



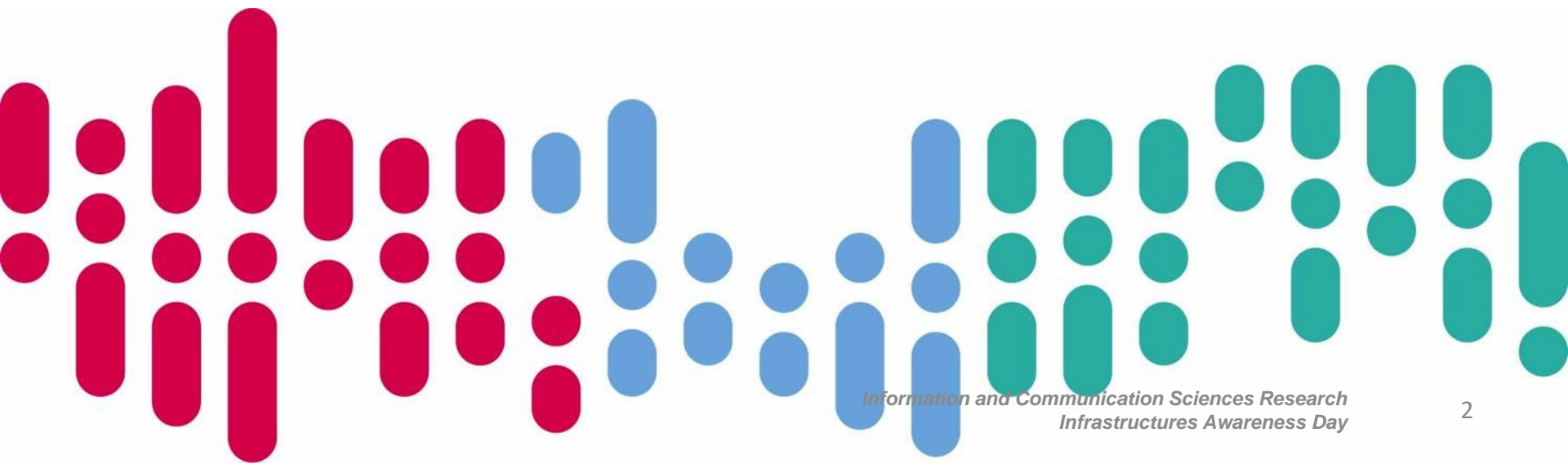
The need for a Research Infrastructure in Digital Sciences

Arturo Azcorra

U. Carlos III and IMDEA Networks

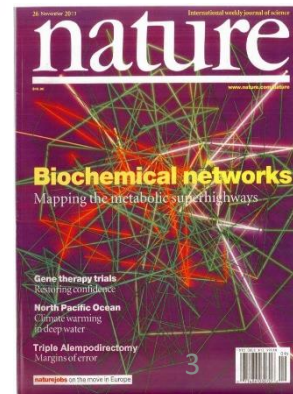
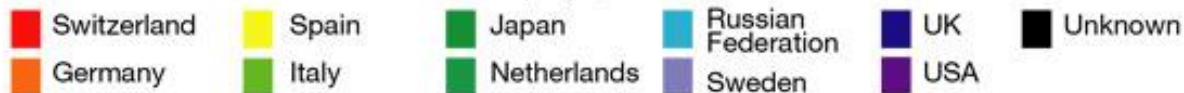
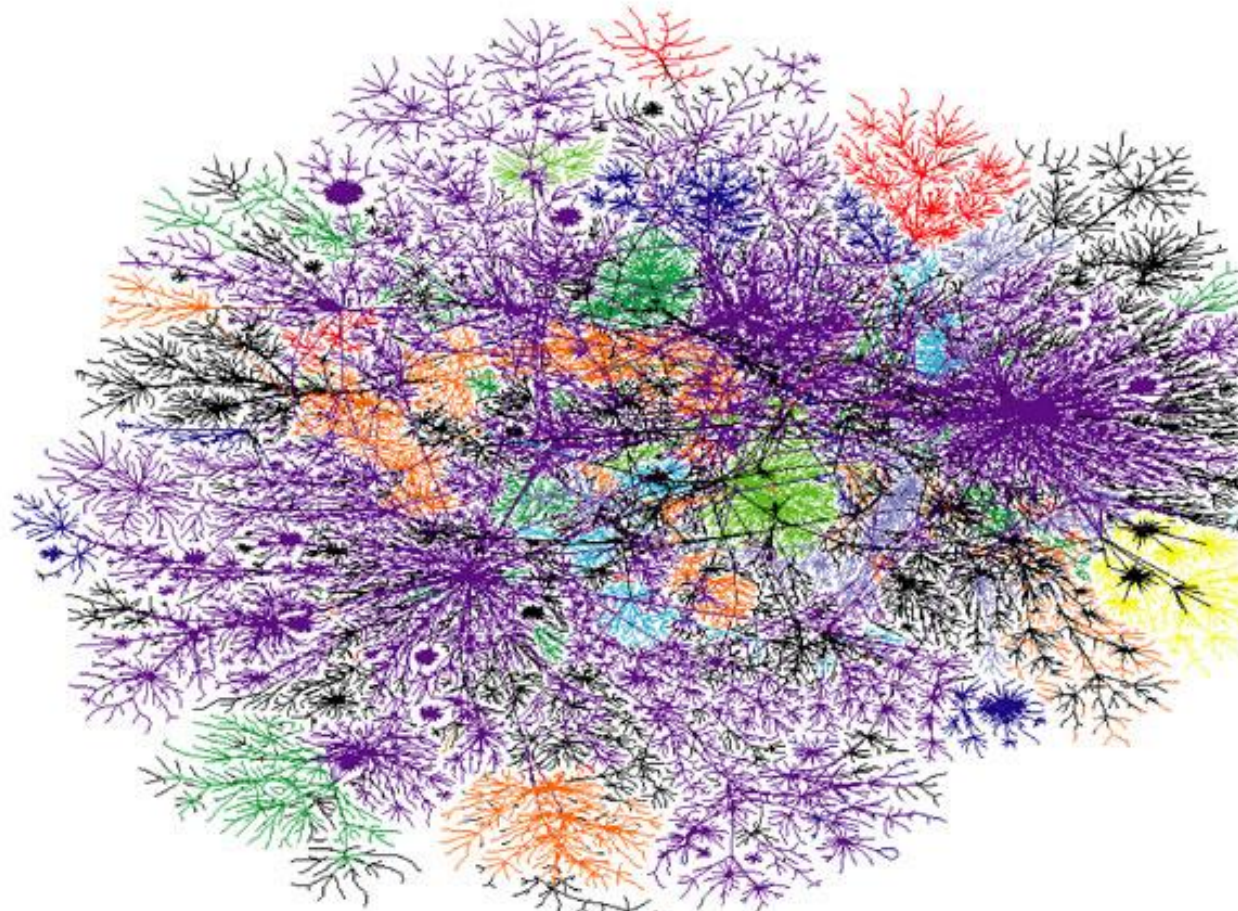
ICSRI2019– May 27 2019

