ICT in Excellent Science

Kostas Glinos, Head of e-Infrastructure

19-20 November 2013

European Commission - DG CONNECT
Directorate C - Excellence in Science

Excellent Science pillar in H2020

- European Research Council
- Marie Skłodowska-Curie actions
- **Future and Emerging Technologies**
- Research infrastructures programme

FET: Pathfinding Europe's technological future

FET in Horizon 2020

*"**Future and emerging technologies** shall support collaborative research in order to extend Europe's capacity for advanced and paradigm-changing innovation. It shall foster scientific collaboration across disciplines on radically new, high-risk ideas and accelerate development of the most promising emerging areas of science and technology as well as the Union wide structuring of the corresponding scientific communities."*

COMMISSION PROPOSAL ON ESTABLISHING HORIZON 2020 - THE FRAMEWORK PROGRAMME FOR RESEARCH AND INNOVATION (2014-2020)

FET's missions

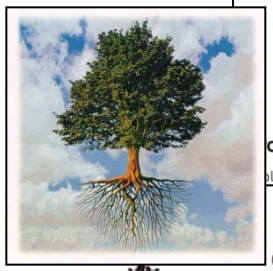
- *To uncover radically new technology areas that will renew the basis for future European competitiveness and growth and will make a difference for society in the decades to come.*
- *To grasp European leadership in research and innovation on the most promising such future and emerging technologies early on.*
- *To turn Europe into the best environment for responsible and dynamic multi-disciplinary collaborations on such future and emerging technologies.*
- *To kick-start European research and innovation eco-systems around such future and emerging technologies, as seeds of future industrial leadership and the tackling of grand societal challenges.*

European Commission

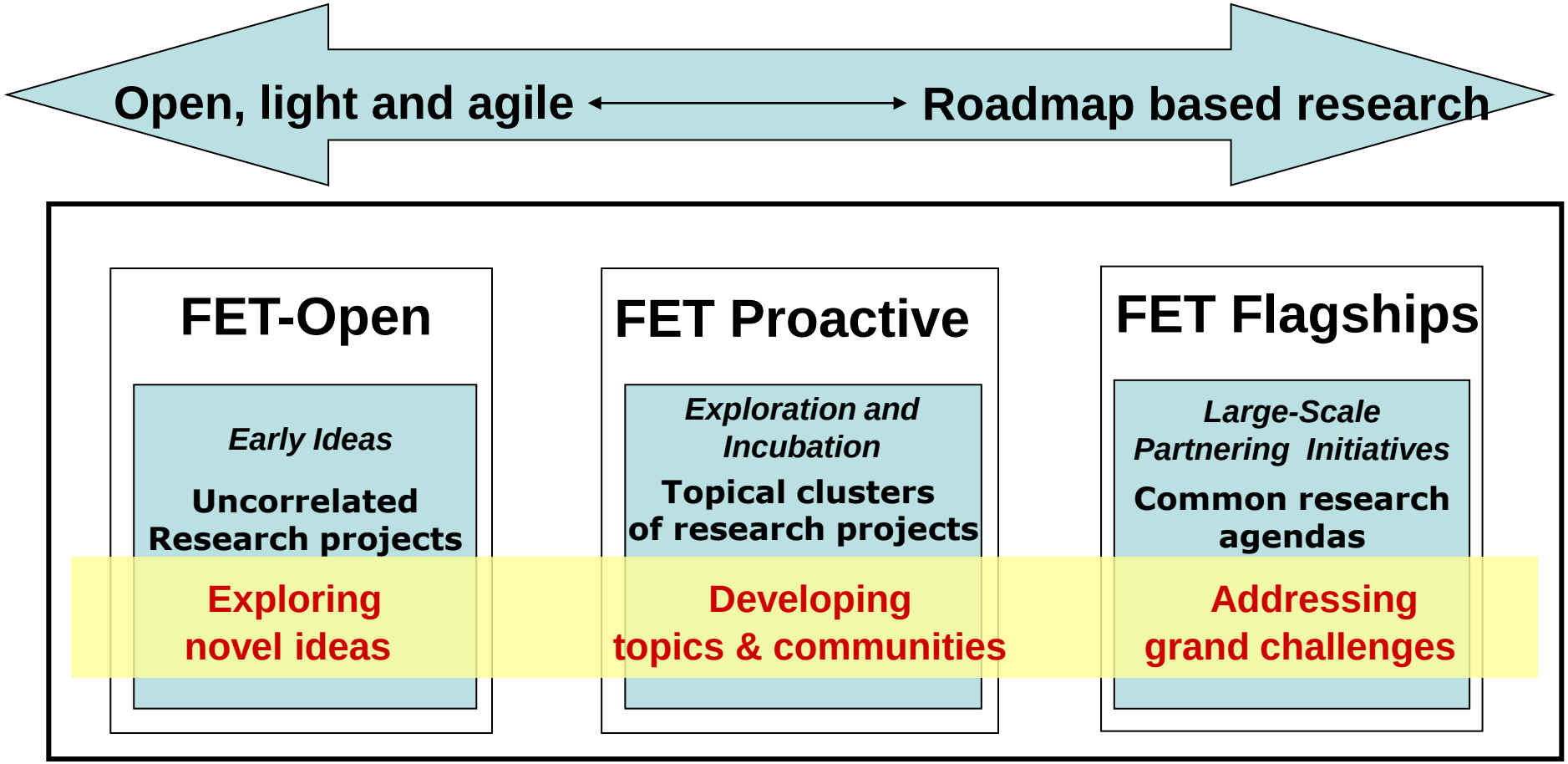
A new level of ambition

- *Pathfinding Europe's technological future*
- *Bootstrapping new R&I eco-systems*
- *Prominent large-scale partnering initiatives*
  - **FET Flagships**
  - **High-Performance Computing (PPP)**

- *A new actor in the S&T funding landscape*
  - **Pathfinding**
  - **Dialogue**
  - **Engagement**

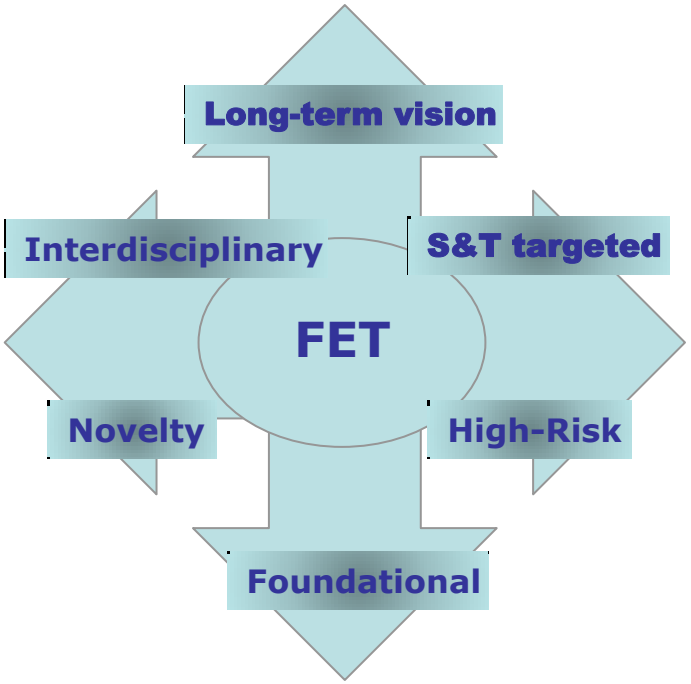


FET – three complementary funding schemes



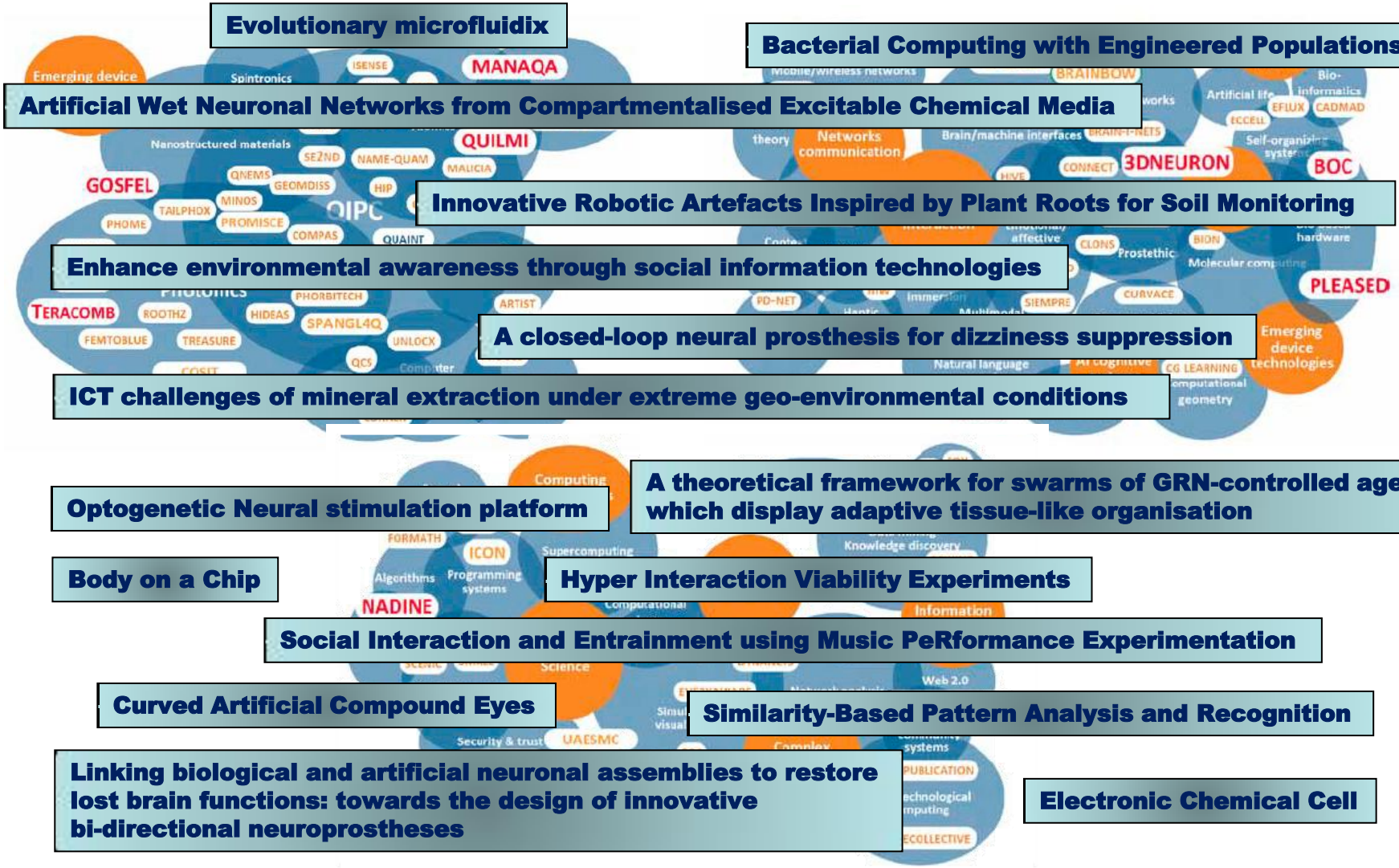
FET Open: fostering novel ideas

- *'Open is open': all technologies, no topical scope.*
- *40% of the FET budget in H2020 (>1B€).*
- *FET gatekeepers define the kind of research that FET is looking for.*
- *An end-to-end light and fast scheme:*
  - **Deadline free, open 24/7**
  - **15 pages proposal**
  - **1 step submission, 1stage evaluation**
  - **FET specific evaluation criteria**
- *Instrument*
  - **Research and Innovation Action**
  - **Coordination and Support actions**



