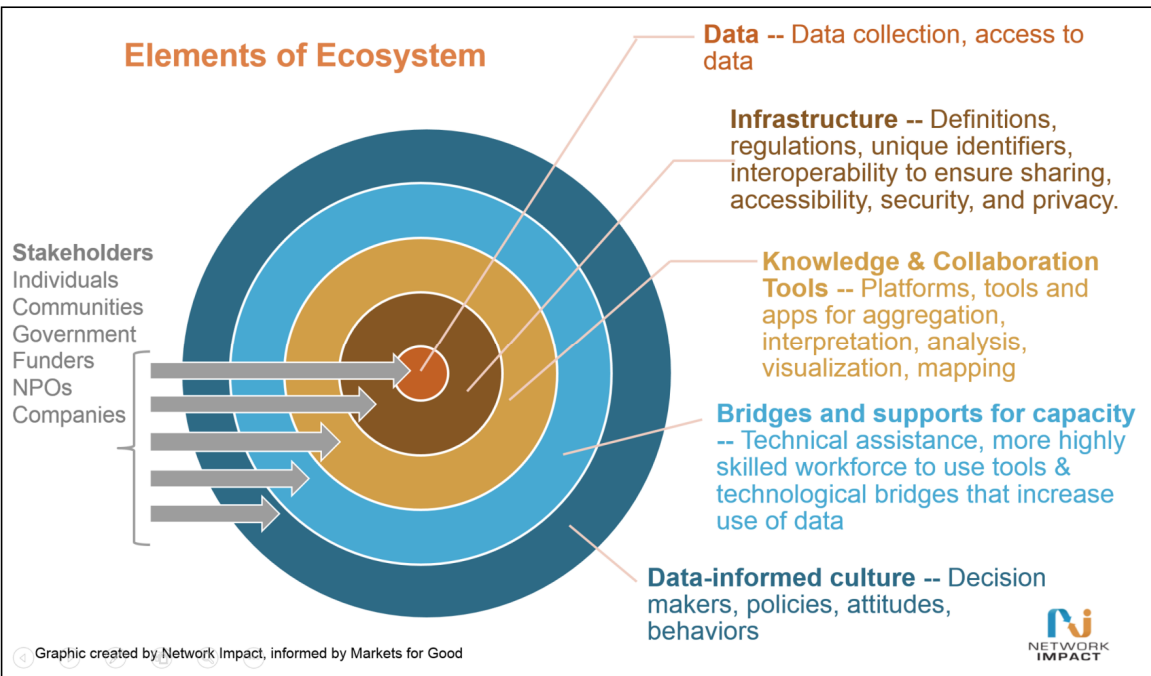
2017



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](#)

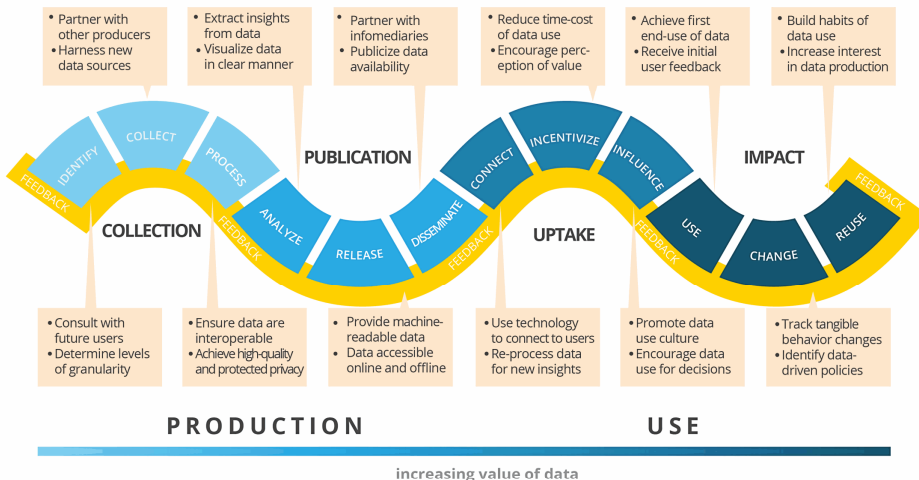
Data ecosystem (economic vs technological view)