The science of networks



The relevance of data networks

- Networks are the most complex and largest system created by mankind



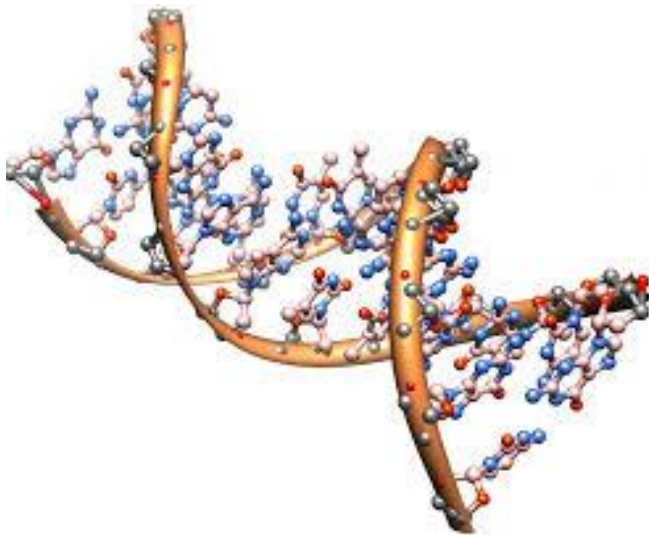
Cosmic-scale systemic complexity

- The mobile telephony network has 7 billion terminals that move throughout the world, plus 1.4 billion fixed lines
 - There are **70 quintillion** (7×10^{19}) combinations of any two phones, and **all of these combinations** interwork properly
 - When you dial a number, the network has to **locate** the specific destination terminal and connect in **less than one second!!**



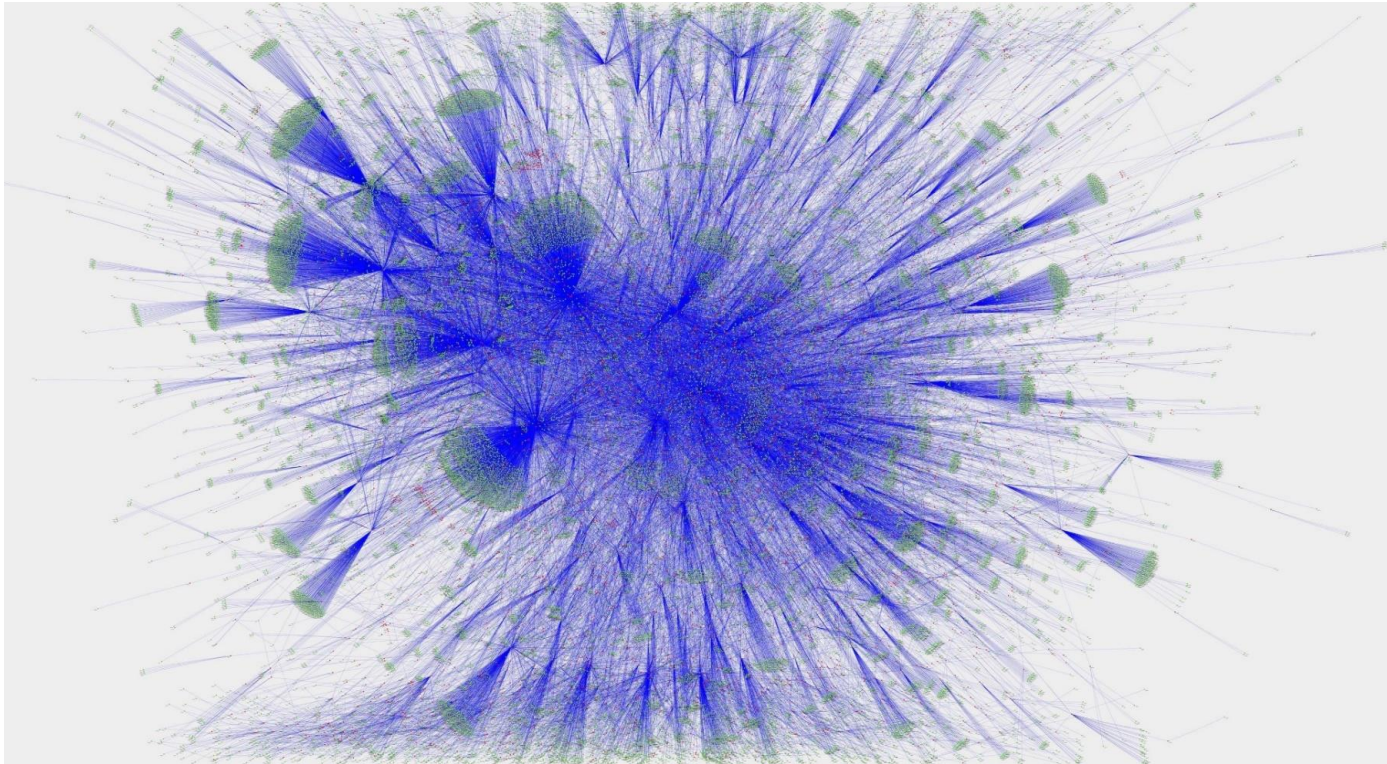
Extreme accuracy and standardization

- The network is composed of millions of routers/switches from **hundreds of manufacturers**, and any combination must interoperate along any data path
- There are thousands of phone models produced by hundreds of manufacturers, and any combination must interoperate



