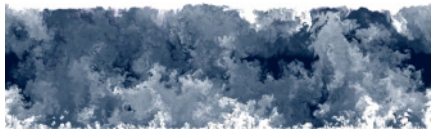
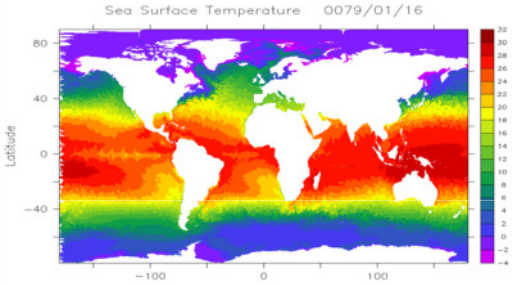
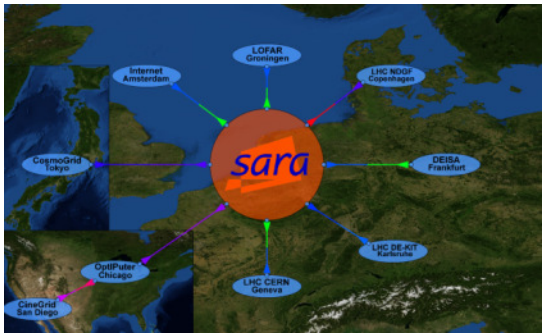
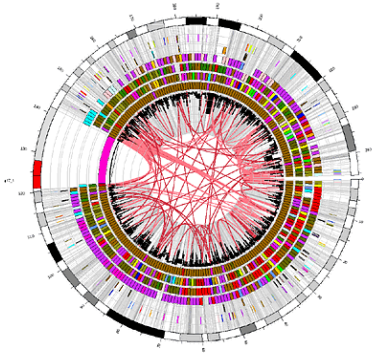
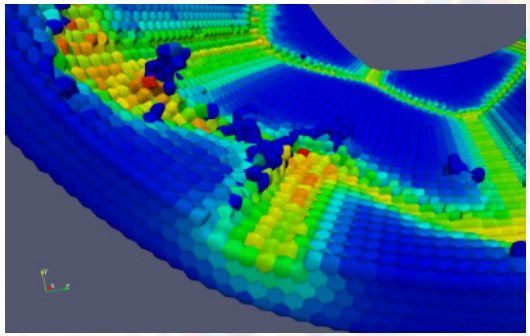
e-Research Infrastructures for e-Science











Axel Berg

SARA national HPC & e-science support center

RAMIRI, June 15, 2011

Science Park Amsterdam

a world of science in a city of inspiration

- Faculty of Science of the "University of Amsterdam"
- National Institute for Nuclear Physics and High Energy Physics (NIKHEF)
- Institute for Atomic and Molecular Physics (AMOLF)
- National Research Institute for Mathematics and Computer Science (CWI)
- SARA national HPC & e-science support center
- + 80 innovative companies

SARA's Mission:
Support Science & Innovation

SARA Foundation is an independent (hybrid) organization with ~140 fte's in 2 locations (Amsterdam and Almere)

The mission of SARA is 2-fold:

1. **Supporting research in the Netherlands by providing high-end not-for-profit ICT services to research communities [SARA for Science & Innovation]**

2. Offering commercial high-end commodity ICT services based on the expertise built in the high-end activities [Vancis for advANCed Ict Services]

a sara company

Science Park, Amsterdam

SARA National Supercomputing Center

> SARA supports research in the Netherlands by providing high-end computing-, networking-, storage-, visualization- and e-Science support services and expertise

> These services are guaranteed by:

- deployment of integrated HPC services and infrastructure
- provision of multidisciplinary expertise and support in ICT-technology and applications
- conducting necessary innovation, engineering and development to support and sustain those services
- participation in National and International e-Science and Grid project's
- connection to and integration into international e-Infrastructures, collaboration

