Infrastructure for Systems Biology Europe

Deliverable No: 13.4

**Final report with all connections
for the implementation phase defined**

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Project ref. no.	INFRA-2012-2.2.4: 312455
Project title	ISBE – Infrastructure for Systems Biology Europe
Nature of Deliverable	R= Report
Contractual date of delivery	Month 36
Actual date of delivery	Month 36
Deliverable number	D13.4
Deliverable title	Final report with all connections for the implementation phase defined
Dissemination Level	PU
Number of pages	13 (excluding cover pages and ToC)
WP relevant to deliverable	WP13
Lead Participant	VUA
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Project funded by the European Commission under the Seventh Framework program for Research and Technological Development

Dissemination level: PU = Public, RE = Restricted to a group specified by the Consortium (including Commission services), PP = Restricted to other programme participants (including Commission Services), CO= Confidential, only for members of the Consortium (including the Commission Services)

Nature of Deliverable: P= Prototype, R= Report, D=Demonstrator, O = Other.

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Introduction

ISBE connections should be formatted in ways that maximize the usefulness of the systems biology centres and, thereby, the infrastructure as a whole. They should greatly increase the yield and efficiency of European science and technology by enabling them to find, connect to, and engage with systems approaches and training thereof.

The ISBE WP13 aims to develop recommendations for what the connections in the infrastructure should comprise and how they should be structured in order to best serve the above purpose. WP13 defines the connectivity amongst ISBE nodes that enable European systems research and training activities to integrate and scale up. Connections include computer-only, computer-assisted and human-human interactions. Through ISBE, large systems biology-driven community efforts become feasible by connecting the expertise and resources of multiple different projects in past and present, and by enabling the new workforce to do so. This builds ISBE as a platform from which to launch large-scale integrative projects with high scientific and societal impact.

The partners of WP13 had finalised a draft proposal on the ISBE connections in month 15 (Deliverable D13.1, October 2013). In spring 2014, the steering committee initiated a structured process, led by WP11, towards drafting a Business Case by November 2014, which was subsequently concurred with by the consortium. The concepts and designs described in D13.1 provided a key part of the basis from which the delineation of the structure and functional coherence of the infrastructure as a whole was further being developed, back-to-back with the full ISBE consortium. Next, WP13 partners engaged in drafting the Business Case and embedding the proposed connections therein, not as a separate activity but within the discourse of the full modus operandi of ISBE. The contents of this document reflect the outcomes and recommendations on ISBE connections as encapsulated in the ISBE Business Plan.

Background information to WP13

Objectives of WP13

ISBE will consist of nodes and strong connections between these. Particularly Systems Biology needs to integrate various types of expertise that do not exist at a single location at the highest level of excellence. WP13 has the aim to make these connections seamless, ultrafast and user friendly. More specifically the objectives are:

- to define and design all possible connections between ISBE nodes that will promote European Systems Biology
- to design standard interfaces at ISBE nodes that enable computer assisted connecting
- to design ways in which large systems biology tasks can be partitioned over nodes and the results reintegrated

Relationship to other work packages

WP3 (Overall Infrastructure, Eligibility and Accessibility) will define the nodes and WP13 (Connections) will define the edges of the ISBE network. Together with WP4 (Data Generation), WP13 will define the technical interfaces for the connections into and out of the data generation centres. WP13 will design the technical aspects of interfacing/data exchange during systems biology research projects (e.g. web services); WP5 (Community Building and Synergies) will define how the various organisations involved engage with each other before, and after, the active research happens. The insights gained by WP13 on the best ways of communicating, will serve WP7 (Strategy Vision and Advocacy) in developing further vision. WP11 (Funding, Governance and Legal) will mediate the discussions of how to implement the best ways of connecting research into actually funded research projects of research consortia. WP15 (Innovation, Impact and Exploitation) will explore possible connections with industry, where WP13 focuses on connections within ISBE and between ISBE and academic institutions.

Vision and implications for the connections

A systems biology research program consists of various components that need to be integrated almost continuously. These components deal with the creation of mathematical models, the comparison with models already existing in literature, the finding of parameter values in literature, the model-driven design of new experiments, the fine-tuning of the experimental approach to appropriate standards (e.g. carrying out the experiment at physiological pH and temperature), the identification of the best standard experimental model system, the execution of experiments, the analysis of the acquired data, the integration of results into an improved version of the model, consistency checks with consensus scientific knowledge, model analysis to discover biological principles, model interrogation for testable predictions, and model deployment in the context of medicine, pharmacology, and biotechnology.

