eutema Technology Management GmbH
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FET Flagships

Recommendations for Implementation

Summary Report

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Disclaimer: The views expressed in this document do not represent the official position of the Commission but those from the authors of this study. For further details please contact Dr. Erich Prem, eutema, www.eutema.com.

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1 Executive Summary

Study objectives

This document summarizes results of the *FET Flagship* study by eutema and FFG. The study aims were to refine the flagship concept, analyse experiences with and success factors of flagship-like initiatives, and to select flagship example topics as test cases for potential implementation frameworks. The second part of the study focused on a framework for implementing FET Flagships, i.e. the legal framework, governance models, and instruments as well as on a roadmap and policy recommendations to support the launch of the flagships.

The study provides insights into success factors of previous large-scale initiatives and lists recommendations for how to make large-scale initiatives a success. It analyses different flagship case studies that are quite different in topic, but surprisingly result in very similar recommendations for the implementation framework. A roadmap for realizing the flagships is also presented here.

Success factors

An overview of previous flagship-like initiatives around the world resulted in a collection of 60 examples of which 36 were studied in more detail. Many of these were large collaborative projects in an academic or a cooperative industry-research setting. A set of six such previous flagship-like examples was subjected to an analysis of success factors including interviews with experts knowledgeable in these flagships. The examples included The Human Genome Project, the DARPA challenge, the Large Hadron Collider, the Long-Term Ecological Network, the Strategic Computing Initiative and Assembling the Tree of Life.

As an example, the lessons learned from the Tree of Life initiative included the importance of having a vision or roadmap to better understand and guide research. It also underlined the benefits of a periodic internal or external evaluation. The DARPA challenge showed that for large initiatives it can be vital to remain flexible since unforeseen events may indeed require important changes in such a large-scale initiative.

The Human Genome Project on the other hand started with extremely ambitious goals that many did not quite believe to be realistic. Many formal meetings and information sharing tools as well as an initial capabilities check of the community proved to be useful for reaching the ambitious goals. The strong sense of community but also peer pressure in the case of the Large Hadron Collider supported collaboration towards a joint goal. Finally, the Long-term Ecologoical Network shows the importance of putting in place data management before starting data collection in such a large initiative.

Lessons learned include the necessity to involve the research community in the shaping of the program and to balance individual researcher goals with those of the initiative. It is highly important to clearly define and strategically re-evaluate the goals of such an undertaking; also the structure of the flagship should be very clear. An environment conductive to integration is important to prevent divergence and fragmentation, and it is similarly essential that a consistent vision is assured by strong leadership, including scientific leadership. The initiatives will benefit from efforts and infrastructure to integrate data between various research groups. In summary:

1. Clearly define and regularly evaluate progress
2. Establish strong leadership
3. Create an environment conducive to integration
4. Involve the research community in shaping the program
5. Balance individual researcher goals with those of the initiative
6. Develop an appropriate and clear structure
7. Implement a data management plan prior to data acquisition

Consultation

The study team also consulted with ICT domain experts. Results from this consultation phase and other sources as well as interviews with external experts were performed to collect further input for the refinement of concept and criteria and to assess potential topics for flagship initiatives.

The *mission* character of flagships is considered very important. Clear goals are deemed important for alignment (integration) and for interdisciplinary integration. They are important for communication with funding agencies, politicians as well as the broad public. Experts warn against oversimplified, narrow, or short-ranged goals. Finding these goals, however, is considered very difficult.

There is some scepticism that fundamental research breakthroughs are possible with large-scale programmed initiatives. The individual scientist is important and breakthroughs often come from small teams. Therefore an appropriate element of exploratory approach and competition is suggested. Expert views on the desirable time-to-impact vary, also because *impact* means different things to different experts. There is very high agreement between experts that the integration of and with different scientific disciplines is very important or even essential.

Several experts suggest that flagships should be managed by a small multidisciplinary team of top experts (2 – 20 people). They must break down high-level goals to smaller aims and topics. This requires managing scientists, not just administrators. Management structures may be different for different topics. Most experts believe that some form of centre (either virtual or physical) is useful for achieving integration.

There is very strong agreement that successful flagships require strong scientific leadership. Leadership should concern the content, not just management aspects. Leaders act as the glue binding people and projects together.

Concept refinement

The five ISTAG topics were submitted to an ex-ante impact assessment. This assessment yielded refinements of the FET flagship concept, the assessment and impact criteria.

Flagships are defined as large-scale interdisciplinary European ICT-based research initiatives. The core elements of a flagship are:

- Clear specification of a broadly accepted long-term mission
- Integrative research agenda to realize the common mission
- Strong potential for technological innovation and economic exploitation
- Focus on areas of established European *scientific* excellence
- Strong scientific leadership steering the research activities
- A federated effort by the EU and Member States including industry and global partners where appropriate

Flagships should use calls or competitions for generating ideas and projects. However, flagships are more than a number of projects or a loosely interrelated cluster of projects grouped around a problem because they create synergy and integration. Different topics may require joint infrastructure, localized centres, or a network of research organisations. This can be realized using different governance models.

The main areas for impact of FET flagships will be the competitiveness of European research, impulses for improved co-ordination of Member State activities, relevance for industry and development of new markets as well as impact on societal problems and the public perception of science. It will also be important to assess the appropriateness of a topic against the specific characteristics of the FET model. It is vital to decide on a clear time frame for the impacts as they will differ significantly for various time horizons.

The main selection criteria can be summarized and systematized as follows:

Dimension	Selection criteria
Mission	- Ambition (novelty, vision, impact horizon) - Potential impact on societal problems - Clarity (tangible, easy to communicate)
Impact	- Existence of and impact on globally competitive EU groups - Industrial absorption potential

	- Potential for new markets - Sustainable development (human resources)
Integration	- Member state commitment - Integration of resources (infrastructure, data mgt., staff exchange etc.) - Integrating different fields of science and areas within ICT - Leadership (reputation, credibility, communicative, multi-disciplinary, stability)
Implementation	- *Flagship progress evaluation and review* - *Appropriate idea/proposal evaluation and selection* - *Strategy for international collaboration* - *Integrative research agenda*

The refined flagship concept is based on input from the various sources of this study such as the success factors from previous flagships, expert input, ex ante assessment etc. It puts some more emphasis on the mission- and goal-orientation than the original definition and aims at reducing the assessment dimensions to a small and clear set.

Analysis of flagship examples

The study team analysed research communities in three areas: *Understanding Cells, Complex Social Systems,* and *Novel (Quantum) Computing*. The selection of these areas was performed by ICT domain experts in a dedicated selection workshop with the EC. The flagship topics are used as potential examples only, without any prejudice to future flagship topics.

The aim of this analysis was to find ways to effectively implement the selected flagship initiatives based on an analysis of the legal conditions, governance models, available instruments, but also of available resources and key players in Europe and elsewhere. This analysis is based on discussions with experts in the flagship domains, on information from National Contact Points, internet resources and EC Framework Programme participation data. Experts also rated the required infrastructure for the different example topics and the necessary instruments, legal and governance conditions. A network analysis of EC participation data was performed to learn about the key players, their networks and the structure of the respective communities.

The analysis points to certain differences concerning the characteristics of the areas. While Understanding Cells and Novel Computing show relatively high integration between the actors, the area of Complex Social Systems is relatively broad and more fragmented. There are only few dedicated national research programmes for Understanding Cells and Complex Social Systems, and the area of Novel Computing benefits from funding through basic research or national science funds. EC project data shows a large number of single institute and single researcher (Marie Curie) grants for Novel Computing.

The three communities show similarities in their infrastructure requirements. Supercomputing (i.e. faster processing and dealing with large amounts of data) is important for all areas, although there is no enthusiasm for a single supercomputing facility. For Complex Social Systems and Novel Computing, Cloud Computing was considered relevant. A knowledge management infrastructure was requested for all three areas.