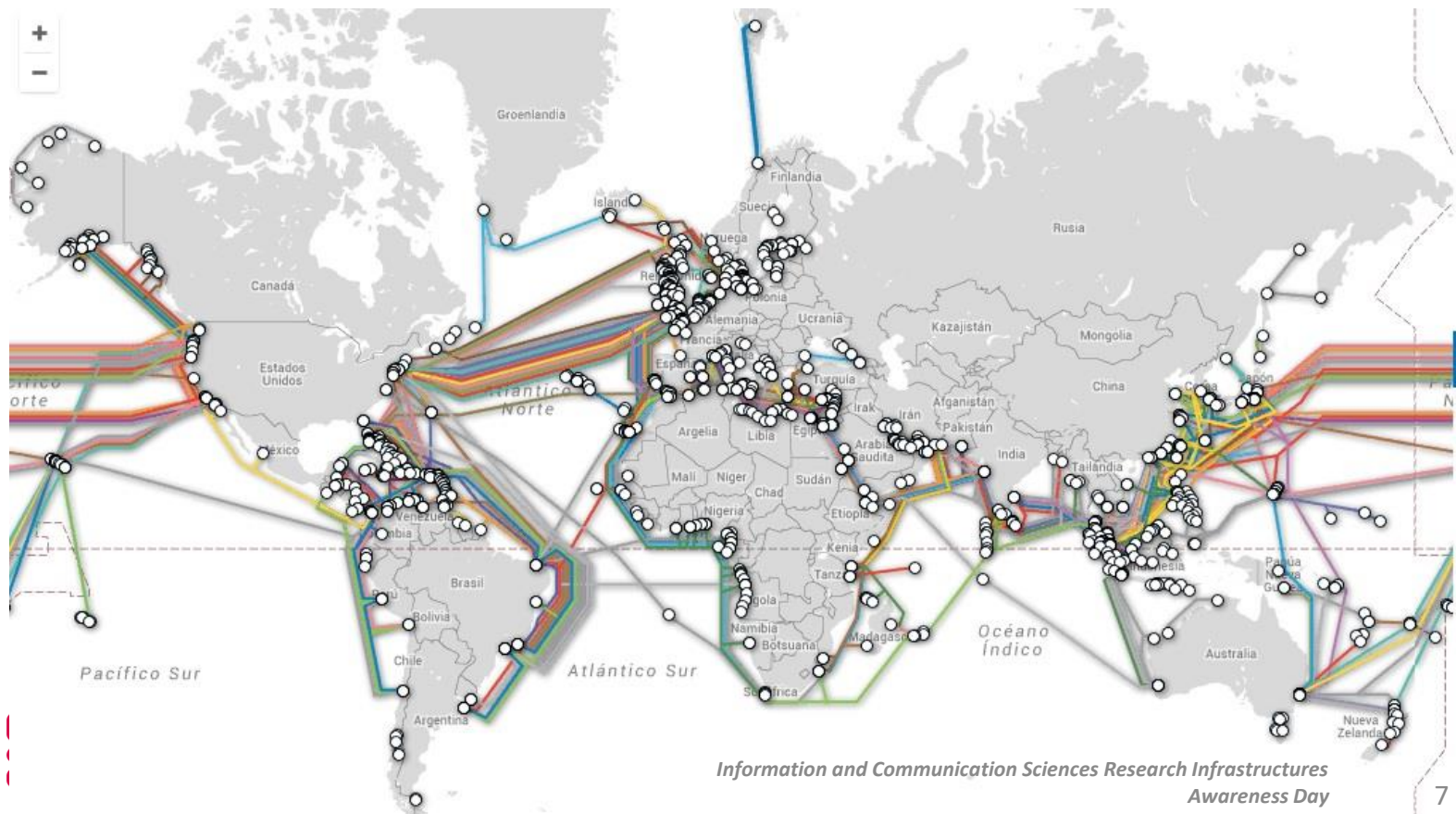
Sheer size and switching speeds

- The Internet Protocol v6 has 340 undecillion (3.4×10^{38}) addresses (more than atoms in the Earth's surface!!)
- Routers must forward a packet towards the correct destination in one microsecond!!



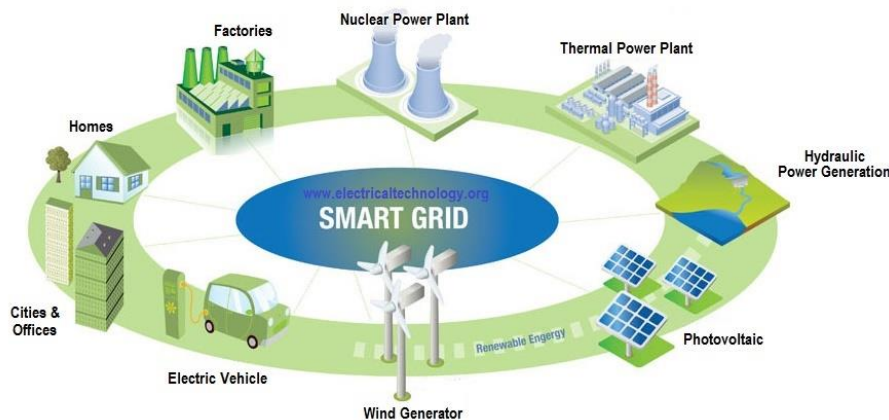
Enormous investment in infrastructure

- Over **1.5 billion** Kilometers of **optical fiber** (ten times the distance between Earth and Sun)
- +300 FO submarine cables totaling over **900,000 Km**
- Over **4,000,000 base stations** for mobile communications

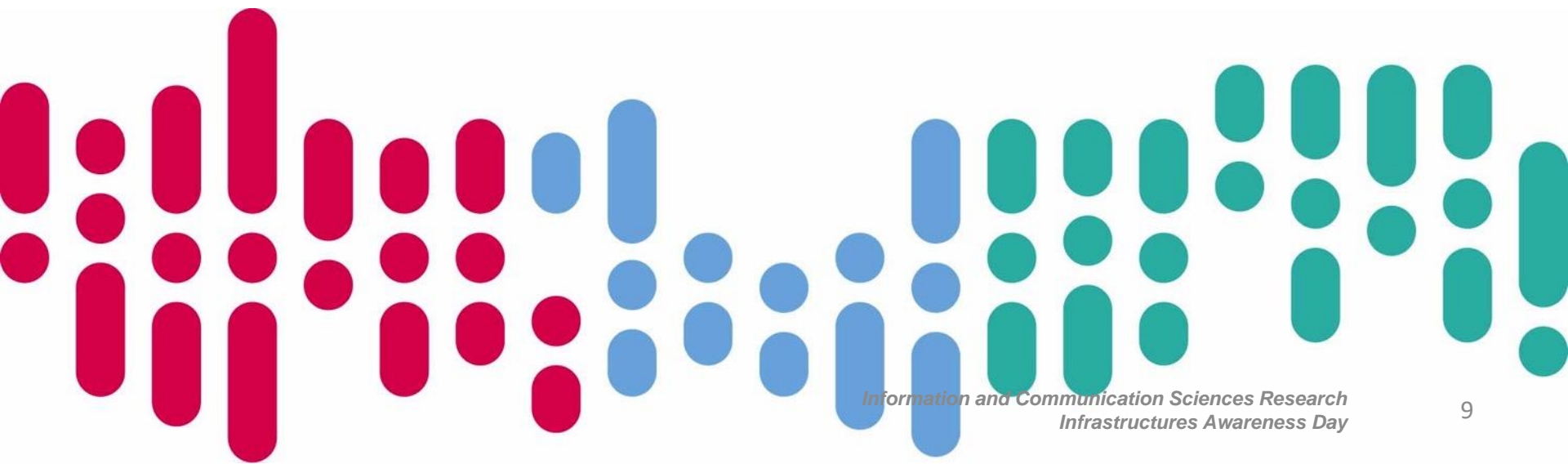


Essential for critical services

- Essential for emergency services (ambulances, firemen, police, ...)
- Essential for critical infrastructures (electrical distribution, water reservoir and supplies, transportation, ...)
- Essential for the economy (bank transfers, ATM, credit cards, ...)
- Essential for society (social networks, TV, radio, ...)
- Essential for health-care (records, images, analysis, data, ...)
- Essential for security and defense (army, intelligence, ...)