At present, researchers engaging with systems biology are typically constrained to organize all these activities in their own labs, or to write research proposals for collaborations with other groups that they predefine to contribute lacking components. The former strategy often gives rise to suboptimal quality in many of the components. The latter strategy greatly slows down the progress of systems biology research. ISBE aims to improve this situation by providing individual researchers and research groups with the possibility to efficiently access desired modelling resources by connecting to a national systems biology centre that makes state-of-the-art systems biology resources and services available. Connections with the ISBE core should be seamless and providing rapid access such to requested systems biology components. Systems biology resources at the national systems biology centre will be of high and certified quality. Because systems biology is not the simple addition of modelling, experimentation, data mining, etc., yet a synergy between such activities, ISBE comprises of a network of systems biology expertise centres that is organized to operate as a dynamic, flexible and scalable infrastructure.

This vision requires two types of scientific connections. First, a set of live and continuous connections between the core systems biology centres (the ISBE nodes). The connections should effectively enable a single expertise centre that may in fact consist of component centres that are geographically distributed throughout Europe. To ISBE users this should enable the provision of a single point of entry into the infrastructure. The second type of connection is that between research groups wishing to engage with systems biology, and the ISBE core. This should enable workflows that resemble task processing in complex computations, where separate threads for a specific job are carried out on different cores, wherever possible in parallel, and controlled by proficient instruction sets.

Although ISBE will enable access to a rich portfolio of services, researchers, research groups or consortia that engage with ISBE will remain the dominant components of the research project, contributing their own expertise. ISBE will assist in directing the research projects by supplying the capabilities that helps ensure the systems biology is of high and certified quality, integrating all that is required to understand the biological question at hand (e.g. modelling, experimental design, connections with systems theory, use of valid experimental data, etc.).

Specifications of the connections

1. Interconnecting systems biology centres at the national and European level

The connections amongst centres that offer systems biology services should allow as much as possible for seamlessness in both collaboration and communication. The infrastructure will build on existing national and European resources, drawing on the technological and scientific strengths of its providers to offer a wide-ranging portfolio of services and resources (see especially outputs from WP2, WP3, WP8, and WP10).

Overall, ISBE connections are to be formatted in ways that maximize the usefulness of the centres and, thereby, the infrastructure as a whole. At the scientific level, the infrastructure aims at efficiently supporting and delivering systems biology workflows. Therefore the connections among nodes and centres should empower workflows that are i) model-driven, and ii) integration-centric (Figure 1).

At the human level, the integration of resources from diverse backgrounds requires that people that operate from within ISBE are open and communicative, and to not be competitive at the individual level but rather at the ISBE level. Furthermore they need to be both well trained in their own discipline as well as trained in a trans-disciplinary fashion, so as to readily understand other disciplines to the extent that one is able to communicate and reach out effectively.

ISBE will draw on standing national efforts and structures, and harmonise assets and resources using a shared philosophy, which will offer a convenient, straightforward and consistent mode of access for users both inside and outside the infrastructure. As a result, present systems biology services and resources will become better interconnected with auxiliary offerings and thus see an increase in relevance and usage. These interconnected and complementary services and resources will form a distributed knowledge-based infrastructure of national Systems Biology Centres across Europe, functioning nationally as well as transnationally.