Data value chain vs Datafication paradigm



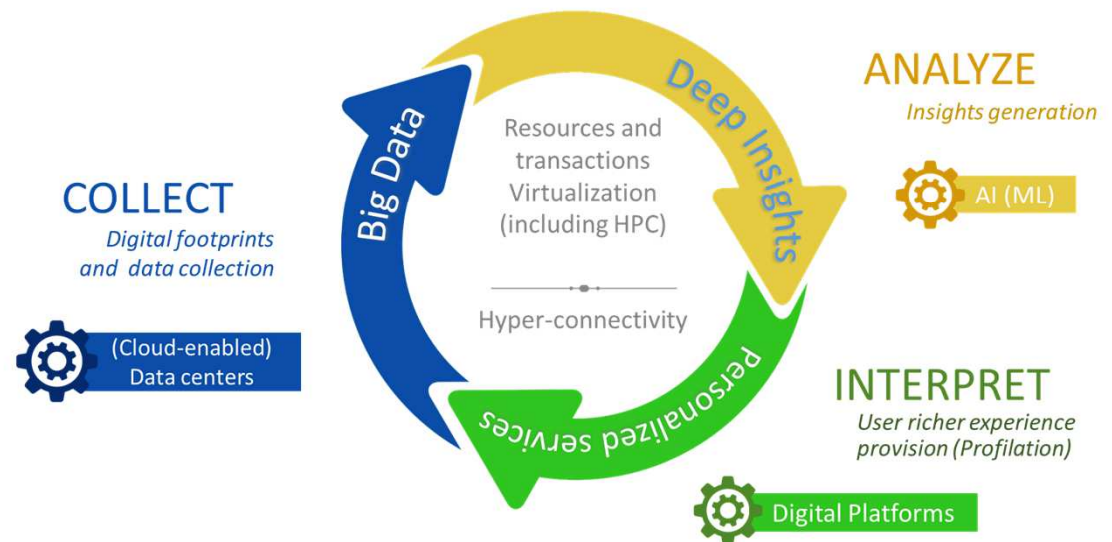
DATA VALUE CHAIN



- 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.