European Research Infrastructure for the Science of Networks



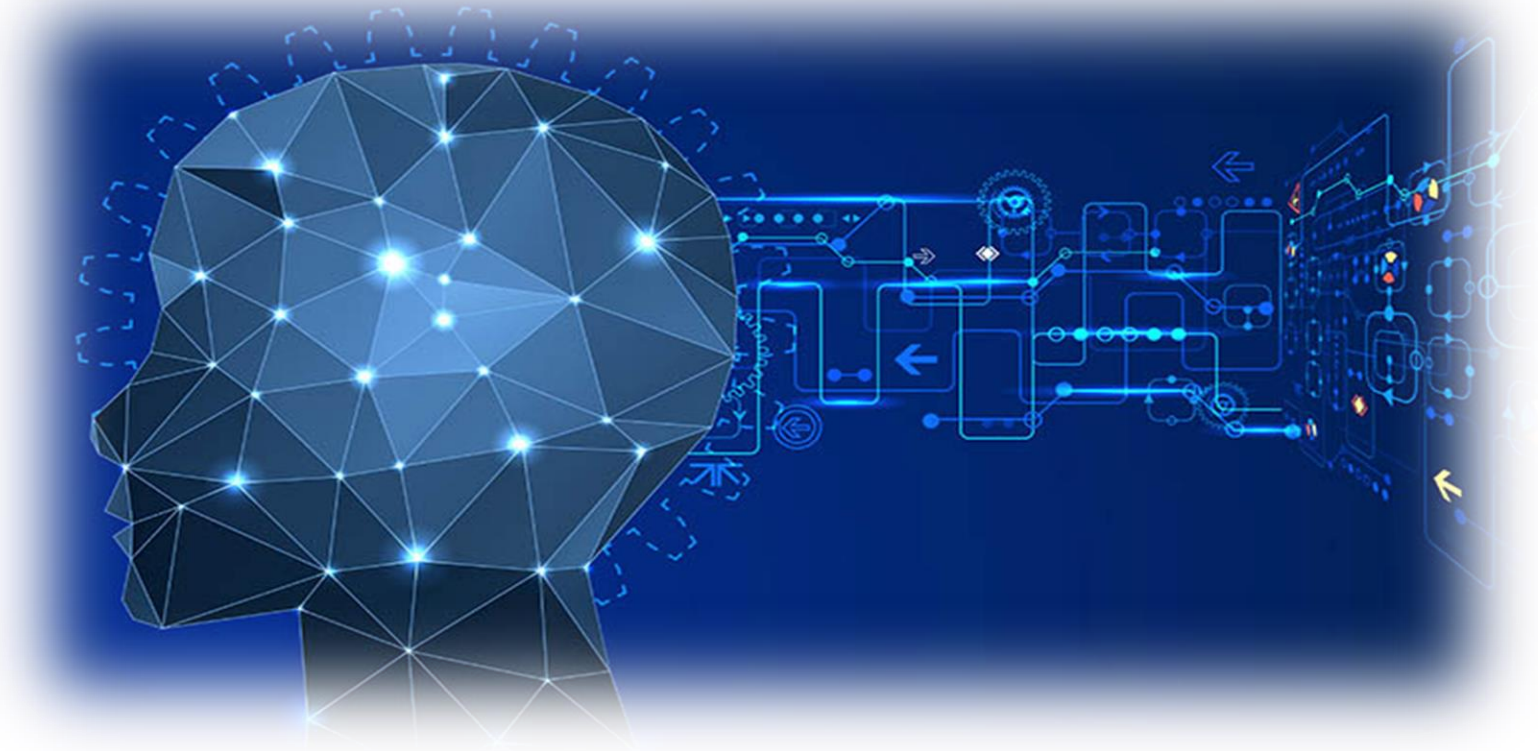
ESFRI Landmarks and Projects

- Summary of ESFRI Landmarks and projects from 2018 Roadmap, by working group

ESFRI LANDMARKS and PROJECTS by Working Group	Number	TOTAL construction costs (M€)	TOTAL operation costs (M€/y)	% Number	% construction costs (M€)	% operation costs (M€/y)
Energy	6	4,584	127	10.9%	25.2%	6.7%
Environment	11	1,584	219	20.0%	8.7%	11.6%
Health & Food	16	1,922	337	29.1%	10.6%	17.8%
Physical Sciences & Engineering	14	9,229	1.070	25.5%	50.7%	56.5%
Social & Cultural Innovation	7	388	81	12.7%	2.1%	4.3%
*Multidisciplinary (PRACE)	1	500	60	1.8%	2.7%	3.2%
Data, Computing and Digital Research Infrastructures	0	0	0	0.0%	0.0%	0.0%
TOTAL ESFRI LANDMARKS and PROJECTS	55	18,207	1,895	100.0%	100.0%	100.0%



Digital transformation, scientific challenges!



Scalable, robust and secure digital infrastructures



Challenges

Scalable:

*Vertical sectors,
IoT, ...*



Robust:

*Softwarization,
Virtualization*



Secure:

*DDOS, fake news,
Back doors,*

Why do we need such a test platform?

- Research to develop scalable, robust and secure DIGITAL INFRASTRUCTURES
- SUPPORT RESEARCH on DIGITAL TRANSFORMATION:
 - Scalability
 - Pervasiveness (anywhere, any time)
 - Heterogeneity & Interoperability
 - Virtualization and Cloudification
 - Security and Data Protection
- TRUSTABLE & REPRODUCIBLE RESULTS

*Encourage **reproducibility and transparency practices** in the scientific community, including public access to raw data and protocols, the conduct of replication studies.*



Scientific community



ComSoc, CompSoc (+6):
Europe: 29,000 members
World: 131,000 members



SIGCOMM, SIGMM, (+2):
World: ~4,000 members

ComSoc Scientific Conferences: ICC, Globecom, INFOCOM, Mobicom, WoWMoM, ...
ComSoc Scientific Journals: ToN, ToMC, ToC, ...: 24 top journals

ACM SIGCOMM Scientific Conferences: SIGCOMM, CoNEXT, ...
SIGCOMM Scientific Journals: SIGCOMM, ...



Fully Controllable, programmable Virtualized Digital Infrastructure Test Platform



Precursor: Planetlab



Directorate General for Communications Networks,
Content & Technology (DG CONNECT)



PLANETLAB

An open platform for developing, deploying, and accessing planetary-scale services