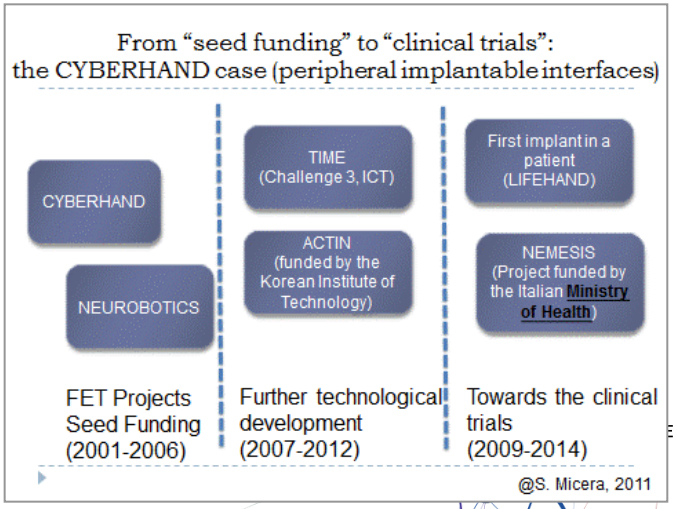
FET Open in FP7
a portfolio snapshot

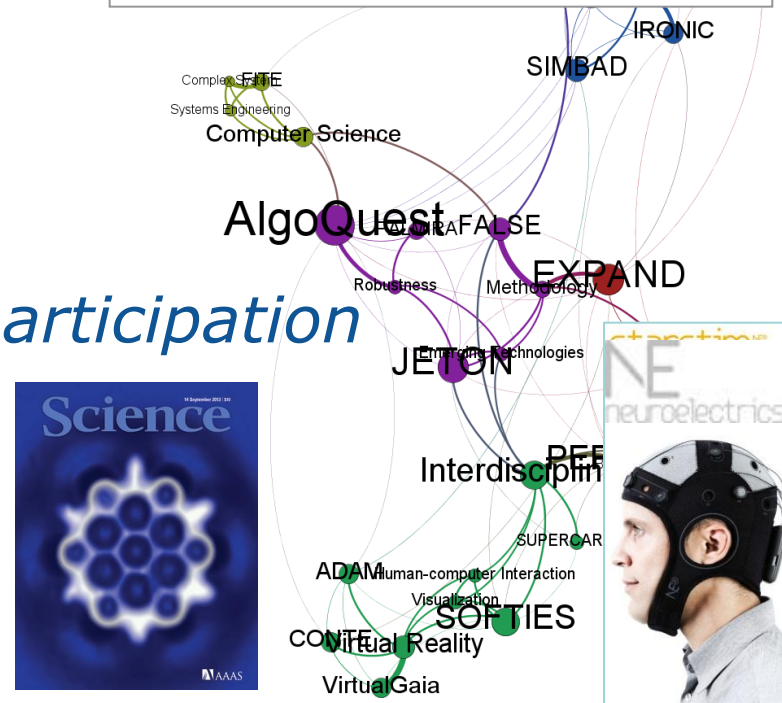
European Commission



FET Open

+ *Popular FET-hallmark scheme*
+ *Attracts new disciplines and actors, including many young ones and SMEs*
+ *Numerous success stories*
+ *A source of new directions and early signals*
+ *Largely academic, with some high-tech industry and SME participation*
+ *Highly competitive!*





FET Proactive - nurturing emerging themes and communities

- A set of thematic initiatives on promising emerging research themes.
- Building up a European pool of knowledge and new interdisciplinary communities.
- Joint exploration or consolidation of promising future technologies.
- Topics defined bottom-up (FET Observatory):
  - **FET-Open portfolio analysis**
  - **Consultations**
  - **Participatory engagement with industry and society**
  - **Coordination and support actions**

FET Proactive Initiatives in FP7

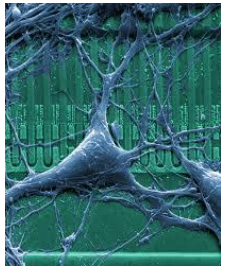
European Commission

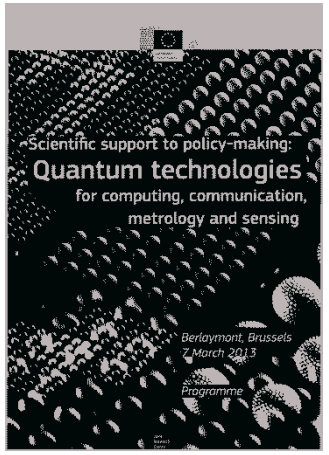
Foundations of Computing & Communication
- Nano-Scale ICT Devices and Systems
- Science of Complex Systems for Socially Intelligent ICT
- Unconventional computation
- Dynamics of Multi-Level Complex Systems
- Concurrent Tera-Device Computing
- Quantum Information Foundations & Technologies
- Quantum ICT
- Molecular Scale Devices and Systems
- Towards Zero-Power ICT
- Minimising Energy Consumption of Computing to the Limit
- Atomic and molecular scale devices and systems

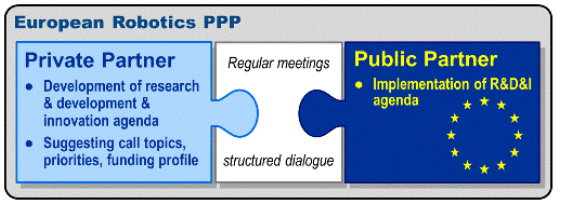
Intelligence and interaction
- Embodied Intelligence
- Pervasive adaptation
- Science of complex systems for Socially Intelligent ICT
- ICT Forever Yours
- Human-Computer Confluence
- Self-Aware Autonomous Systems
- Fundamentals of Collective Adaptive Systems
- Fundamentals of Creativity

Convergence and symbiosis
- Bio-ICT Convergence
- Bio-Chemistry based ICT
- Brain-Inspired ICT
- Neuro-Bio-Inspired Systems
- Evolving Living Technologies
- Symbiotic human-machine interaction

FET Proactive







+ *Balance between continuity and new directions*
  + **It can take time to mature an avenue**
+ *Creation of communities*
  + **for instance in, Bio-ICT, quantum technologies, Neuro-IT, complex systems**
+ *Successful transfers*
  + **for instance in quantum cryptography, cognition, nano-tech, robotics, bio-ICT**

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Future FET Proactives

Topics coming out of the on-line consultation

- **1297 contributions received to the FET on-line consultation on future pro-actives**
- **Structured around 9 candidate topics** **(see next slide)**

http://cordis.europa.eu/fp7/ict/fet-proactive/fetconsult2012-topics_en.html

Complemented by a special action:

- **Towards exascale high-performance computing,** as part of the High Performance Computing Public-Private Partnership.

FET Proactives in WP2014-15

DRAFT

Knowing, doing and being: cognition beyond problem solving

- New foundations for future robotics and other artificial cognitive systems
- Deeper understanding of non-performing aspects of social robotics and interaction in mixed human/technological settings

Global Systems Science (GSS)

- Scientific evidence-based policy responses to societal and global challenges
  - climate change, financial crises, pandemics, growth of cities

Quantum computing

- Focus on quantum simulation

DRAFT

High Performance Computing PPP

*The EC Communication "**High-Performance Computing: Europe's place in a global race**", adopted 15 Feb 2012, describes an ambitious strategy for HPC, combining three elements:*

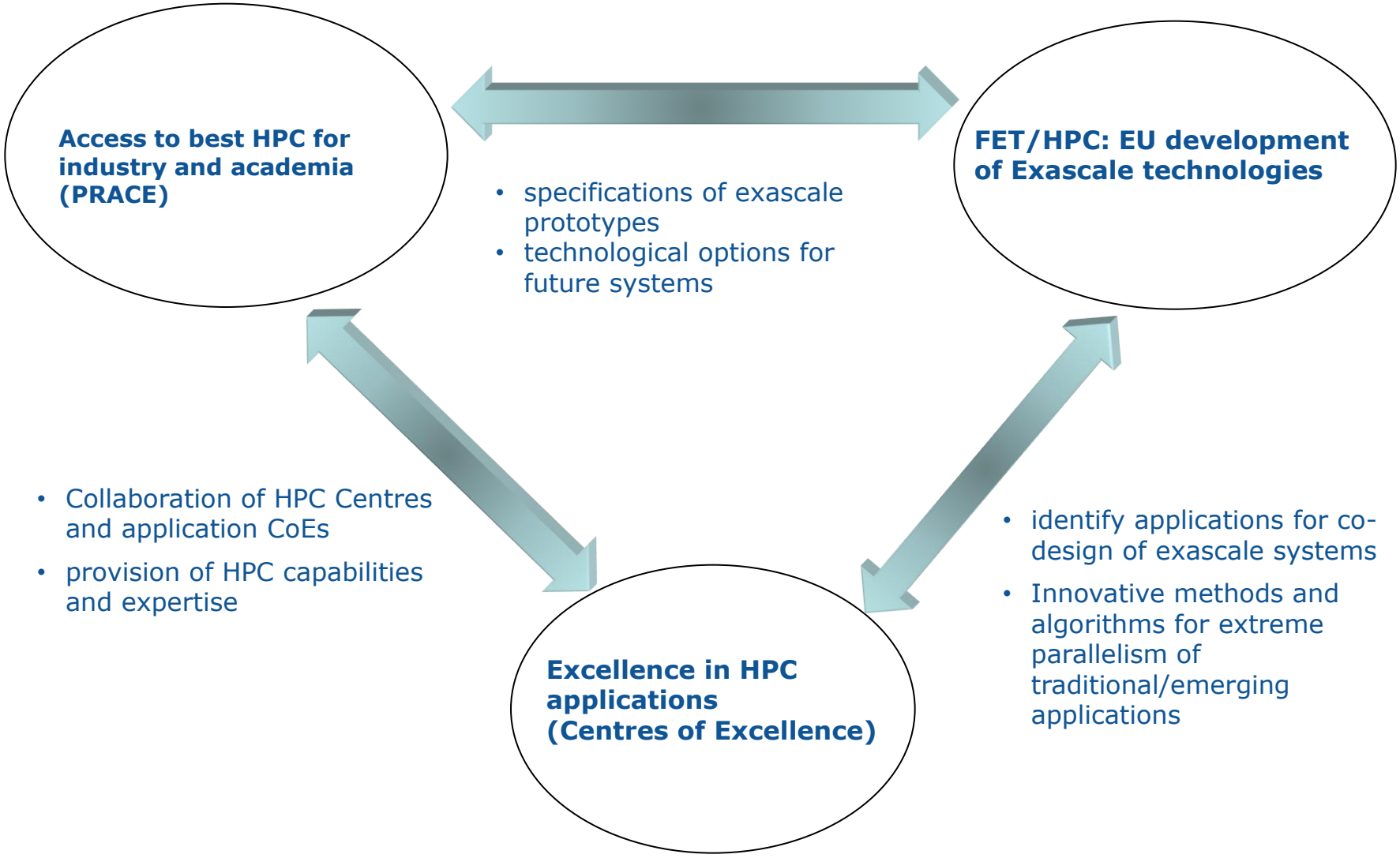
FET — (a) Development of exascale High Performance Computing;