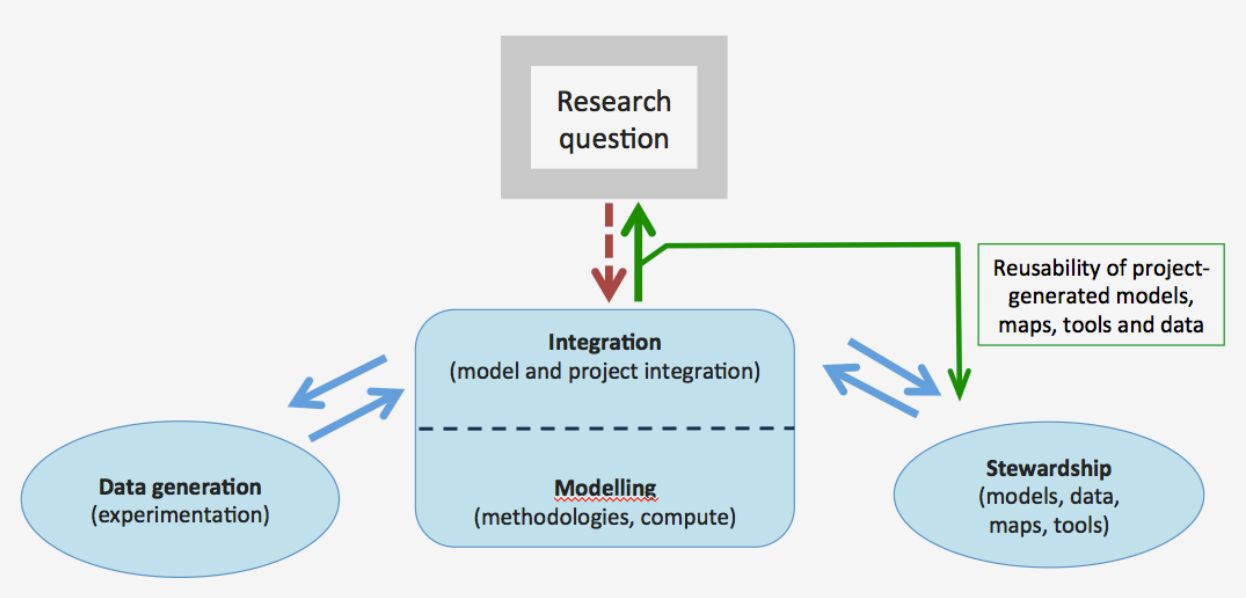

Figure 1 – The model-driven modus operandi of a systems biology research question utilising potentially multiple ISBE centres in an integration-centric fashion.
Dashed arrows: request. Solid arrow: data or model flow. Users can also contribute data and models. Project outcomes are stewarded for use in subsequent research activities.

Linking up systems biology efforts in this way brings together past, present and future national and European investments in systems biology to provide access to a comprehensive, findable and integrated range of services. Moreover, it provides harmonised services with other European research infrastructures to cover all features and components required to effectively position and drive the rapidly maturing field of systems biology.

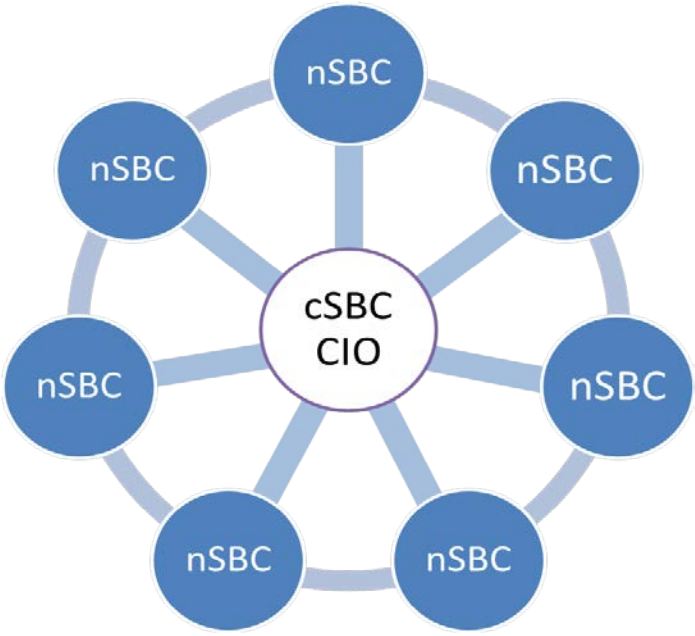

Figure 2: ISBE hub-and-spoke model

As defined in WP3, the effective operation of the infrastructure is empowered through the linking up of three main entities: the national Systems Biology Centres (nSBCs), the coordinating Systems Biology Centre (cSBC), and the Central ISBE Office (CIO) (Figure 2). National Systems Biology Centres form the foundation of the research infrastructure. They will hold the expertise to develop and deliver the portfolio of ISBE services and resources (see e.g. WP2, WP3, WP8, and WP10). In principle, a country maintains one nSBC that acts as the national hub for providing services to the national community. Depending on country size and national preference, the nSBC may constitute a single national institution or a distributed centre drawing expertise from a number of different institutions in a country. Connecting to the nSBC allows users to link up with required systems biology resources, whether users are national academicians and industry researchers, transnational users, or multinational research consortia in the context of for example EU funded research projects. In the latter case, research activities are likely to encompass collaborations of multiple nSBCs, which are then coordinated through the Central ISBE Office and the coordinating SBC. The role of the cSBC is to keep track of the scientific and technical abilities of all nSBCs and coordinate their service offerings. This makes it possible for researchers to find and connect to expertise outside of the national realms. Moreover, the cSBC will manage more complex or extensive user requests that require the cooperation of multiple nSBCs working together to provide the requested services, including e.g. training, consensus model building, or development and implementation of community standards.