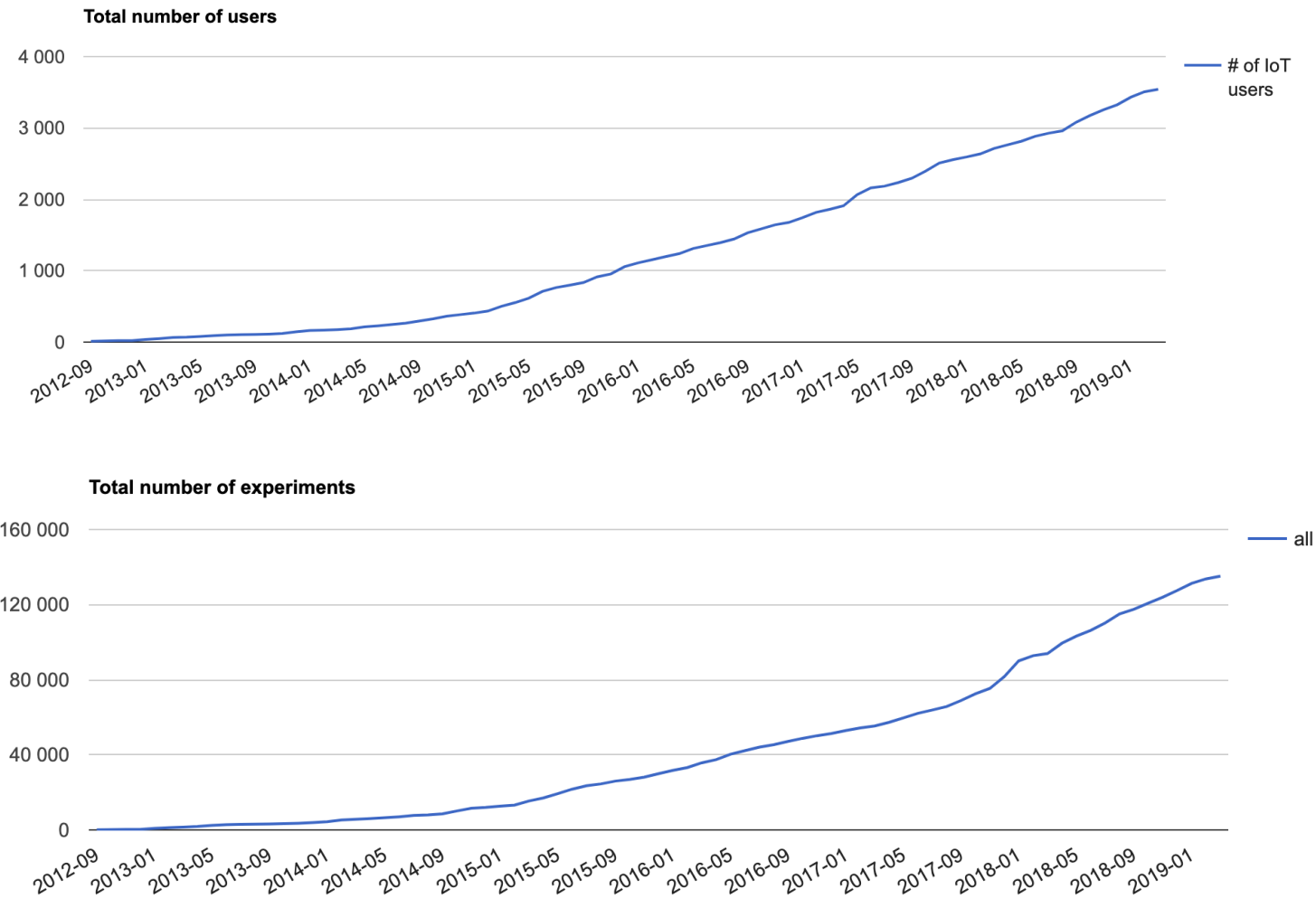


PLANETLAB Europe 

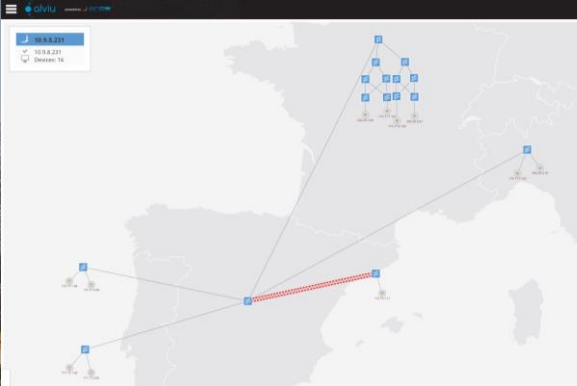
An open platform for developing, deploying, and accessing planetary-scale services



French FIT Platform



5TONIC: 5G Open Laboratory



Directorate General for Communications Networks
Content & Technology (DG CONNECT)



5TONIC



Publications & Achievements

Wide variety of **publications** addressing:


- **R&D** for the next generation of Test Platforms
- Referencing **access** by Users of Test Platforms

Test Platforms as a support to Education and Training


Test Platforms as a support to industrial advance




Planetlab cited in more than 16,000 publications

 Google Scholar

planetlab



 Articles

Environ 16 800 résultats (0,03 s)

Date indifférente

Depuis 2019

Depuis 2018

Depuis 2015


Période spécifique...


Trier par pertinence

Trier par date

Toutes les langues

Rechercher les pages en Français

Planetlab: an overlay testbed for broad-coverage services
[B Chun](#), [D Culler](#), [T Roscoe](#), [A Bavier](#)... - ACM SIGCOMM ..., 2003 - dl.acm.org
PlanetLab is a global overlay network for developing and accessing broad-coverage network services. Our goal is to grow to 1000 geographically distributed nodes, connected by a diverse collection of links. **PlanetLab** allows multiple service to run concurrently and ...
☆  Cité 1271 fois [Autres articles](#) [Les 30 versions](#)

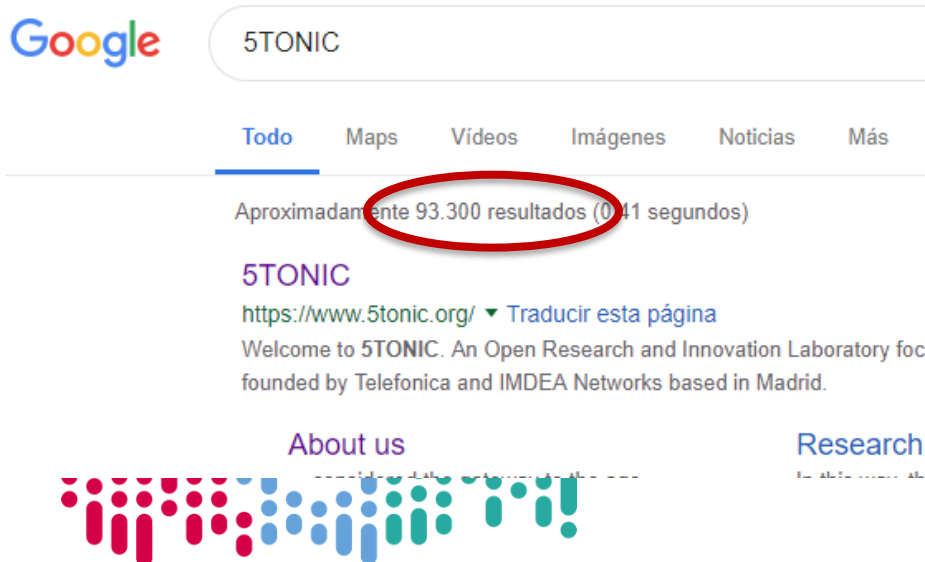
Experiences building planetlab
[L Peterson](#), [A Bavier](#), [ME Fiuczynski](#)... - Proceedings of the 7th ..., 2006 - dl.acm.org
This paper reports our experiences building **PlanetLab** over the last four years. It identifies the requirements that shaped **PlanetLab**, explains the design decisions that resulted from resolving conflicts among these requirements, and reports our experience implementing and ...
☆  Cité 292 fois [Autres articles](#) [Les 25 versions](#)