Governance models

A central aim of the study was the collection and assessment of different legal frameworks with a view to their suitability for the implementation of FET flagships. The study team collected a large amount of information on thirteen governance models already existing and implemented for different purposes for European or multi-national initiatives. Joint Programming was also under consideration for closer analysis, but could not be included as this concept was still under development and no reliable document on its features was available at the time of the study. Thus the following initiatives were surveyed:

a) AAL (Ambient Assisted Living Joint Programme)[1]

b) ARTEMIS (Joint Undertaking)[2]

c) CERN (Nuclear research centre)

d) EIT KIC (European Institute of Technology / Knowledge and Innovation Communities)

e) ESA (European Space Agency)

f) ETP (European Technology Platforms)

g) EUREKA

h) EUREKA Cluster CATRENE

i) EUREKA-Eurostars

j) FoF (Factories of the Future, PPP (Public-Private Partnership) in FP7)

k) FP7 Cooperation

l) IMI (Innovative Medicine Initiative Joint Undertaking)[3]

m) ERA-NETs (using as a particular example the MNT ERA-NET)

[1] Based on Article 185 of the Treaty on the Functioning of the EU (ex Article 169)

[2] Based on Article 187 TFEU (ex Article 171 EC)

[3] Based on Article 187 TFEU (ex Article 171 EC)

For each of these initiatives the study team collected information about legal frameworks, governance in programme design, decision making mechanisms, instruments as well as initial estimations of their strengths/weaknesses and their expected potential suitability for FET-Flagships.

Suitability assessment

It is possible to assess the overall suitability of a framework by simple counts of available features. This results in the ESA, EIT-KIC, CERN, Framework Programme, and EUREKA models as leading the suitability assessment. Since some of the criteria are considered more important for FET Flagships than others, a weighting for the criteria was introduced using assessment by the study team but also by domain experts. These different weights were then used to evaluate the suitability of each framework for the three flagship example topics.

Top ranked initiatives	Total points over all flagship topics	Crit. 1 Legal	Crit. 2 Governance	Crit. 3 Instruments
1. EIT- KIC	**492**	**170**	109	213
2. ESA	466	161	119	186
3. CERN	464	128	**135**	201

The ranking of the overall suitability of funding mechanisms is very stable and similar using the weights of the study team or the domain experts. In our analysis, the EIT KIC framework model has the highest potential for implementing FET flagship initiatives in total. Other recommended models include large-scale initiatives with a focus on infrastructures and involvement of physicists (incl. ESA, CERN). Additional role models for specific aspects are AAL (governance) and FP7 (instruments).

Strengths of the top ranking instruments are the multi-annual budget commitment, the use of different funding sources at different levels (EU, national, regional, etc.), simple and direct hierarchical structures with clear competences, support for co-operative RTD projects as well as general transparency in the evaluation and selection process.

Generally, KIC and ESA have advantages concerning the *legal framework*. In *governance*, CERN's model is strong, and also is governance in AAL. Concerning *instruments*, FP7 allows for a broad range of different RTD projects and actions.

In our assessment, the EIT/KIC model appears best suited for flagship implementation because of the long-term commitment and budgeting, the high degree of autonomy at the institute and centre levels, the efficient way of bringing together different sources, the streamlined bureaucracy, and its relatively quick realisation.

To make the EIT/KIC Model even more suitable for the requirements of FET flagship implementation, further improvements are possible in the area of involvement of scientific leaders, using basic research as the main instruments, clarifying the structural requirements for co-location centres, selection criteria, the use of structural funds, and the avoidance of conflicts of interest of Governing Board Members. To make the model a success, support from strong personalities and scientific leaders will be useful.

Finally, the study presents a roadmap and further recommendations to attract relevant stakeholders. It is suggested to install high-level personalities from industry, science, and policy as FET Flagship Ambassadors. Also, there is a need to support the research community in their analysis of the field and the design of the flagship initiative. The research community will also benefit from clear communication channels with the EC and from support in communicating jointly with the member states. The European Commission is advised to further elaborate the advantages of the Flagship concept and its contribution to EU policies and its contribution to societal challenges. These advantages should be communicated in policy briefings with clear and concise messages to the different stakeholders.

Recommendations for Flagships

- Flagships should be clearly **science-driven with inherent risks, but “goal achieving” character of flagships is key.**
- Scientific mission should be **complex, comprehensive and broad, but it must be clear when it is fulfilled and should be easy to communicate.**
- Goals are important for **alignment**, interdisciplinary integration, and for agencies, politicians and a broad public.
- Flagships are focused, **long-term initiatives, but create impact, new technologies, and evaluations along the way.**
- Flagships will benefit from **strong scientific leadership. Leaders act as the glue binding people and projects together; they have to be identified early.**
- Consider efforts and infrastructure **to integrate data between various research groups. Create an environment rewarding integration.**
- Perform scrutiny in **regularly evaluating progress towards the goals and taking corrective actions.**
- Remain **open to the participation of small groups or individuals as the** possible origins of **new creative ideas.**
- **Integrate different ICT fields or integrate ICT with other scientific disciplines, including the humanities. ICT should be not just at the service of another discipline, but at the core.**
- Flagships should be managed by a small, possibly multidisciplinary **team of top people**. They must break down high-level goals to addressable aims and topics. Management and the shape of flagships may be different for different topics.
- Some form of centre (either virtual or physical) can be useful for achieving integration.

2 The Flagship Concept Study

A flagship is the lead ship in a fleet of vessels, a designation given on account of being either the largest, fastest, newest, most heavily armed or, for publicity purposes, the best known.[4]

2.1 Study objectives

The study on *FET Flagships* aimed at

- an analysis of comparative experiences leading to the validation of the FET flagship concept
- the validation of the revised flagship concept and criteria; the selection of two FET-Fs out of the five FET-F ISTAG FET WG examples;
- a design, legal, operational and assessment framework for the implementation of each of the two selected FET-Fs.
- policy recommendations on how to support the launch and implementation of FET-Fs (see Figure 1).

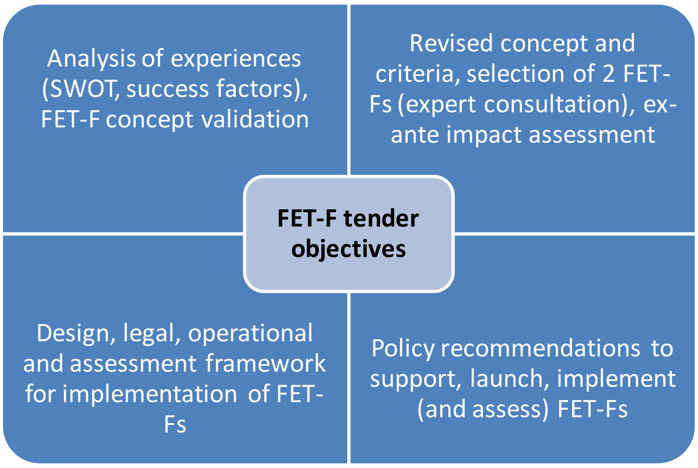

Figure 1: Overview of study objectives

2.2 Approach

The project was divided into two phases:

1) Analysis of past initiatives, concept refinement, and selection of FET-Flagship case studies for detailed analysis

[4] Wikipedia definition: en.wikipedia.org, September 2010.

2) Collection of frameworks and governance models and specification of the FET-Flagship framework, implementation plan and final recommendations.

