Open Source for Cloud-Based Services
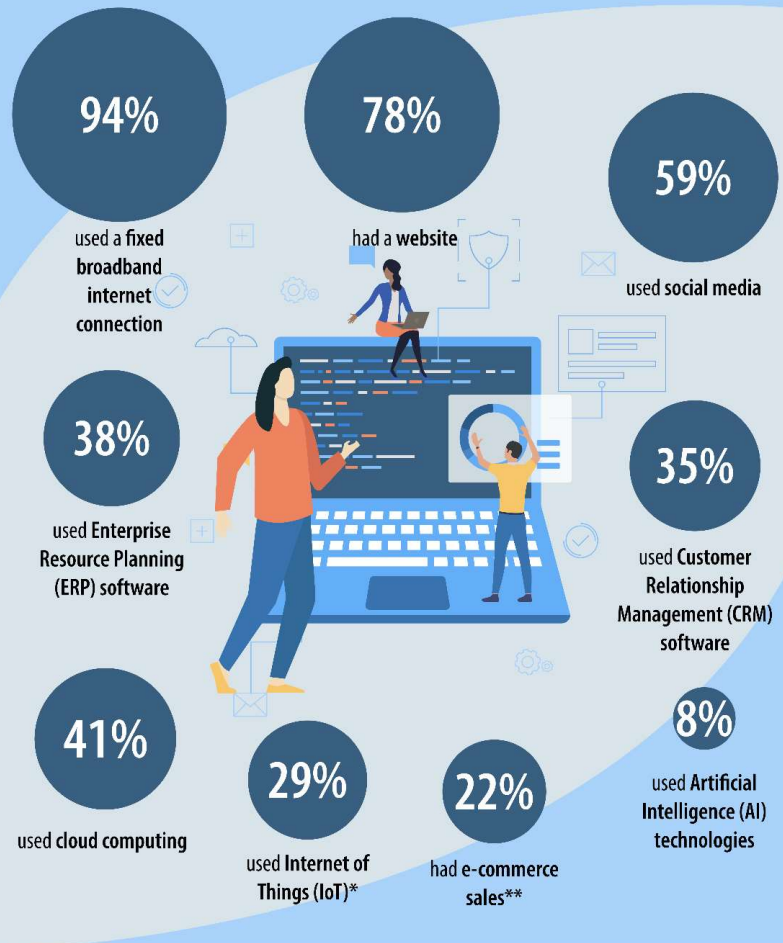
Digital Autonomy in the Computing Continuum

6 June 2023

Luis C. Busquets Pérez
Cloud and Software
DG CONNECT, European Commission

ICT use in EU enterprises, 2021

(% of enterprises with at least 10 employees and self-employed people)

94% used a **fixed broadband internet connection**

78% had a **website**

59% used **social media**

38% used **Enterprise Resource Planning (ERP) software**

35% used **Customer Relationship Management (CRM) software**

41% used **cloud computing**

29% used **Internet of Things (IoT)***

22% had **e-commerce sales****

8% used **Artificial Intelligence (AI) technologies**

* internet-connected devices or systems that can be monitored or controlled remotely via the internet
** in 2020 reference year

ec.europa.eu/**eurostat**

European Commission

Market trends in Europe

SUPPLY Side:

- Since 2017 European cloud market has grown more than threefold (over EUR 23 bn for 2020).

- …but European cloud service providers' market share has declined from 26% to under 16%.

- Amazon, Microsoft and Google hold 66% of the market share.

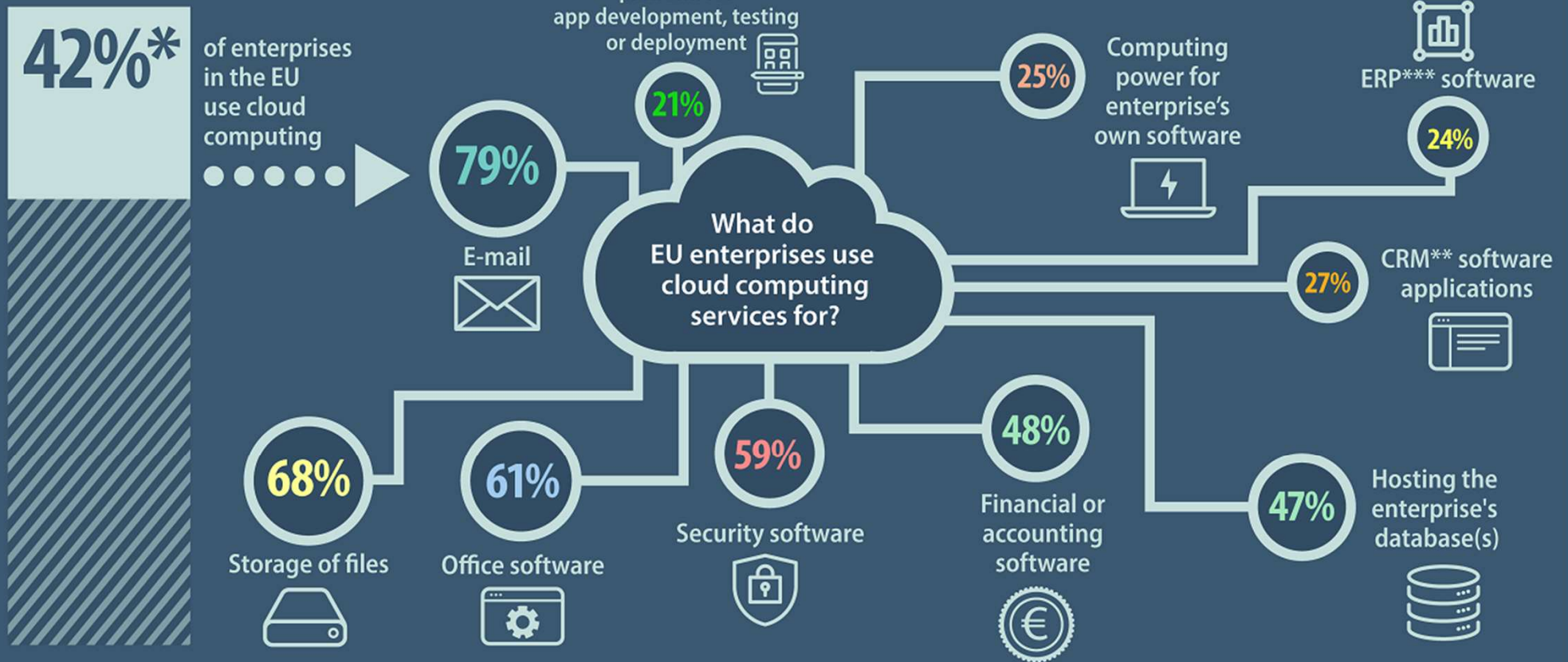- Biggest European provider accounting for 2% in EU market.