e-Infrastructures SARA

Huygens National Super

IBM Power 6, 3328 cores,
15.25 TB of memory,
700 TB of disk space,
60 TFlop/s

LISA National Compute Cluster

Dell cluster
4480 cores,
12 TB of memory,
20 TFlop/s

Grid Resources

2376 Cores, 3408 TB of disk,
2000 TB tape
12 BioInfo Sites Life Science Grid
High Energy Physics, Astronomy, Bio Info

Visualization

High Resolution
Tiled Panel Display
Remote Visualization

Innovative Infrastructures

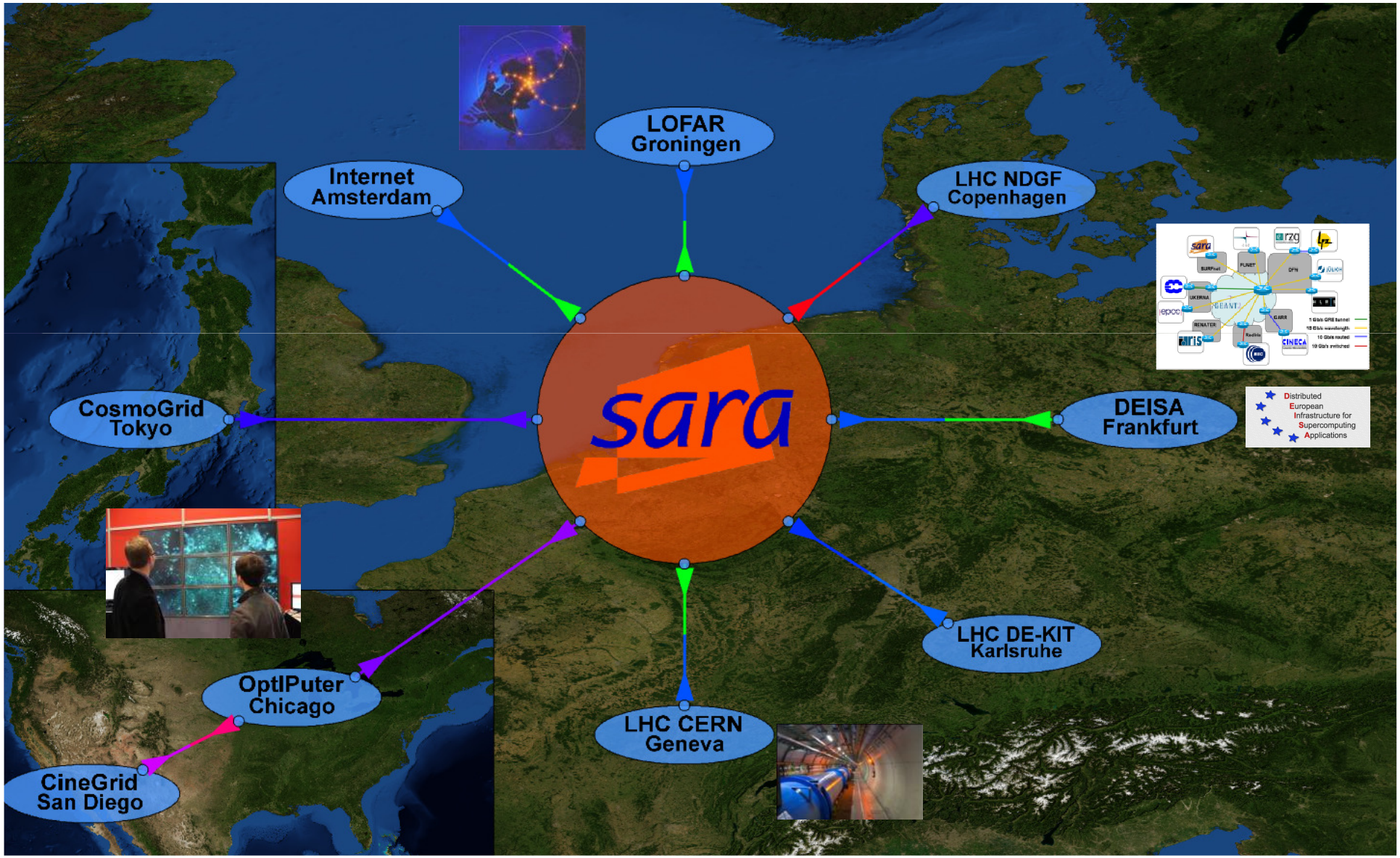
Cloud
GPU
Hadoop
iRODs

Network

SURFnet 6
AMSIX
Netherlight

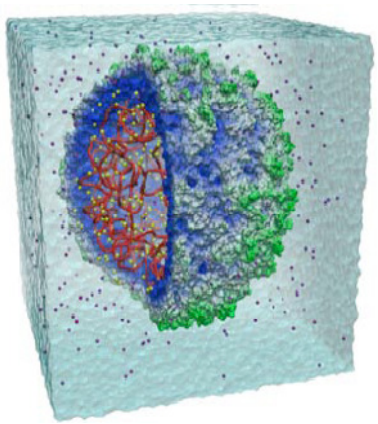
Connectivity is key

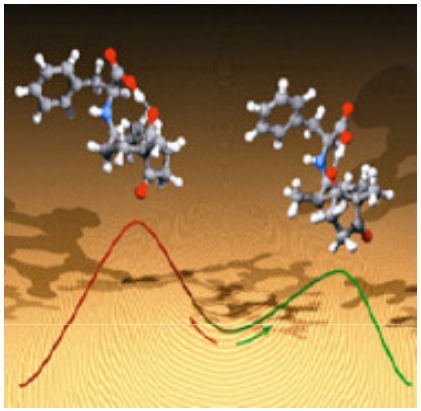
The European Optical Exchange Point @SARA



