

## Elixir: Overview, Progress and Futures

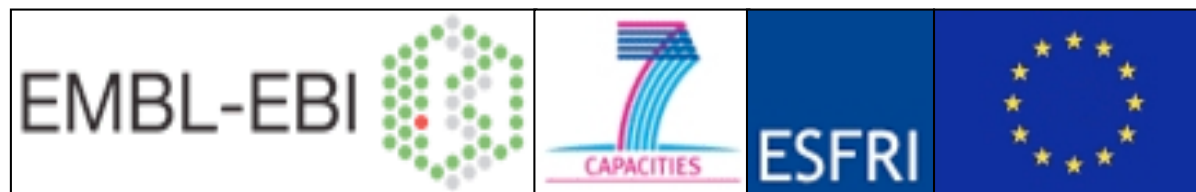
Presented to NGS Innovation Forum

November 24, 2010

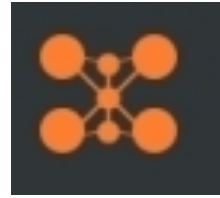
Andrew Lyall

[www.elixir-europe.org](http://www.elixir-europe.org)

[twitter @emblebi](https://twitter.com/emblebi)

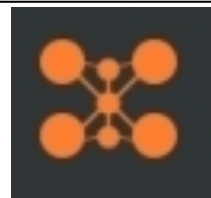


# What is Elixir?

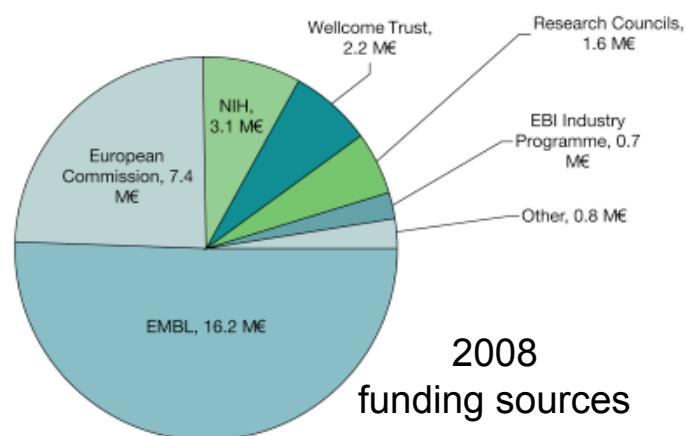


- An EU Framework 7 Preparatory Phase Project
- Coordinated by Prof Janet Thornton, Director EMBL-EBI
- To construct a plan for the operation of a **sustainable** infrastructure for biological information in Europe
- €4.5 million grant awarded May 2007, three year term
- 32 member consortium engaging many of Europe's main bioinformatics funding agencies and research institutes
- Deliverables are memoranda of understanding to fund the implementation phase which could cost €500 million
- Interested parties should register as stake-holders via the ELIXIR Website: [www.elixir-europe.org](http://www.elixir-europe.org)

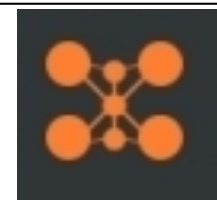
# European Bioinformatics Institute



- Outstation of the European Molecular Biology Laboratory
- International organisation created by treaty (cf CERN, ESA)
- EMBL-EBI has 400 Staff, €30 Million Budget, several million users
- 15 year history of service provision and scientific excellence
- Sited at the Wellcome Trust Genome Campus Hinxton, Cambridge, UK after European competition

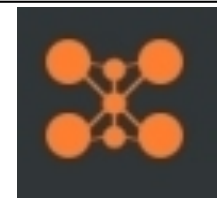


# EMBL-EBI Mission



- To provide freely available data and bioinformatics services to all facets of the scientific community in ways that promote scientific progress
- To contribute to the advancement of biology through basic investigator-driven research in bioinformatics
- To provide advanced bioinformatics training to scientists at all levels, from PhD students to independent investigators
- To help disseminate cutting-edge technologies to industry

# EMBL-EBI: Most important data collections



## Genomes & Genes

1. **Ensembl**: Joint project with Sanger Institute - high-quality annotation of vertebrate genomes
2. **Ensembl Genomes**: Environment for genome data from other taxons
3. **1000 Genomes**: Catalogue of human variation from major World populations
4. **EGA\***: European Genotype Archive\* – genotype, phenotype and sequences from individual subjects and controls
5. **ENA**: European Nucleotide Archive – all DNA & RNA, nextgen reads and traces

## Transcription

6. **ArrayExpress**: Archive of transcriptomics and other functional genomics data
7. **Expression Atlas**: Differentially expressed genes in tissues, cells, disease states & treatments

## Protein

8. **UniProt**: Archive of protein sequences and functional annotation
9. **InterPro**: Integrated resource for protein families, motifs and domains
10. **PRIDE**: Public data repository for proteomics data
11. **PDBe**: Protein and other macromolecular structure and function

## Small molecules

12. **ChEBI**: Chemical entities of biological interest
13. **ChEMBL**: Bioactive compounds, drugs and drug-like molecules, properties and activities

## Processes

14. **IntAct**: Public repository for molecular interaction data
15. **Reactome**: Biochemical pathways and reactions in human biology
16. **Biomodels**: Mathematical models of cellular processes

## Ontologies

17. **GO**: Gene Ontology, consistent descriptions of gene products

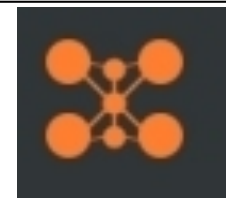
## Scientific literature

18. **CiteXplor**: Bibliographic query system

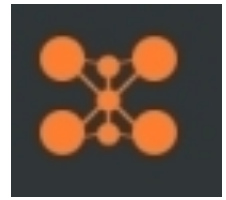
\* Requires authentication

# Contents.

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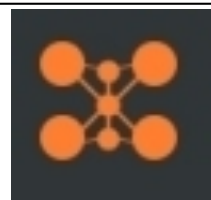
1. Why is ELIXIR necessary?
2. How is ELIXIR organised?
3. Where did ELIXIR come from?
4. What has happened so far?
5. What next?



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# 1. Why is Elixir Necessary?

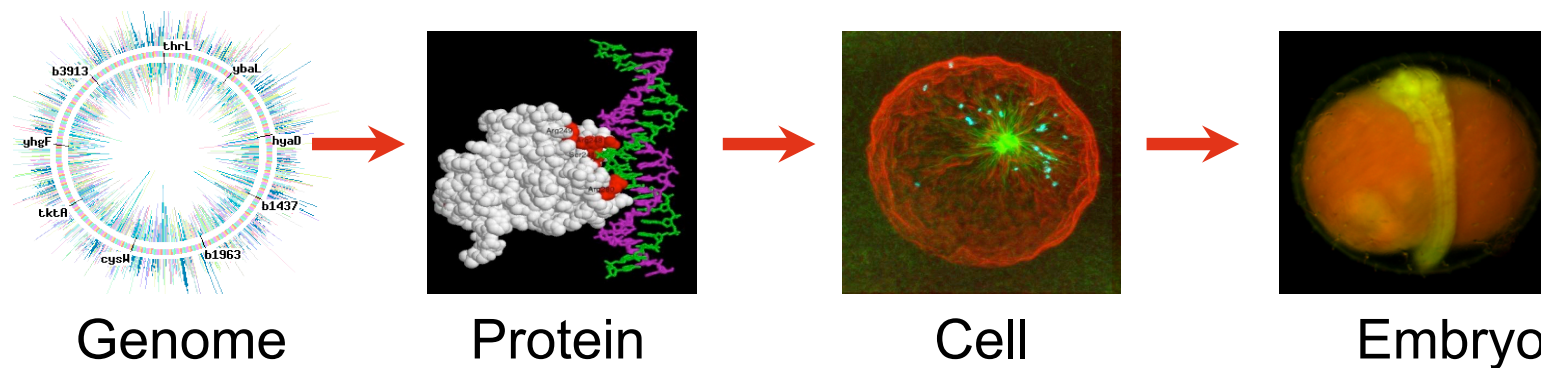
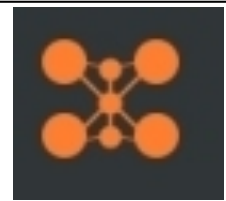
# Why are we here?



## Europe is facing unprecedented (Grand) Challenges

- Healthcare for an aging population
- A sustainable food supply
- An internationally competitive life-sciences industrial sector
- Protection of the environment.
- A sustainable energy supply