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

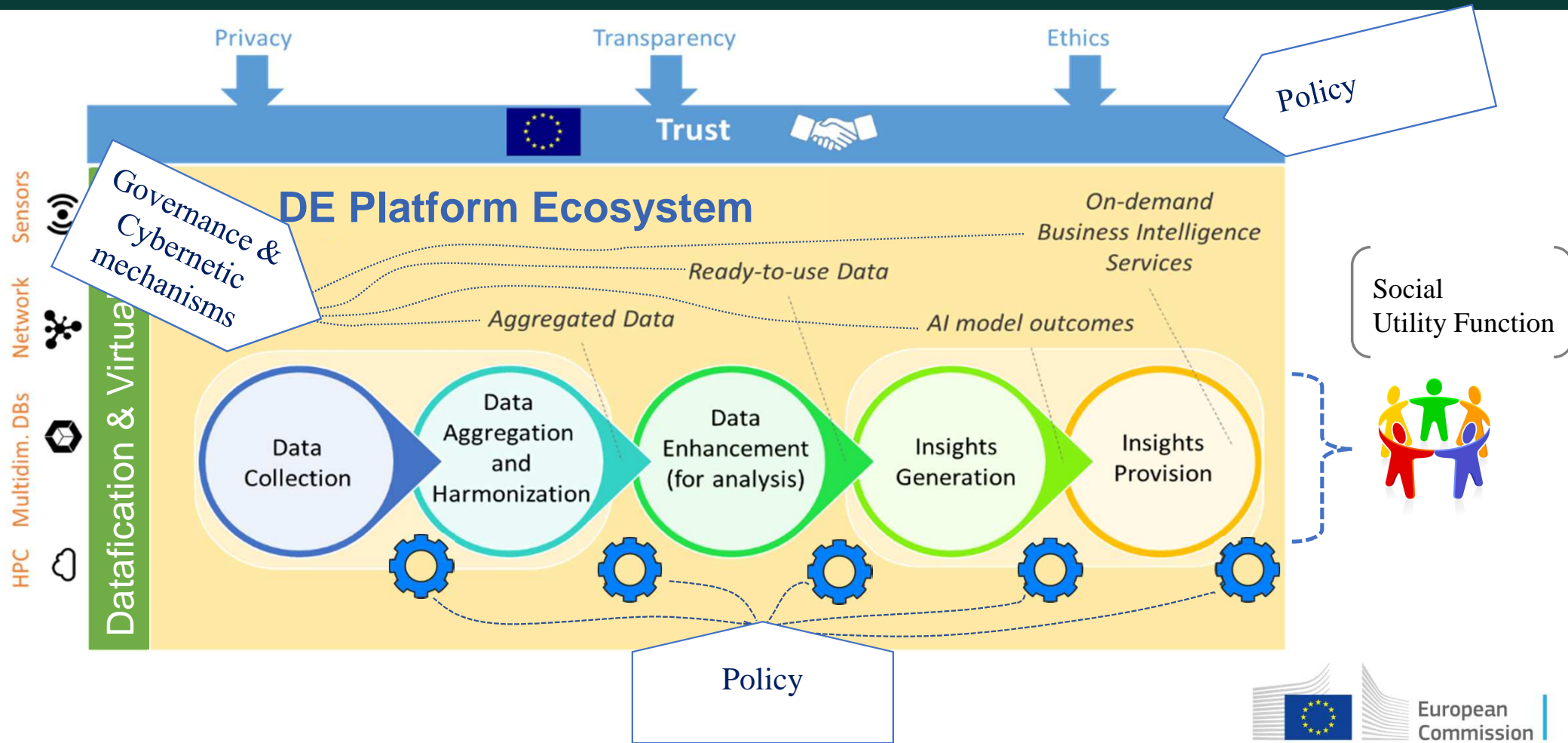
Datafication Paradigm



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