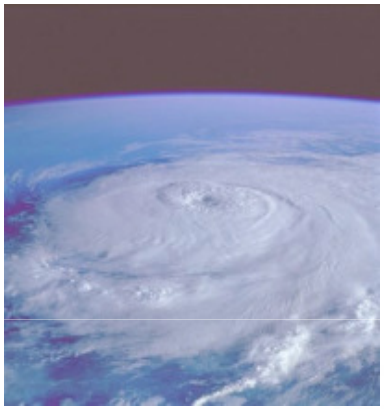
Advances in Science

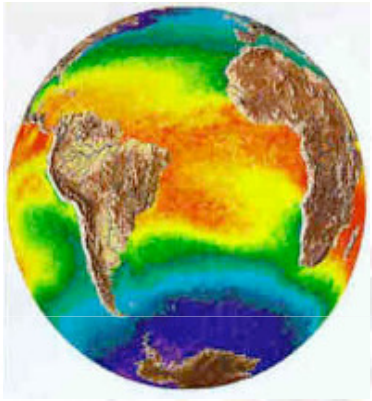
Molecular Sciences



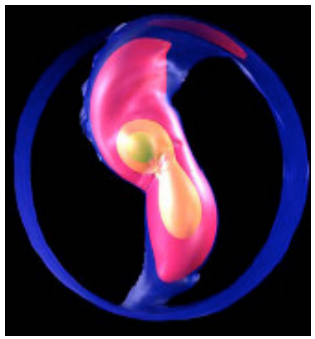


Weather & climate prediction

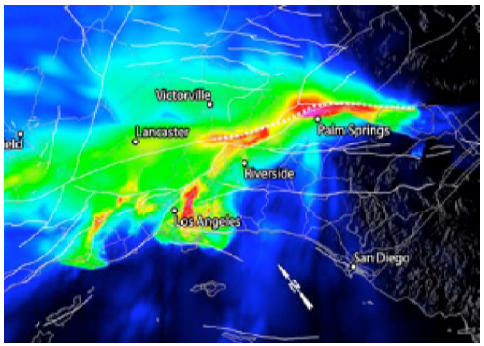




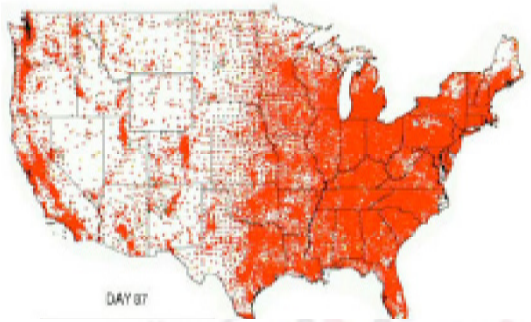
Astronomy



Earth Sciences

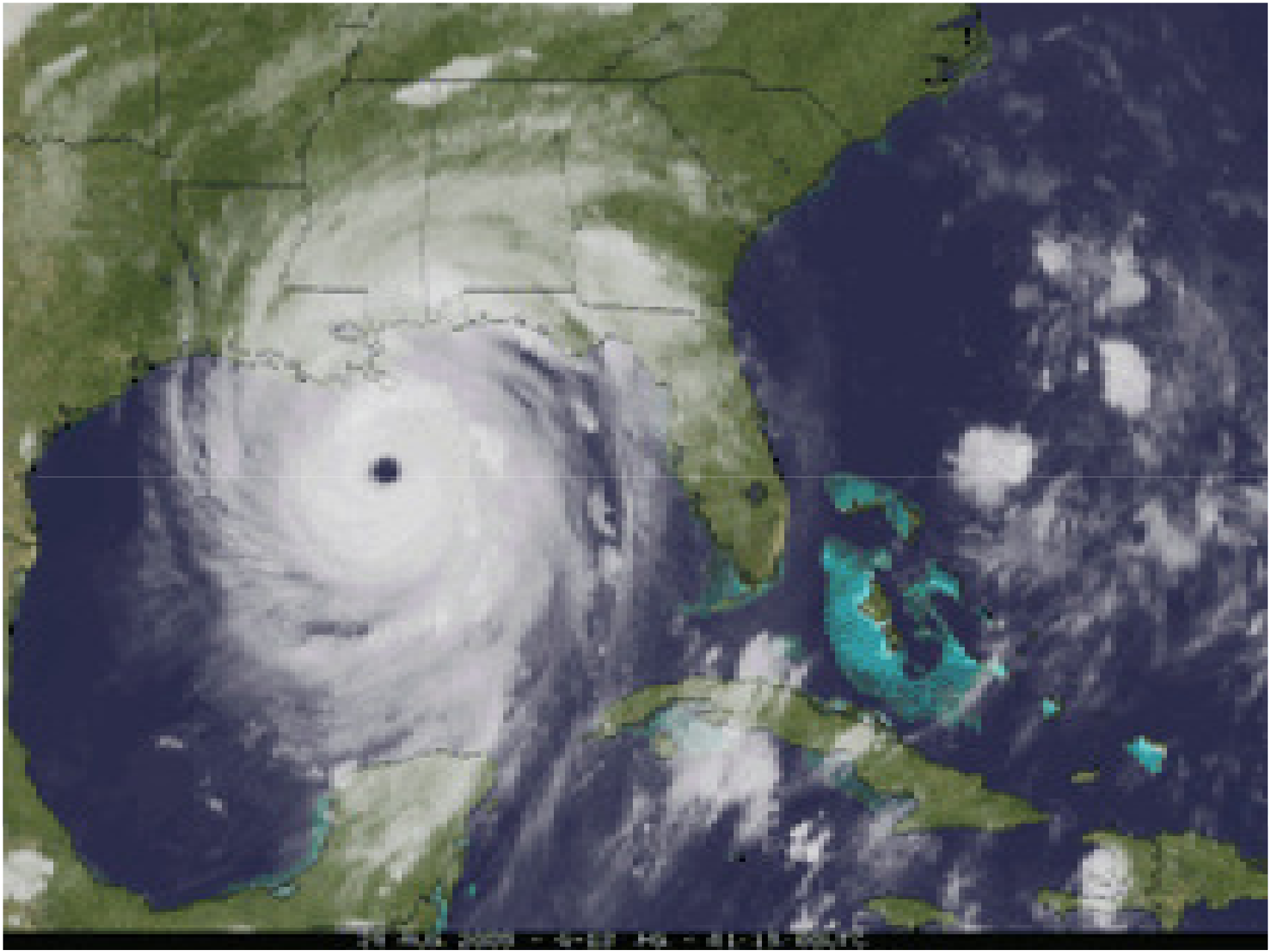


Health care



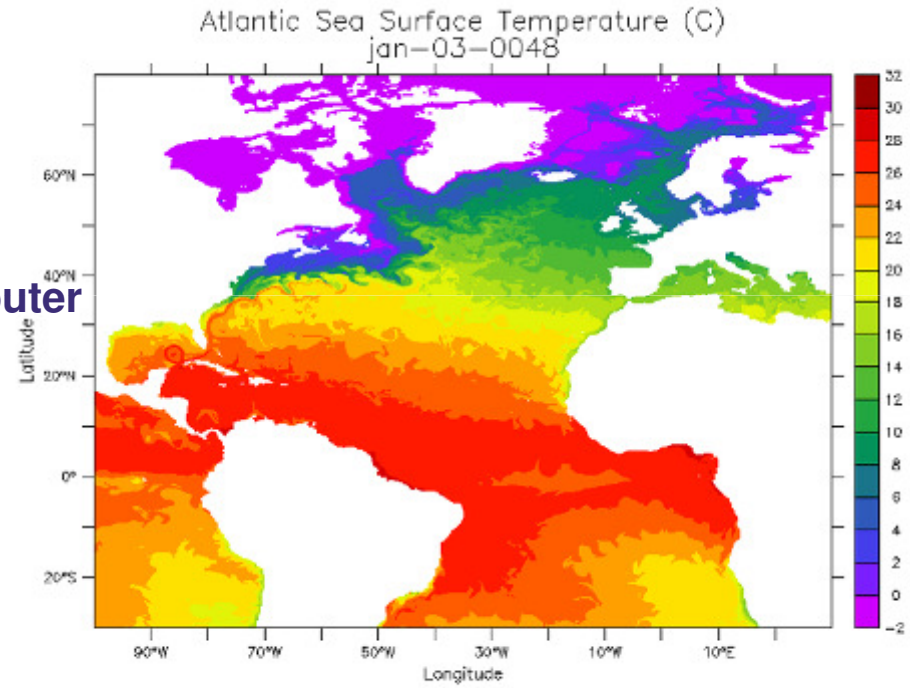
slide from Thom Dunning, NCSA

Advances in Society

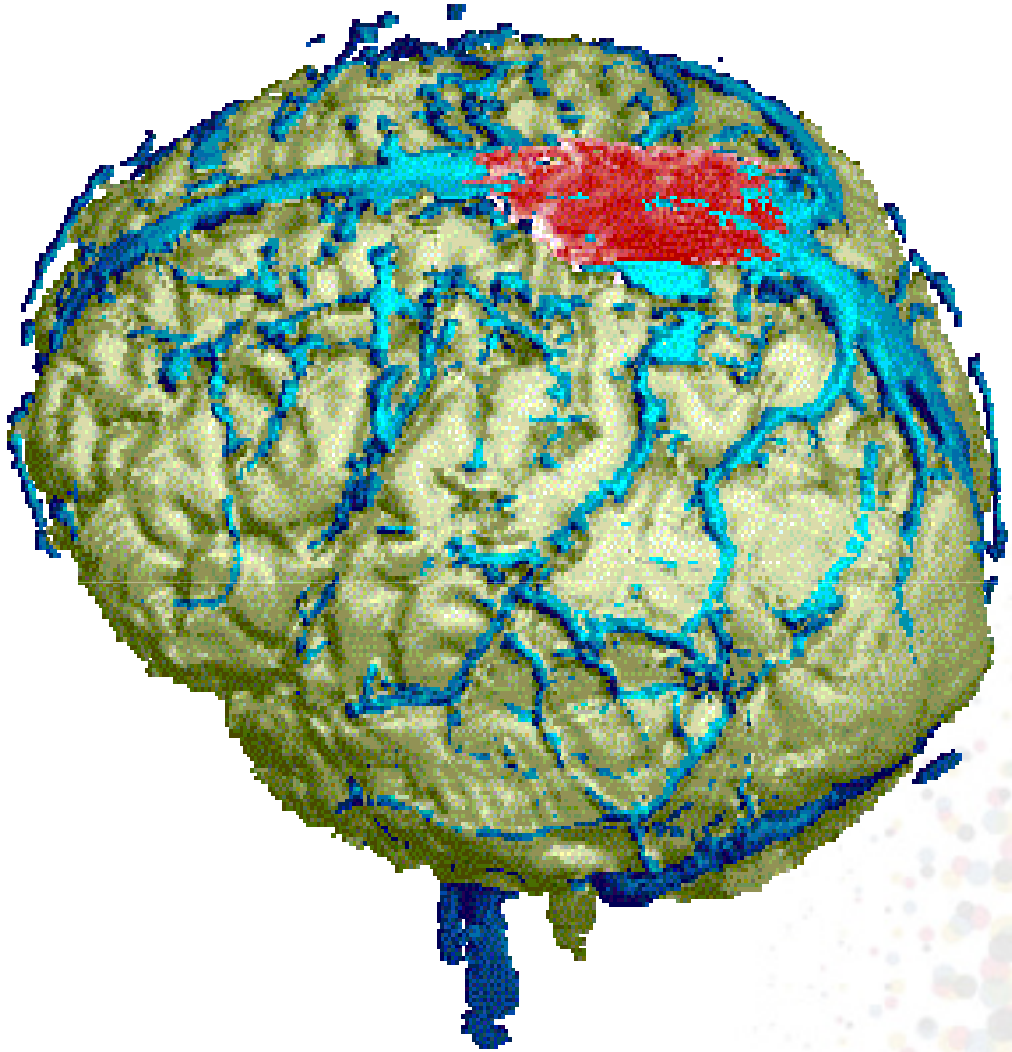


Stability of the Atlantic Meridional Overturning Circulation (SAMOC)

- **Dutch Computing Challenge Project 2008 – 2009**
- **Huygens P6: 750,000 core hours**
- **Ocean model resolution: 10 km (0.1 degree)**
- **1 year model simulation ~ 1 day on about 1200 cores on natl. supercomputer**
- **Utrecht University, Netherlands**
  - Prof. dr. ir. H.A. Dijkstra