2. Connecting a user to the infrastructure

In order to generate as much as possible provide a single point of entry/exit to ISBE for all users, so that they do not have to search around, access will be made easy and efficient through a central web portal. ISBE will be openly accessible to all professionals from European academia, hospitals, clinics and industry, including SMEs, and will cater to users that are proficient in systems biology, as well as those that are less experienced in the field; this will enhance the uptake of systems approaches in all branches of the life sciences, thus maximising the impact of systems biology for society.

The web portal should allow the user to locate essentially all of ISBE's offerings, including finding tools, resources and training courses, but also consultancy services, and brokerage assistance to find specific types of expertise. As such, ISBE will be direct gateway to link up with services provided by connected research infrastructures and provide brokerage to introduce users to services outside of the remit of ISBE, including systems biology compliant data generation and experimental design that is not performed inside within the core infrastructure per se. Typically, after first contact through the ISBE web portal, users will be linked to one of the nSBCs that is able to offer the requested services, or to a number of nSBCs for more complex services. For tasks that involve complex modelling activities, ISBE will serve as a marketplace to introduce prospective users to suitable providers. Modelling services that users can request include model-driven data analysis, model analysis and validation, model-based simulation of systems behaviour, and model construction. In all cases the user will have a single ISBE officer as contact person. Services that are elaborate, such as modelling, model validation and data collection, will likely require a fee and will be based on a contract between ISBE (or the relevant nSBC) and the user. To make engaging with the infrastructure attractive and transparent, users will be presented with clear standard contracts.

Even though the initial connection of users with infrastructure will be web-based, depending on the requested resource or service interactions can subsequently be of various types. An effective means is to offer services through a hotel function, in which users physically go to a systems biology centre to perform a research, training, or standards development activity. On the other hand, activities that traditionally required physical presence, like attending training courses, will also be offered where possible as a remote modality. This would also allow nSBCs to team up internationally in a more efficient matter to pool expertise and jointly develop and offer specific online systems biology courses. Through the web portal users can also find and link up with systems biology related community activities. These will include, on the one hand, connections to the standards development communities. On the other hand there will be connections provided to integrative systems biology initiatives, such as for instance virtual yeast, virtual human, or virtual patient projects.

3. Intra-ISBE connections

In order for the connections to be as efficient as possible within ISBE and towards its users, many recommendations have been put forward and discussed. These recommendations technically can appertain to, for example, interfacing choices, standardisation issues, automation, task modularization, quality control, and higher-order model integration. Many of the detailed arguments and choices hereto are derived from scrutiny within other work packages, especially WP2 (data management), WP3 (centres) and WP8 (modelling services). For details the reader is therefore referred to deliverable reports of said work packages.

Figure 3

**** Research assets***

Include data, models, SOPs, network maps, software, and tools, comprising both user-generated research assets managed and curated by ISBE as well as publicly available model-compliant research assets selected by ISBE. Together they provide a valuable resource for life scientists who want to complement their research efforts with high quality results from other studies.

****Standards & stewardship***

*ISBE will work with research community to develop, promote and manage best practices, community standards and SOPs. It provides an online 'Knowledge Hub' offering best practice material and tutorials to assist researchers in making their research assets FAIR compliant (**f**indable, **a**ccessible, **i**nteroperable, and **r**eproducible)*

****Modelling***

ISBE will act as a marketplace to introduce prospective users to suitable providers of model construction, model-driven data analysis, model analysis and validation, and model-based simulation of systems behaviour.

****Data generation***

ISBE will act as a broker, directing users to relevant academic and commercial systems biology compliant data providers

****Community activities***

ISBE will liaise with its user communities in order for services to be developed towards meeting the needs of academic and commercial users and providers. It will support big integrative systems biology initiatives such as the virtual yeast, the virtual human, the virtual patient, as well as develop and implement community standards, and work with journals and standards communities for their wider uptake.