RI — (b) providing access to the best supercomputing facilities and services for both industry and academia;

FET +RI — (c) achieving excellence in HPC applications;

Complemented with training, education and skills development in HPC

Interrelation between the three elements



HPC in FET Scope

- The exascale computing frontier requires **fundamental science and technology developments** to ensure the transition to extreme parallelism and extreme data with low energy
  - evolution of most of the key technological solutions that are satisfactory today will be **insufficient** to meet the exascale challenge
  - Co-design approach to develop applications in tandem with architectures and systems
- R&D covering the whole spectrum from processors and system architectures to high-level software and tools and novel applications (e.g. encompassing system software, file systems, compilers, programming environments and tools, algorithms etc.)
  - ➢ engaging a European-wide effort to develop technology to build exascale systems and applications within ~10 years

FET Flagships

FET Flagships are ambitious, large-scale, long-term, science-driven, goal-oriented, roadmap-based research initiatives, which are expected to:

- **provide a strong S&T basis for future technological innovation and substantial benefits for society**
- **help overcome fragmentation and increase the impact of European research and innovation efforts**

and which will require:

- **cooperation among a range of scientific communities/disciplines, with industries and with the involvement of representatives from the civil society**
- **a long-term commitment of all key stakeholders sharing a common scientific vision and under a strong leadership**
- **a joint effort of EU and national programmes to provide a large financial support (~ 100 M€/year) over a long period (~10 years)**

Graphene & Human Brain Project selected

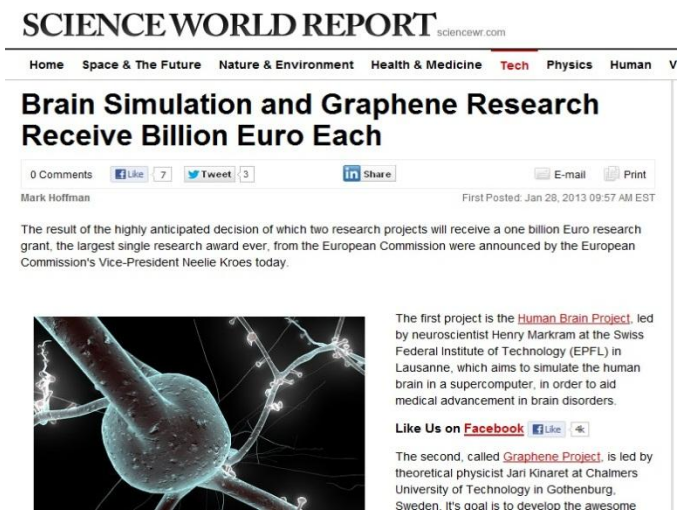
Stimulating ideas & structuring the scientific community
2009 - 2010

Call for Preparatory Actions
21 → 6
July 2010

Preparatory Phase Pilots
05/2011 - 04/2012

Flagship selection
6 → 2
end 2012

FP7 ramp-up phase
10/2013- 03/2016



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Brain Simulation and Graphene Research Receive Billion Euro Each

0 Comments | Like 7 | Tweet 3 | Share | E-mail | Print

Mark Hoffman — First Posted: Jan 28, 2013 09:57 AM EST

The result of the highly anticipated decision of which two research projects will receive a one billion Euro research grant, the largest single research award ever, from the European Commission were announced by the European Commission's Vice-President Neelie Kroes today.

The first project is the Human Brain Project, led by neuroscientist Henry Markram at the Swiss Federal Institute of Technology (EPFL) in Lausanne, which aims to simulate the human brain in a supercomputer, in order to aid medical advancement in brain disorders.

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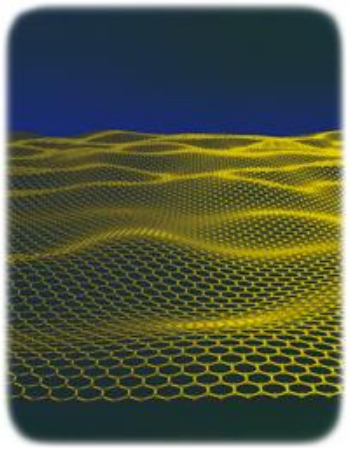
The second, called Graphene Project, is led by theoretical physicist Jari Kinaret at Chalmers University of Technology in Gothenburg, Sweden. It's goal is to develop the awesome

FET Flagship: Graphene

European Commission

Graphene, is a 2D material , a single layer of carbon atoms, stronger than diamond, yet lightweight and flexible
and an exceptional electricity conductor.

The Graphene Flagship will bring graphene, and related 2D materials, **from academic labs to industry, manufacturing and society.**



Artistic impression of a corrugated graphene sheet
Credit: Jannik Meyer

Examples of products:

- ✓ **electronic paper**
- ✓ **bendable smartphones**
- ✓ **enhanced solar cells and batteries**
- ✓ **lighter and more energy efficient airplanes**

On the longer term, graphene is expected to give rise to new computers and revolutionary medical applications such as artificial retinas.

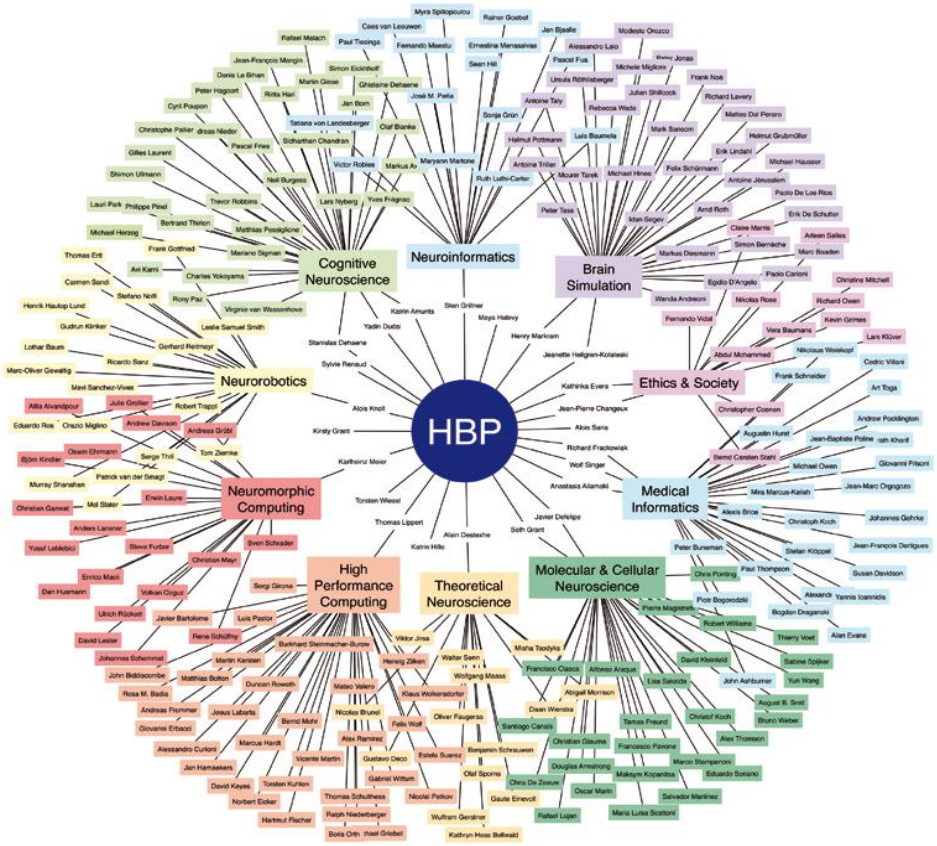
Nokia Morph concept - Credit: Nokia Research Center

FET Flagship: Human Brain Project

European Commission

HBP will create the wold's largest **experimental facility for developing the most detailed models of the brain** (from genes to mind), for studying how the human brain works and ultimately for simulating and developing personalised treatment of brain diseases.

This research lays the scientific and **technical foundation for medical progress**: identifying new drug targets and treatment, in response to the urgent need to combat brain diseases and their associated costs to society.



HBP will also produce brain-inspired **'neuromorphic' computing** systems that could drastically reduce power-consumption for super-computers and enhance robots.