Figure 2 depicts the tasks in the different project phases:

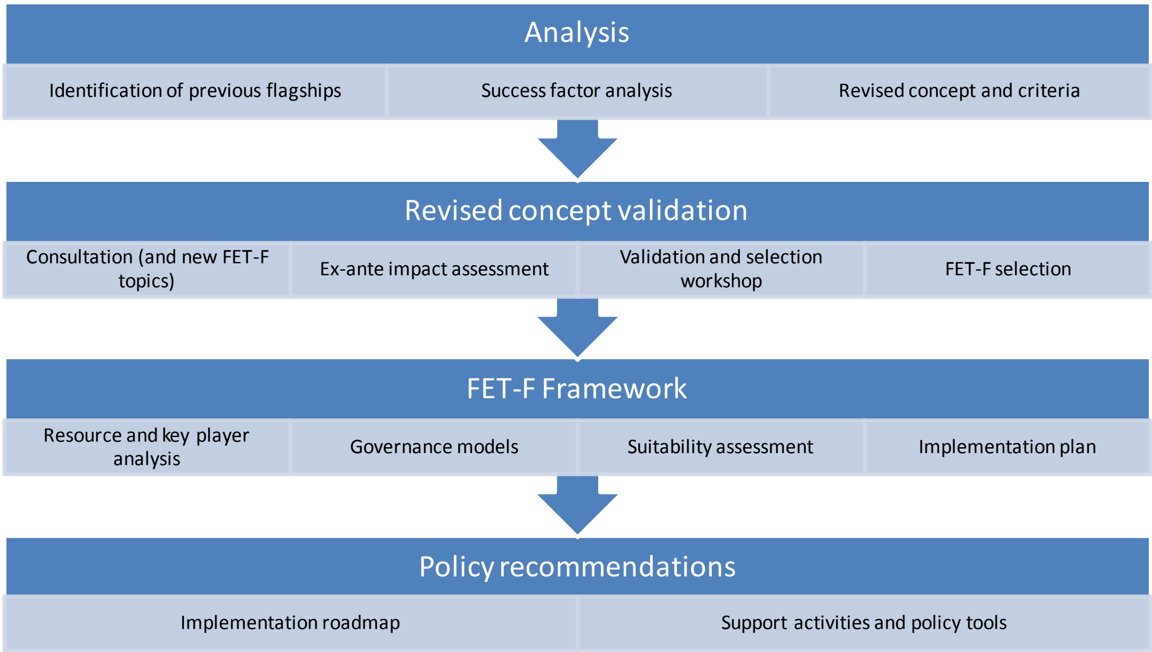

Figure 2 Overview of work packages and tasks

Although depicted as linear here, there were several iterations and refinements that made it necessary to revisit some task results, e.g. the concept revision was a result of the success factor analysis, but also of the consultation phase and the selection and validation workshop.

The main study work was performed between January and September 2010.

2.3 Methods used

This FET flagship study employed different methods to achieve the objectives of the study. Figure 3 provides an overview of the methods employed in the course of the project.

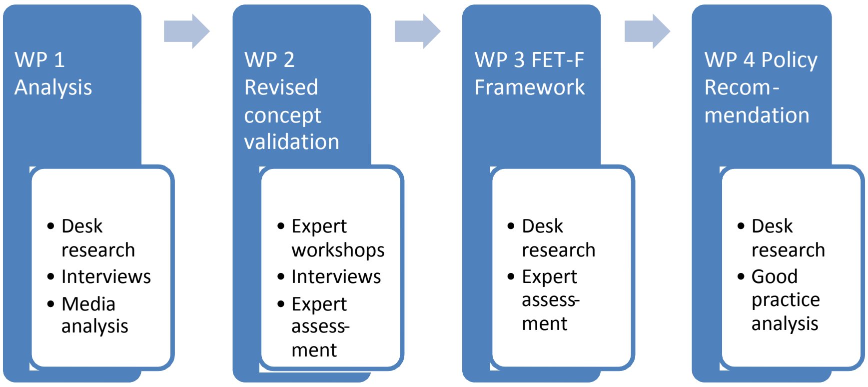

Figure 3 Overview of methods to be applied in the different work packages

The analysis of previous flagship-like examples was based on desk and internet research and interviews with experts. The concept refinement activities of WP2 were based on desk and internet research, phone interview with experts, visits to a lab-based multi-university research centre, and expert workshops.

Expert workshops were held in connection with the following tasks:

- ex ante impact assessment
- previous flagship-like initiative identification and validation

The validation and selection workshop with more than 20 experts from different ICT fields and 3 experts from the study team was organised in Brussels.

Furthermore, interviews with domain experts were performed for the following tasks:

- consultation
- analysis of selected flagship-like initiatives and collection of resources available for the case study areas
- requirements for the legal framework, governance models, instruments
- requirements for infrastructure

Expert assessments were used to validate the impact assessment and SWOT analysis. Policy experts were involved in assessing the validity of the final policy recommendations.

3 Main Results

3.1 The FET Flagship idea

The ICT sector is one of the most dynamic sectors in the EU with above-average growth rates and R&D intensity. More importantly, ICT is a cross-domain technology important to nearly all human activities – private and economic. Paradoxically, the enormous recent successes of ICT research and its pervasive nature can sometimes hinder a clear view of where its grand challenges lie and where the future goes. The European Commission's Future and Emerging Technologies (FET) programme[5] has maintained a long-term perspective of ICT research and an emphasis on the more fundamental questions and radically new answers to those questions. It functions as an incubator and pathfinder for new ideas and themes from a long-term research perspective. Although ICT has undergone dramatic developments and radical changes in the last years, there is no reason to believe that its dynamics will slow down any time soon. ICT benefits from recent advances in nanotechnology, photonics, biochemistry and other disciplines, but it is also a major driver behind these fields. This facilitates the continued emergence of new generations of components and systems including new and unconventional approaches of a breakthrough character.

The success of the FET programme is exemplified by the fact that the IST Advisory Groups (ISTAG) has devoted a special working group to this topic. In June 2009, this group issued a report[6] suggesting the idea of "Transforming ICT for 2020 and beyond" by implementing FET flagships:

These flagships are envisaged to be[7]

- *Long-term, visionary, goal-driven, FET-nucleated, large-scale European ICT research initiatives*
- *Targeting key scientific breakthroughs with strong basis potential for technological innovation and economic exploitation*
- *Built on established strengths of European research, cascading through different scientific and technological areas*
- *Using existing or new funding mechanisms*
- *Implemented through a federated effort by the EU, member states, funding agencies; where appropriate also global partners and industry.*

As a consequence of the ISTAG report and further internal discussions of the European Commission as well as discussions with experts and the member states, the

[5] Emerging technologies describe cutting-edge or breakthrough developments in the emergence in different technologies.

[6] FET flagships: Transforming ICT for 2020 and beyond. Report of ISTAG FET Working Group. ISTAG WG on FET Flagships, ISTAG, June 2009.

[7] Presentation on *New Perspectives for FET* by Wolfgang Boch, Head of Unit, FET Proactive, FET Proactive Information Day, January 21st 2010.

European Commission published a dedicated communication[8] on "Moving the ICT frontiers", i.e. a strategy for research on future and emerging technologies in Europe. This communication defines the goal to "identify and define potential FET flagship initiatives and launch at least two by 2013".

As a result, the European Commission has entered into a dialogue with researchers through workshops and on-line consultations. It also launched the FET-F science forum bringing together science and policy. Most importantly, the Commission opened a call for FET Flagship preparatory actions (pilot projects) to further develop the flagship concept in several areas of research. It is planned to start the pilot phase implementation in March 2011. Finally, the selection and launch of two to three full FET flagships is planned in 2013.

The design and implementation of flagships is demanding because research on grand challenges, on radical ICT innovation and truly foundational questions, is not usually a billion-euro scale endeavour of hundreds of researchers. Quite to the contrary, this type of research is typically pursued by single high-key scientists and smaller albeit excellent groups of researchers distributed all over the globe. The economic prospects of ICT, its breadth and pervasiveness can easily fill the agendas of ICT experts with RTD projects of a more incremental nature and it has not always been easy to make the more fundamental research visible to a broad public. Consequently, it remains a challenge to convince policy makers that persistent efforts are also required for the more fundamental, radical type of ICT research. Clearly visible, large-scale initiatives such as FET Flagships would constitute an important step to harvesting the potential of ICT frontiers research.