****Training and education***

ISBE will maintain a comprehensive and up-to-date database of systems biology-related education, courses, workshops and conferences and make this information openly available. It will drive provision of bespoke training for industry through its national centres of excellence, as well as develop a core curriculum for Masters level students in systems biology

Below is a list that summarises the main choices and recommendations that have impact on the connections:

- ISBE will as much as possible provide a single point of entry/exit to ISBE. Users should not have to search around (Figures 3 and 4) and it is the strategic aim of ISBE to use the present and past research outcomes towards improved models as the basis for serving new ISBE users.
- ISBE will make its services as much as possible available through web services and rapid internal communication (with human supervision where required, eventually working towards more automation in many processes)
- ISBE will build on existing (high-speed) connections, including those offered through other research infrastructures (ESFRI)
- Connecting with ISBE should follow as much as possible the model-driven identity of ISBE, i.e. driven by integration through formal representation that is computable in some way (i.e. unambiguous and predictive)
- Connections may be different depending on secure vs. non-secure access requirements (secure connectivity, local storage, access control etc.)
- NSBCs should aim to support modularization of larger systems biology tasks into subtasks that can be allocated to specific centres for parallel processing and subsequent reintegration (Figure 4). This will also be important to demarcate the identity of those centres. With modelling services being a central part of the infrastructure through shared resources, different types of modelling expertise (e.g. stochastic vs. Bayesian vs. ODE-based modelling) that exist in various centres should help defining modularization strategies.
- ISBE will offer access to an online knowledge hub providing best practice material and tutorials to assist researchers in making their research assets FAIR compliant, that is *f*indable, *a*ccessible, *i*nteroperable, and *r*eproducible. The material will include identifying the most suitable formats, ontologies for annotation, and best practice usage of them, for a wide variety of research assets. Importantly, this will make maps, data, tools and models re-usable over prolonged periods of time, in follow-up research projects and by other researchers, adding significant value to research investment.
- Users should be enticed to deposit the project outcomes – models, data, maps, or tools – in the repositories for use in future projects. Centres will have to find way to deal with users that do not wish to do so (e.g. additional ISBE user fees). Based on the types of research project or its needs, projects can generate general types of results and outcomes: models, data, maps, and tools. All these should be assessed and annotated for reusability in subsequent research projects.
- Towards the future, nSBCs should support a growth model: from more human input/expertise initially through many iterations to an infrastructure where the interactions become more automated
- ISBE should promote the establishment of community-driven consensus physiological maps for cells, tissues, or organisms of great interest. Recent endeavours (like for yeast and human metabolism) have proven this a successful and highly valued community service. ISBE can make the outcomes readily usable for the community at large by making such maps interoperable with existing data and tools.
- ISBE should liaise with the life science communities as well as with international (systems biology) journals to drive the development and implementation of community standards
- ISBE should point different modelling methods towards the same (or corresponding) data to avoid diverse models of the same system using different, inconsistent or incomparable datasets to describe said system.

- Most existing biological data sets are unsuitable for systems biology modelling: they are incomplete, unannotated, or have been acquired for other purposes. Researchers active in the systems biology field generally require precise data obtained under defined experimental conditions. To address this, ISBE is to facilitate the generation of data suitable for systems biology through: (i) the development of community standards and best practices for maps, data, tools, models and SOPs; (ii) the provision of brokerage services to bring researchers in contact with external research infrastructures or institutes with experimental design and data generation capabilities in compliance with ISBE standards; and (iii) support in the experimental design phase and throughout the data generation, integration, modelling and model validation process, in order to obtain model-compliant data.
- Quality control and quality rating procedures should be developed to reporting on the reproducibility between outcomes from different laboratories and nSBCs
- Functional links between nSBCs could include commissioning of novel services, resources and activities
- ISBE should underline that quality control of data differs from quality control of models, and actively drive the development of the latter activity since for models this is highly innovative.
- A (federated) method for the selection, dispatch and tracking of tasks, optimized for federate storage layout (as in above; e.g. middleware layers, used in by VPH, VLN, EBI) should be implemented and/or developed, and optimized. This will include versioning, data stamping of activities, storage of data and workflows. ISBE is actively liaising with these consortia and will continue to do so.