European Cloud Provider Share of Local Market
(IaaS, PaaS, Hosted Private Cloud)

European Cloud Provider Share

European Market Size

| | Q1 17 | Q2 17 | Q3 17 | Q4 17 | Q1 18 | Q2 18 | Q3 18 | Q4 18 | Q1 19 | Q2 19 | Q3 19 | Q4 19 | Q1 20 | Q2 20 | Q3 20 | Q4 20 | Q1 21 | Q2 21 |

European Cloud Revenues (EUR billion)

Market Share of European Cloud Providers

Source: Synergy Research Group

DEMAND Side:

- 2020: 36% of EU enterprises use *basic* cloud services
- Large businesses: 65%, Medium: 46%, Small: 33%
- Large disparities on EU market
- Direct purchases increasingly difficult, marketplace model on the rise
- Demand for edge services with more user control

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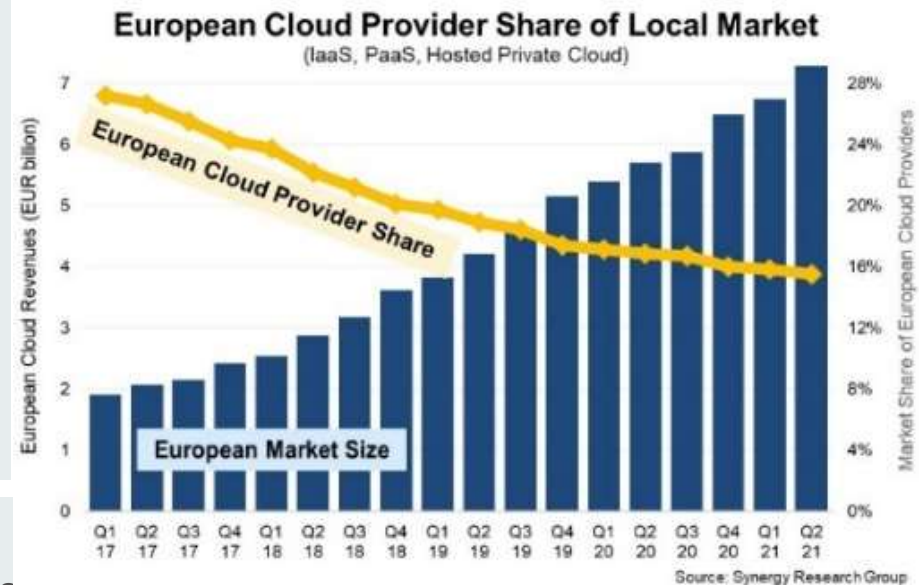
Use of cloud computing services in EU enterprises in 2021, by type of service

(% of enterprises using the cloud)

42%* of enterprises in the EU use cloud computing

What do EU enterprises use cloud computing services for?

79% E-mail

21% Computing platform for app development, testing or deployment

25% Computing power for enterprise's own software

24% ERP*** software

27% CRM** software applications

68% Storage of files

61% Office software

59% Security software

48% Financial or accounting software

47% Hosting the enterprise's database(s)