# Modern biology requires integration.



Fruitfly

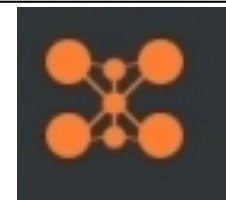


Mouse

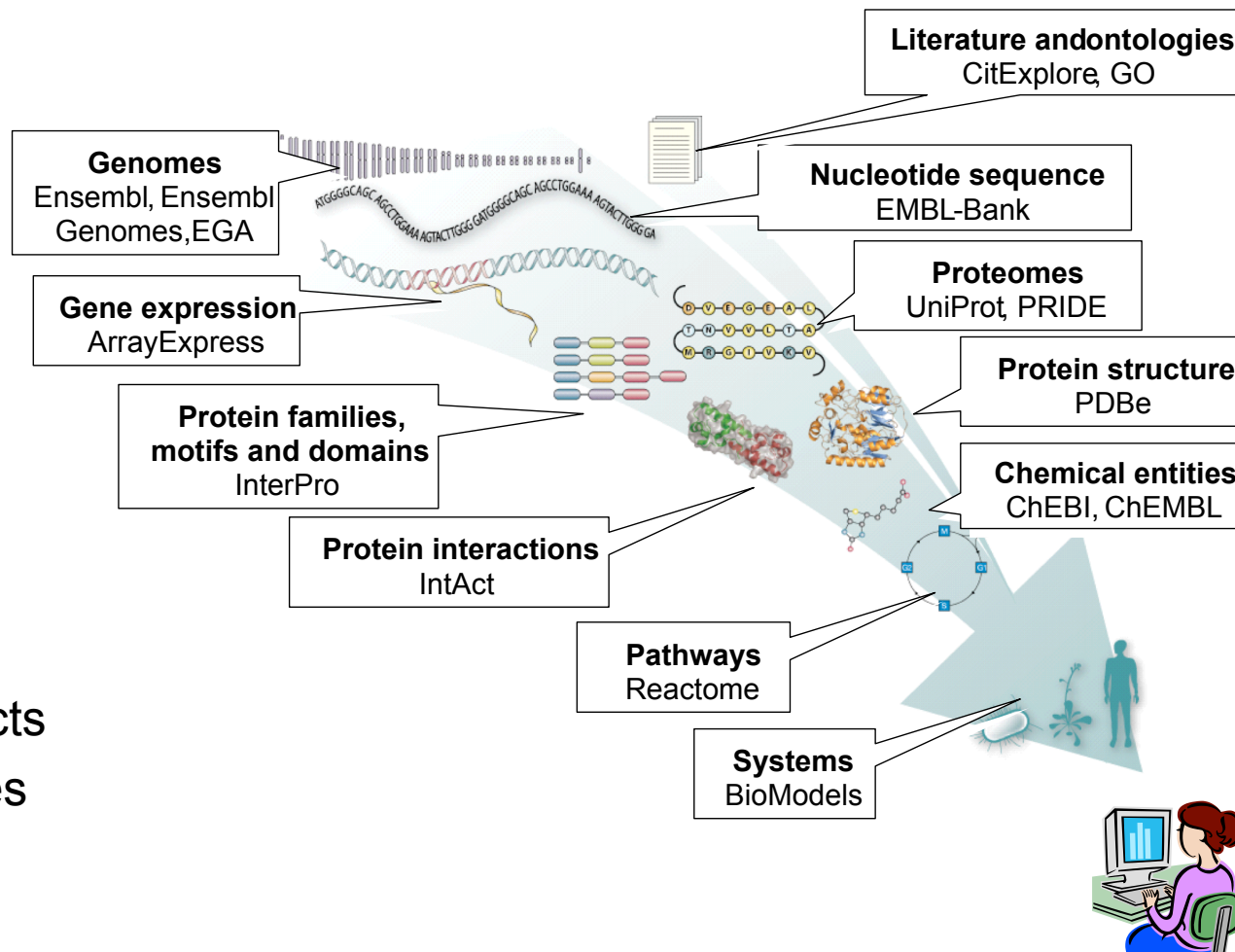


Development,  
Ageing, Disease

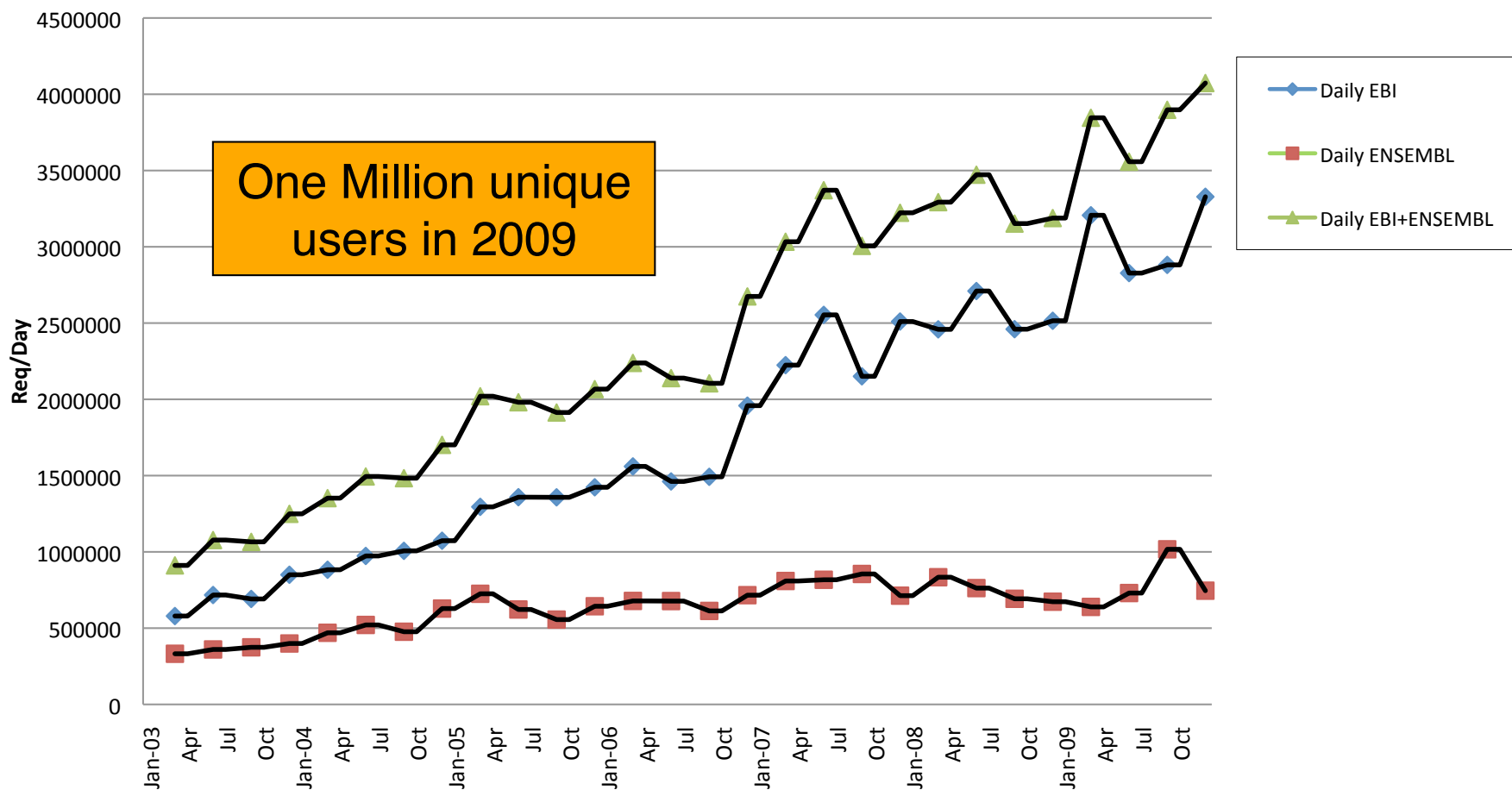
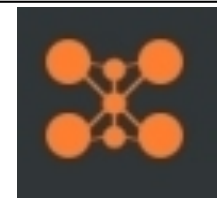
# Comprehensive, universal, integrated...



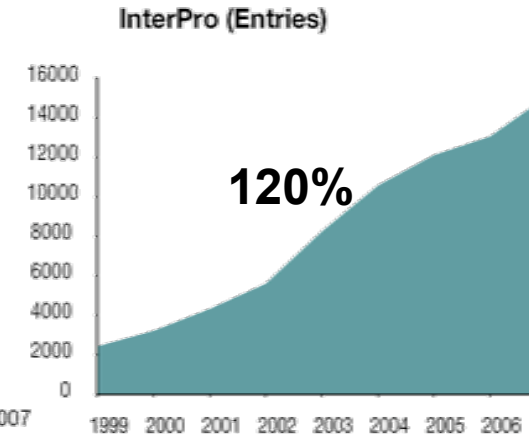
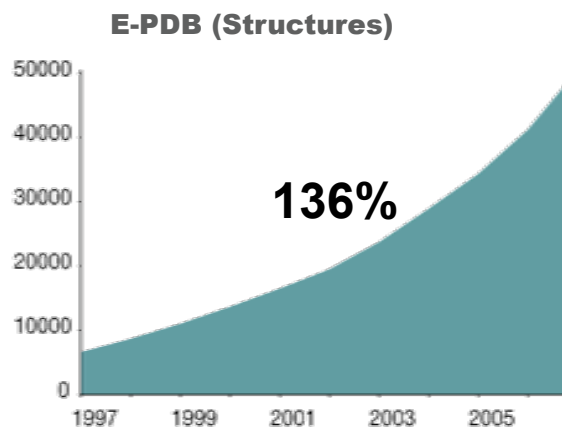
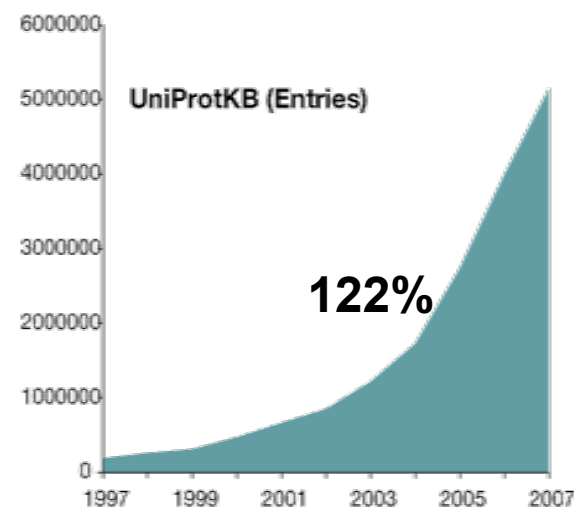
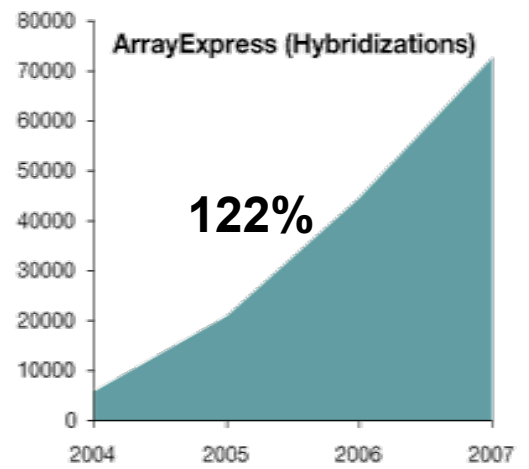
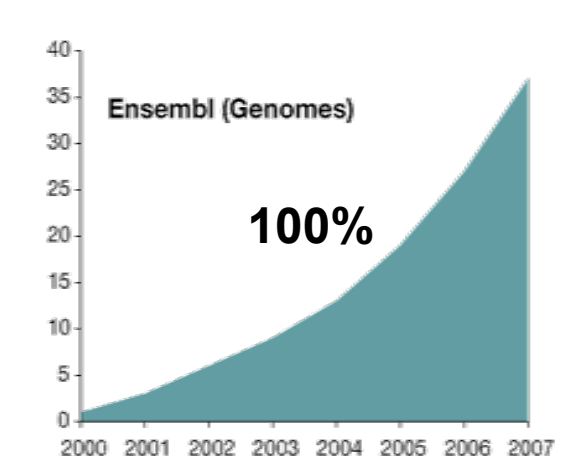
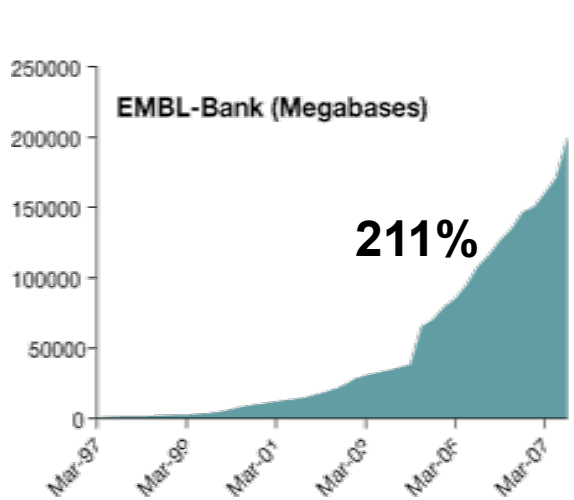
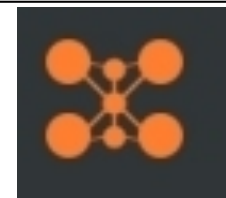
- Life sciences
- Medicine
- Agriculture
- Pharmaceuticals
- Biotechnology
- Environment
- Bio-fuels
- Cosmaceuticals
- Neutraceuticals
- Consumer products
- Personal genomes
- Etc...



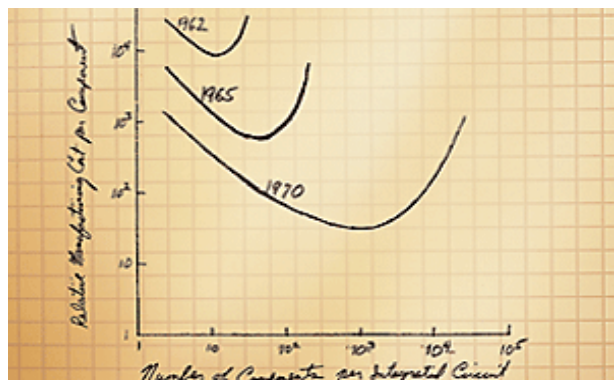
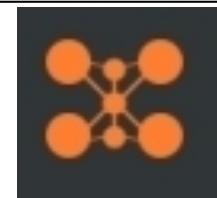
# Very large user community



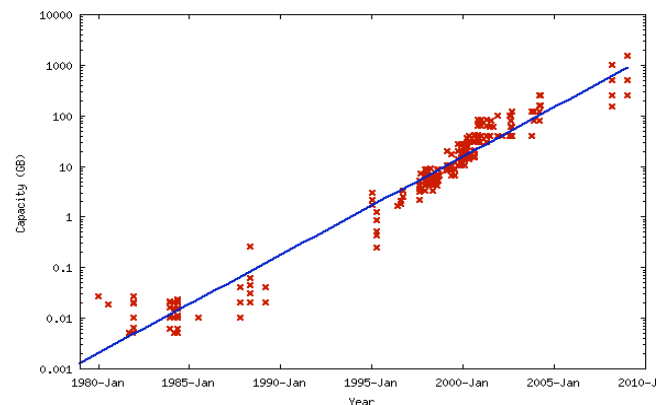
# Database growth (2007/2006 %)



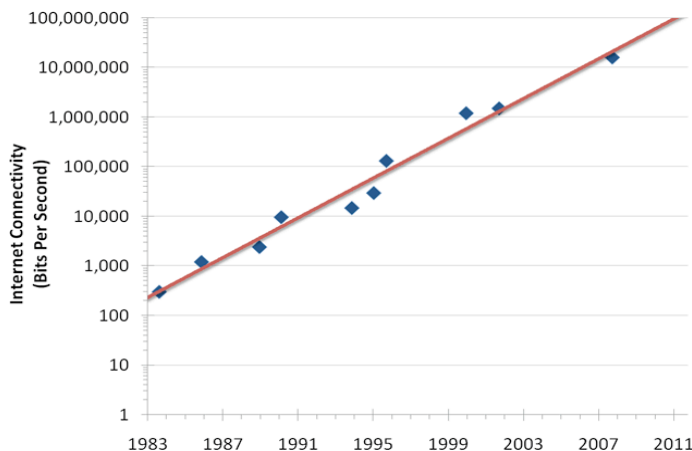
# Data growth exceeds growth in IT capability



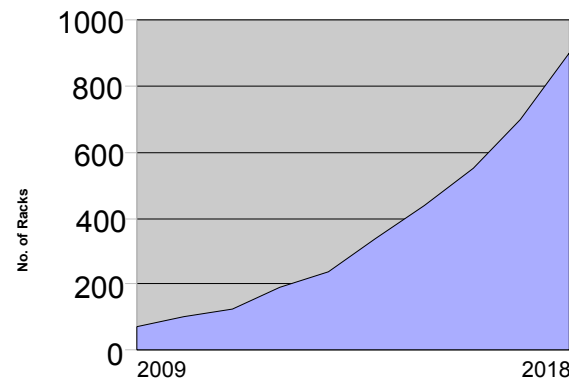
CPU Power doubles  $\leftrightarrow$  24 months (Moore's Law)