The present study was commissioned by the EC to refine the flagship concept as presented by ISTAG, to study in detail flagship example topics with a view of the possible ways of implementing them, to analyse previous flagship-like initiatives, to recommend viable models for flagship implementation, and to advise on policy actions for realizing the FET flagship vision.

3.2 Lessons learned from flagship-like initiatives

The first part of the study focused on the analysis of previous flagships and the refinement of the flagship concept. It aimed at collecting relevant data and information from other flagship-like cases realised in EU und non-EU countries. Particular attention was paid to the U.S., as some initiatives can be seen as best-practice in relation to large collaborative projects between industry and research using different resources.[9]

As a starting point, an extensive *internet and desk research* of national as well as international sources was performed. This task was pursed in a four-step approach:

1) Collecting around 60 short descriptions of flagship-like initiatives in the US, international and a few potential examples

[8] Moving the ICT frontiers, COM (2009) 184, European Commission, 2009.

[9] The *American Association for the Advancement of Science (AAAS)* assisted in the identification of such initiatives, gathering information and analysing the initiatives.

2) This list was further refined adding more information for the initiatives

3) A selection of cases was made for more detailed analysis, resulting in a list of 36 potential examples and a short list of 23 potential flagship-like initiatives for further study. In addition, several examples of currently starting or recently started initiatives were also identified, e.g. Bionic Eye (Australia), Ambient Assisted Living (EU). But they are considered too young to be studied concerning success factors.

4) From this list the study team selected 6 examples for detailed analysis.

The list of 36 potential flagship-like examples contains the following examples:

US-Based - Assembling the Tree of Life - Cancer Biomedical Informatics Grid (caBIG) - Consortium for the Barcoding of Life (CBOL) - DARPA Grand Challenge - Deep Thought/Deep Blue - Earthscope - Geoscience Network (GEON/GRID) - Hubble Space Telescope - Human Genome Project - Human Microbiome Project - iPlant - Long Term Ecological Network (LTER) - Man on the Moon Challenge (Apollo Program) - NASA's Centennial Challenges program - National Ignition Facility (construction phase) - National Nanotechnology Initiative (NNI) - NCEAS - National Center for Ecological Analysis and Synthesis - NIGMS Protein Structure Initiative	- Pacific Rim Applications and Grid Middleware Assembly (PRAGMA) - Sematech - Strategic Computing Initiative - Strategic Defense Initiative (SDI) or Star Wars - Superconducting Super Collider - TeraGrid - The Accelerated Strategic Computing Initiative (ASCI) - War on Cancer - X Prize Foundation **International** - Blue Brain Project - EU-US RFID Lighthouse pilot projects - GBIF, the Global Biodiversity Information Facility - Japan earth simulator - Large Hadron Collider - OMII-UK - Super Kamiokande - The 5th Generation Computing Initiative - Virtual Physiological Human Network of Excellence

Table 1 List of potential flagship-like past initiatives.

The final list of previous flagship-like examples for the analysis of success factors consisted of the six initiatives listed in Table 2, see Annex for summaries of the examples (Section 5.1).

To prepare a detailed analysis of the flagship-like initiatives, information was collected from numerous sources. When possible, planning documents, funding announcements, evaluation materials, and initiative websites were all utilized. For some initiatives, analyses that overlap with the goals of this task have been conducted. Those sources have also been integrated. Finally, interviews were conducted with people intimately familiar with the initiatives to provide a personal context and reality-check for written documentation. For the six initiatives, twenty interviews were conducted using a defined protocol to guide the discussion.

DARPA Challenge
Human Genome Project
Large Hadron Collider
Long-term Ecological Network
Strategic Computing Initiative
Assembling the Tree of Life

Table 2 Selected flagship-like examples for the analysis of success factors

In addition to analyzing each initiative, an attempt was made to identify those principles that appear to transcend specific initiatives. Indeed, despite the fact that the six initiatives came from diverse fields of science, vary in complexity, and cover the last thirty years, similar themes appeared in multiple initiatives. These cross-cutting lessons may be important for the design and implementation of an array of programs and are summarized below.[10]

1) Clearly define goals and regularly evaluate progress.

Clearly defined goals for flagship initiatives are essential to ensure that decisions are made strategically and progress can be assessed. Equally important to establishing goals and milestones is implementing a process for evaluation progress toward them. These evaluations should be used to chart progress, identify challenges and point to opportunities for the initiative.

The Human Genome Project utilized a series of 5-year strategic plans to reach its goals and was constantly evaluating progress. When new DNA sequencing technologies entered the marketplace, the Human Genome Project re-evaluated their strategic plan and adjusted milestones accordingly. Assembling the Tree of Life and

[10] For more information on the lessons learned from the individual past flagships, the reader is referred to the FET study interim public report “Analysis of Flagship-like Examples and Expert Consultation”. http://cordis.europa.eu/fp7/ict/fet-proactive/docs/flagship-ws-june10-55-fet-study_en.pdf

the Long Term Ecological Research Network were implemented with goals in mind, but no milestones or roadmaps with which to chart progress. In addition, both failed to utilize external evaluation until significant drift from the goals of the initiative had taken place. It is conceivable that more frequent use of evaluation could have saved both of these initiatives significant pain. Strategic Computing had a formal strategic plan when implemented that addressed specific long-term technology goals. In addition, the plan had described areas of research that needed to be advanced in order to achieve these technologies. However, it was never described how the areas of research would be integrated to achieve the technologies or alternative plans if research areas did not advance as expected. Both of these omissions haunted Strategic Computing during its existence.

2) Establish strong leadership.

Planning, implementing, and managing initiatives of the scale envisioned for the FET-Flagships is challenging. The person or people charged with these tasks must have sufficient vision to understand the complexities involved in a big-budget, long-term initiative. In addition they must have credibility with the research community, be skilled communicators, and savvy in dealing with the political and societal attention drawn to such initiatives. In many cases these leaders will be existing scientific leaders in the community. The Human Genome Project and construction of the Large Hadron Collider were helped enormously by their respective leadership. Importantly, leadership for these two projects was relatively stable and when change occurred it was managed as seamlessly as possible. This helped ensure a consistent vision for the initiative. In contrast, Strategic Computing underwent numerous changes in leadership. Each change brought a different perspective and identity to the initiative, such that a firm definition for the initiative was challenging. Assembling the Tree of Life has also struggled with consistent leadership, due in part to the use of short-term rotator assignments within the US National Science Foundation to fill the leadership role.

3**) Create an environment conducive to integration.**

The success of flagship-like initiatives is impacted by their ability to integrate the many different partners involved, such that the whole of the initiative is greater than the sum of its parts. This is complicated by the involvement of different research cultures, disciplines, expectations, and personalities. If not done properly, the result is a collection of successful individual projects at best, and a fractured and unproductive program at worst. While integration may occur in the absence of specific action, for most initiatives it may be necessary to put resources and energy into creating an environment for integration. In response to the realization that integration between funded research projects was not occurring to sufficient levels, both Assembling the Tree of Life and the Long-Term Ecological Research Network have recently modified the way they select research projects to reward those with goals of integration or synergy. Previously, projects were selected based primarily on their scientific merit. Integration can also be assisted by providing conduits for interaction. For example, an extensive IT infrastructure was put in place for the Large Hadron Collider experiments. Each of the experiments involves hundreds or thousands of researchers distributed around the world. The common thread that connects the researchers is data, which are centrally collected and distributed throughout the network. Another mechanism to stimulate integration is the use of working groups that cross boundaries (e.g., interdisciplinary or academia/industry). The Human Genome Project used this mechanism to coordinate activities being managed by the US Department of Energy, US National Institutes of Health, and Wellcome Trust-funded Sanger Centre. An additional mechanism is to present a challenge that necessitates the collaboration of disparate groups of scientists. This approach was utilized by DARPA for both the Grand Challenge and Strategic Computing. In both cases, specific research and development goals were presented in ways that encouraged academic and industry collaboration to assist in the transfer of research results to the marketplace.