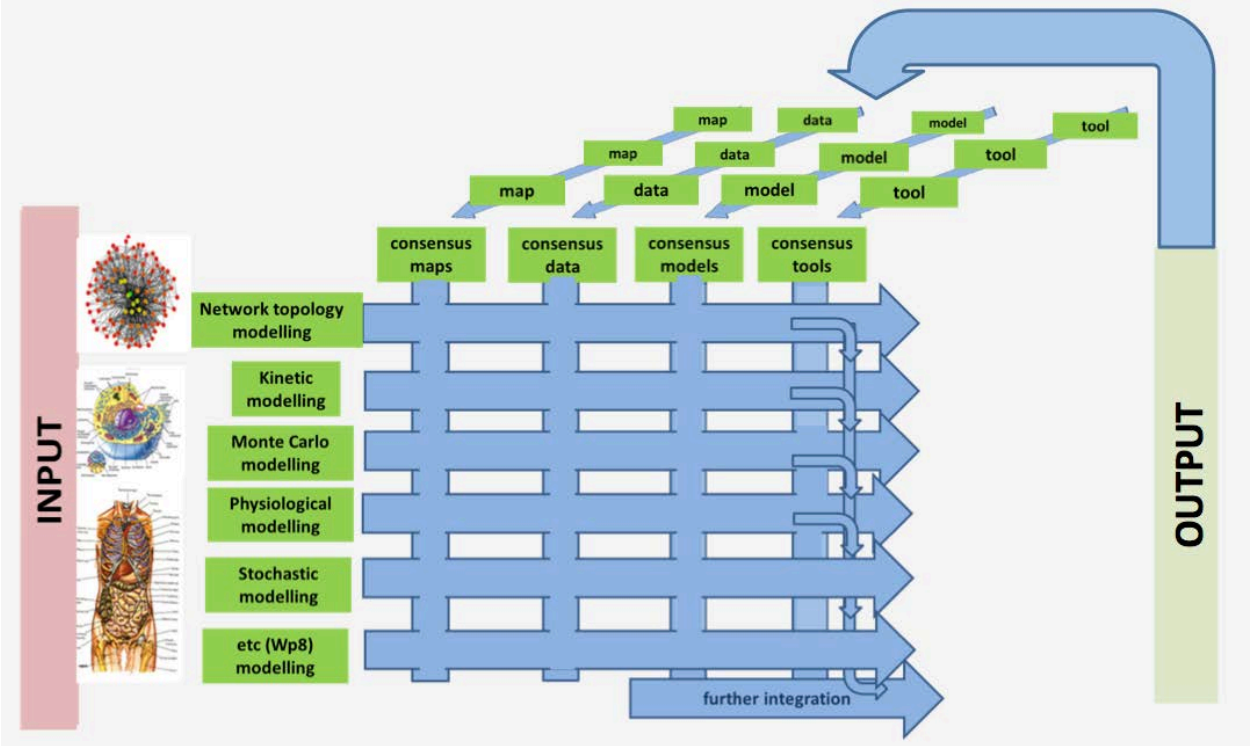

Figure 4 – The ISBE infrastructure will operate such that modelling expertise becomes an integrated and accessible part of the infrastructure through shared resources (nodes in green; connections in blue). The ISBE is self-reinforcing in that the outputs are annotated, versioned, standardized results of known quality, which can find

their place in the same federate storage layout for subsequent iterations or projects, or even further integrated into large systems biology efforts for virtualization of large biological entities (like cells, organs, or full organisms).

4. External connections

ISBE partners are actively engaging at multiple levels with external stakeholders. Here we list are several initiatives and entities that are especially relevant in the context of establishing close and active research and training connections to benefit the ISBE implementation phase.

ESFRI

The 2010 ESFRI Roadmap lists 13 research infrastructures in the life sciences, including ISBE. They complement each other, together forming a strong basis for the development and dissemination of knowledge and the provision of services. With systems approaches becoming more and more pervasive in all branches of biology, ISBE is anticipated to play a central role in in the research infrastructures landscape by enabling overarching model-centric methodologies. The essence of systems biology is to integrate diverse data and technologies to obtain a complete picture of biological systems. Building on this vision, it is important to underline that ISBE already is collaborating with the 12 other biomedical ESFRI research infrastructures to harmonise and optimise their procedures and offerings, through the Horizon 2020 funded programmes COordinated Research Infrastructures Building Enduring Life-science Services (CORBEL) and RItrain.

CORBEL is a 4-year project in response to the Horizon 2020 (H2020) INFRADEV-4 call. It will start in Fall 2015 and aims to enhance the integration and harmonization of actions between all 13 European biomedical research infrastructures. The main goal of CORBEL is to establish a collaborative framework of shared services between the ESFRI Biological and Medical research infrastructures that transforms the efficiency, productivity and impacts of biomedical research and its translational into medicine in the EU (and beyond). This will be achieved by delivering the following objectives:

- forge effective partnerships with user communities
- develop unique solutions to users' needs
- implement a portfolio of generic, shared services that facilitate user access to data, samples and instrumentation through common access policies and shared resource portal

CORBEL's budget is € 14.8 M (2015-2019) of which € 1,5 M is spend through ISBE partners.