ec.europa.eu/**eurostat**

Digital Decade objectives for the cloud & edge computing continuum by 2030
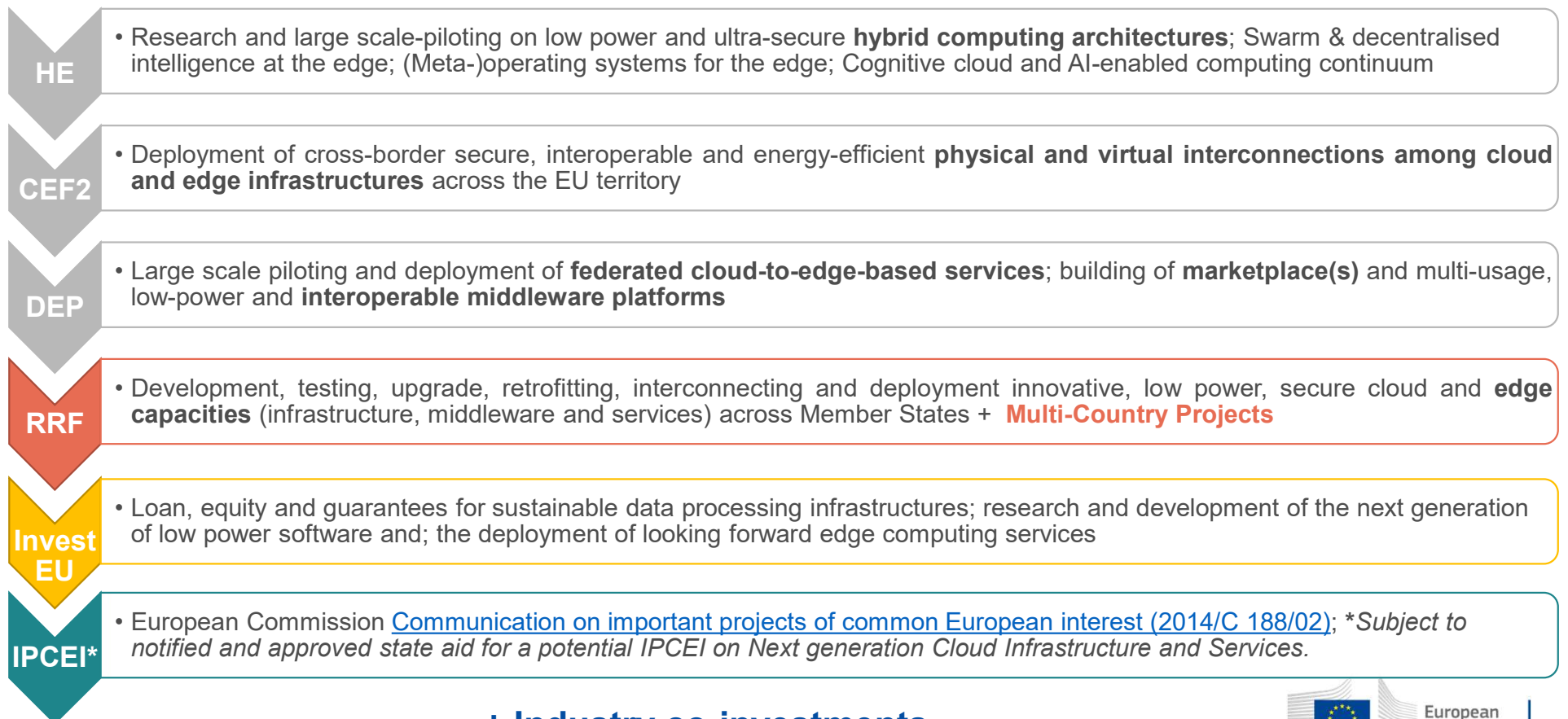
2030 DIGITAL COMPASS
THE EUROPEAN WAY FOR THE DIGITAL DECADE

- ✓ **>10.000 edge nodes by 2030**

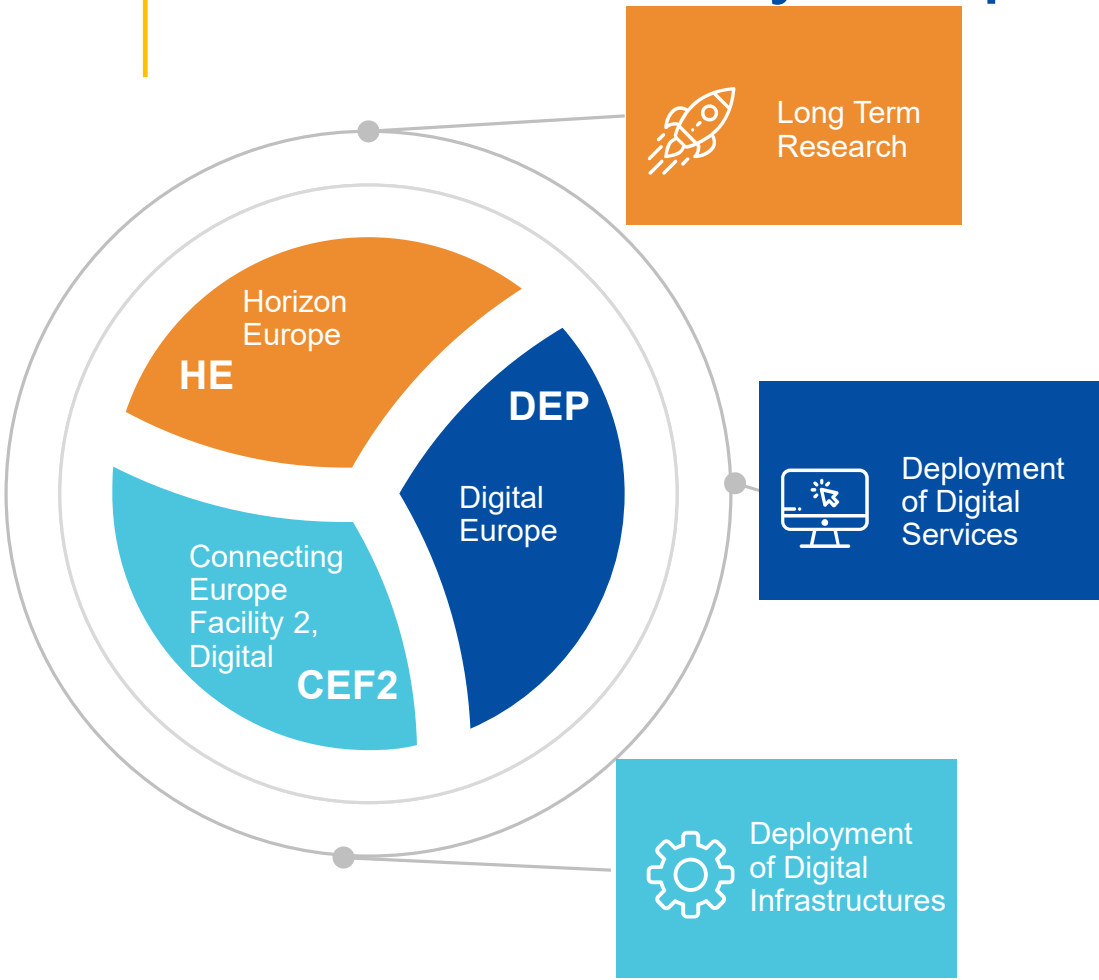- ✓ **75% of cloud uptake by EU enterprises in 2030**