(networked) Supply chain ecosystem

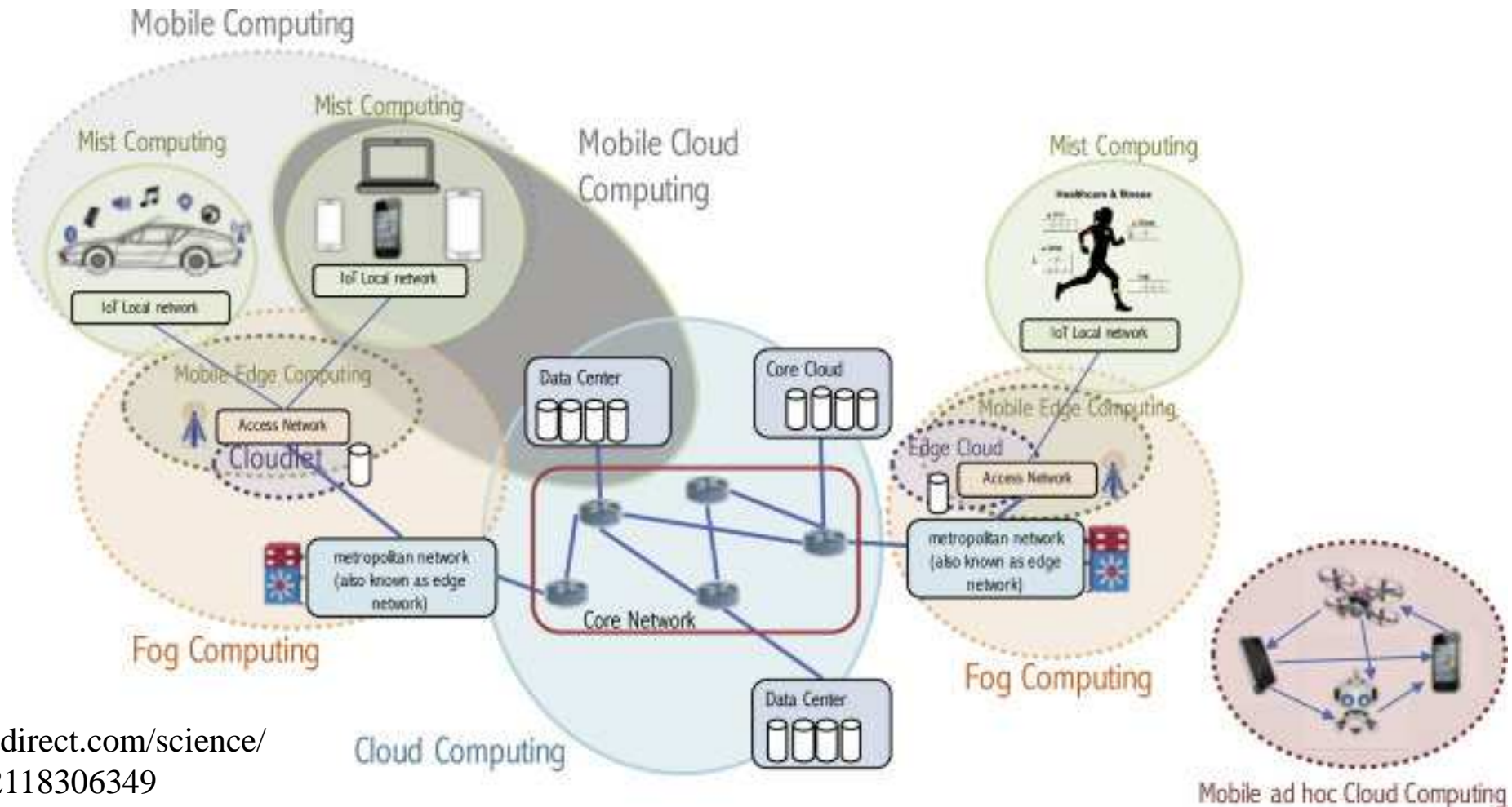


Blockchain



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

