



European  
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# Looking beyond 2020

IEEE – 13th System of Systems  
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Sandro D'Elia - [sandro.delia@ec.europa.eu](mailto:sandro.delia@ec.europa.eu)

# The overall context of EU research

**M**ultiannual **F**inancial **F**ramework

*budget proposal for all EU programmes including:*

- Horizon Europe
- Digital Europe
- Connecting Europe Facility Digital



*Research and  
Innovation*

# The numbers

*European Strategic  
Investments*

*Total R&I proposed  
budget: 114.2B€*

*Horizon Europe  
97.6B€*

*(Horizon 2020: 70B€)*

*Global Challenges and  
Industrial Competiveness  
pillar 52.7B€*

*Digital and industry cluster  
15B€*

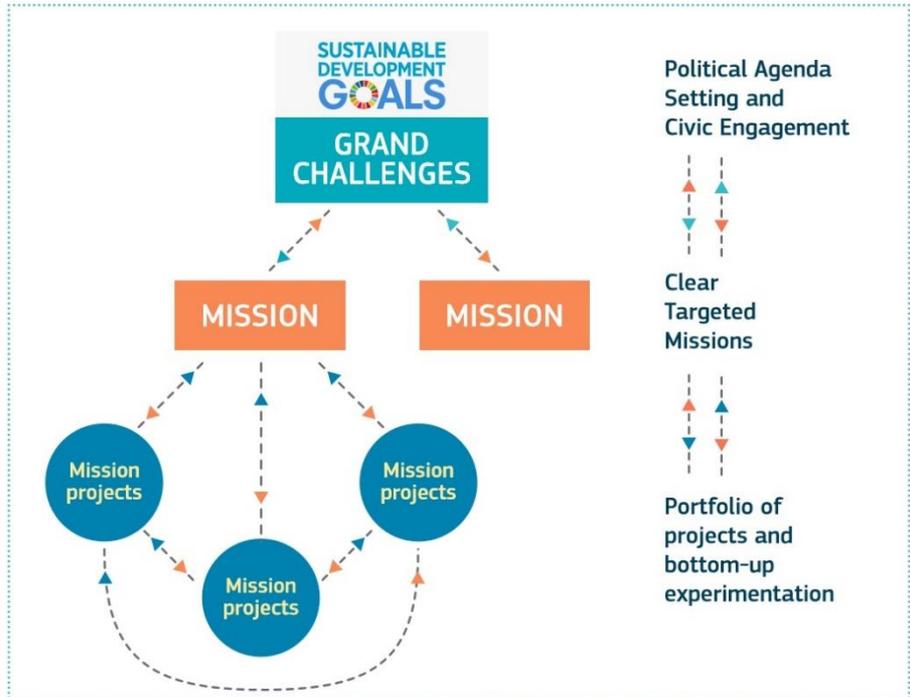
*Digital Europe  
Programme  
9.2B€*

*Connecting Europe  
Facility Digital 3B€*



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# The missions in Horizon Europe



Just one example / proposal:



Integrated transport system reducing car congestion by 50% in 10 European cities by 2030

*...and by the way – every mission will be in the end a “**System of Systems**”*

A mission will consist of a **portfolio of actions** intended to achieve a **bold and inspirational as well as measurable goal** within a set timeframe, with impact for science and technology, **society and citizens** that goes beyond individual actions.

## The trends

Evolution of computing architectures (Heterogeneous, AI accelerators, Quantum processors, ASIC...)

Artificial Intelligence mainstreamed (and powered by big data)

Cyber-security a major concern for any application (and for governments, too)

Long term: synthetic biology, bio-processors, DNA computing

## The challenges

No trust in Artificial Intelligence and autonomous systems => **ROBOTS STEAL OUR JOBS**

Too difficult / expensive to develop dependable, high quality software => **SW DEVELOPMENT NOT FOR HUMANS**

No access to internals of processors (not built in EU) => **CANNOT GUARANTEE SECURITY**

Energy consumption of computing not sustainable => **BLOCKCHAIN NOT A SILVER BULLET**

e.g. Intel Management Engine or  
Qualcomm Secure Execution Environment

According to one estimate, processing a bitcoin transaction  
consumes more than 5,000 times as much energy as using a Visa credit card

Disclaimer:  
This stuff comes from internal discussions – nothing decided yet!