	EDGE	CLOUD
Typical distance	<1 km	1-100 km	100-1000 km	>1000 km
Average latency	1 ms	2-5 ms	10-20ms	> 20 ms

| Millions | 100 000s | 1 000s | 100s | 10s | <10 |

Cell site edge

Aggregation node

Near-premise

CLOUD TO EDGE

EDGE TO CLOUD

Central office

In-country data centre

Central data centre

Mini data centres

| ON-DEVICE | ON-PREMISE | FAR EDGE | NEAR EDGE | CLOUD |
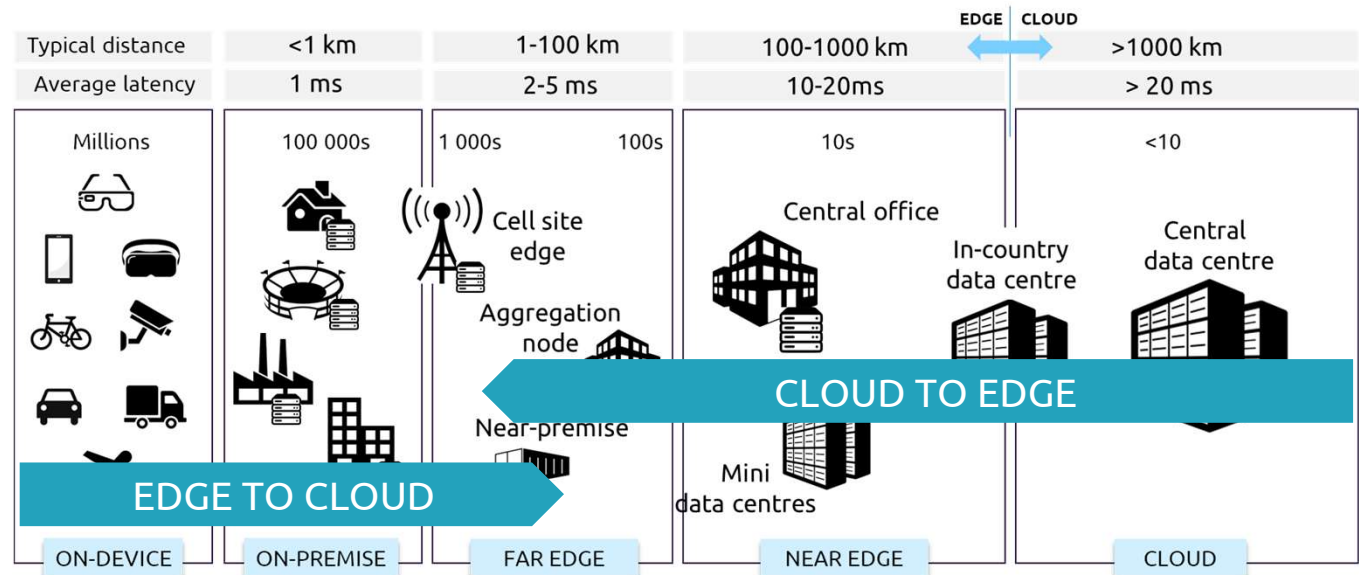
Energy **Rail** **Manufacturing** **Aerospace-defence** **...**

Mobility **Farming** **Health** **Public administration**

European Commission

European Investment Schemes on Cloud & Edge

HE
- Research and large scale-piloting on low power and ultra-secure **hybrid computing architectures**; Swarm & decentralised intelligence at the edge; (Meta-)operating systems for the edge; Cognitive cloud and AI-enabled computing continuum

CEF2
- Deployment of cross-border secure, interoperable and energy-efficient **physical and virtual interconnections among cloud and edge infrastructures** across the EU territory

DEP
- Large scale piloting and deployment of **federated cloud-to-edge-based services**; building of **marketplace(s)** and multi-usage, low-power and **interoperable middleware platforms**