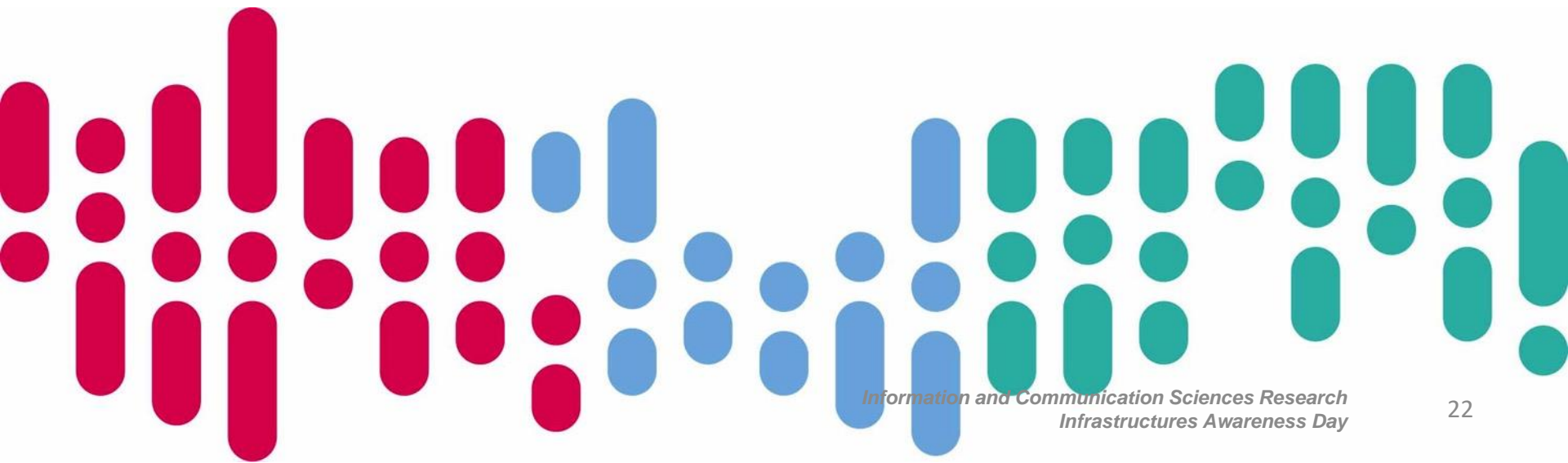
5TONIC producing 93,000 hits



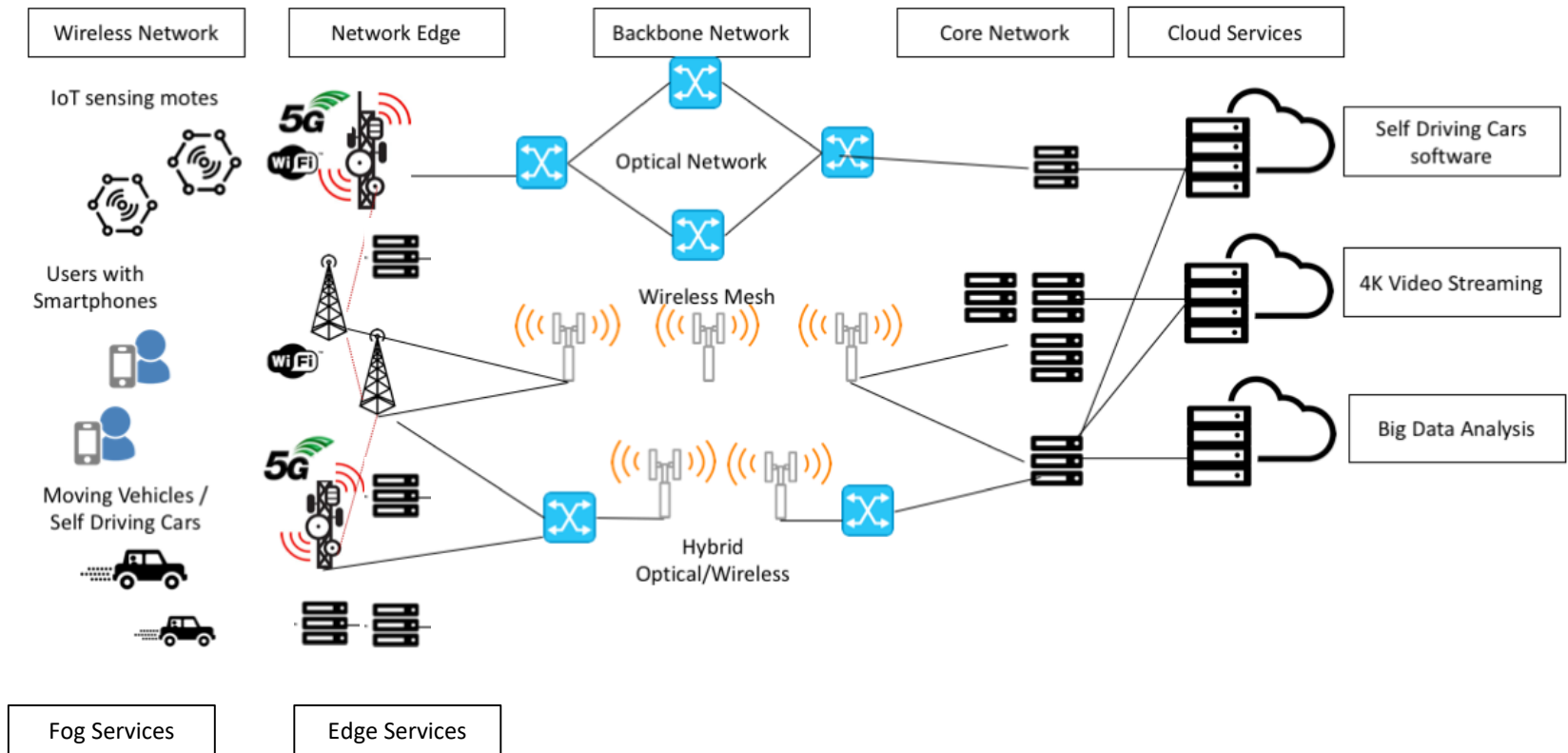
- CERN (1954, 65 years): 25M Google hits
- GranTeCan (1994, 25 years): 44K Google hits
- 5TONIC (2015, 4 years): 93K Google hits
 - 5TONIC hits: 0,5% of CERN
 - 5TONIC hits: 211% of GranTeCan