Disk capacity doubles  $\leftrightarrow$  18 months

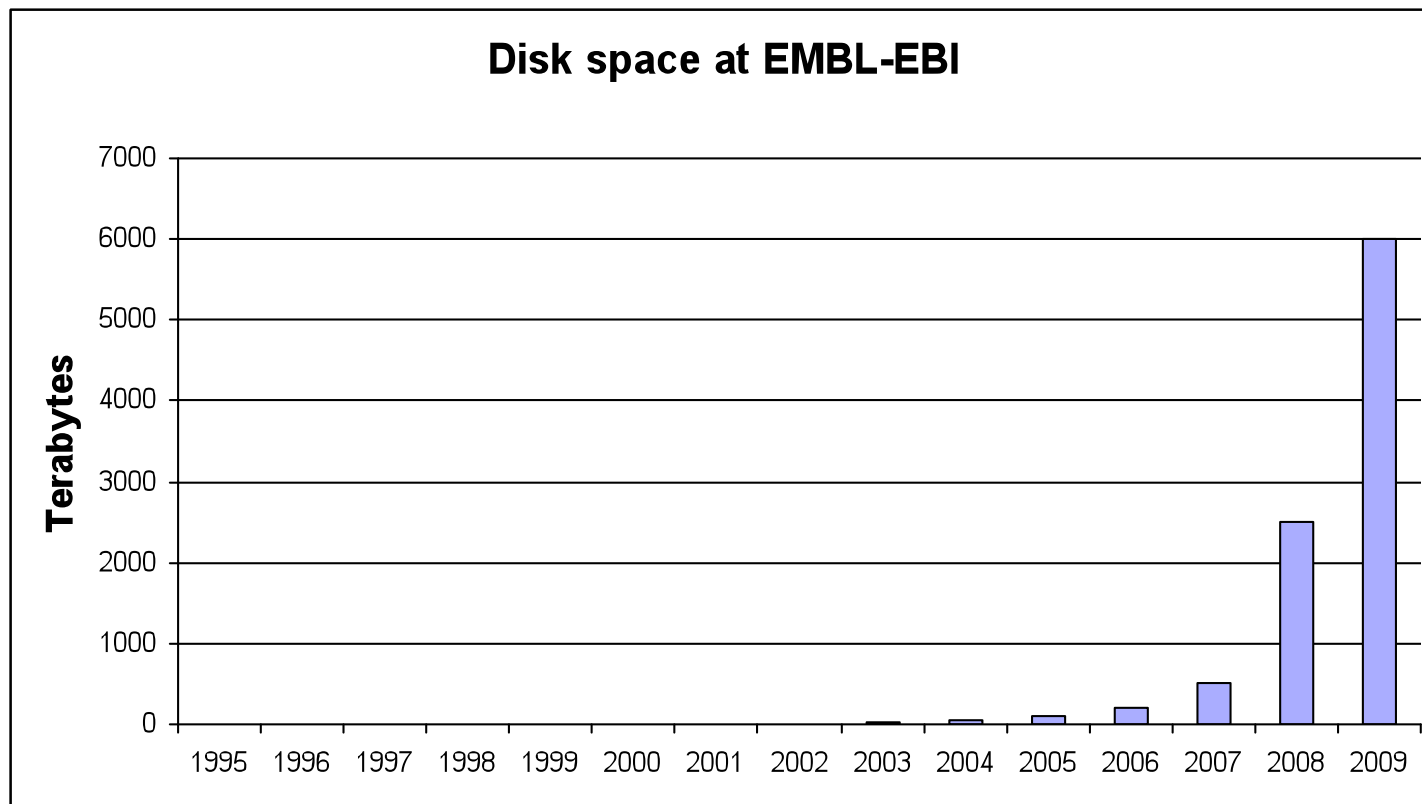
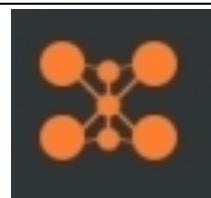


Network bandwidth doubles  $\leftrightarrow$  20 months



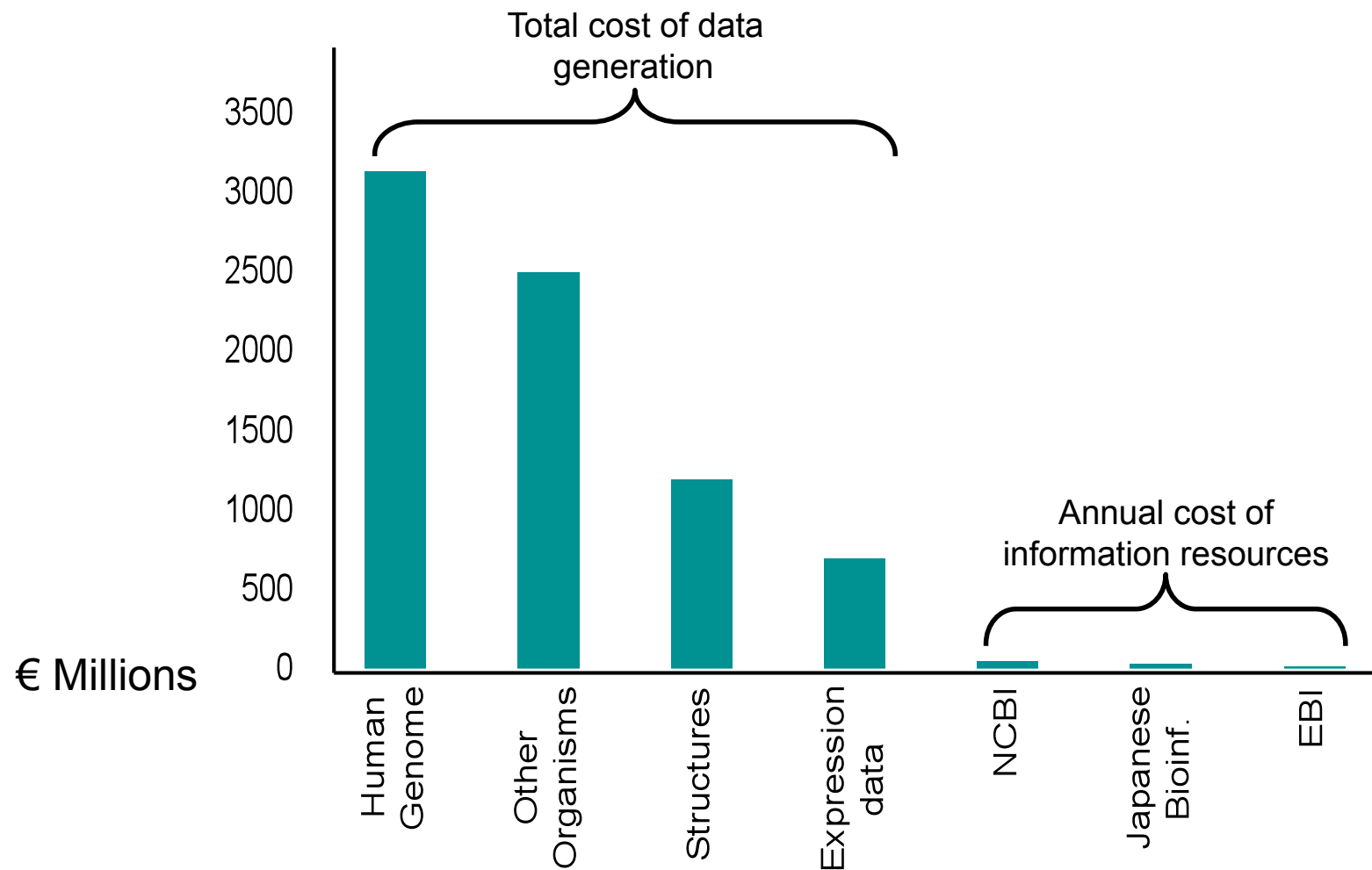
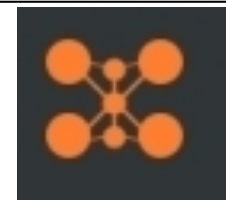
Racks in EBI machine room double  $\leftrightarrow$  12 months

# Growth of disk storage at EMBL-EBI

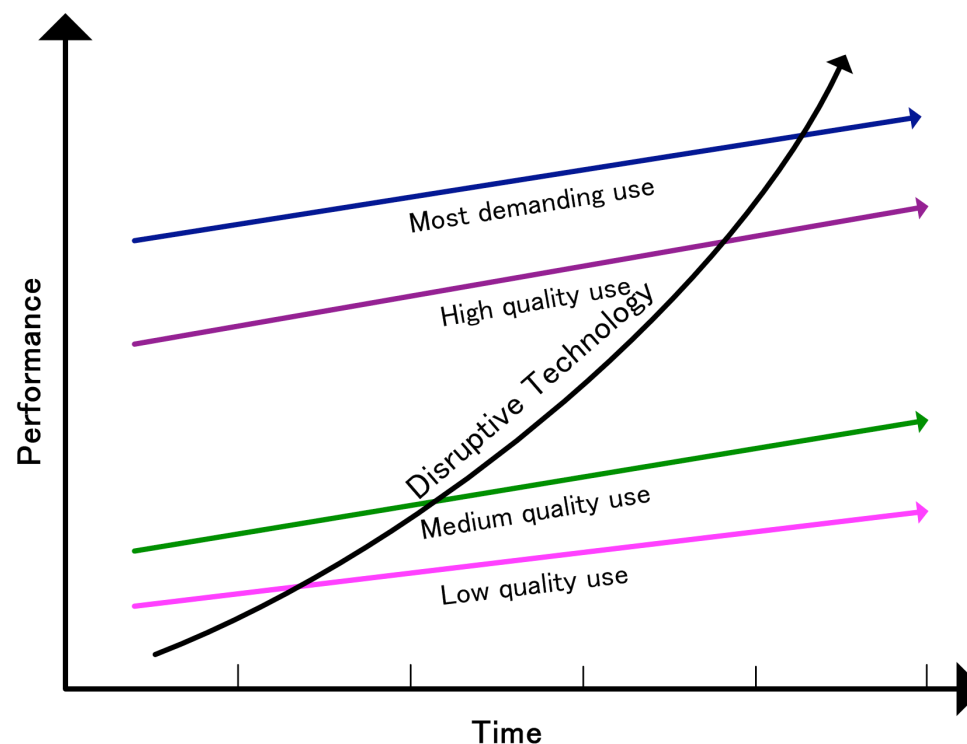
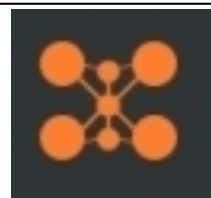


Ten petabytes at May 2010.

# Good value for money



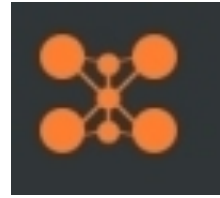
# Disruptive technologies.



“A technology becomes disruptive when the rate at which it improves exceeds the rate at which users can adapt to the new performance.”

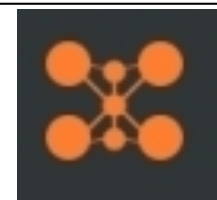
*The Innovator's Dilemma.* Clayton M. Christensen. Harvard Press. 1997

# Disruptive technologies in biology



- Next-generation DNA sequencing
  - Data will be 1,000 <> 1,000,000 times cheaper to produce
  - Data production rates will be 1,000 <> 1,000,000 more by the end of the ESFRI period.
- Imaging (including video) at all scales from molecules to whole organisms
- Protein sequencing by Mass Spectrometry may also be disruptive
- There will probably be others
  - Macromolecular structure determination by Electron Microscopy
  - etc

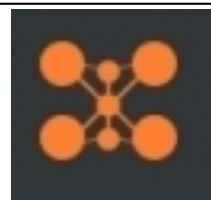
# Exponential growth in data...