RRF
- Development, testing, upgrade, retrofitting, interconnecting and deployment innovative, low power, secure cloud and **edge capacities** (infrastructure, middleware and services) across Member States + **Multi-Country Projects**

Invest EU
- Loan, equity and guarantees for sustainable data processing infrastructures; research and development of the next generation of low power software and; the deployment of looking forward edge computing services

IPCEI*
- European Commission Communication on important projects of common European interest (2014/C 188/02); *Subject to notified and approved state aid for a potential IPCEI on Next generation Cloud Infrastructure and Services.*

+ Industry co-investments

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Overview of key EU programmes, Roadmap

Long Term Research

➔ Cloud and Edge New hardware design, Energy efficiency

➔ Advanced E2E Intelligent Orchestration across compute continuum.

➔ Middleware for large cloud continuum ecosystems, e2e data pipelines

➔ Pilots for Smart IoT

Horizon Europe — HE

Digital Europe — DEP

Connecting Europe Facility 2, Digital — CEF2

Deployment of Digital Services

➔ Federated European Marketplace (Edge 2 Cloud)

➔ Large scale deployments in application sectors

➔ Reference Implementation for federated cloud (& edge)
➔ Open source software stack

➔ Density Edge deployments

Deployment of Digital Infrastructures
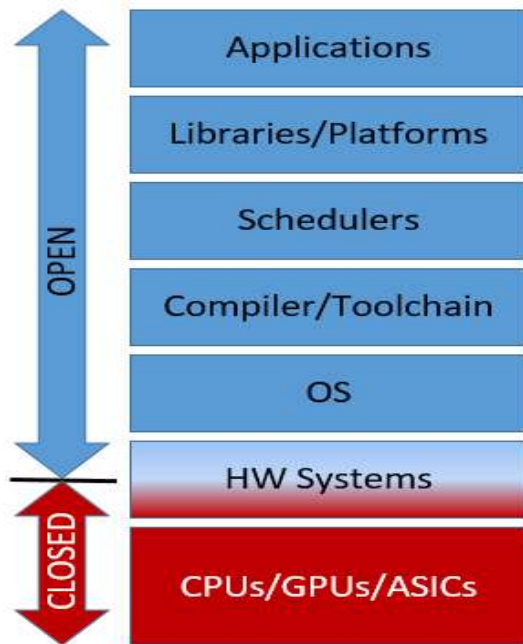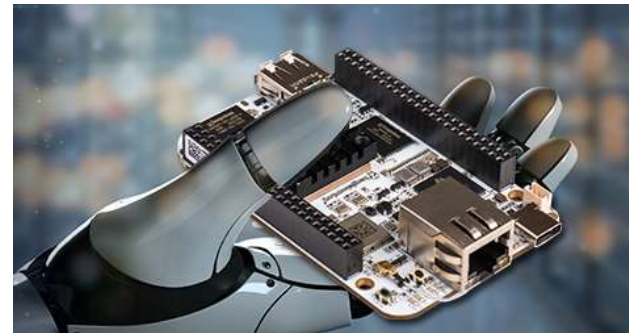
➔ Density Edge and Cloud deployments

➔ Network Services @Edge

➔ Interconnectivity for EU Edge & Cloud
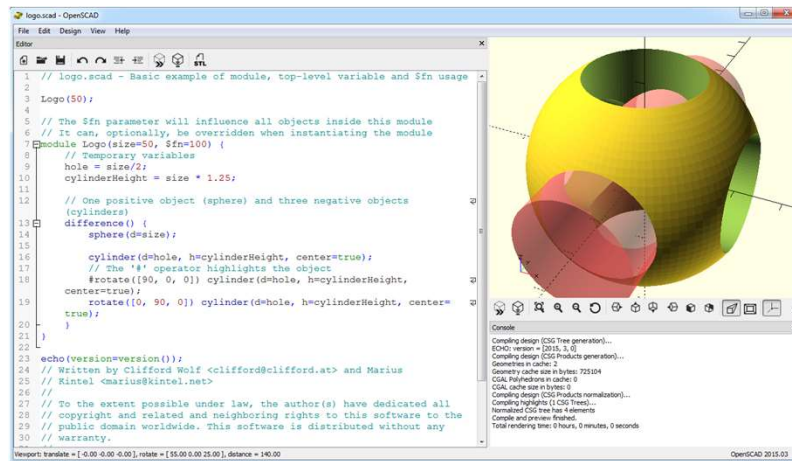
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The path to the future:
From Open Source Software to Open Source Hardware
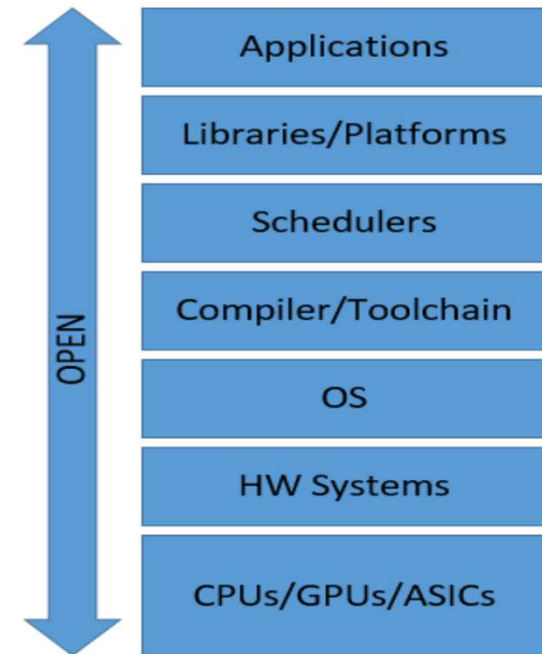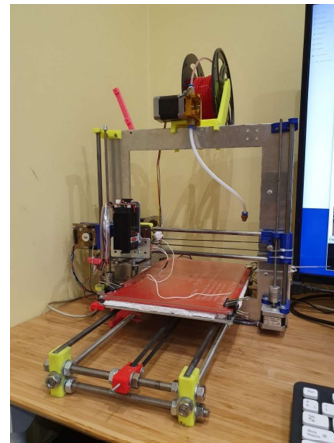
European Laboratory for Open
Computer Architecture