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Flagships: European R&I Partnerships

- **Framework Partnership Agreements** between the EC and the Flagship partners (call in 2014) to formalise:
  - the EC long-term commitment to support the Flagships
  - the partners' commitment to implement the strategic research agenda of each of the Flagships

A **core project** will progress FET Flagship along the defined roadmap (WP2014-2015)

Complementary projects are foreseen to complement expertise and ensure openness (WP2016)

An **ERANET** ("FLAG-ERA") has been started involving 22 National and regional funding organisations and ministries from 17 countries, aiming at enhanced complementarities and synergies and identifying join calls

FET WP2014-15 Structure

DRAFT

Call FET-Open - fostering novel ideas

- Topic 1: FET-Open research projects
- Topic 2: Coordination and Support Activities

Call FET-Proactive - nurturing emerging themes and communities

- Topic 1: Knowing, doing and being; cognition beyond problem solving
- Topic 2: Global Systems Science (GSS)
- Topic 3: Quantum simulation

Call FET Proactive - towards exascale High Performance Computing

- Topic 1: HPC Core Technologies, Programming Environments and Algorithms for Extreme Parallelism and Extreme Data Applications
- Topic 2: HPC Ecosystem Development

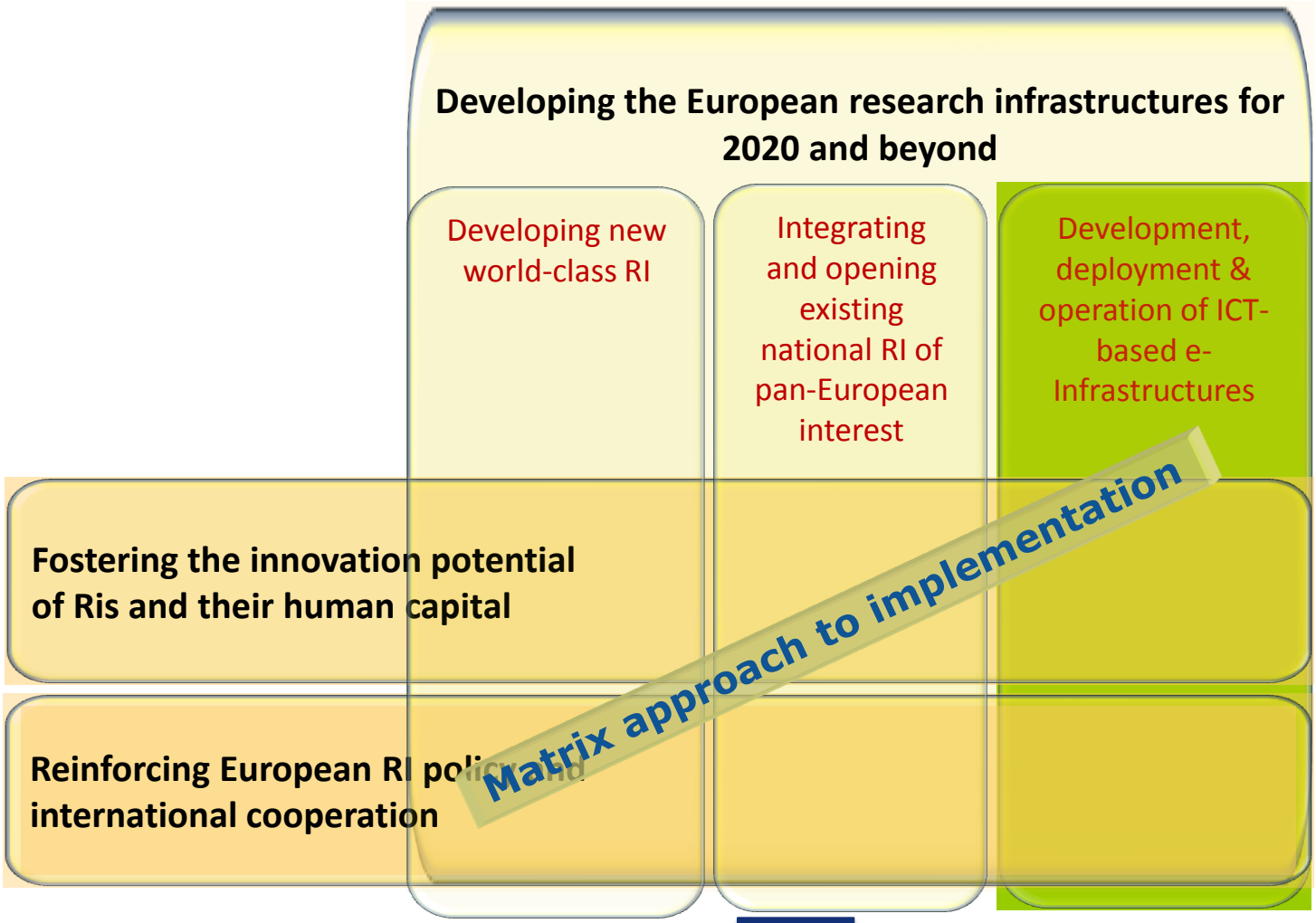
Call FET-Flagships - tackling grand interdisciplinary S&T challenges

- Topic 1: Framework Partnership Agreement
- Topic 2: Graphene FET Flagship Core Project
- Topic 3: Human Brain Project FET Flagship Core Project
- Topic 4: Policy environment for FET Flagships

Excellent Science pillar in H2020

- European Research Council
- Marie Skłodowska-Curie actions
- Future and Emerging Technologies
- **Research infrastructures**

Research Infrastructures in Horizon 2020



European Commission

e-Infrastructure Vision

Research & Innovation: Staying Competitive

- Large scale collaborations becoming the norm
  - ***Transnational, often global***
  - ***virtual research and innovation communities***
  - ***access to talent and remote resources***
- Big Data: Data-intensive science and innovation
  - ***Use and manage exponentially growing sets of data***
- Experimentation in silico, simulation
  - ***Use of high-performance computing***
- *Open is (usually) better*

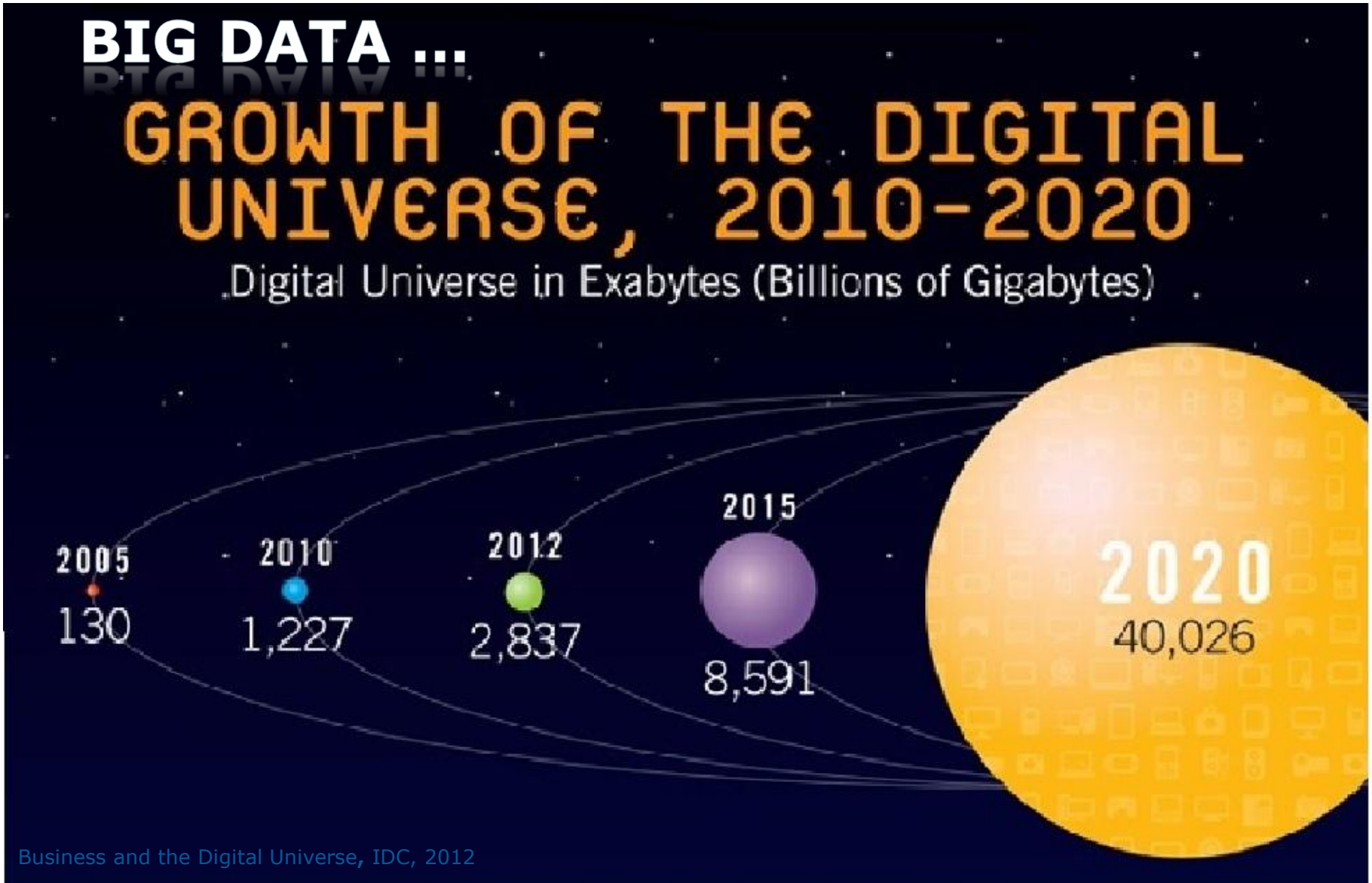
European Commission

GLOBAL CONNECTIONS ...

Map of scientific collaborations from 2005 to 2009
Computed by Olivier H. Beauchesne @ Science-Metrix, Inc.
Data from Scopus, using books, trade journals and peer-reviewed journals

European Commission

BIG DATA …



Business and the Digital Universe, IDC, 2012

e-infrastructure approach in Horizon 2020

Transversal

- Cutting across disciplines and sectors

Support tomorrow's science

- Open science, open access, best solutions

Enabling innovation everywhere

- Developing and testing innovative solutions
- Servicing industry and SMEs
- Spinning out technologies

Skills development across all actions

European Commission

Policy Background: Digital ERA, Open Access, "Riding the Wave of Data", HPC Strategy, Géant Expert Group Report, …

ERA Communication COM(2012)392

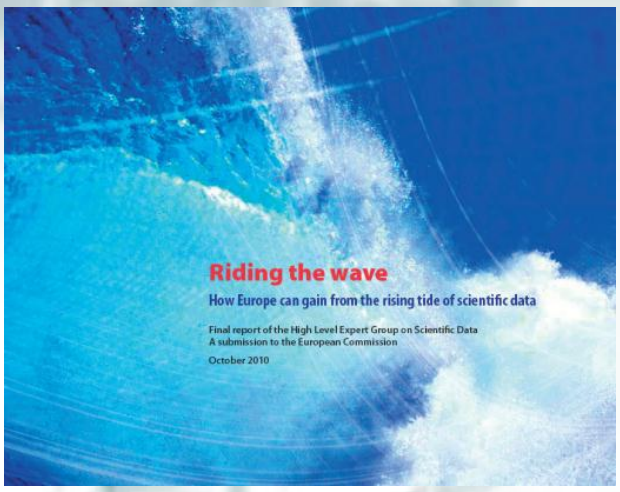
- Federation of researcher electronic identities

Commission Communication on Scientific Information COM(2012)401

- Access, preservation and e-infrastructure (publications and data)

Europe is "Riding the Wave" Report

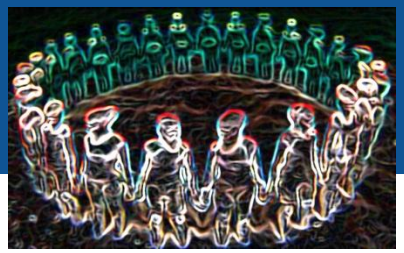
- Data e-infrastructure that supports seamless access, use, re-use and trust of data
- Physical and technical infrastructure become invisible and **data become the infrastructure**