4) Involve the research community in shaping the program.

Generating and maintaining a community of researchers is essential to the longevity of an initiative. This community will serve to drive the scientific accomplishments of the flagship initiative, developing and implementing innovative research activities. In addition, they will serve as ambassadors for the flagship initiative, sharing their accomplishments and enthusiasm with colleagues and society. Both will impact the success of the initiative. Indeed, key success factors that were indicated for the Human Genome Project and Large Hadron Collider were the unity of purpose displayed by the involved community of researchers and passion for the initiatives. Another example is the Long-Term Ecological Research Network, which has benefited greatly from a committed community of ecological researchers for nearly thirty years.

Interestingly, all three initiatives were developed through extensive engagements with their respective research communities. Planning and feasibility workshops were used to develop reasonable research directions and expectations. In addition, all three initiatives involved members of the research community in the formal management structure, helping to maintain this connection. Alternatively, Strategic Computing developed from a more directed approach with minimal input from the research community in the design and implementation of the initiative. The result was a research community that viewed the initiative primarily as a source of financial support, making the initiative vulnerable. Consequently, changes in management structures and key personnel resulted in shifting initiative goals and identities. While individual components of the initiative were quite successful, Strategic Computing as a program eventually drifted into the background.

An additional mechanism for involving the research community in shaping the program is through periodic external evaluation and guidance. External evaluation and guidance provides an unbiased check of progress, while identifying challenges and opportunities that may not be apparent to those on the “inside” of the initiative. Both Assembling the Tree of Life and the Long-Term Ecological Research Network suffered from a lack of such external perspective for too long. Now each is undergoing a painful process of correction.

5) Balance individual researcher goals with those of the initiative.

While involvement of the research community in shaping a long-term initiative is essential, it may not be sufficient to achieve programmatic goals. The bulk of the examples analyzed in this report engaged researchers through the use of grant funding. While the length of the awards differed for each initiative, in general they were short in comparison to the length of the initiative. On the one hand, this continually brings fresh ideas to the initiative and challenges project to remain competitive. On the other hand, short-term projects tend to focus on near-term objectives. Consequently, there is a balance that must be achieved between the near-term objectives of the funded research projects and the long-term goals of the initiative. If weighed too heavily toward individual researcher goals, the initiative may resemble a collection of projects rather than a cohesive program. As both Assembling the Tree of Life and the Long-Term Ecological Research Network learned, without some guidance from the top, drift can occur that may not be easy to correct. However, there are also risks associated with weighing too heavily toward programmatic goals. Without the intellectual freedom to pursue interesting questions, researchers may abandon the initiative.

Defining an appropriate balance is, of course, challenging. It relies on understanding the cultures of the specific research and management communities involved. In addition, the balance may shift depending on multiple variables, such as the “age” of the initiative, or in response to evaluations or external stimuli. Assembling the Tree of Life and the Long-Term Ecological Research Network underwent shifts of balance in response to a realization that they had drifted away from programmatic goals. The Human Genome Project made a strategic decision to shift from a distributed network of DNA sequencing centres to a focused, scaled-up approach in response to competition. In each case, the shift was accomplished through use of a mechanism that matched the cultures of the research and management communities.

6) Develop an appropriate structure.

While an identifiable leader is important, the complexity of flagship-like initiatives often demands a more comprehensive structure. This becomes especially important when integration between disparate parts of the initiative is required. From analysis of the six flagship-like initiatives, there was no apparent “best” structure that could be defined. They ranged from a minimal structure for Assembling the Tree of Life, where individual grants are awarded by a Program Officer at the US National Science Foundation, to a structure for the Large Hadron Collider that involves integration of input from CERN, the individual experiments, and the dozens of countries involved. Other structures showed different combinations of working groups, executive boards, and steering committees to accomplish decision making. Rather than a specific structure, what seemed to be important was the clarity with which one existed. As a counter example, Strategic Computing was implemented without a plan for integrating research being performed in specific technical areas (e.g. artificial intelligence and computer architecture). In addition, management of the initiative was distributed throughout the funding agency with formal plans for coordination. Consequently, integration was sporadic.

7) Implement data management plan prior to data acquisition

While this was touched on briefly in (6) above, the importance of data management cannot be overemphasized. Flagship-like initiatives involve diverse researchers generating data that will be used to move toward established goals. Achieving these goals demands integrating data between various research groups. Thus, data needs to be of sufficiently high quality, consistent, and available. Assembling the Tree of Life is now struggling with how to integrate phylogenetic data from its taxa-specific groups to generate a unified tree of life. The Long-Term Ecological Research Network was originally envisioned as distinct research nodes and left to collect data as they saw fit. As the sophistication of ecological research questions evolved to be more collaborative, the Network was not able to easily adapt due to a failure to implement a Network data management plan.

In addition to the seven success factors, it is interesting that neither construction of the Large Hadron Collider nor the Human Genome Project was in the strict scientific sense hypothesisdriven. Instead, they were essentially large investments designed to enable a plethora of research questions. As such, they will likely have impacts for decades to come. DARPA’s Grand Challenge was also not hypothesis-driven. Instead, it focused on bringing new ideas into autonomous vehicle design and demonstrating a specific technology capability that would move a whole field of research forward. Its innovative use of a prize mechanism resulted in significant advances at a minimum of cost to the funding agency.

3.3 Feedback from the community – the refined concept

To consolidate the feedback from the scientific community, results from the public consultation phase and other sources was integrated. Also, interviews with external experts were performed to collect further input for the refinement of concept and criteria and to assess potential topics for flagship initiatives. The interviews focused on the following three aspects:

- The general flagship concept
- The subject areas for a flagship
- The management of a flagship

General flagship concept

The “mission” character of flagships is deemed very important. Goals are considered important for alignment (integration), for interdisciplinary integration, but also for funding agencies, politicians and the broad public. Experts warn against oversimplified, narrow, or short-ranged goals. Finding the goals is considered very difficult. The example topics presented in the ISTAG report are judged to be very broad,overlapping, and require further elaboration.

There is some scepticism among experts that flagships are the best way of achieving fundamental research breakthroughs. However, the area of ICT is still seen as a field with a lot of potential for breakthroughs and many experts consider it necessary to aim at these breakthroughs. It has been pointed out that the individual scientist is important and breakthroughs often come from small teams, not from large initiatives. It is therefore important to leave sufficient room for creative thinking in flagships.

Expert views on the desirable time-to-impact vary, also because "impact" means different things to different experts. It has been pointed out, however that in ICT quick transfer of scientific results to economic exploitation is possible in principle. Although this will also depend on the specific topical area, a long initiative will require visible results and real-world impact already along its way and not only after 20 years.

It will be important that the flagship goals and achievements are evaluated at regular intervals to demonstrate progress and to adapt the strategic research programme.

Subject areas for flagships

There is strong agreement between experts that the integration of and with different scientific disciplines is essential. There is consensus among the experts to focus on areas of European strengths, i.e. on areas where Europe has globally leading groups; otherwise there is a risk to put money in the wrong areas with only mediocre outputs. A possible danger lies in the fact that ICT can contribute to other fields without progress in ICT itself.

Flagship management and evaluation

There are significant challenges involved in managing a large initiative such as flagships. Risk assessment is also a huge challenge, but necessary to avoid failure.

Several experts suggest that flagships should be managed by a small multidisciplinary team of top experts (2 – 20 people). They must break down high-level goals to smaller aims and topics. This requires managing scientists, not just administrators. Management may be different for different topics but scientists need to be involved early.

Most experts believe that some form of centre is useful for achieving integration, but this varies with the topic. In areas with joint infrastructure, this can create enormous synergies. If centres are created, established centres of high-quality research in Europe should be included. But even if there are joint centres, it will be necessary to remain open for researchers in other places as they may not be able to move. It should be avoided to first "create" a centre and then fill it, instead centres should grow naturally, e.g. from integrating projects.