Open Source Beyond Software
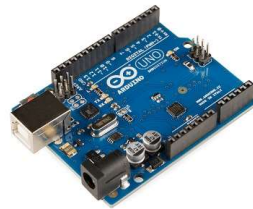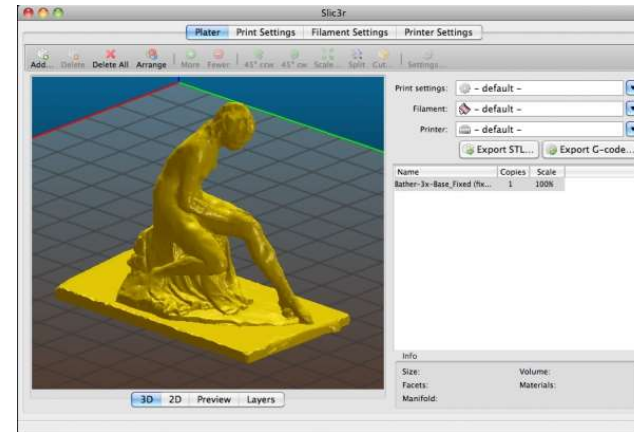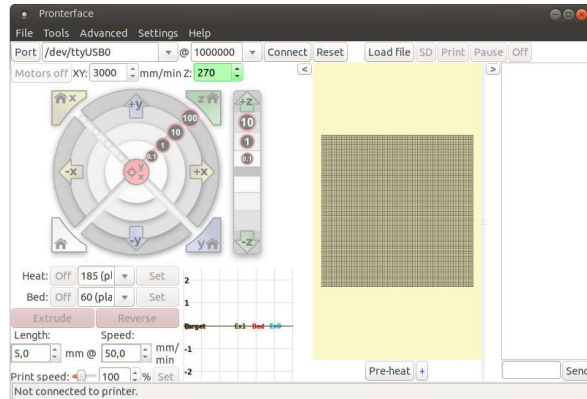
Study on the Economic Impact of Open Source in the EU economy

Study link:

- Published in **September 2021**
- Open Source Software and Hardware
- Analysis of its current role, position and potential for the European economy
- Investigate and quantify the economic impact of OSS and OSH on the European economy.
- Levels: Both Macro- and Microeconomic
- Use cases: Arduino, NextCloud, RISC-V, Reprap, X-Road
- Literature review, more than 150 publications screened, Numerous expert interviews, Stakeholders survey
- Public policies around the globe screened

Main Outcomes of the Study

- Confirmation of big impact:
  - Companies located in the EU invested around €1 billion in OSS in 2018
  - Impact on the European economy of between €65 and €95 billion.
- Cost-benefit ratio of above 1:4
- Increase of 10% of OSS contributions:
  - Annual generation of an additional 0.4% to 0.6% GDP
  - More than 600 additional ICT start-ups in the EU.
- Open Source → Public good
- Maximization of its return in Europe requires policies at EU level.
- Case studies reveal that by procuring OSS instead of proprietary software, the public sector could reduce the total cost of ownership, avoid vendor lock-in and thus increase its digital autonomy.
- Analysis of existing public policy actions in Europe and around the world.

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Cloud - Edge – IoT: Horizon Europe Work Programme 2023/24

2021/22

CSAs: Co-ordination and roadmapping

DATA-2021-01-07 / DATA-2021-01-08

Destination 4	Destination 4		Destination 3	
2022-DIGITAL-EMERGING-01-26	**2022-DIGITAL-EMERGING-01-26**	DATA-2022-01-03	**DATA-2021-01-05**	DATA-2022-01-02
Open Source for **Cloud based services**	Open Source for **Cloud based services**	Environments & tools for **Decentralised Intelligence** at edge	Future European Platforms for the Edge: **Meta OS**	**Cognitive Cloud** Framework: AI-enabled Computing Continuum

2023/24

Open Source for Cloud/ edge Digital Autonomy: Research TRL 2-5

- Open architectures for Cloud/Edge processing
- Complementing on SW-level EU semiconductor projects
- Enabling EU HW for Cloud/ edge data-centre use
- Stimulating open source communities
- Increase strategic autonomy

Fundamentals for SW Engineering: Research TRL 2-5

- ???
- Increase strategic autonomy

Piloting emerging Smart IoT Platforms and decentraised intelligence: Innovation TRL 4-7