Riding the Wave
High Level Expert Group on Scientific Data, October 2010

http://cordis.europa.eu/fp7/ict/e-infrastructure/docs/hlg-sdi-report.pdf

Commission Communication "High-Performance Computing: Europe's place in a Global Race" (2012)



European Commission

RESEARCH INFRASTRUCTURE
Work Programme 2014-2015

CALL 1
DEVELOPING NEW WORLD CLASS INFRASTRUCTURES

- DESIGN STUDIES
- SUPPORT TO PREPARATORY PHASE OF ESFRI PROJECTS
- SUPPORT TO THE INDIVIDUAL IMPLEMENTATION AND OPERATION OF ESFRI PROJECTS
- SUPPORT TO THE IMPLEMENTATION OF CROSS-CUTTING INFRASTRUCTURE SERVICES AND SOLUTIONS FOR CLUSTER OF ESFRI AND OTHER RILEVANT RESEARCH INFRASTRUCTURE INITIATIVES IN A GIVEN THEMATIC AREA

CALL 2
INTEGRATING AND OPENING RESEARCH INFRASTRUCTURES OF PAN-EUROPEAN INTEREST

- INTEGRATING AND OPENING EXISTING NATIONAL AND REGIONAL RESEARCH INFRASTRUCTURES OF PAN-EUTROPEAN INTEREST

CALL 3
E-INFRASTRUCTURES

- MANAGING, PRESERVING AND COMPUTING WITH BIG RESEARCH DATA
- E-INFRASTRUCTURES FOR OPEN ACCESS
- TOWARDS GLOBAL DATA E-INFRASTRUCTURES: RESEARCH DATA ALLIANCE
- PAN-EUROPEAN HIGH PERFORMANCE COMPUTING INFRASTRUCTURE AND SERVICES
- CENTRES OF EXCELLENCE FOR COMPUTING APPLICATIONS
- NETWORK OF HPC COMPETENCE CENTRES FOR SMES
- PROVISION OF CORE SERVICES ACROSS E-INFRASTRUCTURES
- RESEARCH AND EDUCATION NETWORKING – GEANT
- E-INFRASTRUCTURES FOR VIRTUAL RESEARCH ENVIRONMENTS (VRE)

CALL 4
SUPPORT TO INNOVATION, HUMAN RESOURCES, POLICY AND INTERNATIONAL COOPERATION FOR RESEARCH INFRASTRUCTURES

- INNOVATION SUPPORT MEASURES
- INNOVATIVE PROCUREMENT PILOT ACTION IN THE FIELD OF SCIENTIFIC INSTRUMENTATION
- STRENGTHENING THE HUMAN CAPITAL OF RESEARCH INFRASTRUCTURES
- NEW PROFESSIONS AND SKILLS FOR E-INFRASTRUCTURES
- POLICY MEASURES FOR RESEARCH INFRASTRUCTURES
- INTERNATIONAL COOPERATION FOR RESEARCH INFRASTRUCTURES
- E-INFRASTRUCTURE POLICY DEVELOPMENT AND INTERNATIONAL COOPERATION
- NETWORK OF NATIONAL CONTACT POINTS

European Commission

INTEGRATED e-INFRASTRUCTURE SERVICES

VRE

E-INFRASTRUCTURES FOR VIRTUAL RESEARCH ENVIRONMENTS (VRE)

PROVISION OF CORE SERVICES ACROSS E-INFRASTRUCTURES

DATA

COMPUTING

NETWORK OF HPC COMPETENCE CENTRES FOR SMES

MANAGING, PRESERVING AND COMPUTING WITH BIG RESERACH DATA

RESEARCH AND EDUCATION NETWORKING – GEANT

CENTRES OF EXCELLENCE FOR COMPUTING APPLICATIONS

E-INFRASTRUCTURES FOR OPEN ACCESS

CONNECTIVITY

PAN-EUROPEAN HIGH PERFORMANCE COMPUTING INFRASTRUCTURE AND SERVICES

TOWARDS GLOBAL DATA E-INFRASTRUCTURES RESEARCH DATA ALLIANCE

SUPPORT

E-INFRASTRUCTURE POLICY DEVELOPMENT AND INTERNATIONAL COOPERATION

NEW PROFESSIONS AND SKILLS FOR E-INFRASTRUCTURES

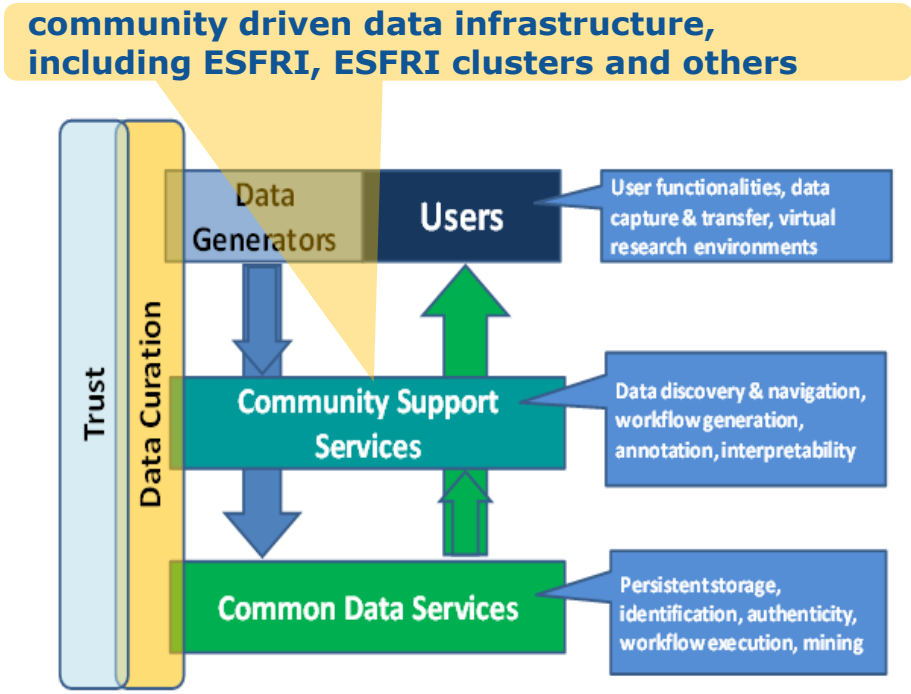
Implementing interoperable data infrastructures

(a) data generators; research projects, big research infrastructure, installations or medium size laboratories, simulation centres, surveys or individual researchers

(b) discipline-specific data service providers, providing data and workflows as a service

(c) providers of generic common data services (computing centres, libraries)

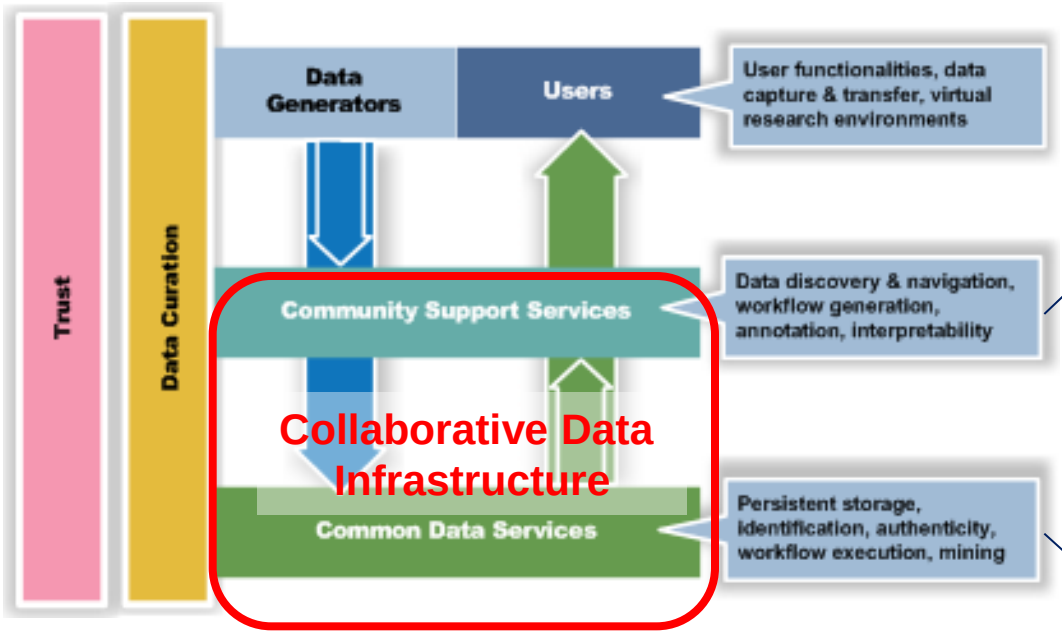
(d) researchers as users, using the data for science and engineering

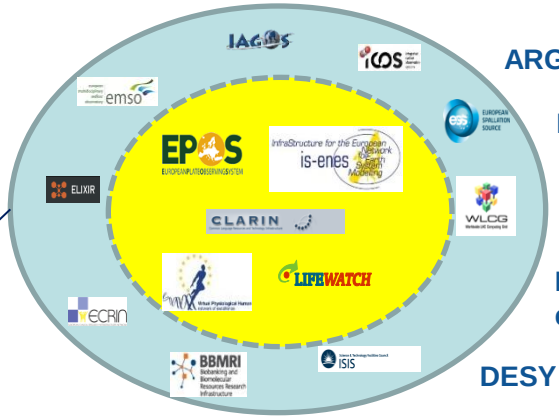


European Commission

Data driven research across disciplinary and geographical boundaries
Register relevant data objects stored in certified repositories
Virtually integrate data objects in trusted federations
Foster advancements in interoperability of object content
Fragmentation and heterogeneity of data require standardization vs. innovation dynamics