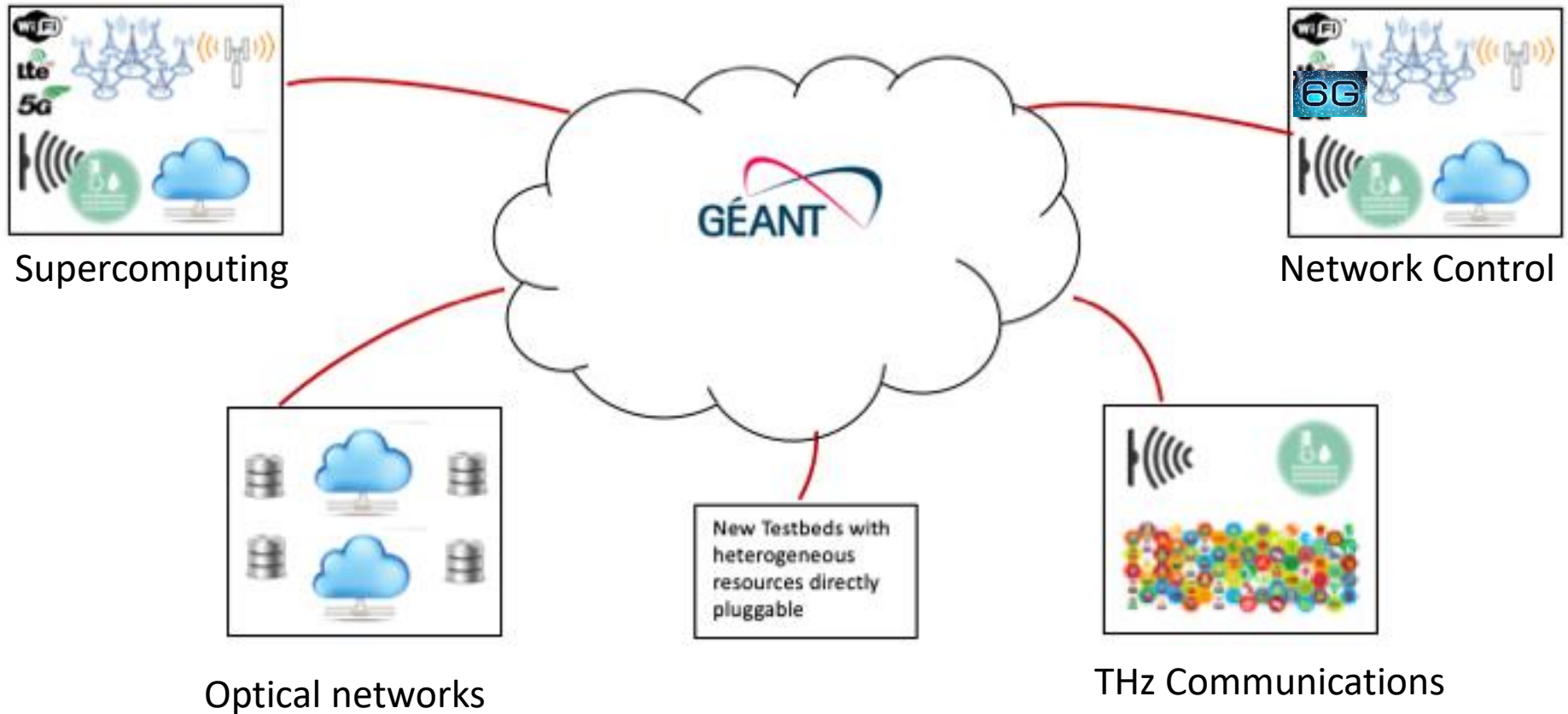
The Design Study



Motivating Experiment from digital transformation



Physical Architecture – Distributed Infrastructure: specialized sites



Access

Compliant with EU document “*European Charter for Access to research Infrastructure*”:

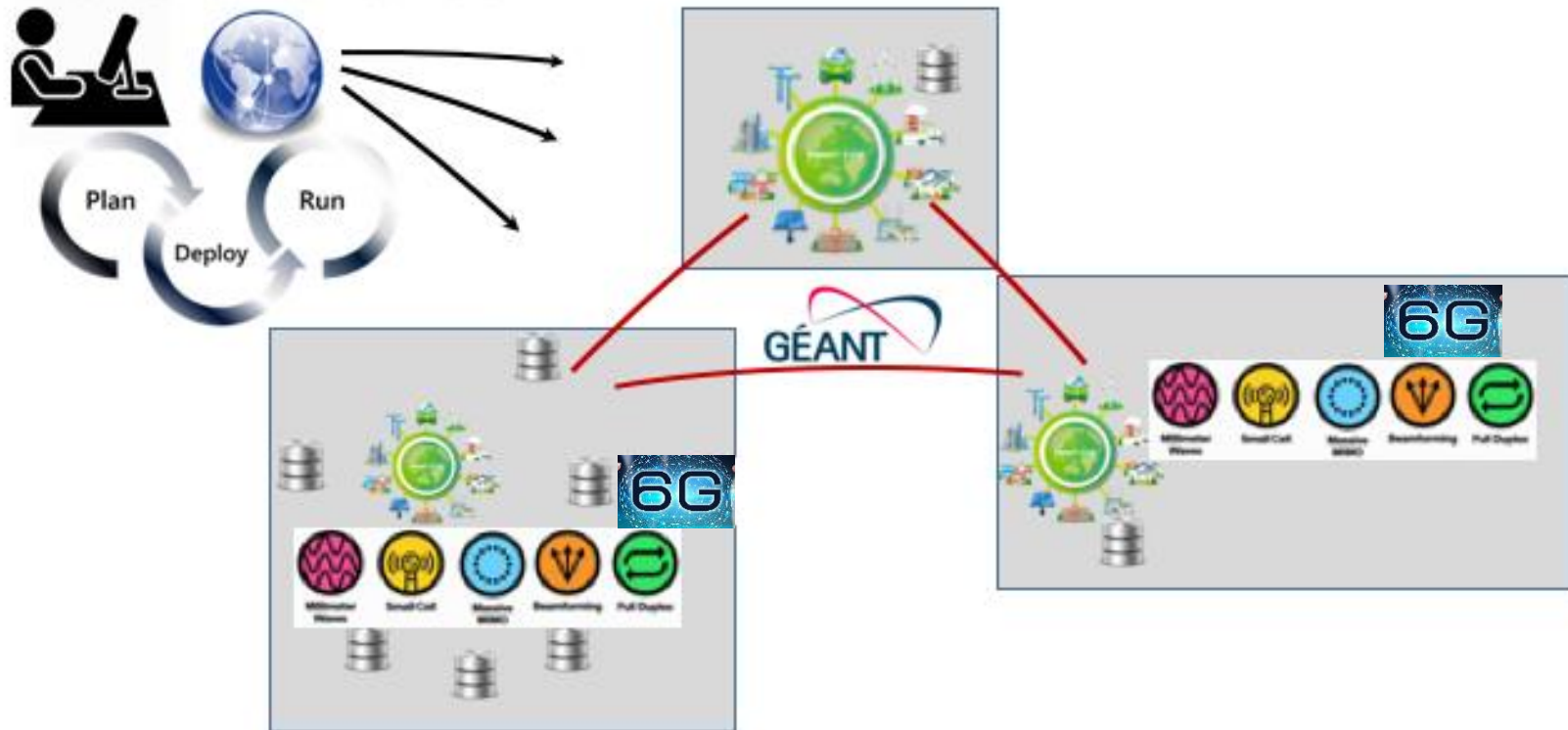
- Global approach and Access regardless of their location
- **Excellence-driven access** (Access Committee)
 - *Market-Driven Access* (Industry)
- Access unit (“Slice”)
- Monitoring and Accounting (users, resources, data)
- Ease of use, Tutorials, Hands-on, etc.
- One-Stop-Shop







Access Request: single point of entry

Experiment: distributed reservation of resources

Experimenter over the Internet accesses all the resources in a unified manner



Testbed abstractions

	Object	Service
	resource	Testbed ensures proper management of nodes, links, switches, ...
	user	Testbed guarantees the identity of its users
	slice	A distributed container in which resources are shared : <ul style="list-style-type: none">• sharing with VMs, in time, frequency, within flowspace, etc. The base for accountability
	authority	An entity responsible for a subset of services (resources, users, slices, etc.)