There is very strong agreement that successful flagships require strong leadership. Leadership should concern the content, not just management. Leaders act as the glue binding people together. Leaders are trusted people willing to also work for others. Flagships cannot be micro-managed, they need a large amount of freedom balanced by evaluation at regular intervals. It is important to avoid mere collections of projects without interaction. Large projects are not enough. Also, cooperation between projects is necessary.

Flagship management needs to analyse the field and react in a flexible way, e.g. by creating calls for research proposals and ideas. Calls are an accepted instrument in the scientific community to collect new ideas from a large number of people. It has been suggested several times that a flagship basically should be an advanced funding agency.

In a large flagship, a very large number of European domain experts will be involved. This poses significant challenges for evaluation and review of flagship progress but also for external advice.

Refined concept and criteria

The consultation and the views of a group of experts assembled in a workshop in Brussels resulted in the following refinement of the flagship concept.

Flagships are defined as large-scale interdisciplinary European ICT-based research initiatives. The core elements of a flagship are: • Clear specification of a broadly accepted long-term mission • Integrative research agenda to realize the common mission • Strong potential for technological innovation and economic exploitation • Focus on areas of established European *scientific* excellence • Strong scientific leadership steering the research activities • A federated effort by the EU and member states including industry and global partners where appropriate Flagships should use calls or competitions for generating ideas and projects. However, flagships are more than a number of projects or a loosely interrelated cluster of projects grouped around a problem because they create synergy and integration. Different topics may require joint infrastructure, localized centres, or a network of research organisations. This can be realized using different governance models.

Table 3 The refined FET Flagship concept

A revised list for assessing possible flagship topics resulted from the analysis of previous flagships and the ex-ante impact assessment and consecutive discussions. ISTAG originally proposed a list of eight selection criteria in its report[11] while a simplified version of this list was used by the EC later.

The FET-F selection criteria were subjected to critical analysis by the study team and a team of scientists and researchers. It is recommended to structure the refined selection criteria along four dimensions, of which the first three are to be evaluated at the first (proposal) stage while the criterion on *implementation* is to be assessed only after the selection of a flagship topic (Table 4).

[11] Goal, Impact, Novelty, Ambition, Interdisciplinary research, Resources, Plausibility and Sustainability

Dimension	Selection criteria
Mission	- Ambition (novelty, vision, impact horizon) - Potential impact on societal problems - Clarity (tangible, easy to communicate)
Impact	- Existence of and impact on globally competitive EU groups - Industrial absorption potential - Potential for new markets - Sustainable development (human resources)
Integration	- Member state commitment - Integration of resources (infrastructure, data mgt., staff exchange etc.) - Integrating different fields of science and areas within ICT - Leadership (reputation, credibility, communicative, multi-disciplinary, stability)
Implementation *(to be assessed after topic selection)*	- *Flagship progress evaluation and review* - *Appropriate idea/proposal evaluation and selection* - *Strategy for international collaboration* - *Integrative research agenda*

Table 4 Refined FET-F selection and assessment criteria

Also, there was a set of impact dimensions for the FET flagships from ISTAG[12] that was expanded in later discussions. These lists were partially redundant and subjected to further analysis and refinement. For the impact dimensions, an ex-ante assessment was performed to validate the independence of the impact dimensions. The result for the five topics is depicted in Figure 4.

[12] Societal impact, impact on science and technology, innovation and the creation of emerging markets

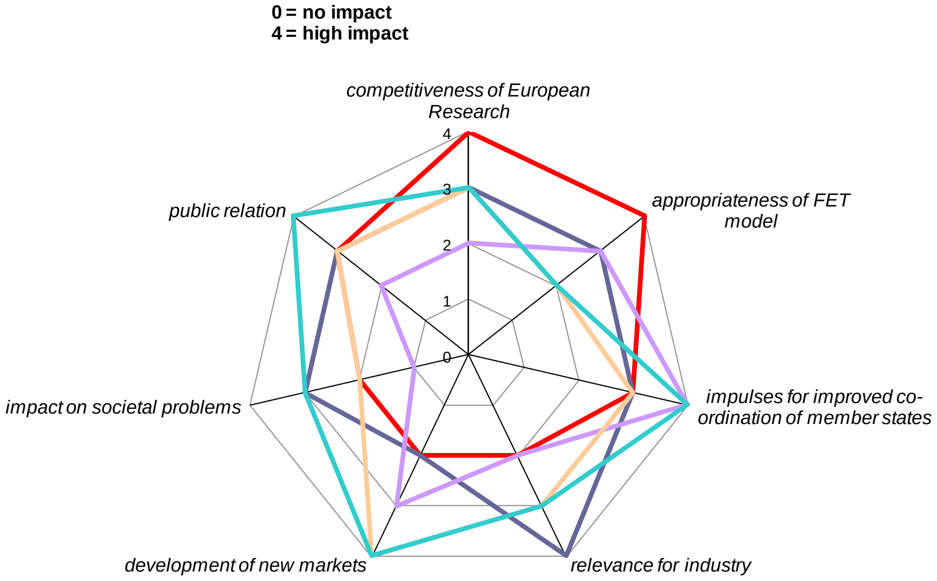

Figure 4: Ex-ante impact assessment for five FET-F example topics to validate the independence of impact dimensions

As a result of this analysis, the FET flagship impact dimensions were reduced to the following list:

Criterion	Impact dimension
1	Competitiveness of European research
2	Appropriateness of the FET model
3	Impulses for improved co-ordination of member states
4	Relevance for industry
5	Development of new markets
6	Impact on societal problems
7	Public relation

Table 5 Refined impact dimensions

It is important to note that for assessing these impact dimensions, it is absolutely vital to decide on a clear time frame for these impacts. The ex-ante assessment clearly showed that the flagship impacts can vary significantly depending on the time-frame chosen for considering impact.

3.4 Analysis of flagship examples

3.4.1 Resource and Key Player analysis

This part of the report summarizes the analysis of research communities in three areas: *Understanding Cells, Complex Social Systems,* and *Novel (Quantum) Computing*[13]. The selection of these areas was performed by ICT domain experts in a dedicated selection workshop. The selected example areas are hypothetical and used only as general case studies, without any prejudice to future flagship topics. The aim of this analysis was to find ways to effectively implement the selected flagship initiatives based on an analysis of the legal conditions, governance models, available instruments, but also of available resources and key players in Europe and elsewhere.

It must be noted that a draft *design* of flagships for these three areas was not part of the analysis and indeed could not have been achieved based on the general formulation of the topics and the feedback received. Such a design would have relied heavily on the study steam selecting groups and resources at will. The study team felt that this would not have facilitated any valid conclusions. Instead, the analysis of flagship case studies was focused on the differences between the three subject areas and on the suitability of different frameworks for implementing them as flagships (Section 3.5.2).

The analysis of the different example topics is based on the following sources of information:

- Discussions with domain experts in the three subject areas concerning requirements of their field and available resources such as research groups and infrastructure
- Numerical weights indicating the relative importance of framework requirements, governance aspects, instruments, and infrastructure
- Information from National Contact Points on available resources including national programmes, dedicated research institutes, research groups[14]
- Internet research on available resources
- Project participation data based on research projects (including Marie Curie and other activities) in the EC's 6th and 7th Research Framework Programme

From these sources, the EC project participation data and numerical weightings from experts were considered most relevant by the study team.

For the infrastructure aspects, experts were asked to rank the importance of infrastructure (using weights 0-10) based on a questionnaire which included the use of

[13] Note that *Novel Computing* is also sometimes used to refer to more biologically inspired new forms of computing. Here, the term is limited to the field of quantum computing.

[14] The information from NCPs cannot be considered complete as there is information lacking from several member states.

supercomputing, processing requirements, joint data and knowledge management infrastructure, cloud computing etc.