EUDAT



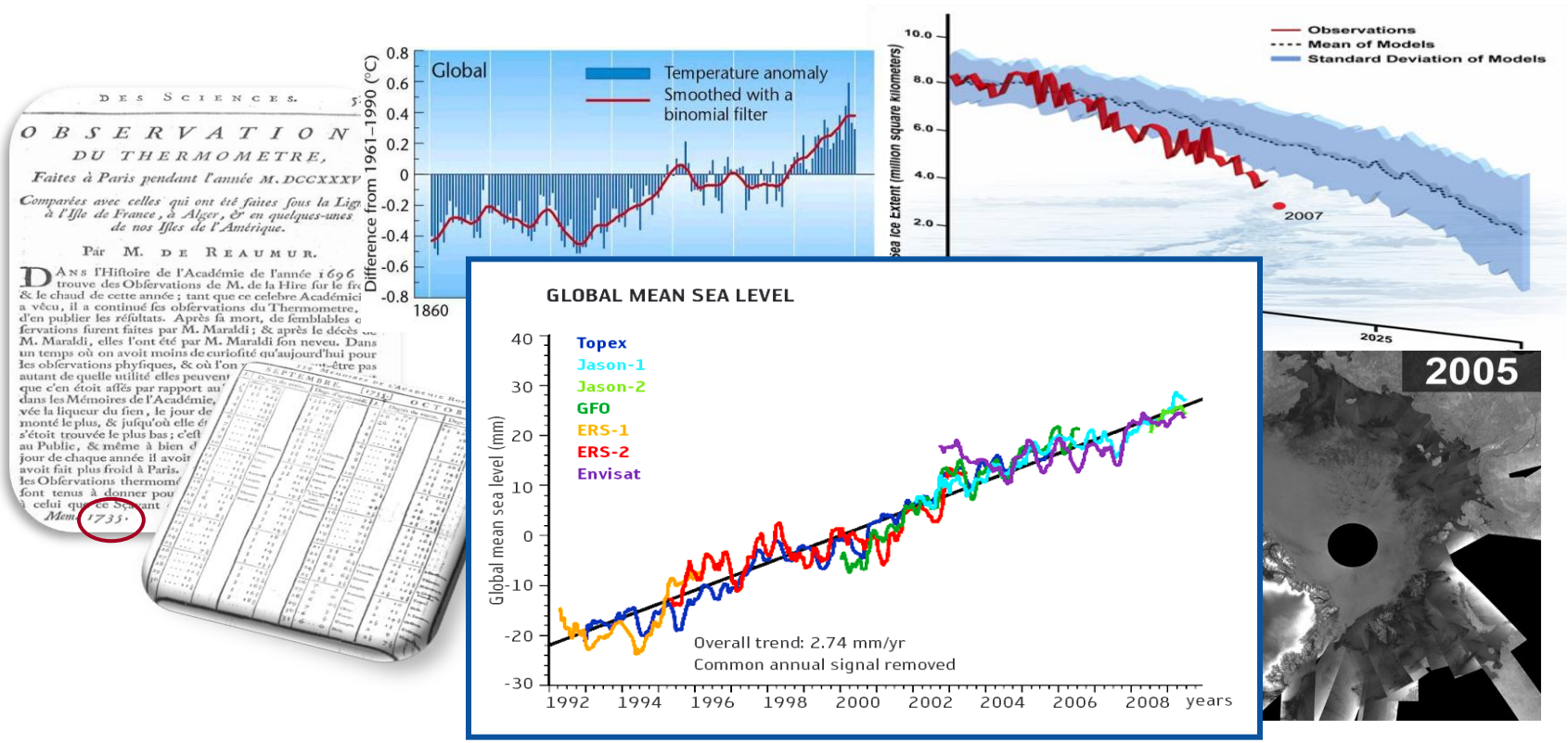


EUDAT Scenario

European Data Centers

community-driven data e-infrastructures

SCIDIP-ES (Earth Observation Long Term Data Preservation)



Adapted from a slide of Dr. Mirco Albani (ESA), project leader of SCIDIP-ES

European Commission

community-driven data e-infrastructures

i-marine

* Vessel Activity Analysis
* Biological Niche Modeling
* Fishery Country Profile Product
* Global Catch Statistics Quality Improvement
* ...

Simplified access and explotation of tools for data analysis and processing

harmonization, aggregation, access to heterogeneous, multi-disciplinary and multi-format data

GEOSeas

EMODNET

GENESI-DR

GBIF

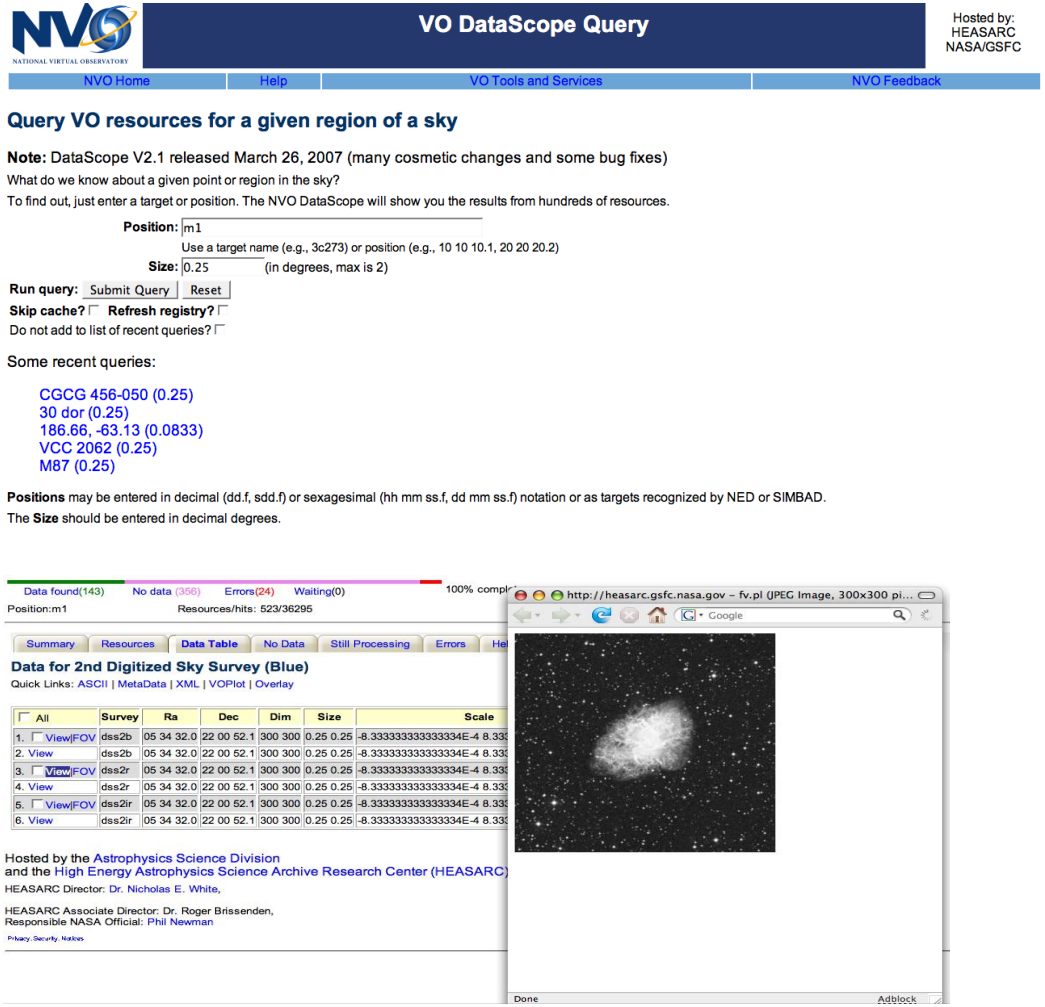
European Commission

community-driven data e-infrastructures

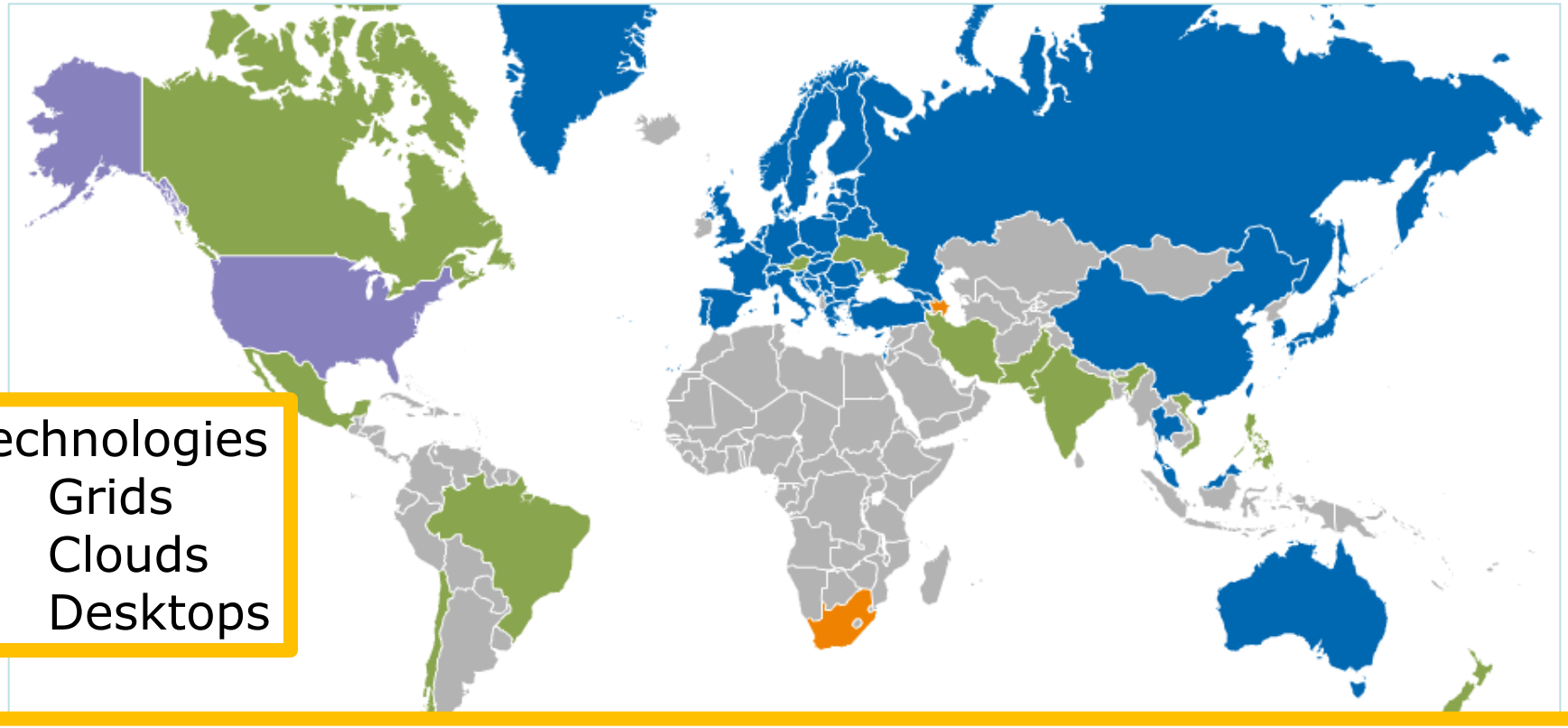
EURO VO

IVOA

The **Virtual Observatory** is a community-led response to the challenges the astronomical community faces in data management and storage.