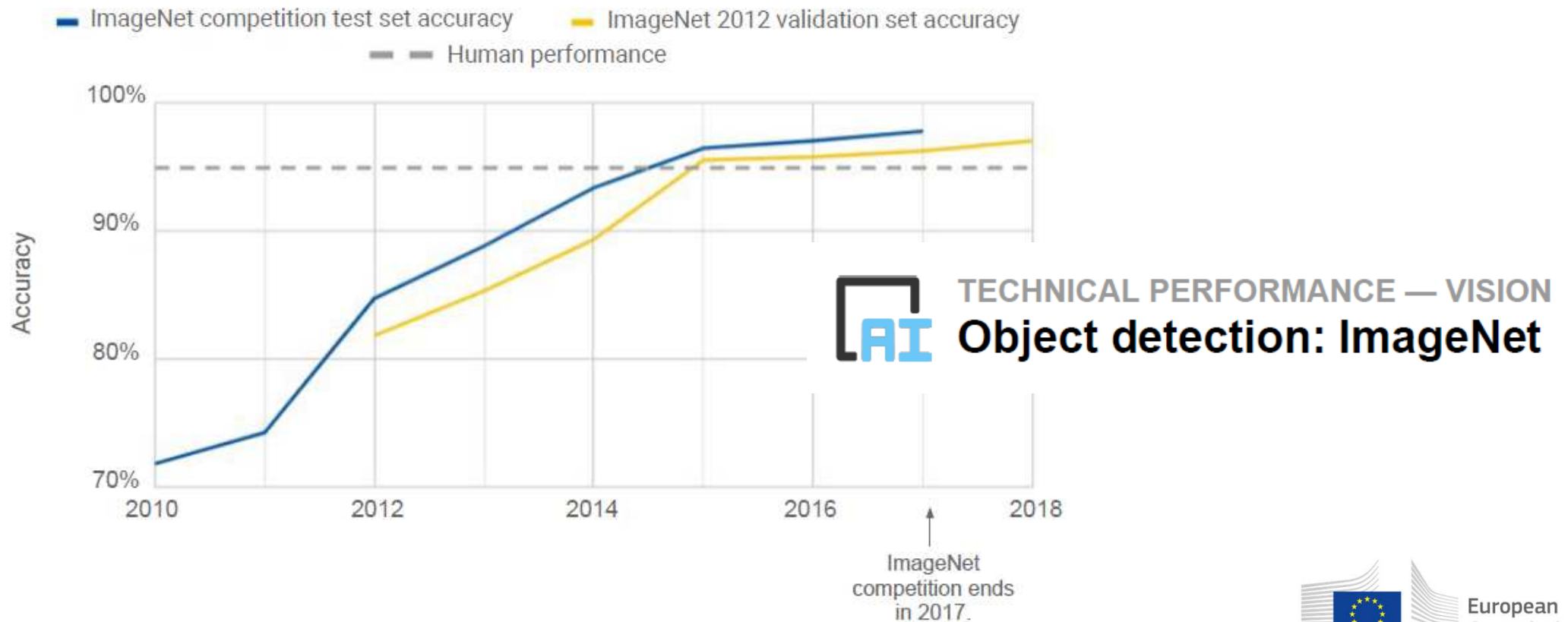
Better decision making



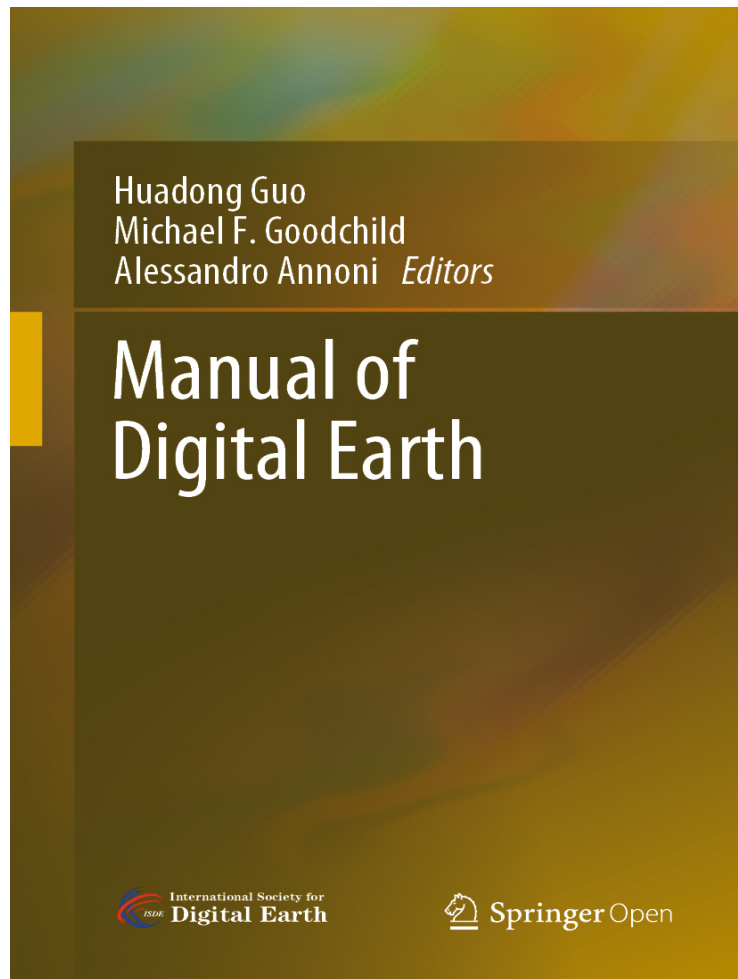
Readiness and Maturity of the technologies