- **Climate System Modeling Group, Los Alamos Natl. Lab., USA**
  - M. Maltrud, M. Hecht, P. Jones, W. Weijer
- **Simulation data produced: > 100 TB**



BOEING

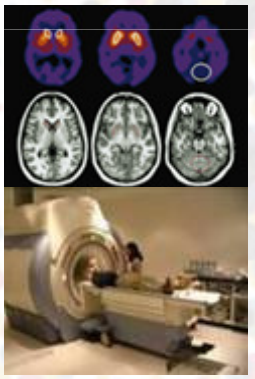


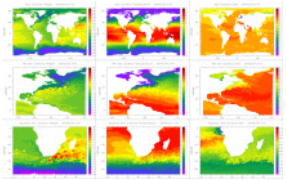
Science towards Exascale

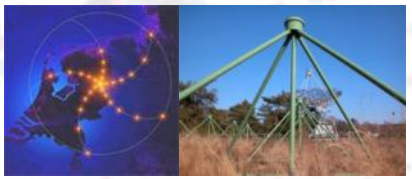
- Scientific experiments and data-intensive computing generate today *exabytes* of data
- Driven by e.g. detector and HW developments
  - Increased resolution, automation & robotization

Medical imaging (fMRI):	~ **1 GByte** per measurement
Satellite world imagery:	~ **5 TByte**/year
Climate modelling:	**100 TB** per simulation
Astronomy LOFAR:	**>2,5 PByte** per year
LHC physics:	**10-30 PByte** per year

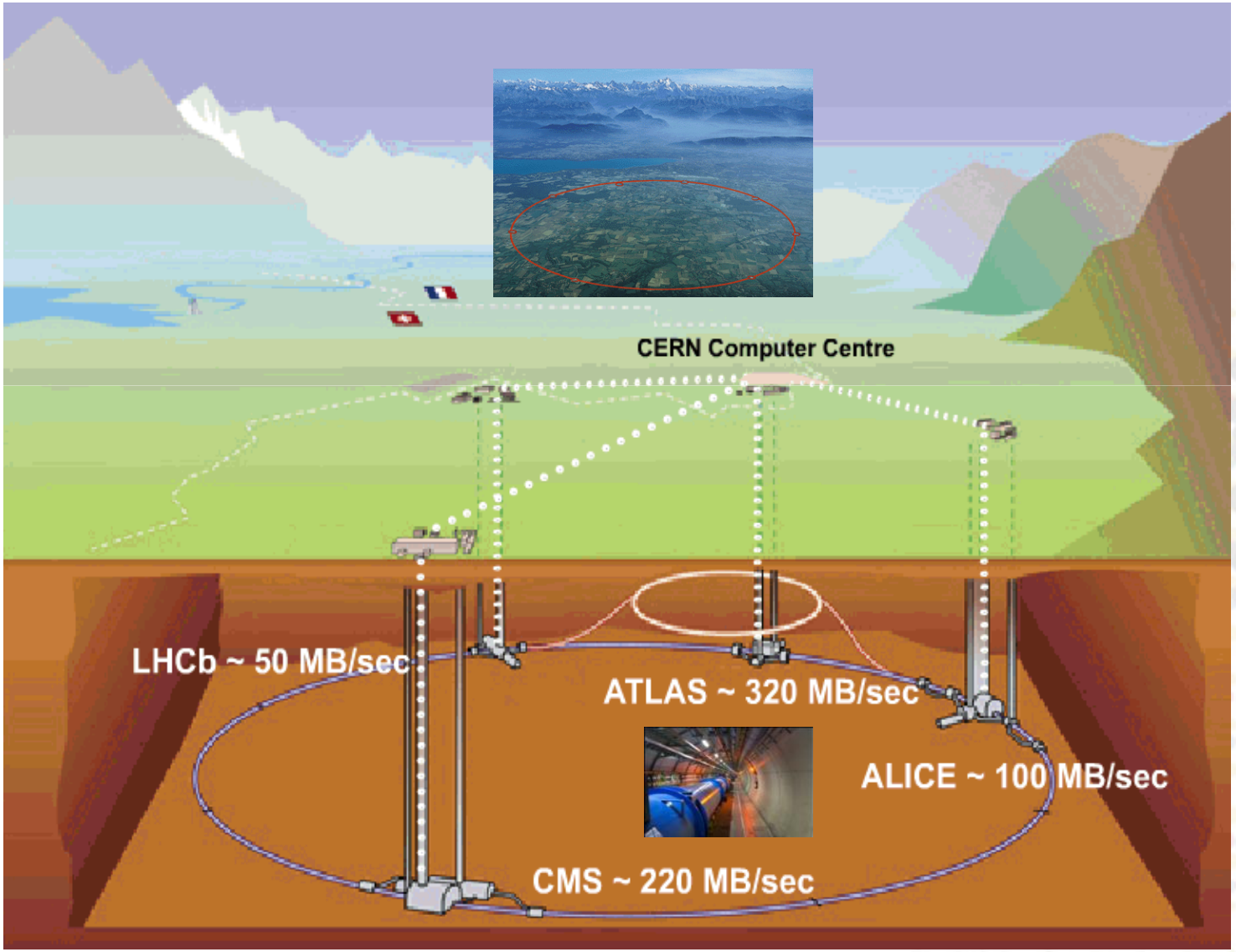
- Entering new area of science at Petascale/Exascale level: more than just evolutionary approach will be needed