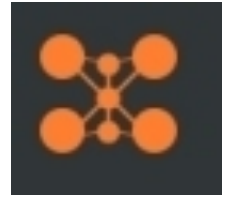
Cannot equate to exponential growth in funding, so

1. Link budgets for data generation and data processing
  - Only produce as much data as you can deal with
  
2. Take steps to control staff growth
  - Automation of annotation and curation
  - Implement distributed annotation (DAS)
  - Use web services and distributed resources
  - Support for metadata deposition
  
3. Take steps to control IT resource requirements.
  - Develop policies for which data are to be kept (& which not)
  - Develop data compression techniques

# Elixir rationale



- Optimal Data Management
  - Coordinated data resources with improved access & economy of scale
  - Integration and interoperability of diverse heterogeneous data
- Forge links to data in other related domains
- A single European voice to influence global decisions and maintain open access
- Enhance European competitiveness in bioscience industries
- Address need for Increased Funding & its Coordination



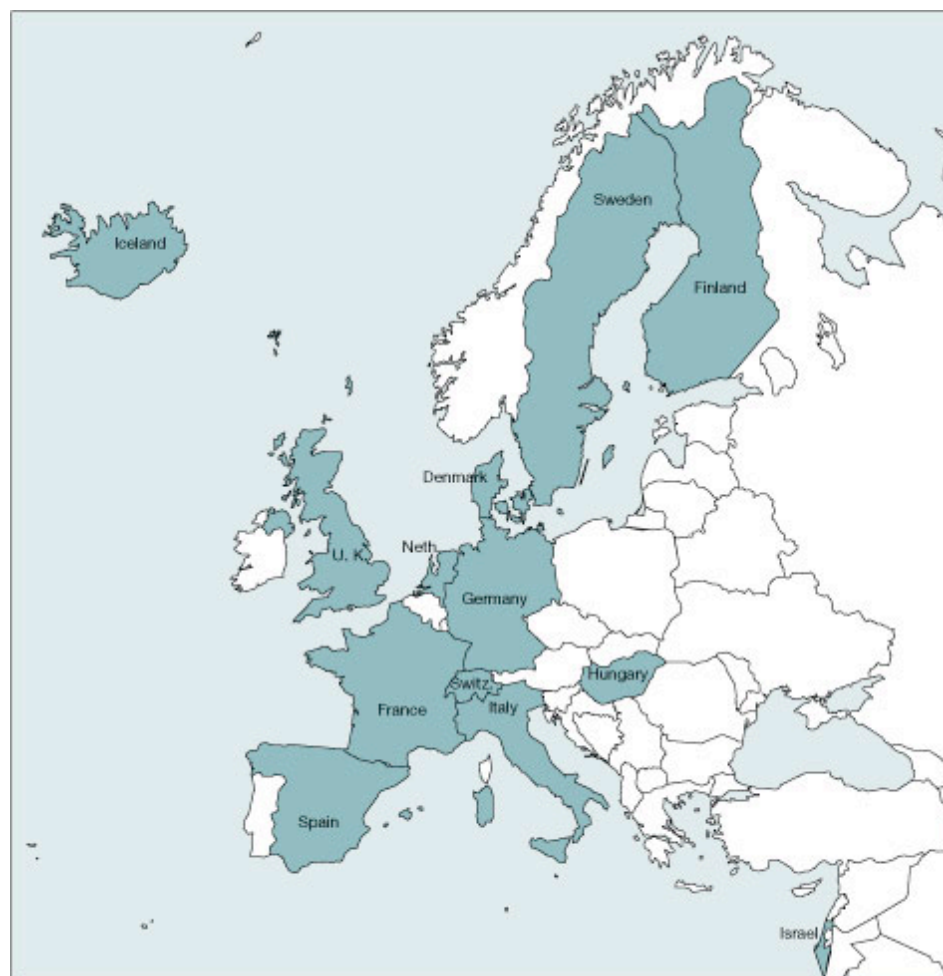
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## 2. How is ELIXIR Organised?

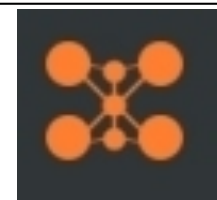
# Members of the ELIXIR consortium



- There are 32 partners from 13 member states and associated countries
- 16 of the partners are funding agencies or Government Bodies
- 16 of the partners are scientific organisations or institutes
- There are expressions of interest from many others

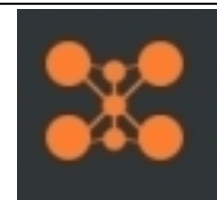


# ELIXIR preparatory phase



- 1. Mobilisation and planning**, November 2007.
- 2. Committee and recommendations phase** (lasting 18 months), Jan 2008
  - Hold stakeholder meetings
  - Establish working committees to write reports
  - Present the reports at an open stakeholders meeting for wider discussion
  - Define ELIXIR**
- 3. Documentation and negotiation phase** (lasting 18 months). July 2009
  - Consolidate reports into a proposal to be sent to all the member states and funding agencies with a draft Memorandum of Understanding by month 26.
  - Define how or which parts will be funded by whom**
  - Reach agreement after 38 months, so that “construction” can start

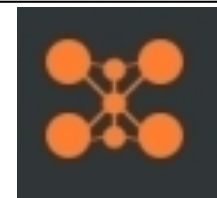
# ELIXIR Work Packages.



*Elixir is organised into 14 work packages which have committees of (mainly) European experts associated with them. It is organising two surveys, one of users and one of data-providers, and five technical-feasibility studies. The Elixir Steering Committee is associated with WP1 and has oversight of the whole project. WP3 has four committees; for Bioinformatics Communities, for Data Providers, for Industry and for Interactions with the rest of the World (International). There will be regular Stakeholder meetings intended to encourage the widest possible participation.*

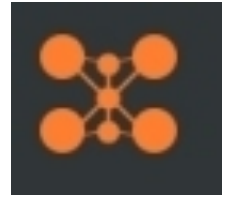
1. Project management
2. Data providers
3. User communities
4. Organisation and Legal
5. Funding
6. Physical infrastructure
7. Data interoperability
8. Literature
9. Healthcare
10. Chemistry & Environment
11. Training
12. Tools integration
13. Feasibility studies
14. Reporting and negotiation

# Is Elixir technically feasible?



*Elixir does not depend for its success on any technology that has not been developed yet. However, it will be providing solutions to very demanding data management problems presented by things such as the 1000-genome project, the great increase in imaging of biological systems and the impending scale-up of structural and systems biology. We are thus conducting five technical feasibility studies that support the more challenging aspects of Elixir. More information on these studies is available from the Elixir Web Site.*

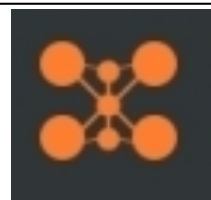
1. Strategic Review of Cell Phenotype Image Data Resources.
2. Pilot of the use of European Supercomputing facilities for distributed processing of Bioinformatics data.
3. Assessment of European Resources for Systems Biology.
4. Search across heterogeneous distributed data resources (EB-eye).
5. Safe and ethical use of personal genetic information (European Genotype Archive).



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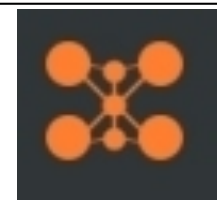
### 3. Where did ELIXIR come from?

# 2000: Strasbourg Conference on RI



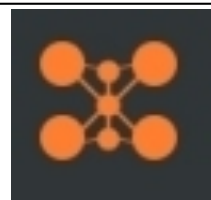
- Held by the European Commission in September 2000
- Attended by 400 scientists and reps of scientific agencies
- Ministers and the European Science Commissioner participated
- Conference endorsed idea of European Research Infrastructures
- These should provide access to facilities, samples or **data**
- Promote cooperation, enhance competitiveness & provide training
- May be operated at the national level or by European organizations.
- To qualify as a European RI must satisfy the following criteria:-
  - (i) they must be unique
  - (ii) they must provide outstanding services
  - (iii) access must convey a 'European added value'

# The European Research Area (ERA).



The EU created a unified area all across Europe (2000), the purpose of which it to

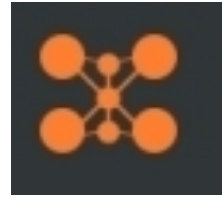
- Enable researchers to move and interact seamlessly
- Benefit from world-class infrastructures
- Work with excellent networks of research institutions
- Share, teach, value and use knowledge effectively for social, business and policy purposes;
- Optimise, open and co-ordinate national and regional research programmes to address major challenges
- Develop strong links with partners around the world
- **Construction of the ERA is the purpose of FP6 & FP7**



## The European Strategy Forum on Research Infrastructures

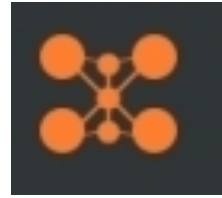
- Created by the Commission in February 2002
- Adopted by the Competitiveness Council in April 2002
- Representatives of EU Member States, Associated States, and one representative of the European Commission.
- Chairman: Prof Carlo Rizzuto (Sincrotrone Trieste S.c.p.A.- ELETTRA, IT)
- To support a coherent approach to policy-making on research infrastructures in Europe
- To act as an incubator for international negotiations about concrete initiatives

# European Roadmap for Research Infrastructures.



- 35 'mature' projects for new large scale Research Infrastructures
- Based on an international peer review process
- Covers all scientific areas, regardless of possible location
- Likely to be realized in the next 10 to 20 years
- Supported by a relevant European partnership or intergovernmental research organisation.
- Impact on science and technology development at international level
- Support new ways of doing science in Europe
- Contribute to the enhancement of the European Research Area

# Roadmap projects summary.

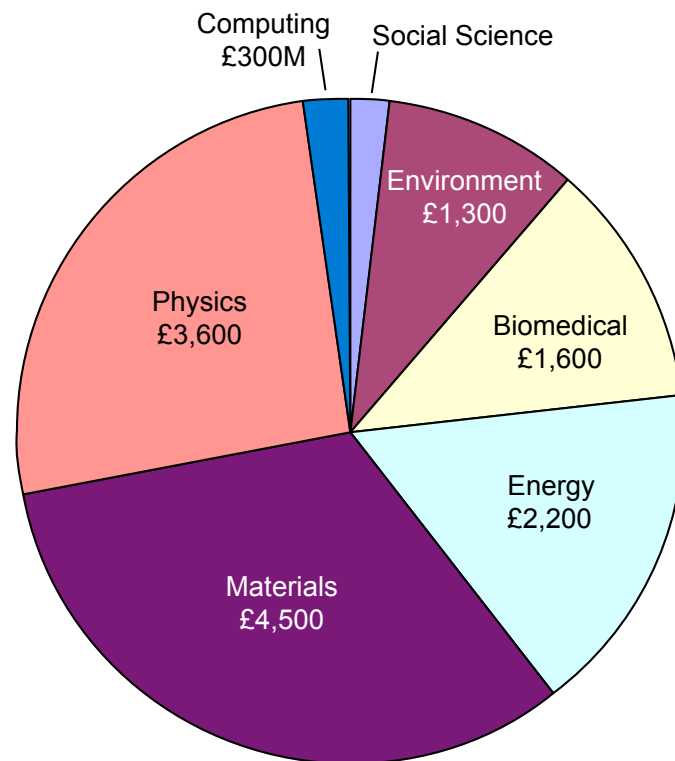
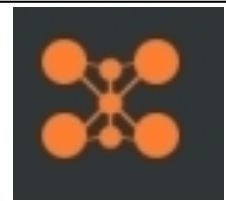


- 6 Social Science & Humanities
- 8 Environmental Sciences
- 3 Energy
- 6 Biomedical and Life Sciences
- 7 Material Sciences
- 5 Astronomy, Astro-, Nuclear and Particle Physics
- 1 Computer and Data Treatment (*transverse*)

<http://cordis.europa.eu/esfri/>

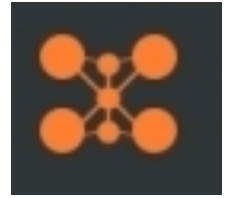


# Cost of 35 Mature ESFRI RI Projects



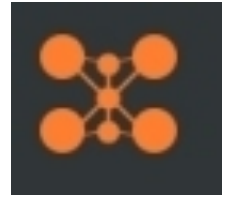
Total Capital Cost = €13,696 Million

# But...



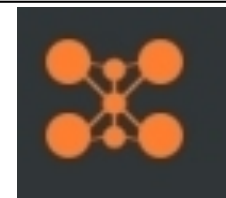
- The commission needed €14 Billion to fund the RIs
- Which the member states refused to provide it
- So, the commission created the preparatory phase projects
- The purpose of which are to create the consortia to fund the construction of the RIs