## The constraints

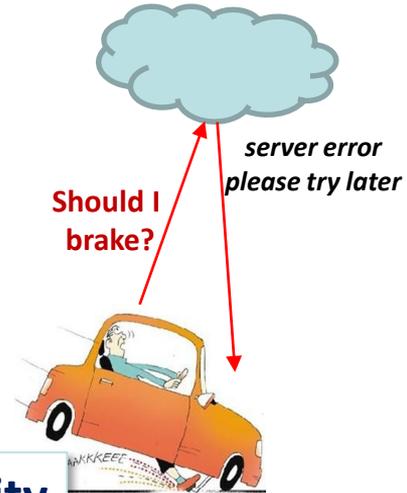
### Energy / spectrum

Data transmission is expensive. Mobile data transmission depends on radio spectrum which is a limited resource



### Safety / latency / predictability

Autonomous systems cannot rely on cloud-based computing in all situations ( $1\text{ms} = 150\text{Km}$  at speed of light)



### Privacy / security

Processing data at the edge, without transmitting and storing it in the cloud, is good for privacy and security (*and also for GDPR compliance*)

## ... and what about Artificial Intelligence?

### EC communication 25/4/2018

- **connect and strengthen AI research centres** across Europe;
- support the development of an "**AI-on-demand platform**" that will provide access to relevant AI resources in the EU for all users;
- support the **development of AI applications in key sectors**.

### Ensure an appropriate **ethical and legal framework**

- **GDPR** already in place
- **AI ethical guidelines** in 2019
- **Product liability** – interpretation guidance in 2019

### Declaration of cooperation on **Artificial Intelligence**

- 25 European countries signed a **Declaration of cooperation** on Artificial Intelligence
- **coordinated plan** on AI by end 2018

Prepare for **socio-economic changes** brought about by AI

**2018: AI becomes “just another technology”**



### AI needs data

Large cyber-physical systems of systems are the best applications of AI

## Cyber-physical systems that people can trust and accept

### Pillar 1: trust and acceptance

**Make people trust** complex autonomous systems:

- reduce (10x) number of **bugs**
- increase **usability** and human-like behaviour
- harden against **cyber-attacks**
- provide the technical foundations for **explainable AI** technologies which can be trusted by humans.

*This means moving to AI-assisted software development...*

*...and by the way, online code repositories can provide the data to train AI*

*Most security problems are primarily "just bugs" (Linus Torvalds)*

*Major research challenge! Today there is no easy way to explain decisions of a neural network*

**Bonus: software-based systems that need service just once per year**  
**(like today's cars, not like today's operating systems :-)**



## Cyber-physical systems that people can trust and accept

### Pillar 2: productivity

Increase productivity of EU companies by supporting tools for development of dependable software, addressing the reference markets: CPS, autonomous systems, robotics, artificial intelligence, and delegating complexity management to AI-enabled tools. Support spreading of digital skills (policy).



*"dependability" as  
the key feature of  
software*

**Bonus: make careers in digital tech accessible for non-geniuses**  
(complexity of today's tech make development of advanced applications very difficult)

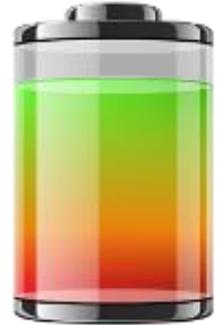
## Cyber-physical systems that people can trust and accept

### Pillar 3: energy

Deliver orders of magnitude improvement in computing energy efficiency, enabling on one side exascale high-performance computing and on the other side "no-battery" applications in the Internet of Things domain. Explore unconventional computing.

*High-Performance Computing today is limited by power consumption of data centers*

*E.g.: neuromorphic, approximate, bio-inspired, DNA-based*



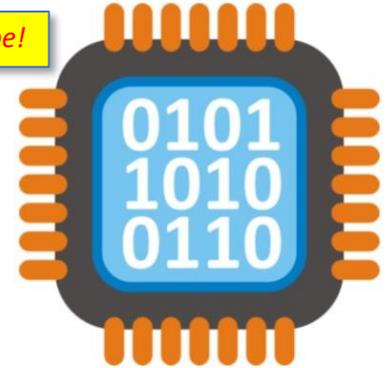
**Bonus: significant contribution to Sustainable Development Goals**

## Cyber-physical systems that people can trust and accept

### Pillar 4: hardware

*Need more Electronic Design in Europe!*

Full access to hardware internals for European industry.  
Availability of hardware that can be optimised for real-time,  
delivering worst-case-execution-time guarantees, while  
securing the performance of manycore chips.



*Lack of low-level access does not allow full use of the hardware and is a huge security backdoor*

*Critical applications need deterministic behaviour, not possible in multicore chips today*

**Bonus: full EU sovereignty for defence and security application**

# Contacts



***#DigitiseEU***  
***@DigIndEU***

<http://bit.ly/futuriumDEI>  
<http://bit.ly/europaDEI>



Sandro D'Elia - [sandro.delia@ec.europa.eu](mailto:sandro.delia@ec.europa.eu)  
European Commission DG CONNECT