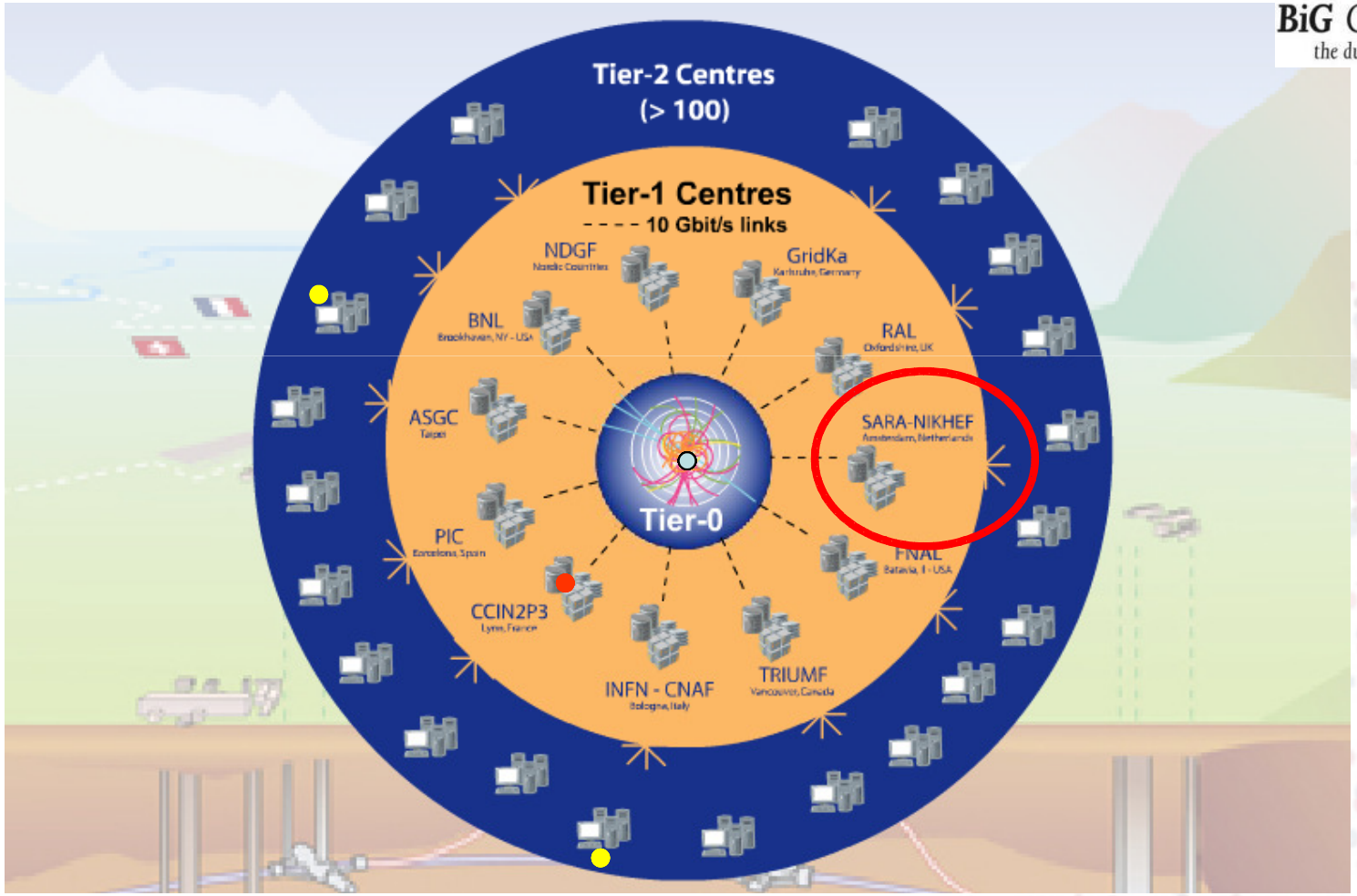


High Throughput Data Analysis for the Large Hadron Collider (CERN)