# The ten ESFRI BMS RI



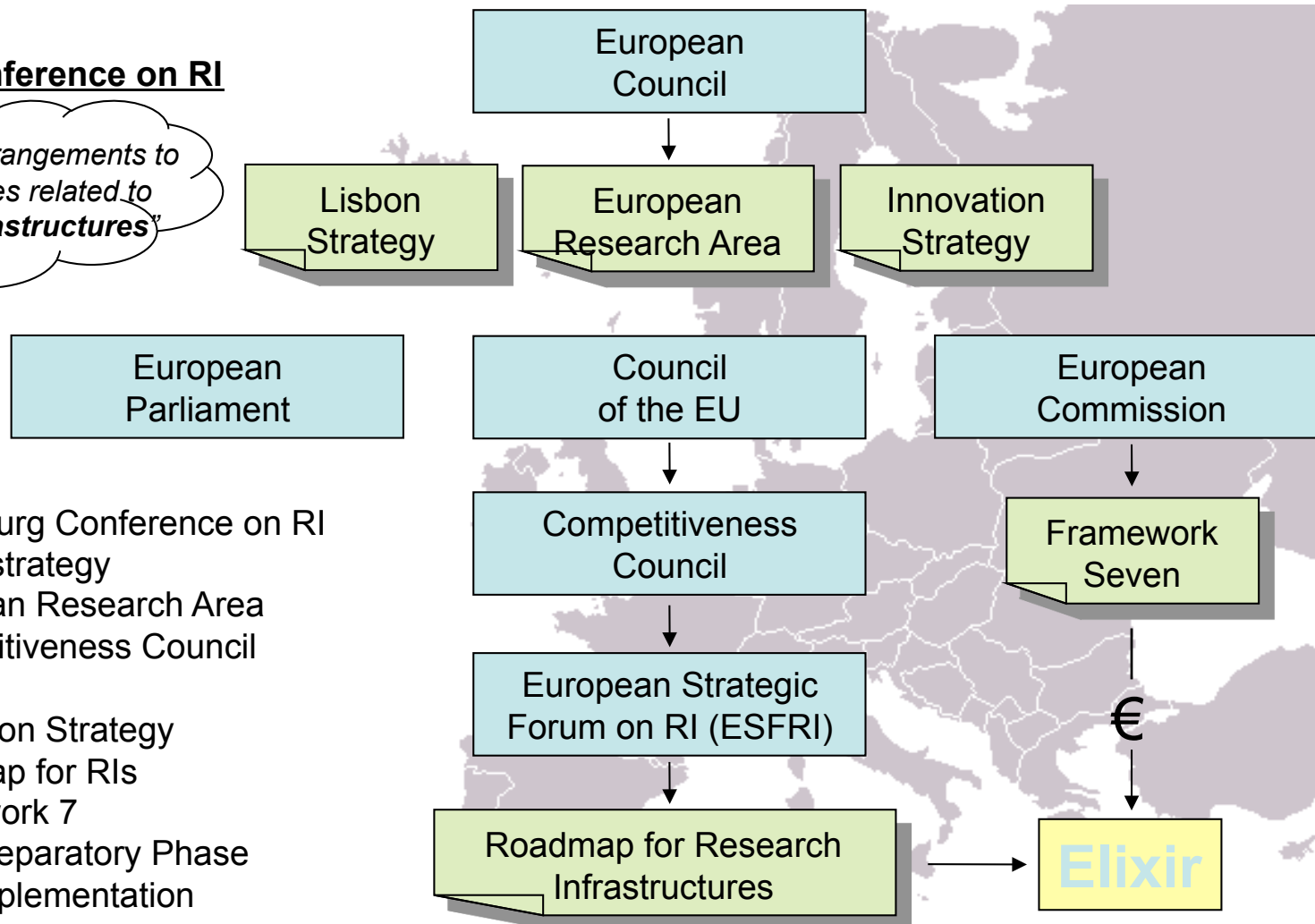
BBMRI	Biobanking and Biomolecular Resources Research Infrastructure
EATRIS	European Advanced Translational Research Infrastructure in Medicine
ECRIN	European Clinical Research Infrastructures Network
ELIXIR	European Life Science Infrastructure for Biological Information
EMBRC	European Marine Biological Resource Centre
EU-OPENSREEN	European Infrastructure of Open Screening Platforms for Chemical Biology
Euro-BioImaging	European Biomedical Imaging Infrastructure
ERINHA	European Research Infrastructure on Highly Pathogenic Agents
Infrafrontier	European Infrastructure for Phenotyping and Archiving of Model Mammalian Genomes
INSTRUCT	An Integrated Structural Biology Infrastructure for Europe

# Where did Elixir come from?



## Strasbourg Conference on RI

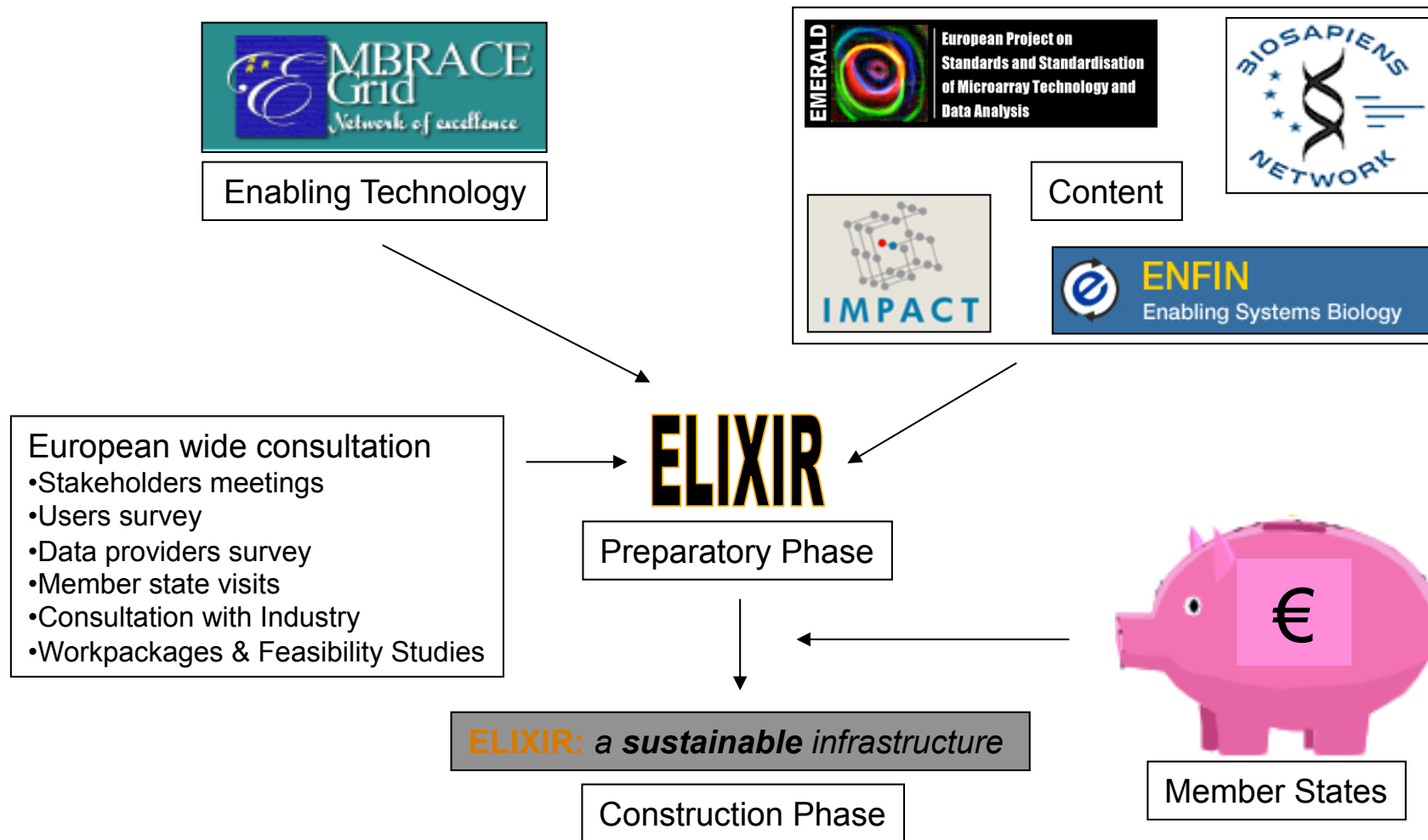
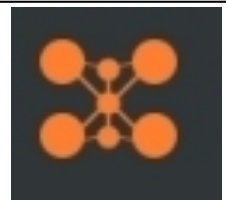
“...need new arrangements to support policies related to **research infrastructures**”

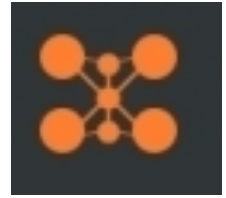


## Timeline

- 2000 Strasbourg Conference on RI
- 2000 Lisbon strategy
- 2000 European Research Area
- 2002 Competitiveness Council
- 2002 ESFRI
- 2006 Innovation Strategy
- 2006 Roadmap for RIs
- 2007 Framework 7
- 2008 Elixir Preparatory Phase
- 2011 Elixir Implementation

# Infrastructure for tools & services integration





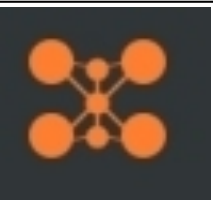
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## 4. What has happened so far?

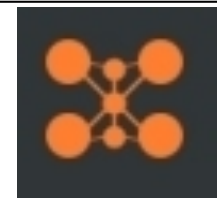
# Visits during consultation phase.



# Sites of ELIXIR survey data providers

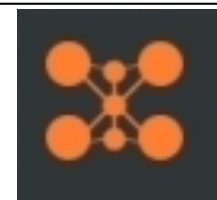


# What might Elixir be?



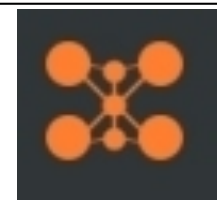
- A reliable ***distributed*** infrastructure to provide equality of access to biological information across all of Europe
- Sustainable funding for the ***core*** European biological data collections (genomes, sequences, structures etc)
- Sustainable funding for the ***global*** biological data collaborations (UniProt, ww-PDB, INSDC etc)
- Processes for
  - developing ***new*** core data collections
  - supporting ***interoperability*** of bioinformatics tools
  - developing bioinformatics ***standards*** and ***ontologies***
- ***Enhanced*** use of biological information in Academic Research, the Pharmaceutical Industry, Biotechnology, Agriculture and for the Protection of the Environment

# A Reliable Distributed Infrastructure



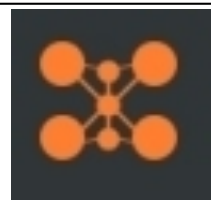
- Elixir will be constructed by enhancing and linking existing infrastructures in the member states.
- It will integrate member state infrastructures into a single infrastructure or a 'Grid'.
- Each member-state will
  - Identify and catalogue its requirements
  - Identify funding agencies that are prepared to fund bioinformatics
  - Identify projects and organisations that could become part of Elixir
  - Include funding for Elixir in its National Research Infrastructure Plan
  - Where appropriate, identify structural funds that can be used for Elixir
  - Make suggestions for ELIXIR Nodes
  - Take part in the ELIXIR Construction Phase

# Summary of ELIXIR Components.



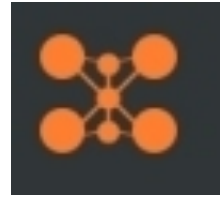
- Biomolecular and related data collections
- Computational resources
- Standards and ontology development
- Training infrastructure
- Tools and services integration infrastructure (achieved through interoperability with EMBRACE)