The European Grid Infrastructure today

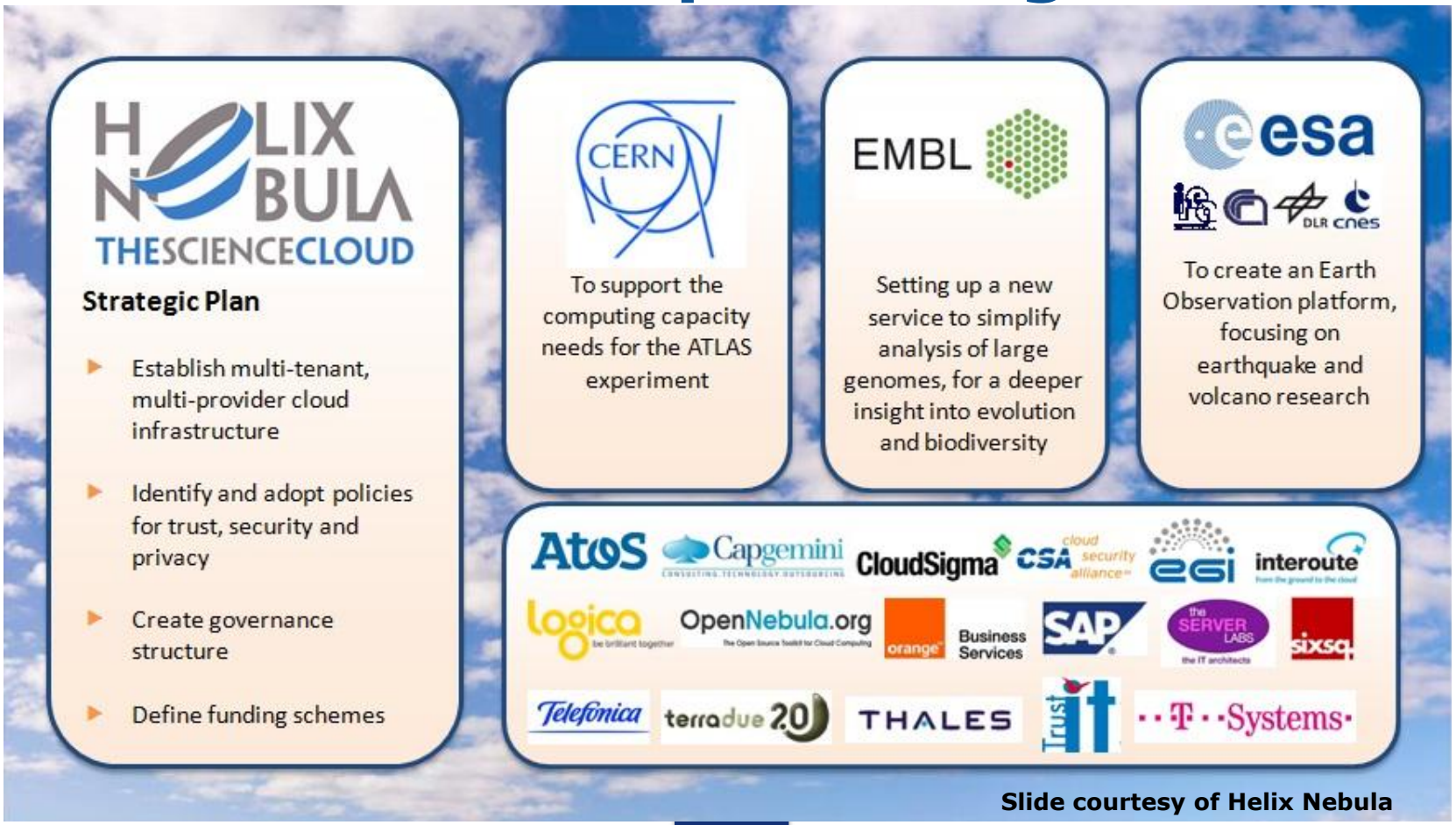


Technologies
- Grids
- Clouds
- Desktops

From 14 regional to 34 operations centres in 53 countries
From 188,000 jobs/day with 80,000 cores on 250 Resource Centres
to 1,200,000 jobs/day with 430,000 cores on 337 Resource Centres

Courtesy of EGI.eu

A European Cloud Partnership: big science teams up with big business



European Commission

INTEGRATED e-INFRASTRUCTURE SERVICES

VRE

E-INFRASTRUCTURES FOR VIRTUAL RESEARCH ENVIRONMENTS (VRE)

PROVISION OF CORE SERVICES ACROSS E-INFRASTRUCTURES

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COMPUTING

NETWORK OF HPC COMPETENCE CENTRES FOR SMES

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E-INFRASTRUCTURES FOR OPEN ACCESS

CONNECTIVITY

PAN-EUROPEAN HIGH PERFORMANCE COMPUTING INFRASTRUCTURE AND SERVICES

TOWARDS GLOBAL DATA E-INFRASTRUCTURES RESEARCH DATA ALLIANCE

SUPPORT

E-INFRASTRUCTURE POLICY DEVELOPMENT AND INTERNATIONAL COOPERATION

NEW PROFESSIONS AND SKILLS FOR E-INFRASTRUCTURES

Scientific
Information
Infrastructure

Open. Share. Re-use.

Science. Set Free.

Research results. Linked.

OpenAIRE

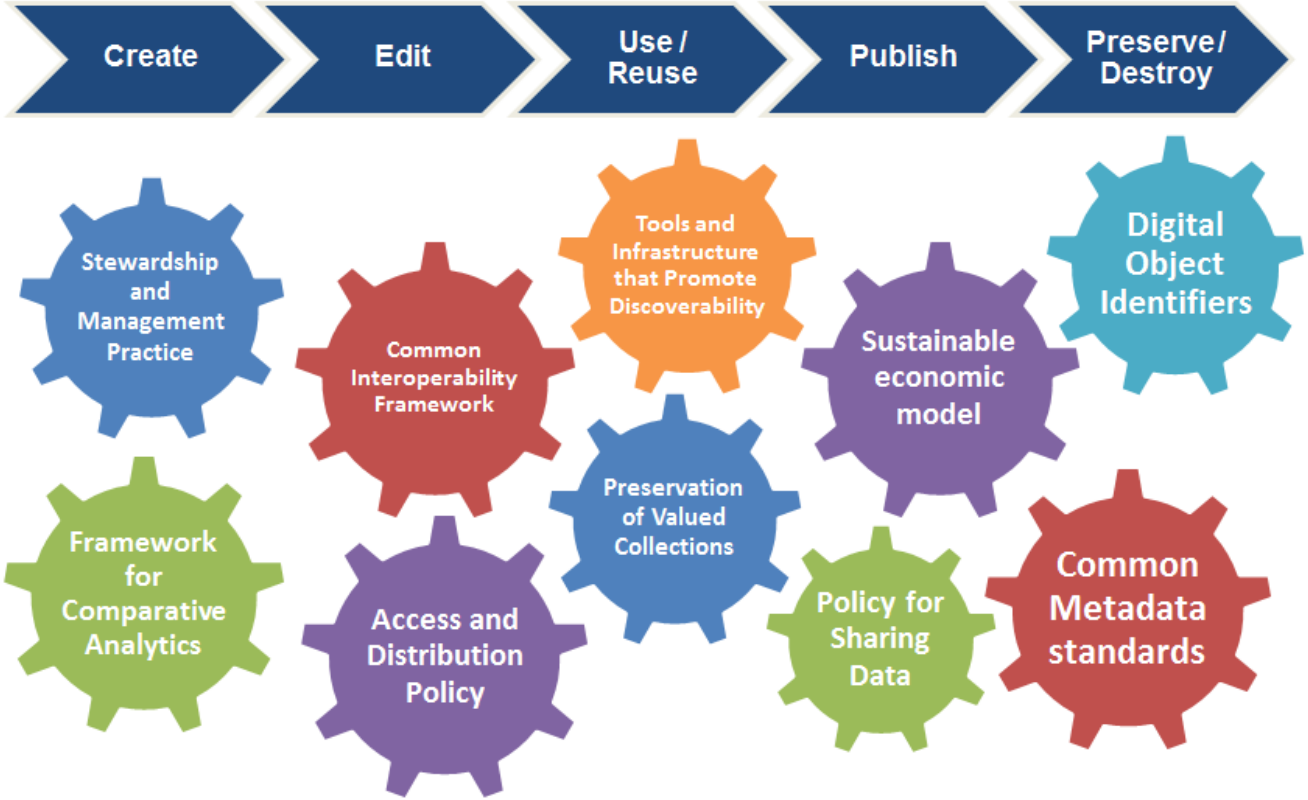
Open Access Infrastructure for Research in Europe

launched 18 March

European Commission

Research Data Alliance:

Common Infrastructure, Policy and Practice
Drives Data Sharing and Exchange throughout the Data Life Cycle



From Prof. Fran Berman and Prof. John Wood, Members of the RDA Council

European Commission

INTEGRATED e-INFRASTRUCTURE SERVICES

VRE

E-INFRASTRUCTURES FOR VIRTUAL RESEARCH ENVIRONMENTS (VRE)