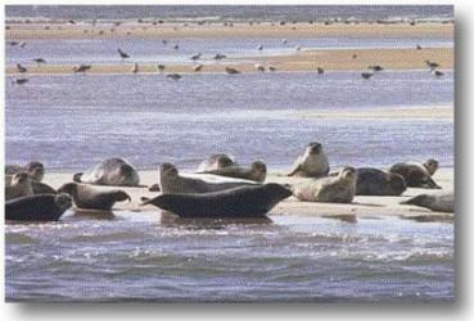


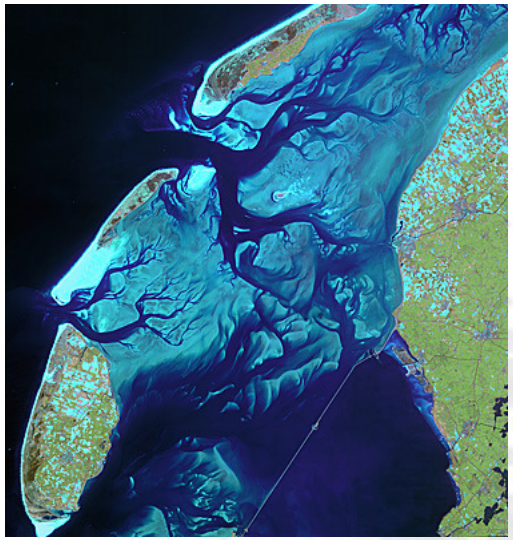
SARA & NIKHEF receive, store and analyze 10% of all LHC data

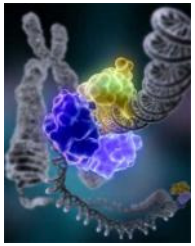
BiG Grid
the dutch e-science grid

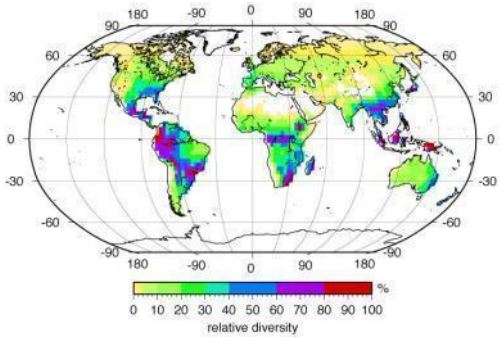


LIFEWATCH: e-science & technology infrastructure for biodiversity data and observatories





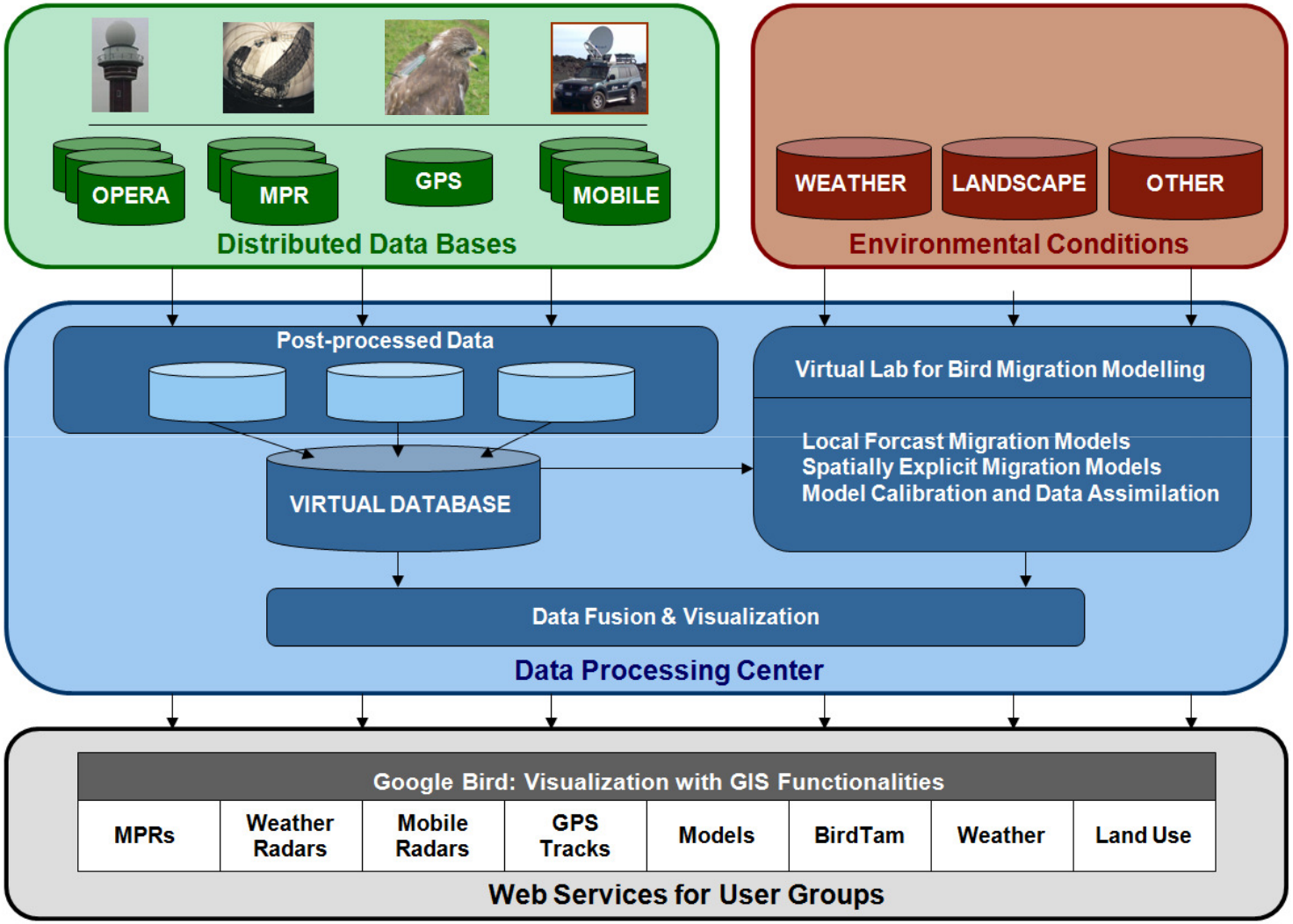




Problem Solving Environments: FlySafe: development of bird avoidance models

Slides courtesy of prof. W. Bouten, UvA

Bird Migration and Avoidance System



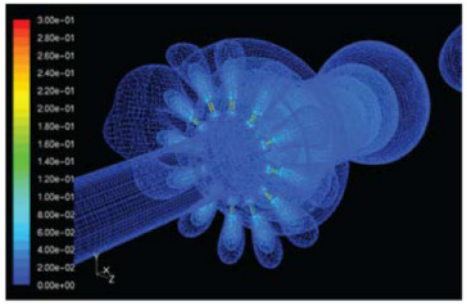
Slides courtesy of prof. W. Bouten, UvA

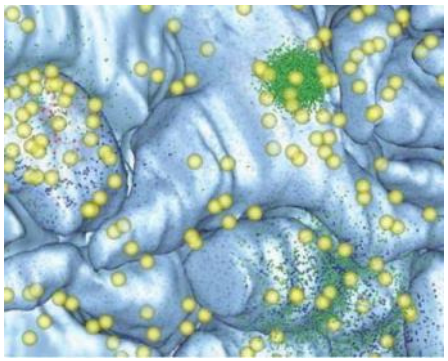
HPC is recognized as an important infrastructure (USA, Europe, Japan, India, China)