# Core data collections at EMBL-EBI



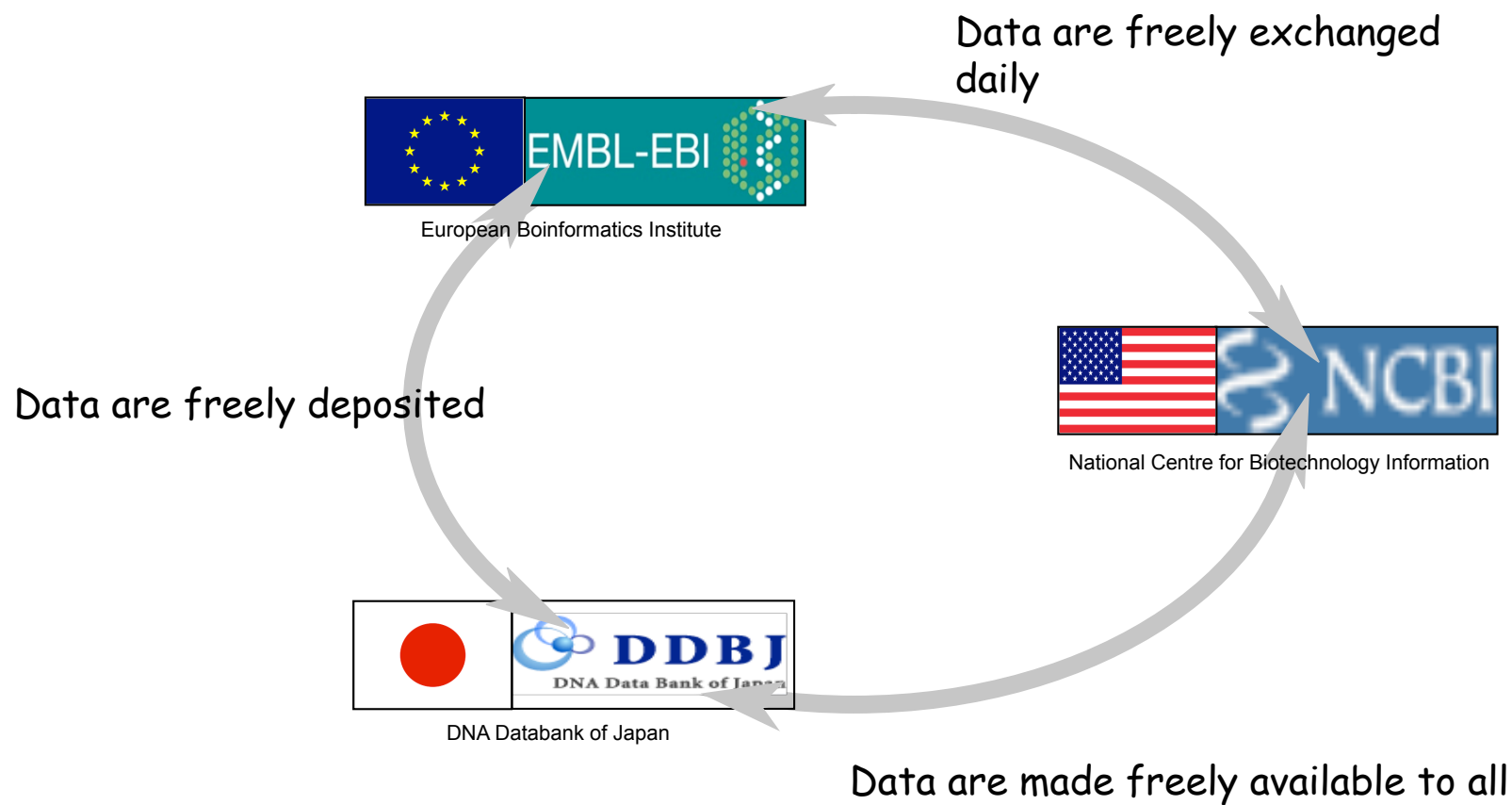
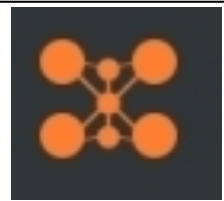
1. **European-PDB** — the European partner in the wwPDB Macromolecular Structures Database.
2. **UniProt** — the world's definitive collection of protein sequence data.
3. **EMBL-Bank** — the European instance of the global archive of nucleotide sequence data.
4. **Ensembl** — a world leader in the provision of annotated eukaryotic genomes.
5. **ArrayExpress** — a major public repository for microarray data.
6. **InterPro** — a database of protein families, domains and functional sites which aggregates such information from a large number of collaborators.

# Attributes of core data collections

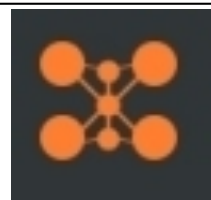


- Universally relevant to biology and medicine
- Journals insist on data deposition as a condition for publication
- Very, very large user communities
- Aim to be complete collections with Global significance
- Exchange with other data centres ensures completeness
- Science is stable enough to allow standardisation of data structures
- Host institute needs to be involved in standards development
- Support requires substantial institutional commitment

# Global context of data collections



# Sweden is first country to commit



## Sweden to be the first country to pledge long-term funding for ELIXIR

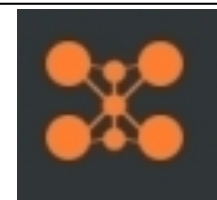
*Posted on Tue Jun 23, 2009 7:32 am*

The Swedish funding agencies (the Swedish Energy Agency, Fas, Formas, the Swedish Research Council and VINNOVA) have suggested that the Government allocate a total of **19 million SEK** (1.7 million Euro) over three years to ELIXIR & the Swedish Bioinformatics Infrastructure for Life Sciences (BILS), which would make Sweden the first country to secure long-term funding for ELIXIR. A final decision along these lines is expected during the Autumn 2009.

**Contact:** Prof. Bengt Persson, Linköping University & Karolinska Institutet

**Web site:** [www.bils.se](http://www.bils.se)

# UK commits to ELIXIR



## **UK leads European research programme with £10M investment in bioscience data handling capacity**

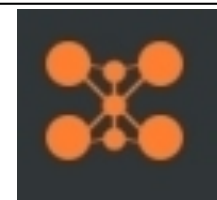
*Posted on Tue Aug 25, 2009 8:35 am*

The UK has made its first substantial commitment to ELIXIR with a £10M investment by the Biotechnology and Biological Sciences Research Council (BBSRC). BBSRC has awarded funding to the European Molecular Biology Laboratory's European Bioinformatics Institute to permit a dramatic increase in the institute's data storage and handling capacity. The funding is the first step in developing the existing data resources and IT infrastructure of EMBL-EBI towards its planned role as the central hub of the emerging European Life-Science Infrastructure for Biological Information.

**Contact:** Matt Goode, BBSRC External Relations

**Web site:** [www.ebi.ac.uk](http://www.ebi.ac.uk)

# Denmark commits to ELIXIR



## **Denmark invests €5 million in pan-European infrastructure for biology**

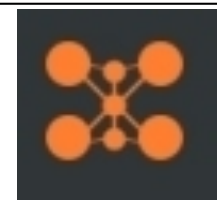
*Posted on Jan 10, 2010 9:00 am*

Denmark has made its first substantial commitment to the European Life-Science Infrastructure for Biological Information (ELIXIR), a major emerging pan-European science project, with a €3.5M investment by the Danish Agency for Science, Technology and Innovation. Substantial co-financing from the University of Copenhagen, Aarhus University, the University of Southern Denmark, and the Technical University of Denmark will increase the total amount invested in ELIXIR to €5 million.

**Contact:** Katrina Pavelin, EMBL-EBI Scientific Outreach Officer - Hinxton, UK

**Web site:** [www.ebi.ac.uk](http://www.ebi.ac.uk)

# Finland commits to ELIXIR



## **Finland invests €1.85 million in pan-European infrastructure for biomedical research**

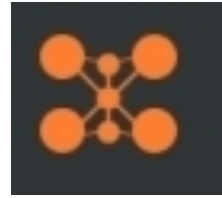
*Posted on Feb 3, 2010 9:00 am*

Finland has made its first specific commitment to the development of European biomedical research infrastructures (BMS ESFRIs) by supporting a joint pilot infrastructure project in bioinformatics (ELIXIR), biobanking (BBMRI) and translational research (EATRIS). The initial commitment of 1.85 M€ is to support preparation and pilot studies in 2010. The purpose of the funding is to ensure Finland's commitment to the building of these European infrastructures. The level of funding in future years was left open as this depends on the outcome and structures that will be developed in the pilot phase.

**Contact:** Katrina Pavelin, EMBL-EBI Scientific Outreach Officer - Hinxton, UK

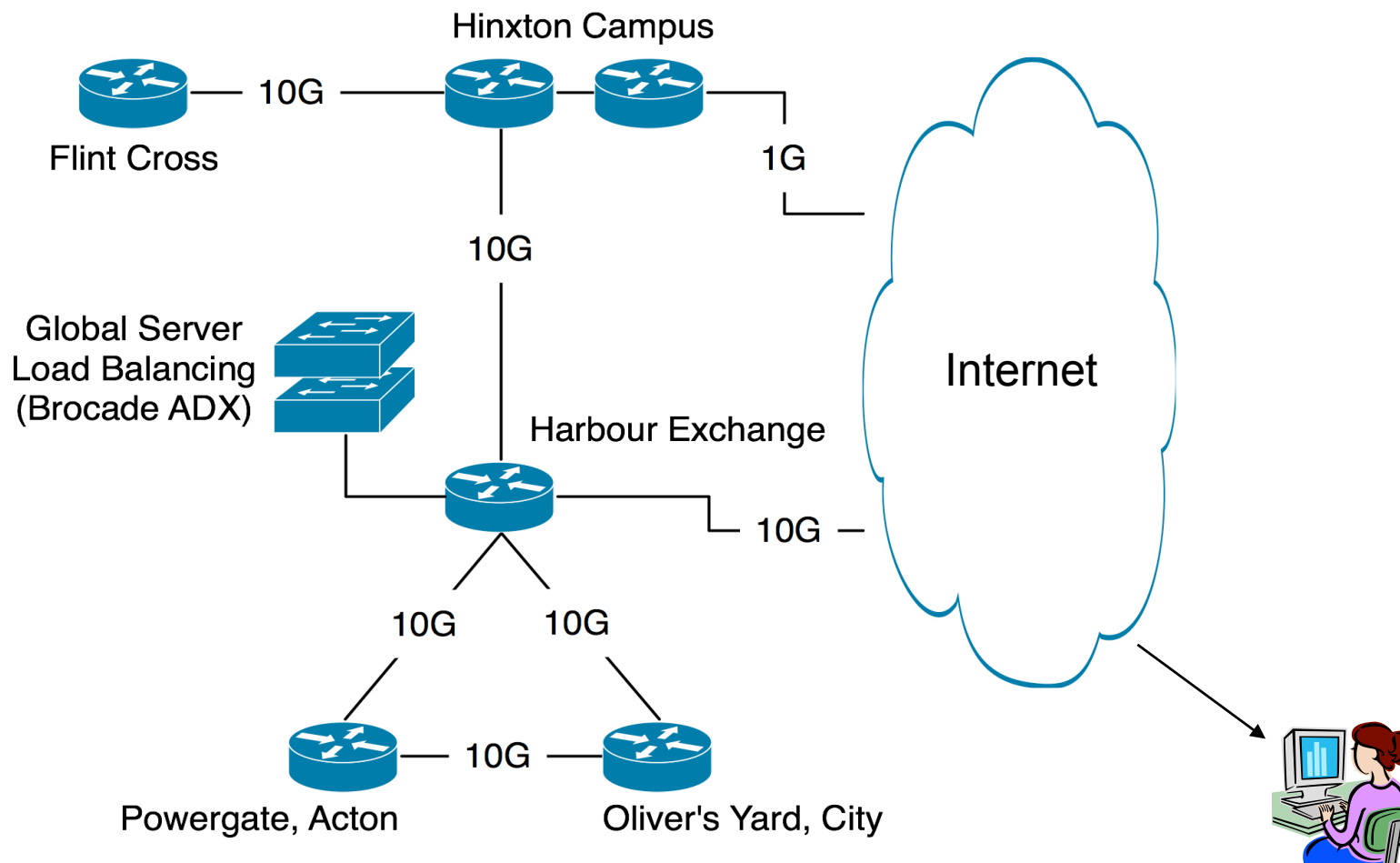
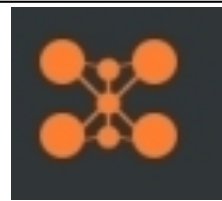
**Web site:** [www.bbsrc.ac.uk](http://www.bbsrc.ac.uk)

# Data Centre Issues



- Insufficient capacity in current data centre
- Data are so large that tape is no longer feasible for Backup and Disaster Recovery.
- Topology must provide resilience against local & regional disaster through geographical separation.
- Resilience against national disaster will be provided through international collaboration
- Tier 3 is sufficient (confirmed by consultation with Industrial and Academic Users)
- In fact we chose Tier 3+ - keeping redundant equipment live

# ELIXIR European Data Centre



# Telecity Group Solution

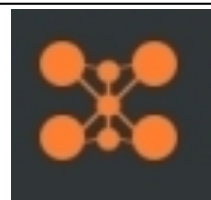


Headquarters in London, Market Capitalisation £750M, Operates 23 Tier 3+ European data centres in prime city centre positions.