Technologies (Resources)

IoT

- Large clusters of IoT resources generating massively data
- Connected to the network with state-of-the-art technologies
- Indoor/Outdoor

Wireless

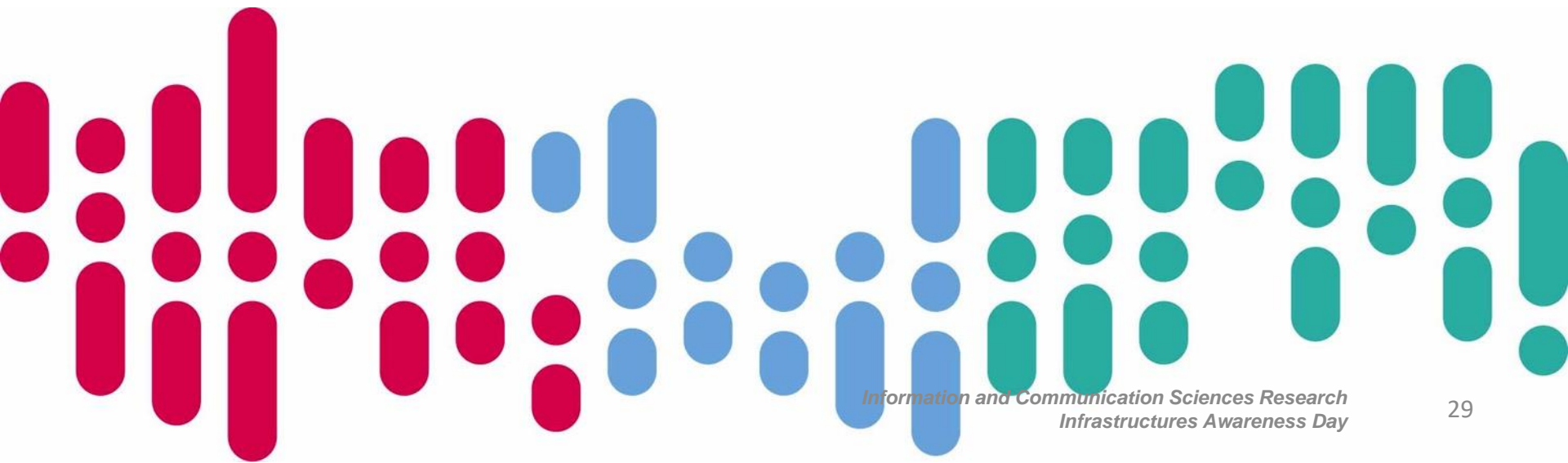
- 6G/THz/LIFI/WiFi access, Indoor/Outdoor/RF-isolated setups
- Off-the-shelf and open source equipment fully programmable
- Massive MIMO, beam steering and beam forming equipment
- Mobile nodes with wireless connectivity

Cloud

- Provide access to VM and Bare metal
- Open cloud testbeds
- Cloudblab & Chameleon together with NSF



Some background ...



International context

- Communications is a **Geopolitics** key asset
- Europe must keep up with other regions

Large Scale Infrastructures as a support to the design and validation of systems



A global initiative towards ICT Test Platforms



EU FIRE: Future Internet Research & Experimentation
US GENI: Global Environment for Networking Innovations



Funding

- **NSF GENI**
 - 2008-2016
 - 120 M\$
- **NSF TIPOFF**
 - 2017-2020
 - 10 M\$
- **NSF CloudLab & Chameleon**
 - 2013-2018
 - 20 M\$
- **DARPA Colosseum**
 - 2019-2023
 - 25 M€



- **EU FIRE**
 - 2007-2020
 - 200 M€



Advance in other regions

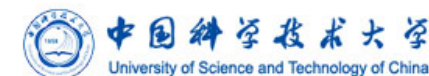
- **PAWR** (Platforms for Advanced Wireless Research):

- NSF + Industry
- 2017-2022
- **100M\$**

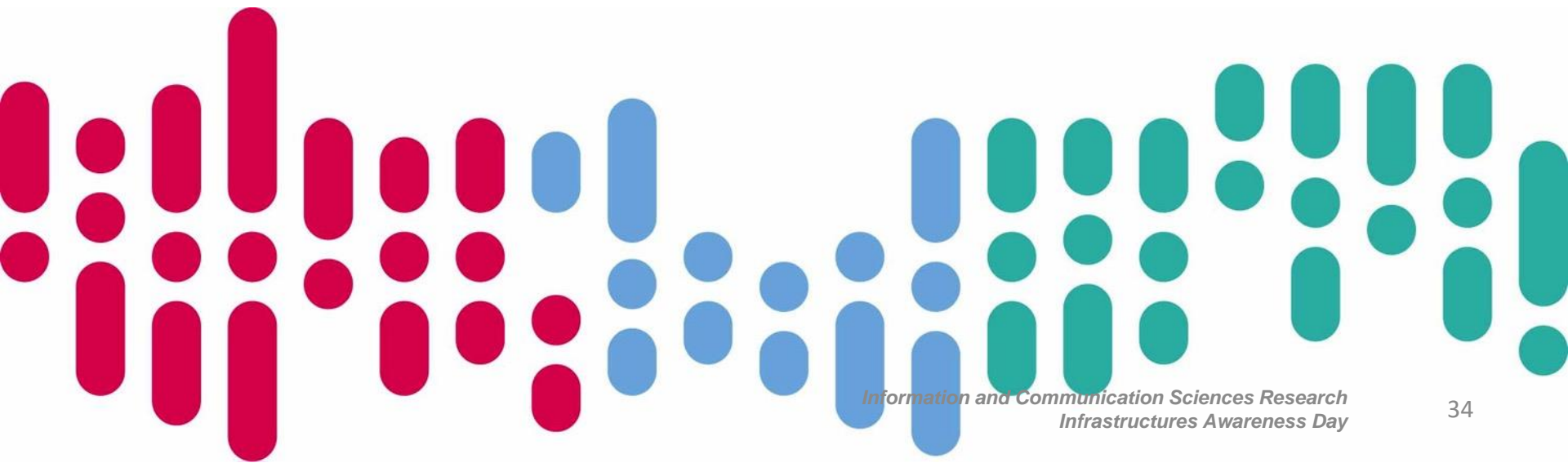


- **CENI** (Chinese Experimental National Infrastructure):

- 2018-2019: first phase deployment, proof of concept
- 2020-2022: second phase, scaling up
- **190 M€**



Conclusions



Take away?

- Research and develop scalable, robust and secure DIGITAL INFRASTRUCTURES
- Large community in Europe and Worldwide
- TRUSTABLE & REPRODUCIBLE RESULTS

Main Issues:

Discovery for the future generations

Competitiveness regarding the know-how

Technological Sovereignty



Thanks for your attention

For more information, please
contact:

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azcorra@it.uc3m.es

?



PRACE Mission

The mission of PRACE (Partnership for Advanced Computing in Europe) is to **enable** high-impact scientific discovery and engineering **research** and development **across all disciplines** to enhance European competitiveness for the benefit of society. PRACE seeks to realize this mission by offering world class computing and data management resources and services through a peer review process.

PRACE also seeks to **strengthen** the European **users of HPC** in industry through various initiatives. PRACE has a strong interest in improving energy efficiency of computing systems and reducing their environmental impact.