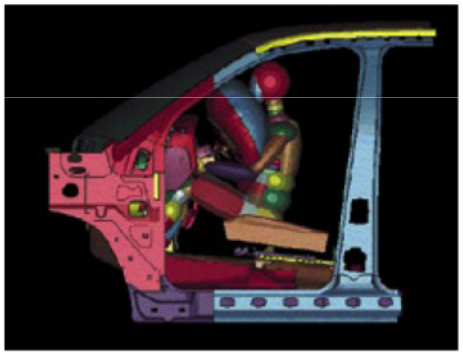
HPC supports innovation

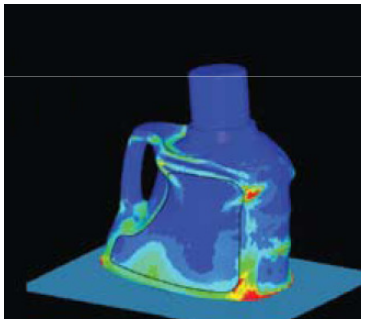
Out-Compute to Out-Compete™ *

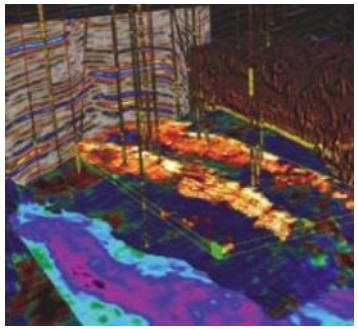
Simulated flow field from the prototype device as computed by 3D Computational Fluid Dynamics software at PSC. Image coutesy of Medrad, Inc.

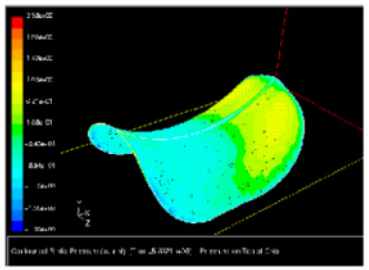












Simulation of a Pringle. Image courtesy of The Procter & Gamble Company

Council on Competitiveness

(*)

Research communities and research infrastructures

- **ESFRI**: European Strategy Forum on Research Infrastructures

- Examples of research communities/research infrastructures:
- **CLARIN**: Common Language Resources and Technology Infrastructure
- ***ENES***: European Network for Earth System Modeling
- **ELIXIR:** European Life Sciences Infrastructure For Biological Information
- **LIFEWATCH**: e-science and technology infrastructure for biodiversity data and observatories
- ***wLCG***: High Energy Physics
- ***LOFAR/SKA***: astronomy
- ***VPH***: Virtual Physiological Human

CLARIN
Common Language Resources and Technology Infrastructure

ELIXIR

LIFEWATCH

LCG

LOFAR

Virtual Physiological Human
network of excellence

Dutch national and European e-infrastructures

	national		international	
High Performance Computing	National super-computer www.sara.nl		www.prace-ri.eu/	PRACE
Grid & Cloud Computing	BiG Grid www.biggrid.nl	BiG Grid the dutch e-science grid	www.egi.eu	egi
Network	SURFnet www.surfnet.nl	SURF NET	www.geant.net	GÉANT
Data services	BiG Grid www.biggrid.nl	BiG Grid the dutch e-science grid	'www.eudat.eu'	EUDAT

sara

eGI

eGee
Enabling Grids for E-sciencE

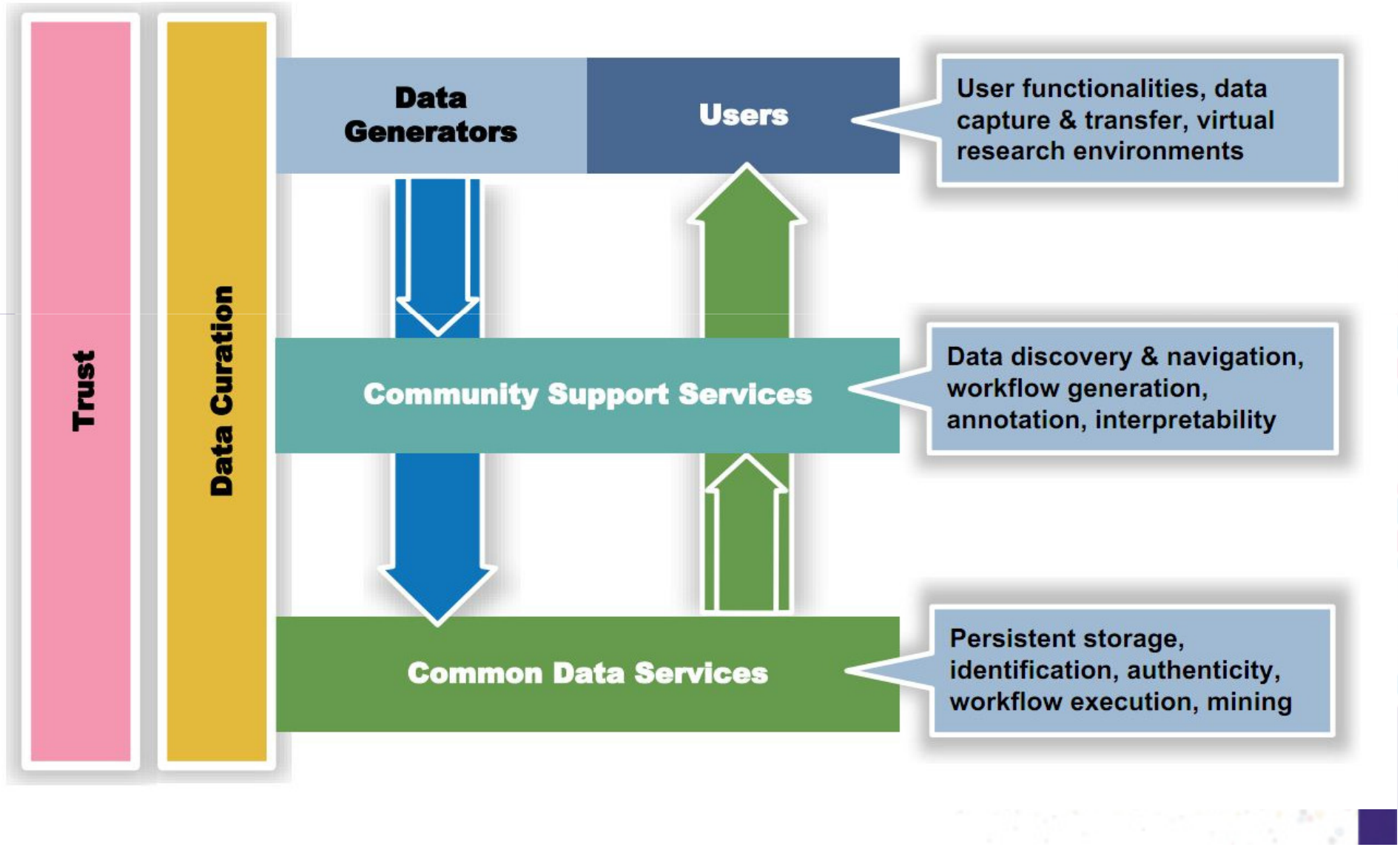
Distributed European Infrastructure for Supercomputing Applications