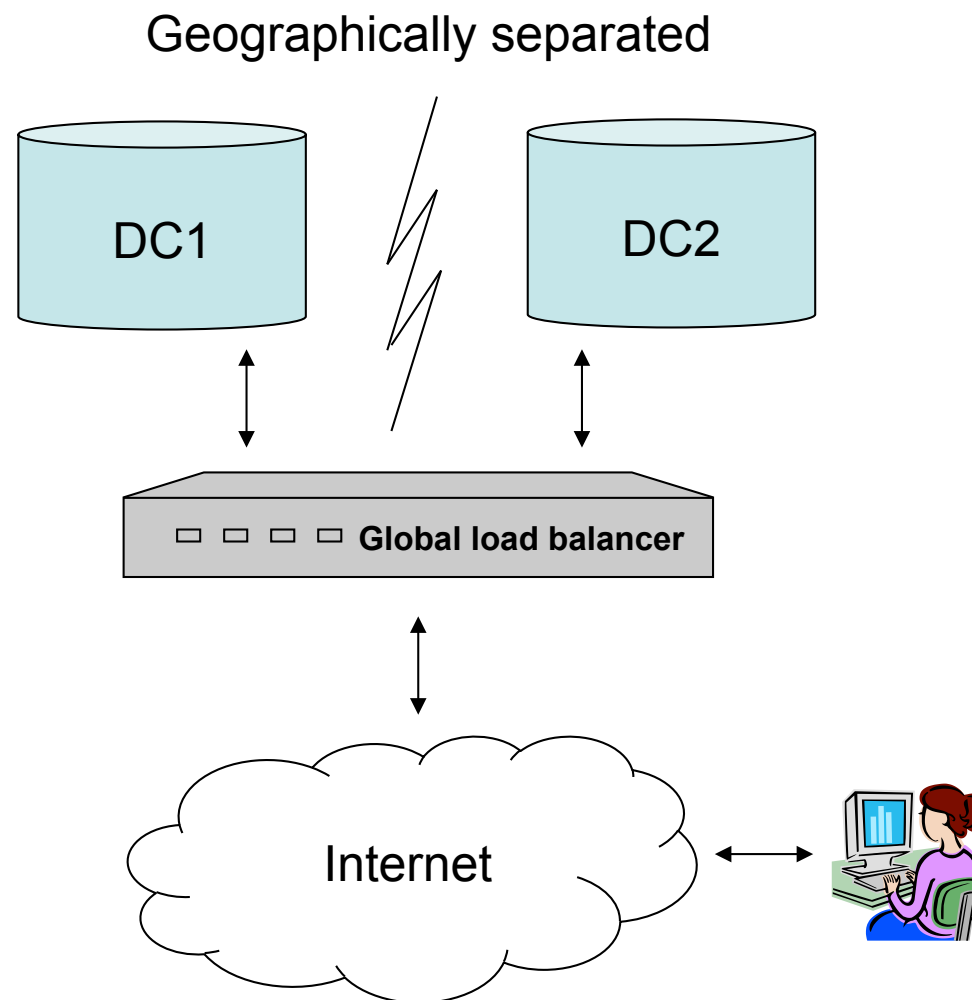
1. Oliver's Yard, a PCI DSS accredited data centre near Old Street, Central London
2. Powergate, their newest and most advanced data centre in Acton, West London



# Tier 3+ service provision



- Both systems active
- Hot failover
- Less than 2h/y downtime
- No planned down time
- Protection from local & regional disaster

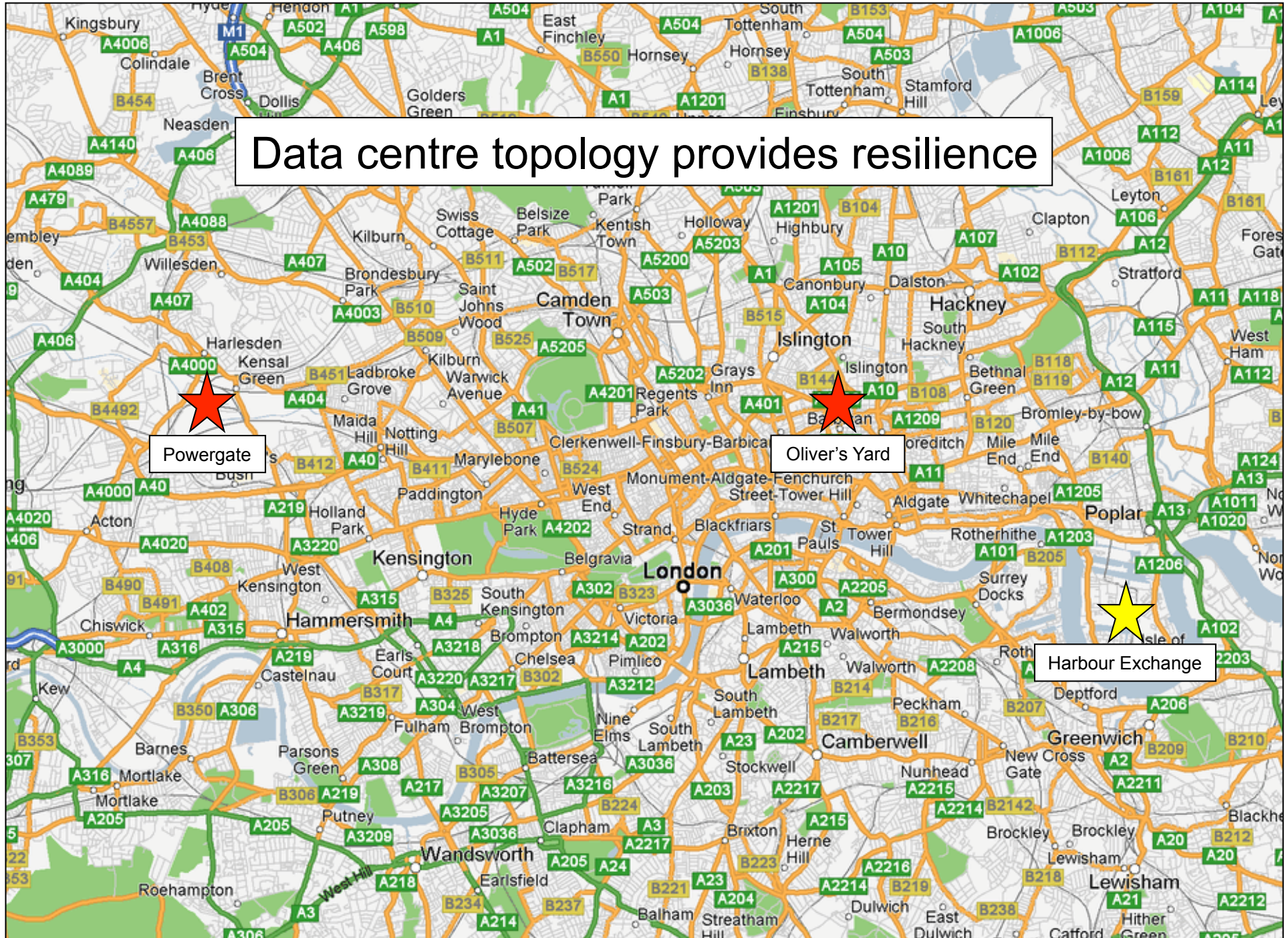


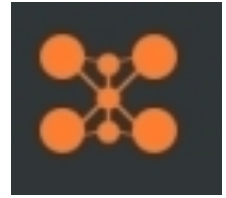
# Data centre topology provides resilience

Powergate

Oliver's Yard

Harbour Exchange

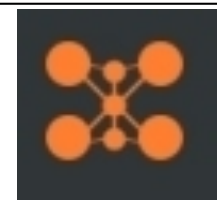




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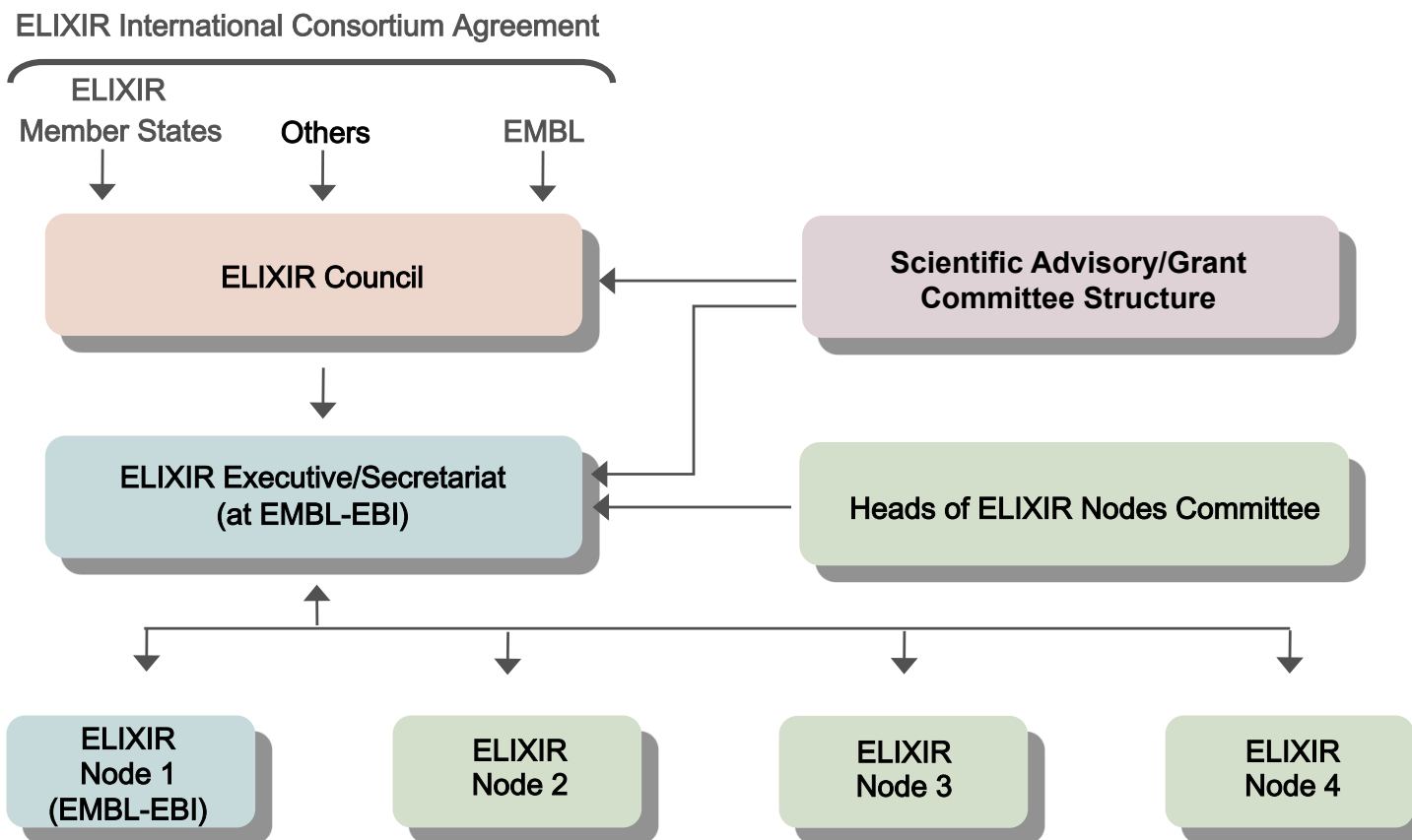
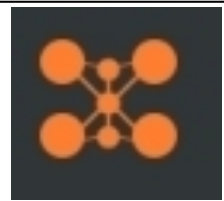
## 5. What happens next?

# ELIXIR Legal Personality

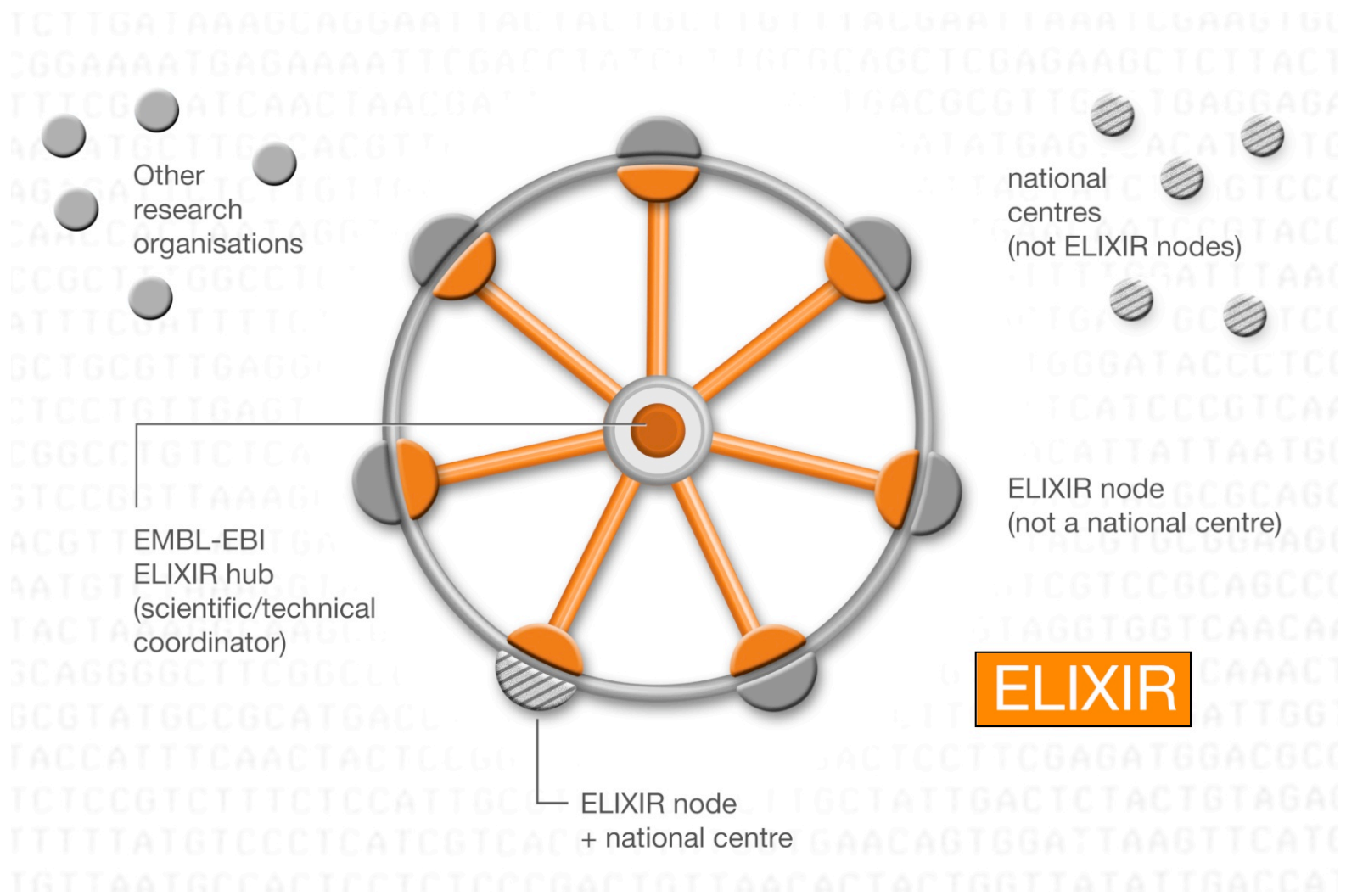
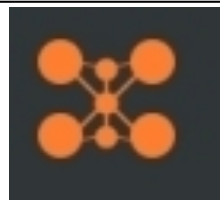


- Initially ELIXIR is most likely to be an EMBL “Special Project” although the decision has not been taken yet.
- In due course this will probably be transferred to an “ERIC”
- This approach will allow a quick start for the construction phase.
- Early adoption of “ERIC” was considered high risk.
- Decision to change will be taken by ELIXIR Management.
- We have taken legal advise on this.
- Bearing in mind the critical importance of ELIXIR for Europe, this is considered the safest way to proceed.