- Mature and customise emerging smart IoT technologies
- Validate reference architectures and open platforms in application context
- Foster innovation scenarios of ubiquitous data and computation in the computing continuum
- Consensus and ecosystem building in and across verticals
- Bridging between research & adoption through piloting in/across verticals

Cognitive Computing Continuum: Intelligence & automation for more efficient data processing: Research TRL 2-5

- Management of the computing continuum
- Swarm computing and decentralised intelligence
- End-to-end security and identity management across the continuum
- „Green" optimisation of data processing across the continuum

Key Input: Industrial Cloud / Edge Technology Roadmap

Key Input: Cloud-Edge-IoT Strategy Forum

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European Commission

Open Source: The Pursue of Digital Autonomy

CPU

Compatibility description: Packaging, pin description and instruction set
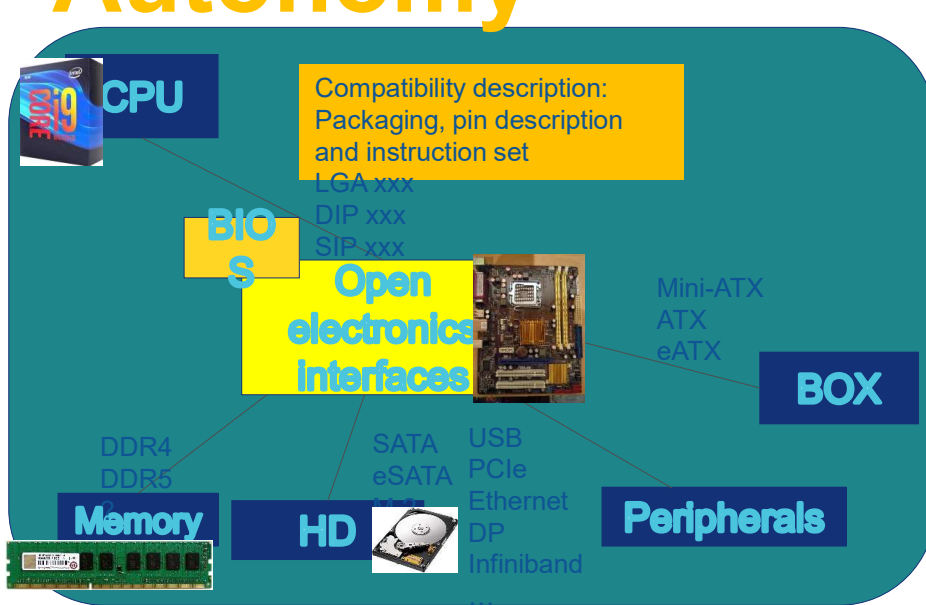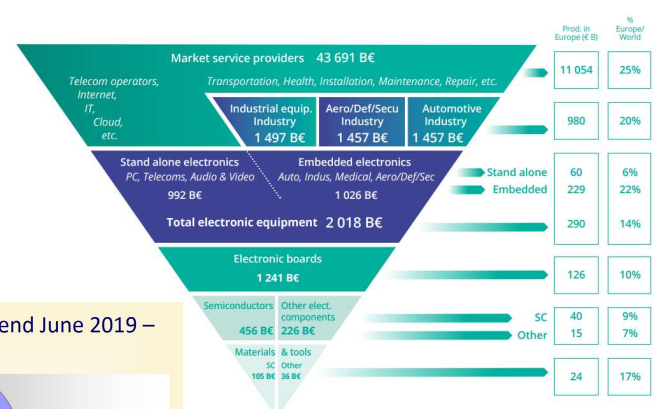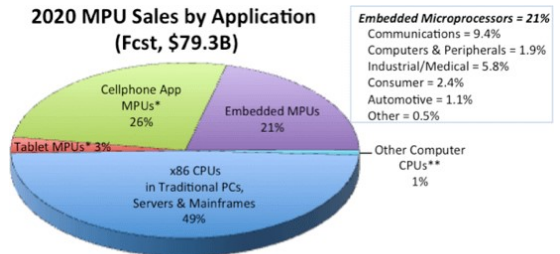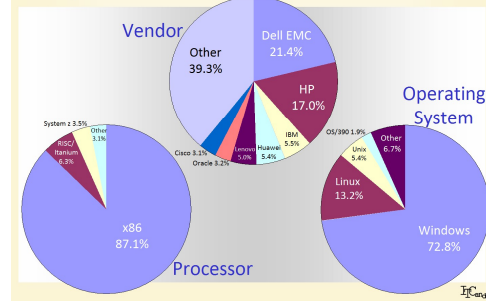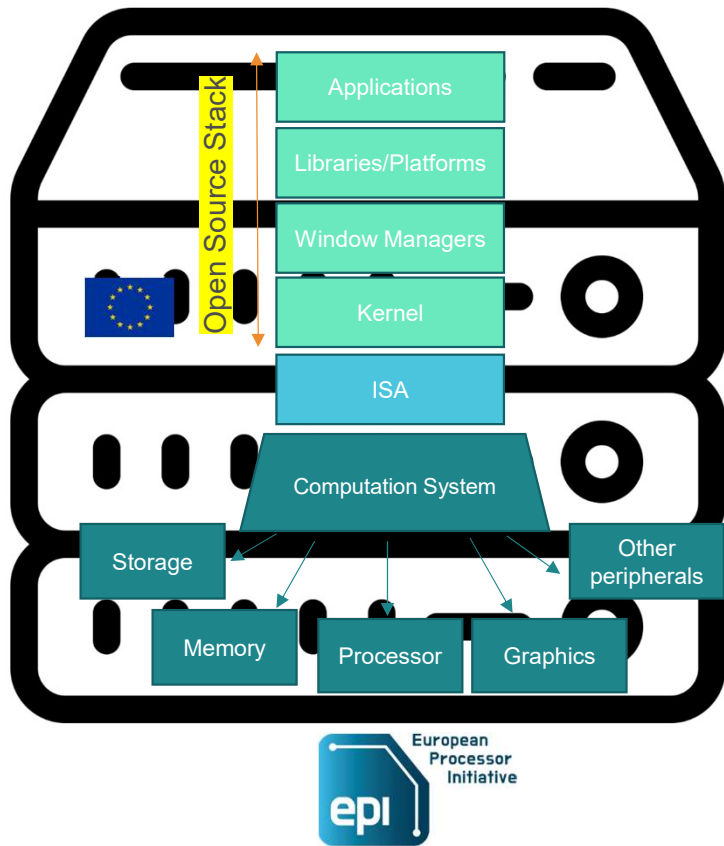LGA xxx
DIP xxx
SIP xxx