Co-leading the workpackage "Bioscience use-cases", ISBE partners will be involved in all four proposed research use-cases therein:

1) "Genotype-Phenotype relations based on models that build on experimental data" with the aim to establish an integrative pipeline to predict genotype-phenotype relationships based on models that use different types of experimental and biological data. A key ISBE contribution here is to deploy diverse model types and modelling methodologies (e.g. Boolean, Bayesian, Petri-Nets, ODE, PDE, stochastic).

2) "Knowledge-driven assessment and prediction of systems responses to pharmacological challenges for safer drugs and chemical products", aiming to establish an Integrative pipeline to assess and predict protein-effector interactions from an integrated compound analysis , 3D structures and curated reference datasets. To this end ISBE partners will provide Integration of data through association with models; multi-scale and multilevel modelling of cellular and whole body networks; omics technologies and big data generation; making data predictive of pharmacology and toxicology through models, connecting PKPD with molecular systems biology.

3) "Structure-function analysis of large protein complexes by integrating imaging technologies and image data across scales" with the aim to establish an integrative access and service pipeline to predict functions of protein complexes based on structural data in vitro and in situ. ISBE partners will provide quantitative analysis, data integration and modelling for functional predictions.

4) "Marine Metazoan Developmental Models for BioMedical research – from predictive integrated databases to functional testing", aiming for the establishment of harmonised MM developmental model databases integrating genomic, transcriptomic and morphological data, building on NSEED database framework, covering 4 MM models". Here, ISBE partners provide access to and data-integration with computational models of marine organisms.

This will provide the ISBE community with a long running cross-infrastructure research trial that will help drive the implementation phase and beyond. This is further strengethed by the fact that ISBE partners also have a substantial role in the parallel "Data access, management and integration" workpackage.

RItrain

The goal of Horizon 2020 RItrain (Research Infrastructures Training Programme) is to identify the competency requirements for the professional management of European research infrastructures (RI) and design a training programme to fulfil these requirements. Its highest priority is those professionals who are already working in research infrastructures, including directors, project managers, heads of HR, legal representatives and communications experts. However, by designing a flexible, modular programme, the project will also be able to provide a new qualification aimed at future managers within research infrastructures – the Master in Research Infrastructure Management.

The RItrain consortium has identified four major objectives for this application.

1. Definition of required competencies in distributed RIs throughout the lifecycle of an RI, from the initial preparatory phase through to operational maturity.

2.Mapping of these competency requirements to existing training courses and programmes.

3. Development and piloting of a comprehensive curriculum, at master's level (EQF level 73), incorporating existing training opportunities and creating new content to fill the gaps.

4. Development of continuing professional development, including a series of webinars based on how real challenges in research infrastructures have been overcome, and a staff-exchange programme.

RItrain's budget is €1.9M of which €185.7k will be spend through ISBE partners. As such, linking with RItrain provides a good basis for ISBE to, during its implementation phase, fine-tune its training offerings to make them maximally relevant in the light of the major European biological and biomedical training programmes.

ELIXIR

ISBE actively engages with ELIXIR to establish synergies in delivering training, data interoperability and data standardisation to address community needs. In developing its portfolio, ISBE recognises the key links it has already forged with ELIXIR as part of developing the CORBEL and RItrain proposals. In addition, the FAIRDOM project addresses the overlapping data standards requirement across both Research Infrastructures. ISBE and ELIXIR will continue to work closely in ensuring a common strategic framework for delivery of services and resources that avoids duplication and redundancy of provision. As a first stage both RIs are committed to developing a common strategic stance.

ERASysAPP

This initiative was launched to coordinate and enhance research opportunities in the emerging scientific field of Systems Biology. A total of 16 funding agencies/partners cooperate within the novel ERA-Net for Applied Systems Biology ERASysAPP. This ERA-Net predominantly aims at funding transnational Applied Systems Biology research, encouraging institutions and scientists from different countries, EU Member States as well as others, to network and share existing resources.

ISBE has actively engaged with the ERASysAPP community and, together with CAsyM (see below), the three have expressed their intention to keep working together in the future. Moreover, as the ERASysAPP project ends on December 2015, ERASysAPP has expressed an interest for ISBE to ingest the resulting data and knowledge for their continuing sustainability and accessibility.