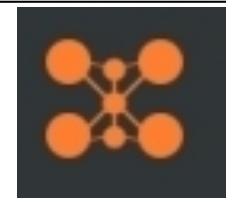
# ELIXIR Management structure



# ELIXIR Scientific & Technical Structure



# Construction Phase



- Request for suggestions for nodes
- Application form and guidelines on web site
- One page advertisement in Nature
- Funders meeting planned for fall
- Applied for one year extension to Preparatory Phase

## Request for suggestions to contribute to ELIXIR's construction

[www.elixir-europe.org](http://www.elixir-europe.org)



ELIXIR

### What is ELIXIR?

The purpose of the ELIXIR project is to construct a sustainable infrastructure for biomolecular data and related information in Europe. This should build on existing pan-European infrastructures or construct new resources with an international focus.

ELIXIR will be a distributed infrastructure arranged as a hub and nodes. The hub will be located at the European Bioinformatics Institute (EMBL-EBI) and will provide its current portfolio of services. It will also house the ELIXIR Secretariat and provide coordination of the nodes.

ELIXIR, in common with all of the ESFRI Research Infrastructures, will be paid for by funding agencies in the member states, which will decide themselves whether and how they will invest in ELIXIR, and will define their own process for considering proposals.

### Stakeholder Consultation

The ELIXIR Preparatory Phase has been consulting stakeholders across Europe in academia, governments and industry for more than two years. As a result of this consultation, ELIXIR has developed a plan for the construction of an infrastructure that will provide world-class data collections and associated resources for Europe's life scientists in academia and industry. This will be critical for tackling the Grand Challenges of healthcare for an aging population, a sustainable food supply and protection of the environment. It will also be essential in ensuring that Europe continues to support an internationally competitive pharmaceutical and biotechnology industry and it will contribute to the construction of the European Research Area.

### ELIXIR will consist of...

- Data resources
- Bio-compute centres
- An infrastructure for integration of biological data, software tools and services
- Services for the research community, including training and standards development

### Request for suggestions

The ELIXIR Steering Committee is seeking suggestions from existing or new European infrastructures to provide pan-European international capability in one or more of the four areas listed above.

The purpose of the request for suggestions is: to provide a means for the Steering Committee to define the landscape of potential nodes; to provide the coordination necessary to ensure interoperability; and to identify duplications and missing capabilities. It will also help ELIXIR, funding agencies and groups within Europe who are interested in developing Node proposals to gain a clearer idea of the Hub and Nodes concept, the means by which it might operate and the implications for its support.

### How to make a suggestion

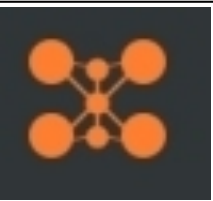
For a template and guidelines for making a suggestion please visit [www.elixir-europe.org/call](http://www.elixir-europe.org/call)

You will also find a detailed description of ELIXIR, guidelines including a description of the hub and node concept, links to the ELIXIR preparatory-phase work-package final reports, and a summary of the results of the stakeholder consultation phase. The deadline for submission is **Monday 12 July 2010**, after which these suggestions will be used to draft a concrete plan for construction. Your early involvement will help to shape the future scope and coordination of ELIXIR. Completed suggestions should be e-mailed to

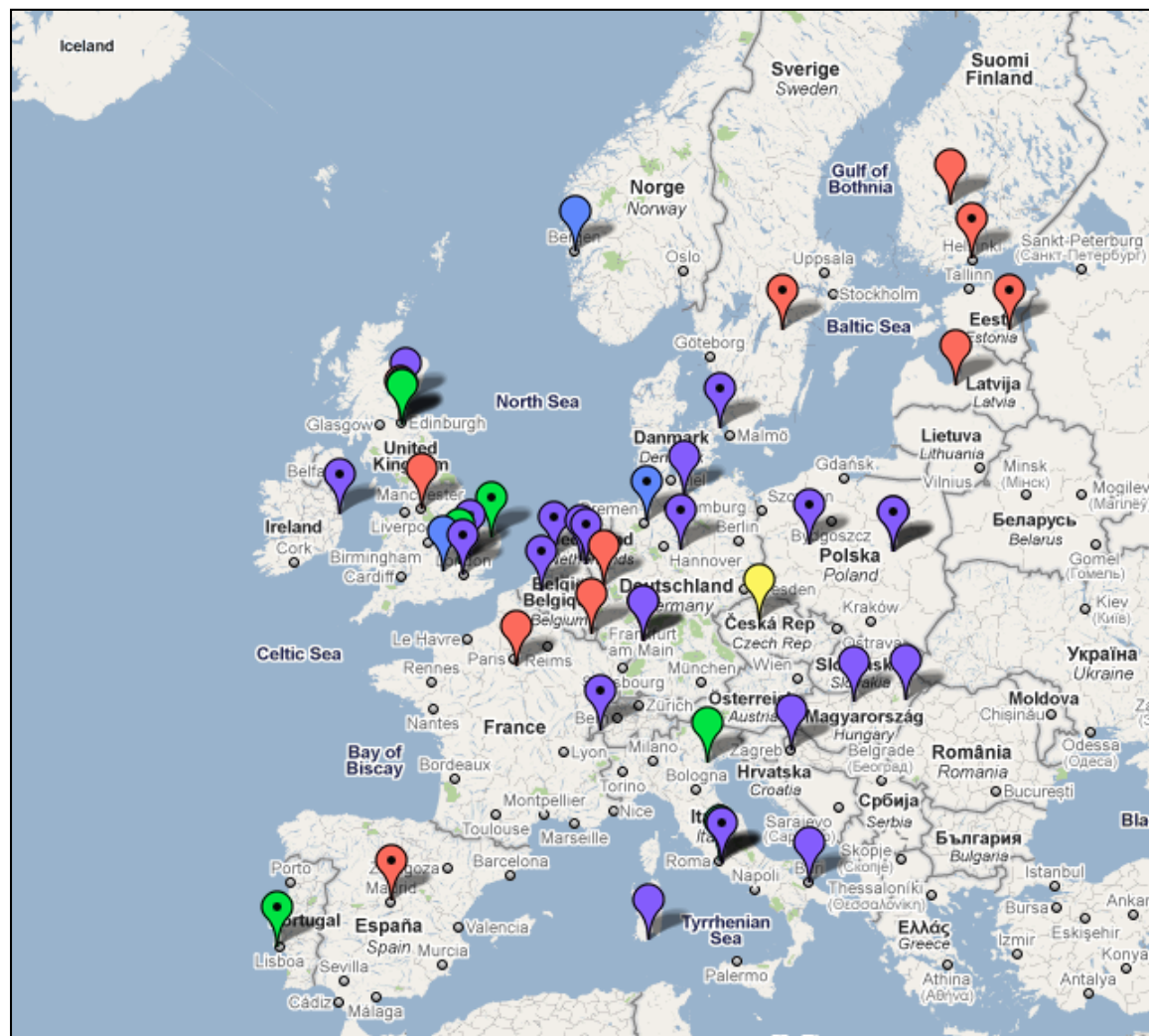
[nslater@ebi.ac.uk](mailto:nslater@ebi.ac.uk)



# Locations of suggestions for Nodes.

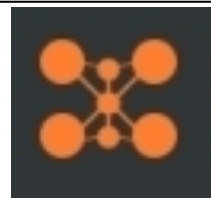


- Medical
- Agriculture
- Environmental
- Pharmaceutical
- General
- Training



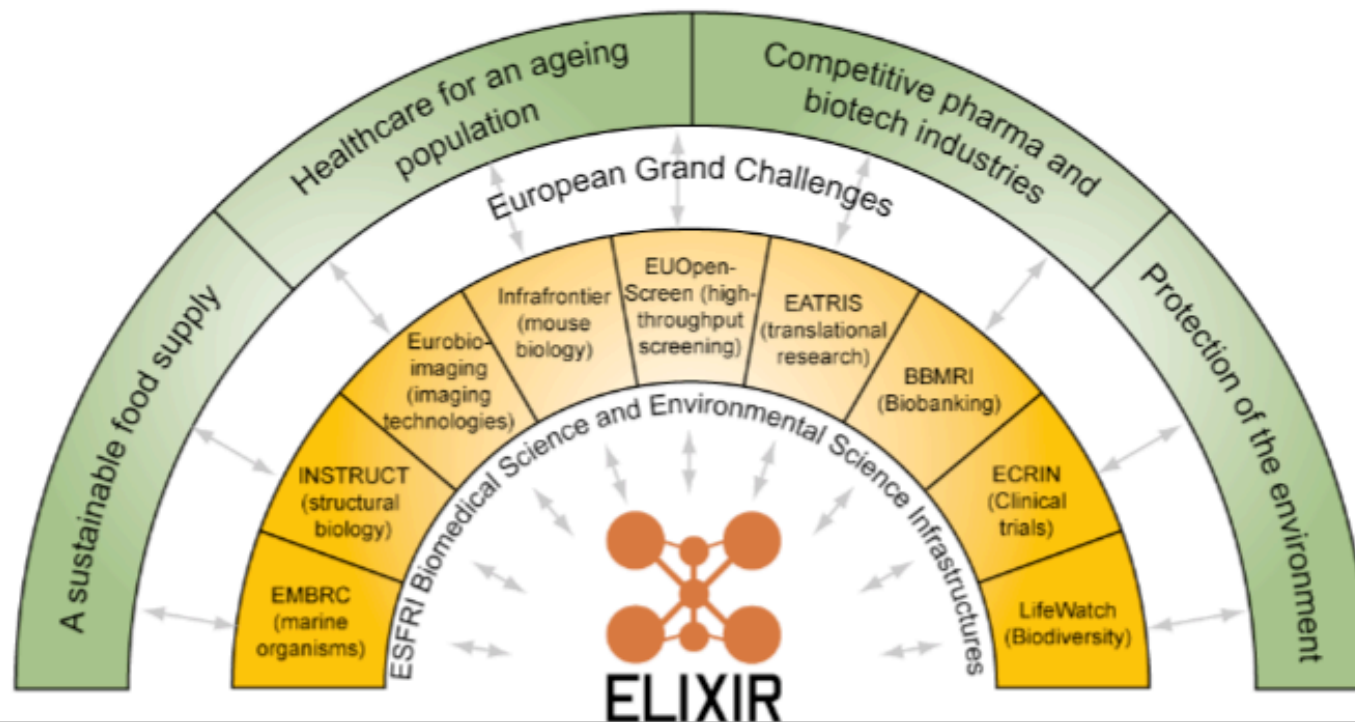
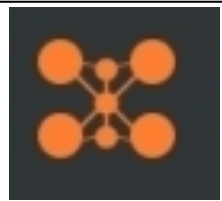
# Tasks for the construction phase

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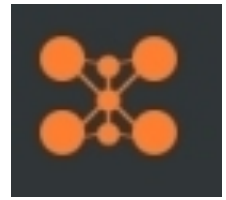


- Clustering ESFRI BMS RI
- Mediating interactions between ESFRI BMS RI & e-Infrastructures
- Providing services and tools for new communities (eg Plant Sciences, Environmental,...)
- Maybe others too...

# BMS Support of the European Grand Challenges



ELIXIR will provide Infrastructure for the other ESFRI BMS RI.



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Thank you for your attention!