BIOS

Open electronics interfaces

BOX

Mini-ATX
ATX
eATX

DDR4
DDR5

Memory

SATA
eSATA

HD

USB
PCIe
Ethernet
DP
Infiniband

Peripherals

Open Source Distributions

2020 MPU Sales by Application (Fcst, $79.3B)

Cellphone App MPUs* 26%
Embedded MPUs 21%
Tablet MPUs* 3%
x86 CPUs in Traditional PCs, Servers & Mainframes 49%
Other Computer CPUs** 1%

Embedded Microprocessors = 21%
Communications = 9.4%
Computers & Peripherals = 1.9%
Industrial/Medical = 5.8%
Consumer = 2.4%
Automotive = 1.1%
Other = 0.5%

*Includes ARM-based and x86 processors.   **Includes ARM-based and other RISC processors.
Source: IC Insights

Server market shares – year to end June 2019 – total: $81b

Vendor
Other 39.3%
Dell EMC 21.4%
HP 17.0%
System z 3.5%
Other 3.1%
RISC/ Itanium 6.3%
Cisco 3.1%
Oracle 3.2%
Lenovo 5.0%
Huawei 5.4%
IBM 5.5%

Processor
x86 87.1%

Operating System
OS/390 1.9%
Other 6.7%
Unix 5.4%
Linux 13.2%
Windows 72.8%

	Prod. in Europe (€ B)	% Europe/ World
Market service providers 43 691 B€		
Telecom operators, Internet, IT, Cloud, etc.		
Transportation, Health, Installation, Maintenance, Repair, etc.	11 054	25%
Industrial equip. Industry 1 497 B€ Aero/Def/Secu Industry 1 457 B€ Automotive Industry 1 457 B€	980	20%
Stand alone electronics PC, Telecoms, Audio & Video 992 B€ Embedded electronics Auto, Indus, Medical, Aero/Def/Sec 1 026 B€	Stand alone 60 Embedded 229	6% 22%
Total electronic equipment 2 018 B€	290	14%
Electronic boards 1 241 B€	126	10%
Semiconductors 456 B€ Other elect. components 226 B€	SC 40 Other 15	9% 7%
Materials & tools SC 105 B€ Other 36 B€	24	17%

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Open Source:
The way Forward

Next Steps for EU actions & programmes

Industrial view

2021-2022

Long Term Research

Deployment of Digital Services

Deployment of Digital Infrastructures

2027 and beyond

European Commission

Cloud - Edge – IoT: Horizon Europe Work Programme 2023/24

2021/22

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Destination 4
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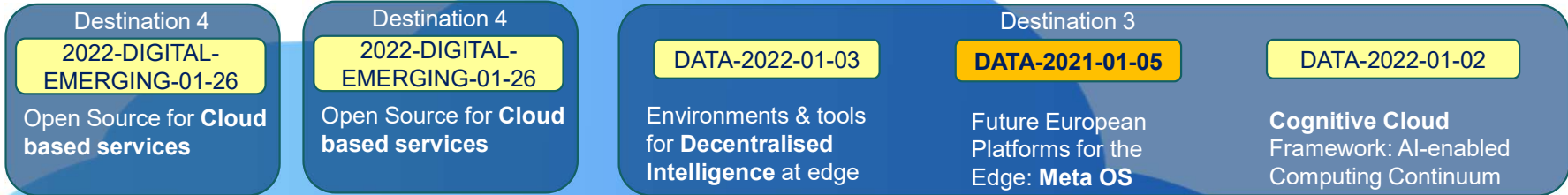Open Source for **Cloud based services**

Destination 4
2022-DIGITAL-EMERGING-01-26
Open Source for **Cloud based services**

DATA-2022-01-03
Environments & tools for **Decentralised Intelligence** at edge

Destination 3
DATA-2021-01-05
Future European Platforms for the Edge: **Meta OS**

DATA-2022-01-02
Cognitive Cloud Framework: AI-enabled Computing Continuum

2023/24

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Thank you

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