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

TOTAL WORLD POPULATION



vs



7.324
BILLION

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

INTERNET USERS AS A PERCENTAGE OF TOTAL POPULATION

TOTAL NUMBER OF ACTIVE MOBILE INTERNET USERS

MOBILE INTERNET USERS AS A PERCENTAGE OF TOTAL POPULATION



4.388
BILLION

we are social



57%

global web index



3.986
BILLION

we are social



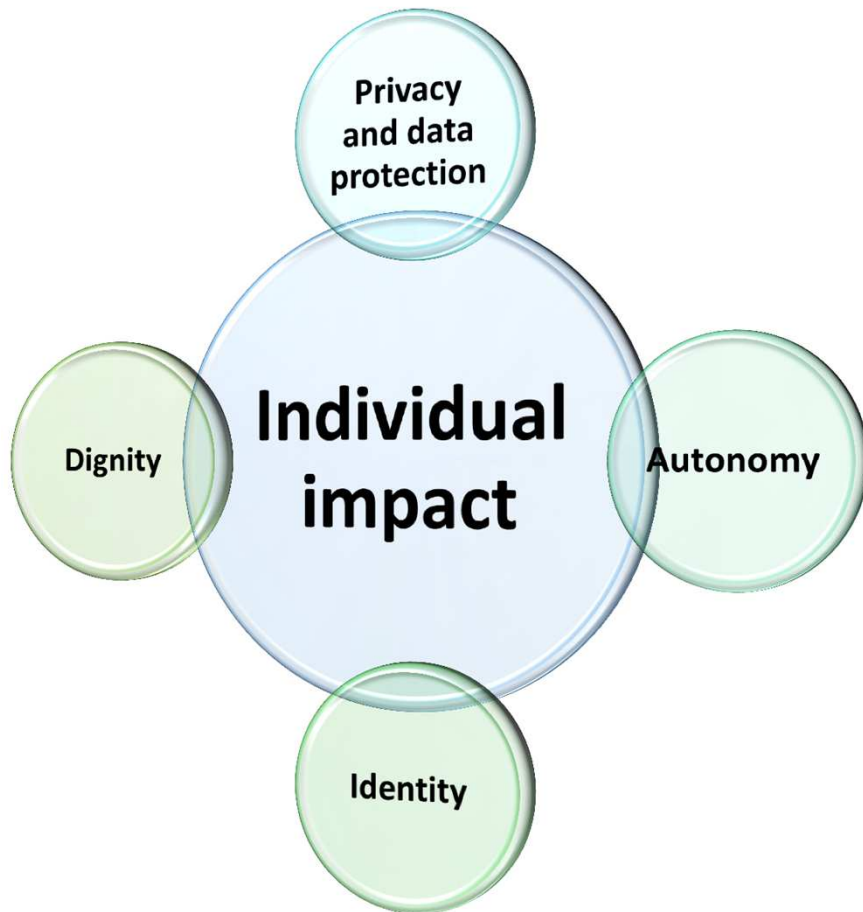
52%

32

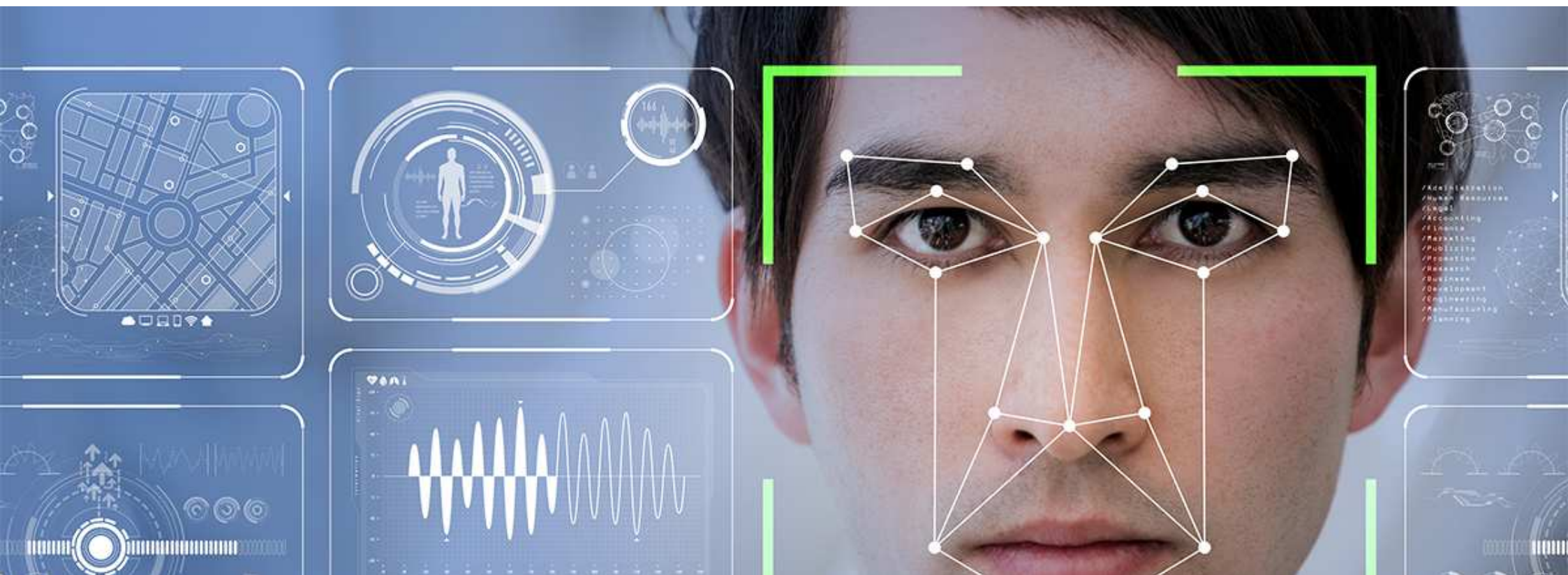
SOURCES: INTERNETWORLDSTATS; ITU; WORLD BANK; CIA WORLD FACTBOOK; EUROSTAT; LOCAL GOVERNMENT BODIES AND REGULATORY AUTHORITIES; MIDEASTMEDIA.ORG; REPORTS IN REPUTABLE MEDIA. MOBILE SHARE DATA: A COMBINATION OF DATA FROM GLOBALWEBINDEX (Q2 & Q3 2018) AND EXTRAPOLATED DATA FROM THE SELF-SERVE ADVERTISING 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>

Technology may raise ethical concerns



The image shows a screenshot of a BBC News article. At the top, the BBC logo is on the left, and navigation links for 'Sign in', 'News', 'Sport', 'Reel', 'Worklife', 'Travel', and 'Future' are on the right. Below this is a red banner with the word 'NEWS' in white. Underneath the banner is a secondary navigation bar with links for 'Home', 'Video', 'World', 'UK', 'Business', 'Tech', 'Science', 'Stories', and 'Entertainment & Arts'. The 'Tech' link is highlighted. Below the navigation is the word 'Technology' in a blue link. The main headline of the article is 'San Francisco is first US city to ban facial recognition' in a large, bold, black font. Below the headline, it says 'By Dave Lee' and 'North America technology reporter'. At the bottom left of the article header, there is a date '15 May 2019' and a small red icon. To the right of the date are social media sharing icons for Facebook, Messenger, Twitter, Email, and a 'Share' button.