CASyM

The Coordinating Action Systems Medicine (CASyM) is a multidisciplinary European consortium that joined forces to develop an implementation strategy (roadmap) for Systems Medicine. It has 22 partners from 11 countries, and is funded under the FP7 program with €2.9 M for 4 years (2012-2016). The CASyM road map is driven by clinical needs: It aims to identify areas where a systems approach will address clinical questions and solve clinical problems. CASyM's first draft roadmap already clearly states that systems medicine will be scientifically driven through systems biology, and through joint partners

and several interactions the it has become clear that both initiatives continue to work closely together, with CASyM providing the link for ISBE to achieve maximum medical relevance.

FAIRDOM

FAIRDOM is a joint action of ERA-Net EraSysAPP (ending December 2015) and European Research Infrastructure ISBE (starting Autumn 2015) to establish a data and model management service facility for Systems Biology. The €2.7m project was funded in 2014 for 3 plus 2 years. Its prime mission is to support researchers, students, trainers, funders and publishers by enabling Systems Biology projects to make their data, pperating procedures and models, Findable, Accessible, Interoperable and Reusable (FAIR).

FAIRDOM builds on the outcomes of the successful SysMO-DB and SyBIT data management projects, uniting their tool and database development as well as their experience serving large systems biology projects. The project will achieve this by:

- The FAIRDOM Open Software Platform and toolset to manage data, models and projects that combines standards, the SEEK4Science and openBIS tool suites and community tools.
- A centrally hosted, public FAIRDOMHub - a “Systems Biology Community Commons” - for independent researchers, projects and programmes. Researchers can manage their projects and project assets in a secure way. Journals, funders and communities have a resource for shared and published data, models and methods. FAIRDOMHub brings together already established programme SEEKs for SysMO, VLN and independent project SEEKs.
- A Facility of support services for curation, training, and data management planning for the EraSysAPP projects.
- A European Knowledge community for standards, data and model management expertise, FAIRDOM users and developers, and developers of Systems Biology tools and resources. We run workshops and summer schools, and will develop a library of standard templates for data, model and SOP management.
- Working with stakeholders - funders, policy makers, research infrastructures, journals and standards initiatives - to foster FAIR data and model management in Systems Biology. We work actively with COMBINE and ISBE, as well as other national initiatives.

FAIRDOM is supported by 4 national funders (BBSRC, UK; BMBF, Germany; NWO, the Netherlands; SystemsX.ch, Switzerland). Several ISBE partners are already active in FAIRDOM and there is active engagement with ISBE to find ways to support long-term sustainability of FAIRDOM outcomes.

ERACoSysMed

"Collaboration on systems medicine funding to promote the implementation of systems biology approaches in clinical research and medical practice" is the first ERA-Net on Systems Medicine under the EU framework programme Horizon2020. The 14 funding bodies of ERACoSysMed joined forces to support transnational research consortia that demonstrate the feasibility and socio-economic benefits of systems medicine in clinical practice. In the first, co-funded call national financial contributions will be complemented with an EU contribution (co-fund model).

The first transnational call (February 2015) with EU co-funding aims at the development of Proof of Concept and success stories (demonstrator projects) in Systems Medicine to improve understanding and show the utility of this approach in a clinical setting. Projects were requested that specifically demonstrate the translation of systems biology approaches into medical research and practice. ISBE and partners are seeking to deploy activities that would build on, and further showcase, the infrastructure.

VPH

The Virtual Physiological Human (VPH) Initiative has been working to produce patient-specific computer models aimed at delivery of personalised and predictive healthcare, and ICT-based tools for modelling and simulation of human physiology and disease-related processes, from the genome to the whole organ and organism levels. ISBE has been in active engagement during its preparatory phase, and

several ISBE partners and SAB members are long-standing VPH community members. There are ongoing assessments to see how tools, models, software and know-how developed within the VPH initiative can be fully exploited via integration into the IISBE environment.

SysMO-DB

SysMO-DB is a project that is creating a web-based platform, and tooling, for finding, sharing and exchanging data, models and processes in systems biology. It was designed to support the SysMO Consortium (Systems Biology for Micro-Organisms), but the principles and methods employed are equally applicable to other multi-site Systems Biology projects.

The main objectives of SysMO-DB are to: facilitate the web-based exchange of data between research groups within the consortium and with other consortia, and to provide an integrated platform for the dissemination of the results of the SysMO projects to the scientific community. The SysMO-DB system is a progressive and scalable solution to the data management needs of the SysMO initiative. ISBE partners have been active members of the community and ISBE continues to liaise during it implementation phase.