PROVISION OF CORE SERVICES ACROSS E-INFRASTRUCTURES

DATA

COMPUTING

NETWORK OF HPC COMPETENCE CENTRES FOR SMES

MANAGING, PRESERVING AND COMPUTING WITH BIG RESERACH DATA

RESEARCH AND EDUCATION NETWORKING – GEANT

CENTRES OF EXCELLENCE FOR COMPUTING APPLICATIONS

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PRACE

European Commission

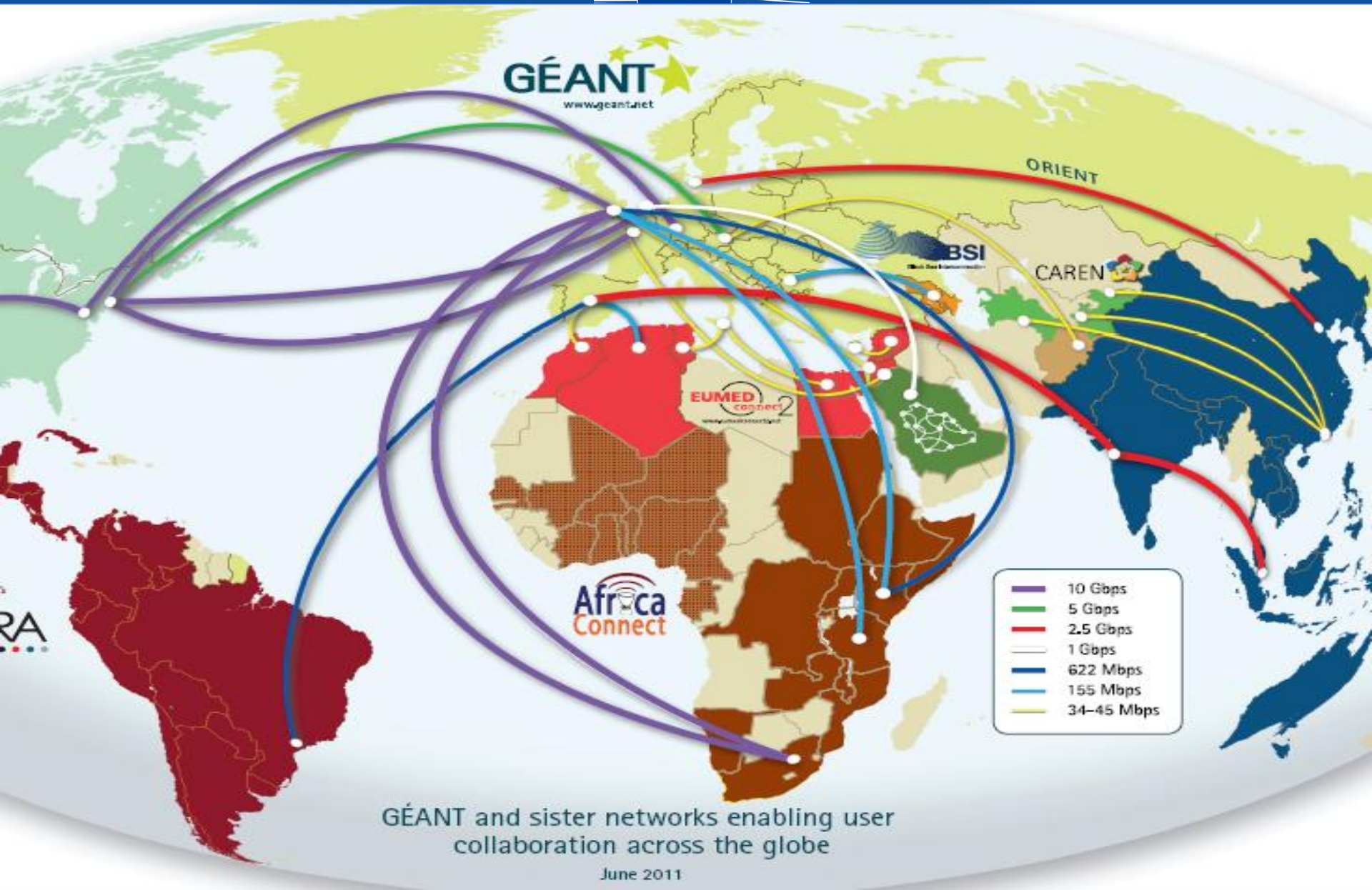
a European e-Infrastructure in the ESFRI list

- deliver world class high performing computing and data management resources and services (Tier-0 systems)
  - ***to all European researchers***
  - ***to all Countries even with no HPC capabilities***

- In operation since April 2010
  - PRACE (AISBL) legal entity – 25 new members

- *Machines are funded nationally (400 Million € from France, Germany, Italy and Spain provided as Tier-0 services on Total Cost of Ownership basis)*

  Funding for 2010-2015: 530 M€ (from MS + EC)


GÉANT
www.geant.net
ORIENT
BSI
CAREN
EUMED connect2
Africa Connect
10 Gbps
5 Gbps
2.5 Gbps
1 Gbps
622 Mbps
155 Mbps
34–45 Mbps
GÉANT and sister networks enabling user collaboration across the globe
June 2011

European Commission

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e-Infrastructures

European Commission

Vitual Research Environments

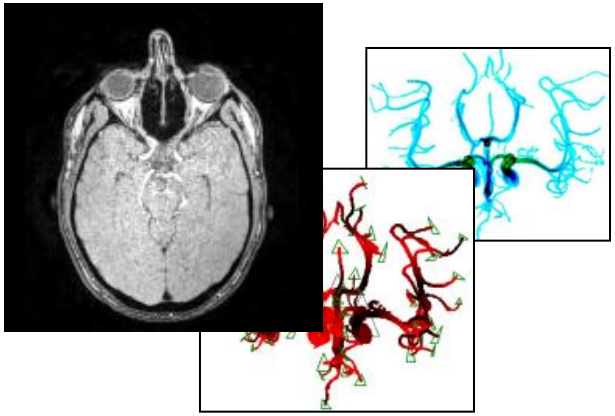
chemical safety and toxicogenomics:

non-animal tests for predicting
chemical safety

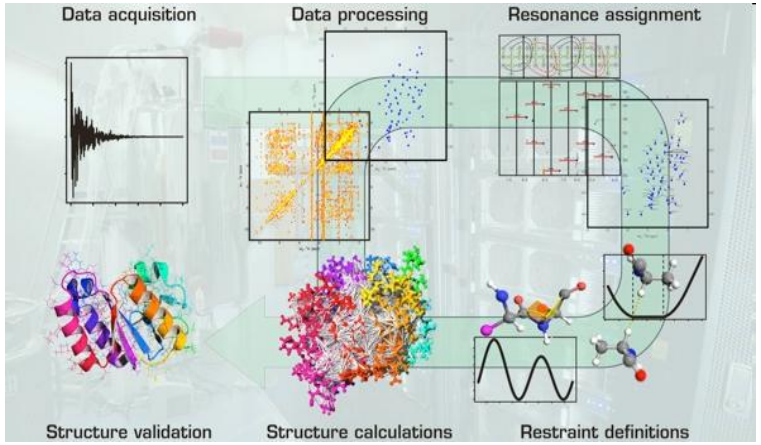
diXa

global virtual brain scan imaging laboratory

outGRID harmonises
EU neuGRID, Canada CBRAIN and US LONI-ADNI

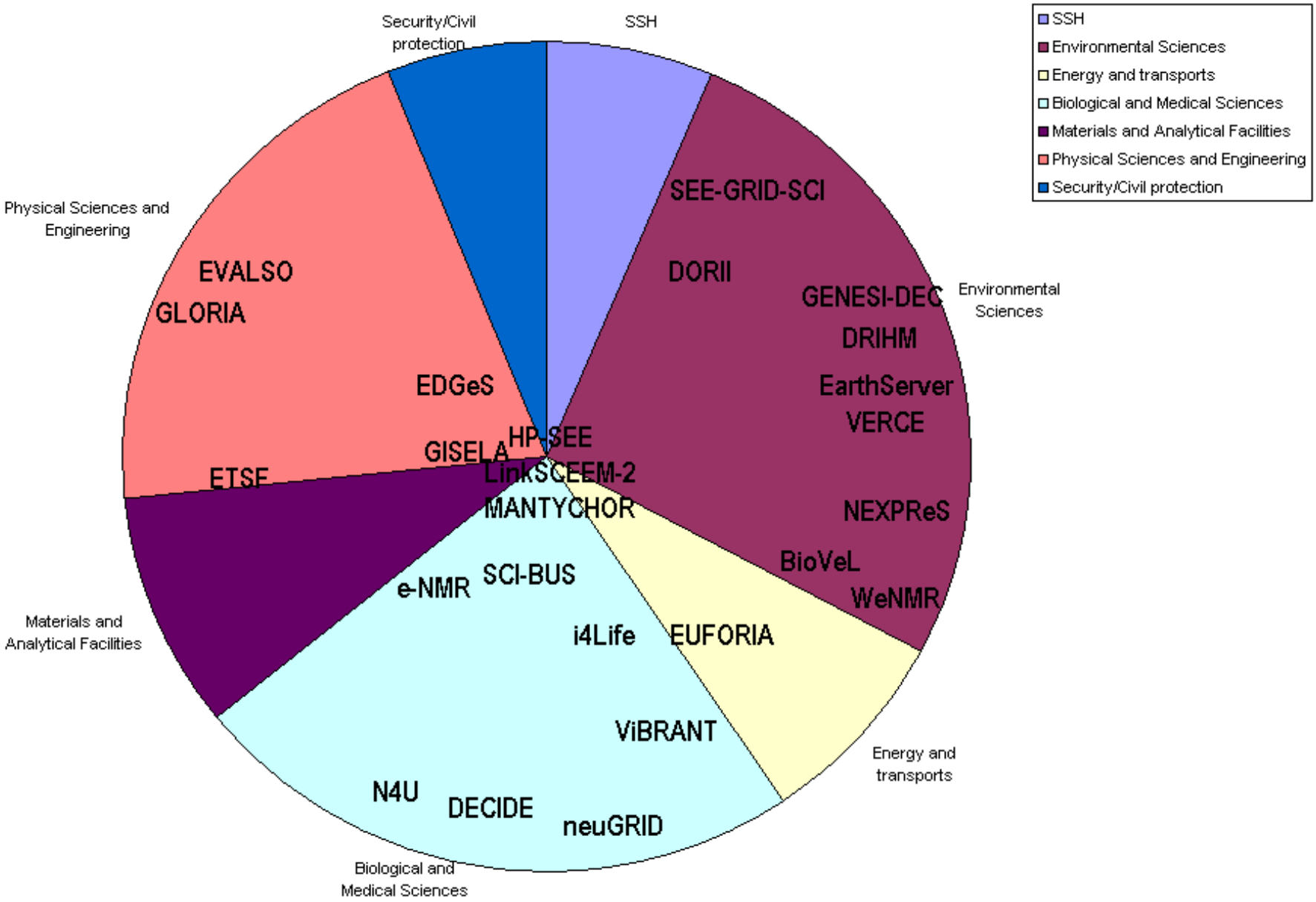


WeNMR - A worldwide e-Infrastructure for NMR and structural biology



hydrometeorology e-Infrastructure
for natural disasters prediction

DRIHM(S), eiAfrica


SSH
Environmental Sciences
Energy and transports
Biological and Medical Sciences
Materials and Analytical Facilities
Physical Sciences and Engineering
Security/Civil protection
SSH
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Physical Sciences and Engineering
Environmental Sciences
Energy and transports
Materials and Analytical Facilities
Biological and Medical Sciences
SEE-GRID-SCI
DORII
GENESI-DEC
DRIHM
EarthServer
VERCE
NEXPReS
BioVeL
WeNMR
EUFORIA
ViBRANT
neuGRID
DECIDE
N4U
i4Life
SCI-BUS
e-NMR
ETSF
MANTYCHOR
LinkSCEEM-2
HP-SEE
GISELA
EDGeS
GLORIA
EVALSO

European Commission

DRAFT

Putting emphasis on:

- *Services*
- *Thinking innovation*
  - With both suppliers or users
- *Mainstreaming skills development*
- *Integration between data and computing*
- *Business plans for financial sustainability*
  - …and partnerships with the private sector
- *Supporting policies; Open data and software*
- *Sharing basic operations services and building blocks*
- *Monitoring performance (KPIs)*

European Commission

SUMMARY …

European Commission

Thanks for your attention!