PRACE

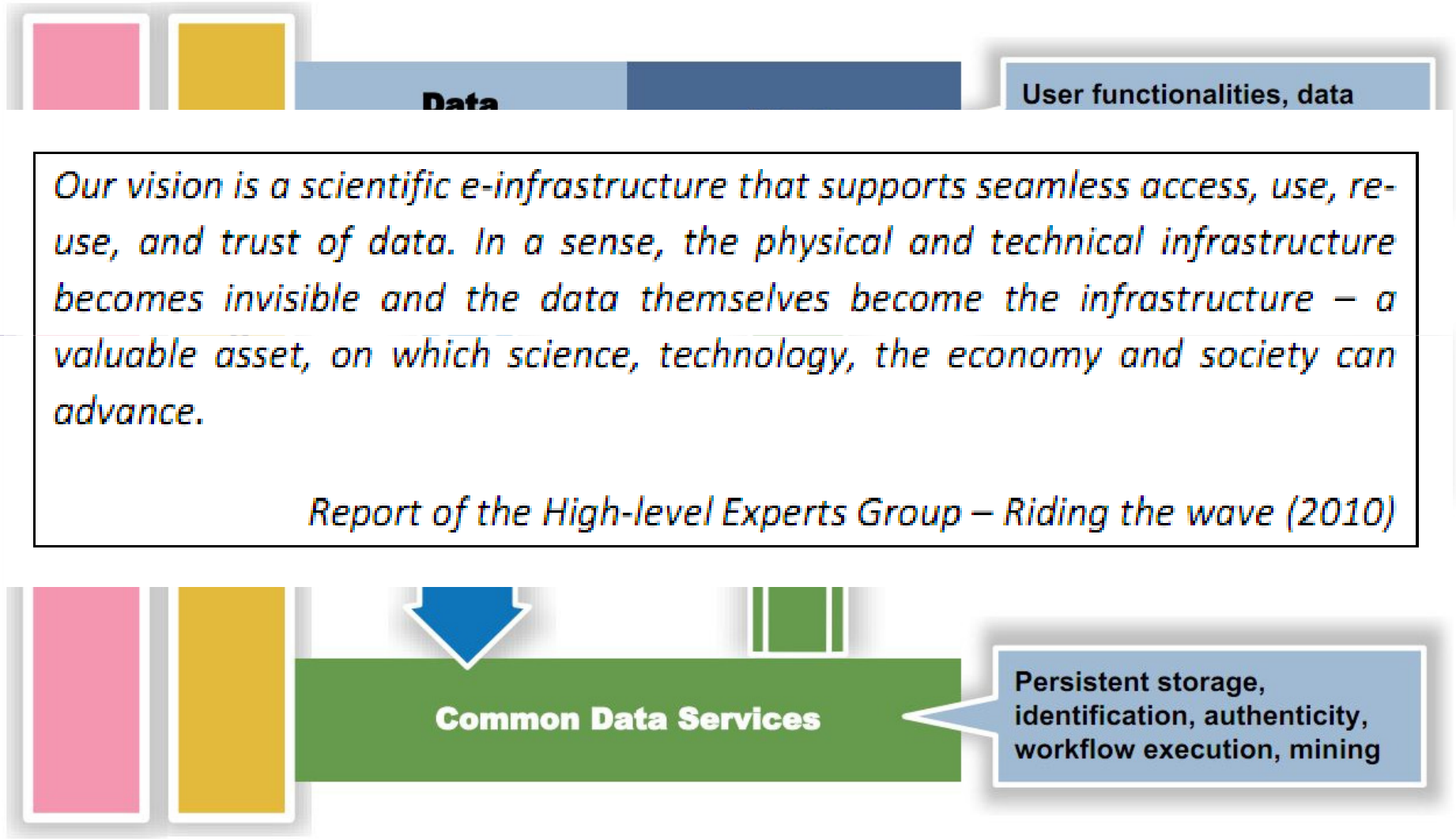
GÉANT

TERENA

EUdat: Collaborative Data Infrastructure



EUdat: 'data as infrastructure'



Our vision is a scientific e-infrastructure that supports seamless access, use, re-use, and trust of data. In a sense, the physical and technical infrastructure becomes invisible and the data themselves become the infrastructure – a valuable asset, on which science, technology, the economy and society can advance.

Report of the High-level Experts Group – Riding the wave (2010)

Open Access and Permanent Access

- **Open access to scientific information and data**
- Significant difference between '**Open Access to research results**' and '**Permanent Access to research data**'
- Permanent Access can be addressed at a technical, operational and funding level
- Open Access is policy-based and primarily the issue of the data owners
- Service providers can facilitate services that enable policy-based access

To take home part 1

- Data explosion in science (experimental sciences & data-intensive computing); data is generated centrally and/or distributed
- Scientific communities are getting organized and are global, and so are e-infrastructures (PRACE, EGI, GEANT, Eudat)
- Research requires a tightly integrated e-infrastructure service that contains all elements (compute, storage, network, visualization, support)
- Next PRACE Research Infrastructure as an example