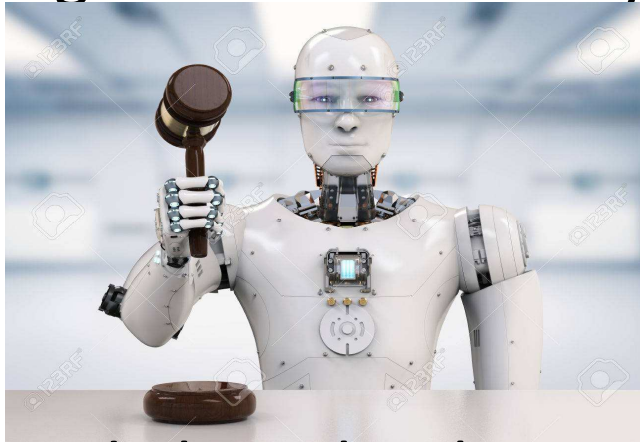
Legislators in **San Francisco** have voted to ban the use of **facial recognition**, the first US city to do so.

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

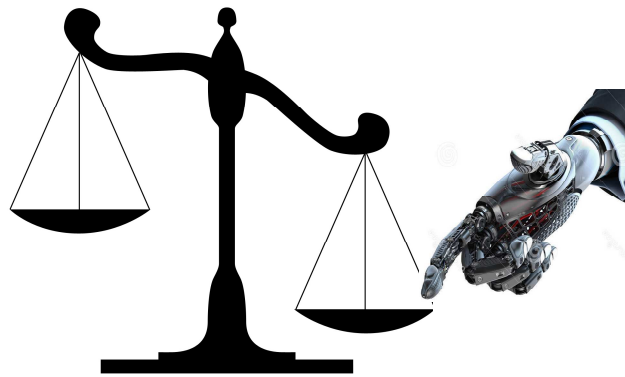
With this vote, San Francisco has declared that face surveillance technology is incompatible with a healthy democracy and that residents deserve a voice in decisions about high-tech surveillance,"

Trust in technologies

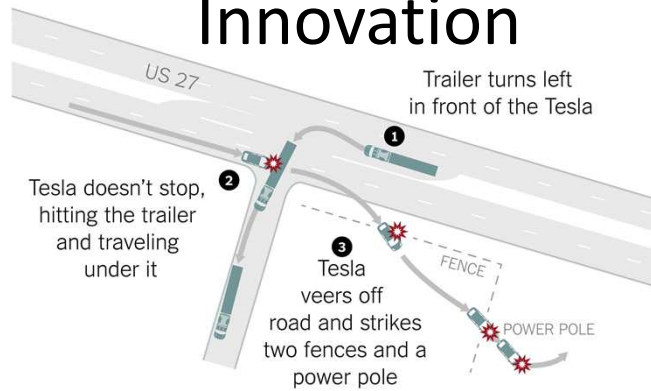
Algorithmic Authority



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

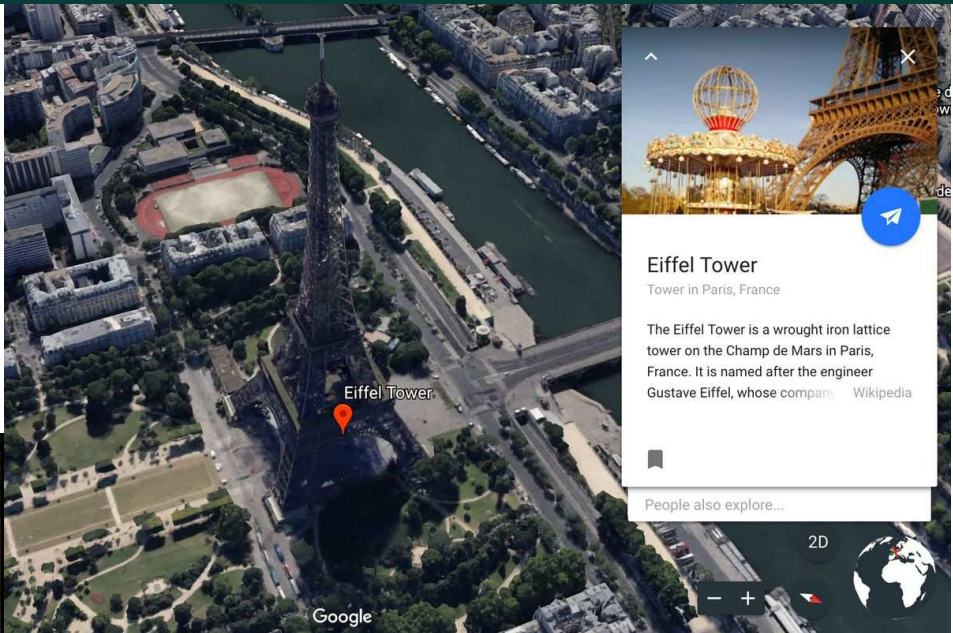
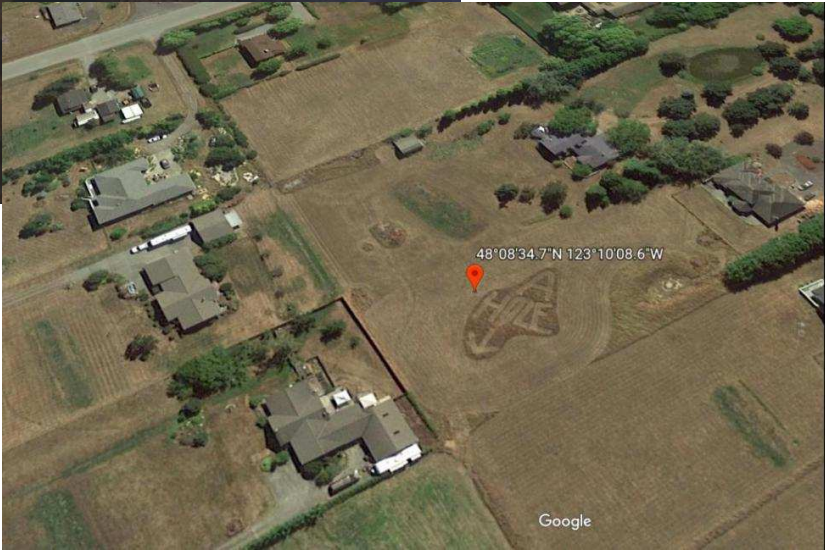
Technological Determinism: Technological Neutrality

- 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



Virtual Reality / Augmented Reality

PLAYERUNKNOWN'S BATTLEGROUNDS

Unofficial PLAYERUNKNOWN'S BATTLEGROUNDS Interactive Maps



ERANGEL



MIRAMAR



SANHOK



VIKENDI

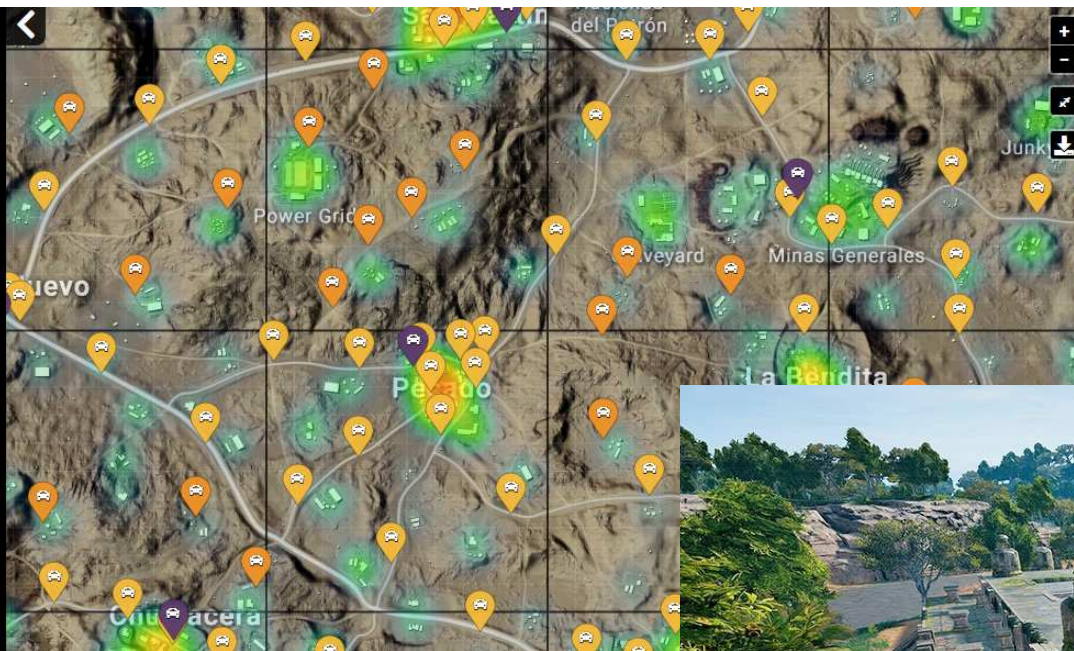
Virtual Reality / Augmented Reality and Collaborative Platform

PLAYERUNKNOWN'S BATTLEGROUNDS
INTERACTIVE MAP
MIRAMAR
Return to Map Selection

- Vehicles: 317
- Offroad Vehicles: 61
- Boats: 54
- Vehicles (eSports): 20
- Loot Heatmap: 43k

Hide All | Hide Grid
Hide Locations | Measure Mode
Flight Path | Elevation
Reset

English
Want to help translate?
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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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