In order to analyze the structure of the different research communities, EC project participation data was used to list actors in the different subject areas. In a next step, we performed a network analysis of this data. We used the tool Netdraw[15] for network visualization; it combines multidimensional scaling techniques (Gower scaling) with an iterative fitting algorithm (spring embedding).

3.4.2 Understanding cells

In the area of Understanding Cells, mainly R&D projects were used in the past as the preferred funding method at EC level.

Understanding cells is a relatively small (less than 200 actors) but well integrated community with key players integrating different sub-communities which acts mostly at a European level. When integrating all areas into a single network Understanding cells does not form a consistent community but rather becomes positioned at the edge of the core.

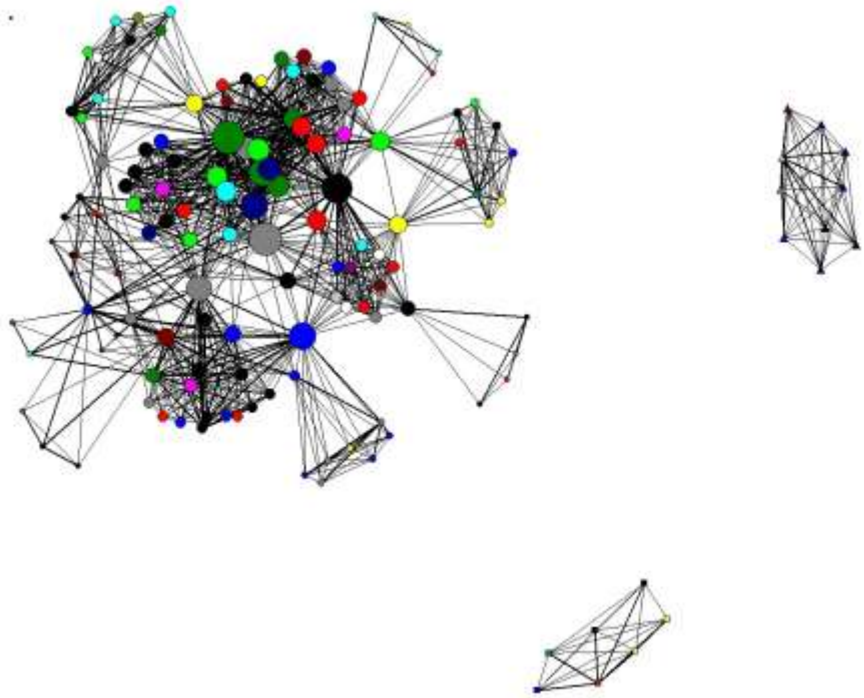

Figure 5 Result of the network analysis for Understanding Cells (EC project data)

Countries which are best established in Understanding cells include Germany (DE) which acts as a hub integrating many other active countries such as SE, FR, CH and NL. Examples for important institutions are

[15] http://www.analytictech.com/Netdraw/netdraw.htm

- Chalmers Tekniska Hoegskola (SE)
- Eidgenössische technische Hochschule Zürich (CH)
- Max-Planck Gesellschaft zur Förderung der Wissenschaften (DE)
- Vrije Universiteit Amsterdam (NL)
- École polytechnique fédérale de Lausanne (CH).

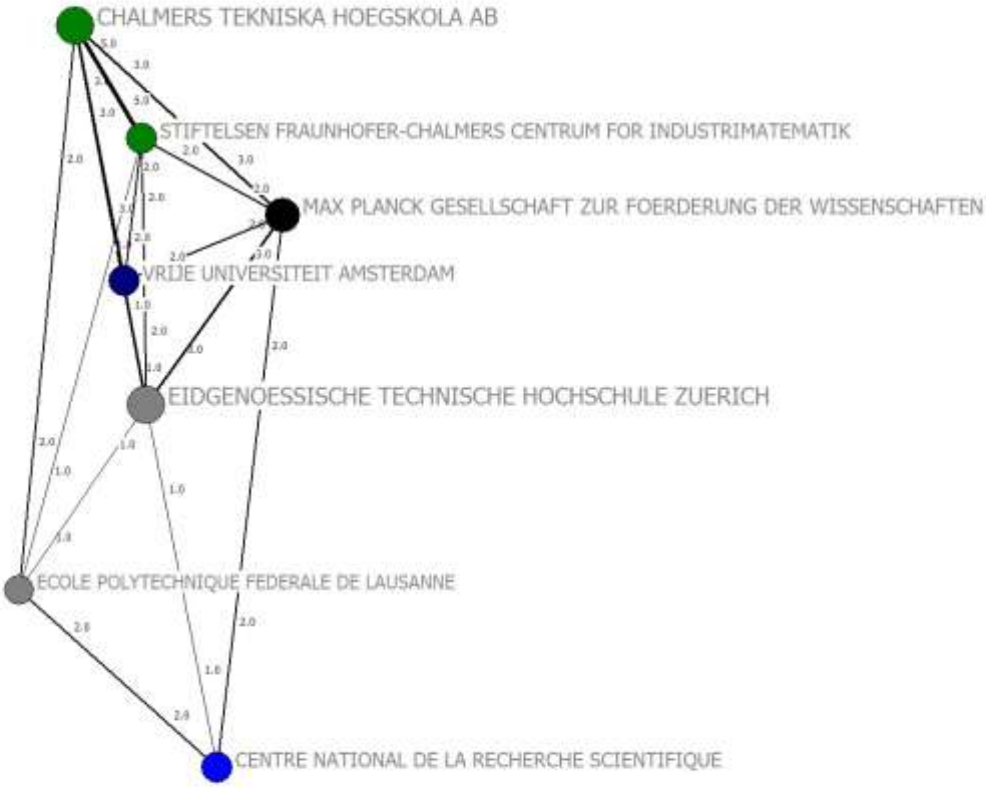

Figure 6 Overview of top networkers in Understanding Cells

Players with strong ties are depicted in the following Figure 7:

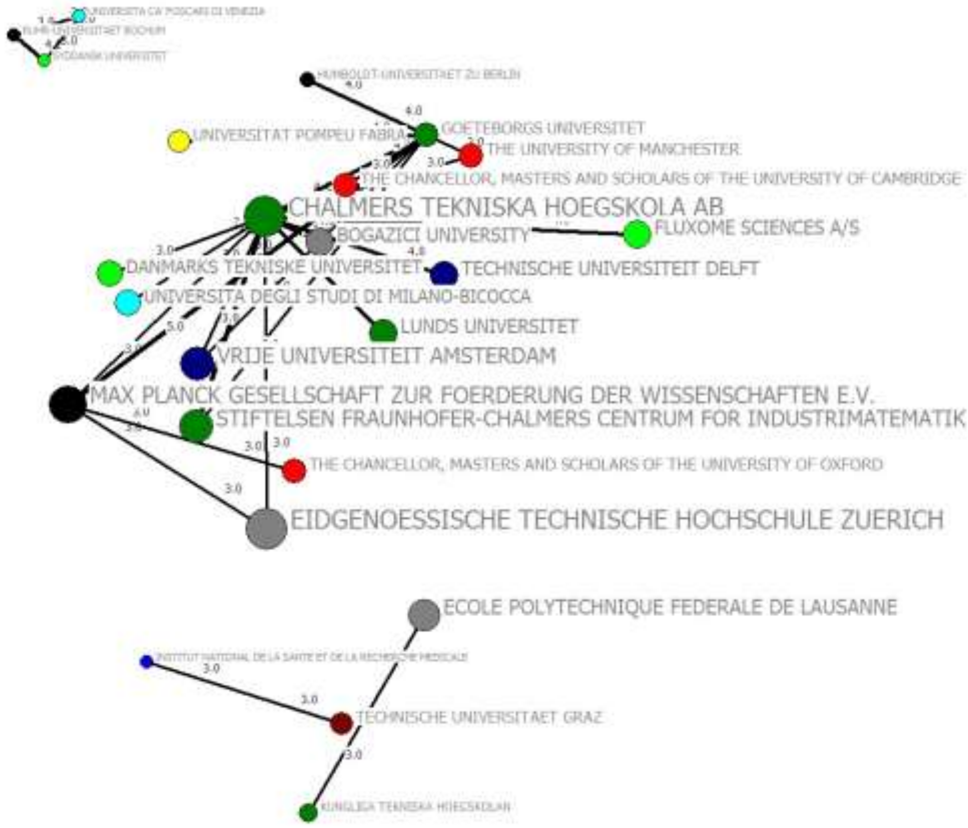

Figure 7 Players with strong ties in Understanding Cells

The role of infrastructure in this domain was characterized as follows:

	How important is…	Weight 1 (low)-10 (high)
4.1	the use of supercomputing for this flagship topic in general	**8**
4.2	a single joint supercomputing facility (rather than possibly smaller scale computers for each group)	**4**
4.3	much faster processing power than available today	**5**
4.4	a joint infrastructure for data collection and data management	**3**
4.5	facilities for storing very large amounts of data (e.g. Petabytes)	**5**
4.6	the use of cloud computing for this flagship topic in general	**3**

4.7	data bases to integrate mostly results from the projects	**6**
4.8	knowledge management infrastructure (e.g. for papers, reports, lab books, etc.)	**6**

Table 6 Assessment of the role of infrastructure for Understanding Cells

The use of supercomputing, faster processing, but also storing large amounts of data is considered important while cloud computing is not considered as relevant as in the other topics. Note that in this topical domain, a knowledge management infrastructure is also deemed an important asset.

From the national perspective, there are relevant programs in NL, CH, ES and research centres and groups in NL, IT, SI, CH, ES.

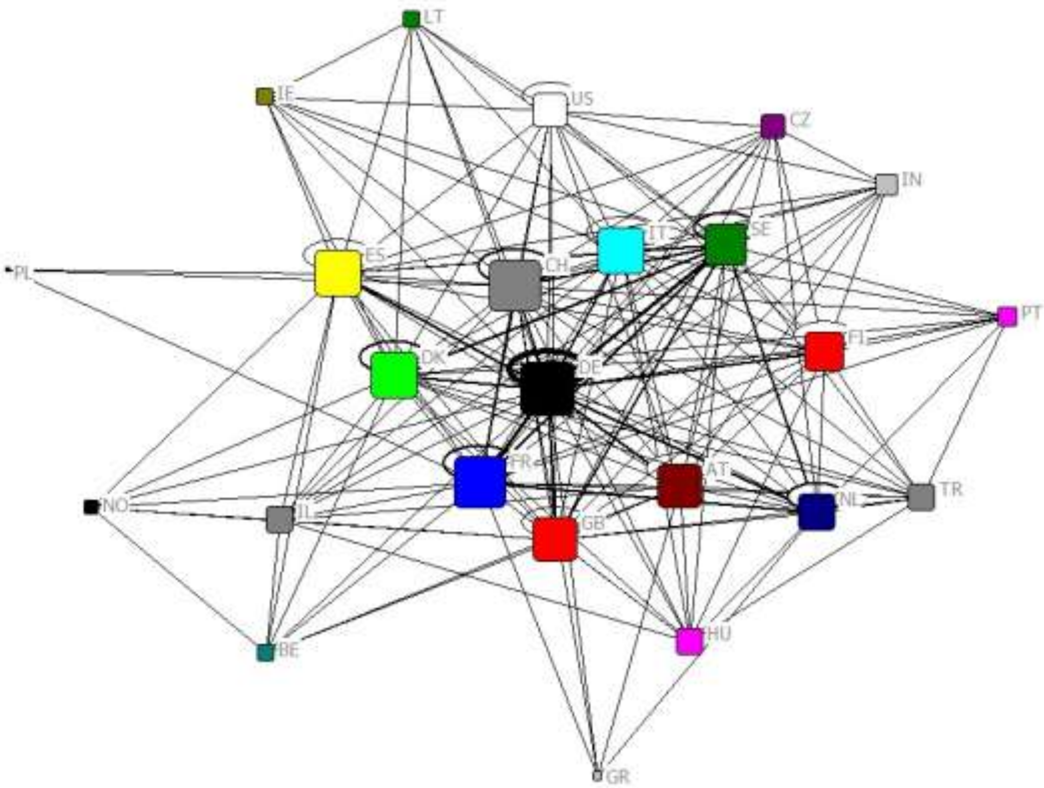

Figure 8 Connections of countries in Understanding Cells

In summary, "Understanding Cells" is a relatively small field in the Framework Programme. Its actors are very well integrated forming four clusters in our analysis. The key player nations are CH, DE, FR, NL, and SE. The use of supercomputing is considered important, both concerning faster processing and large amounts of data.

3.4.3 Simulating complex social systems

For the area of Complex Social Systems, R&D projects have been the most important funding method at EC level in the past. There are also a few integrative structures (centres, infrastructures) present in this area.

Based on the EC project participation data but also on feedback from the community, Complex Social Systems is a broad topic with more than 300 actors in a fragmented community with different focal points including broad EU and international cooperation.

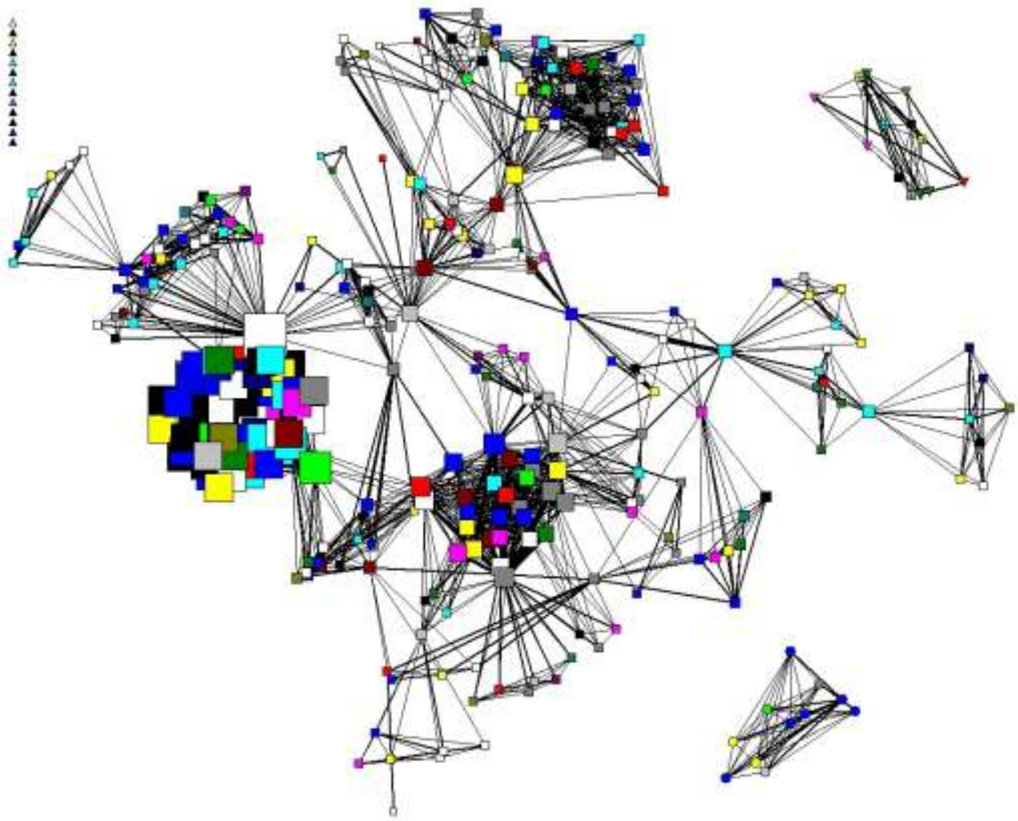

Figure 9 Result of the network analysis for Complex Social Systems EC project data.

For the topic Complex Social Systems there are many countries with at least one well established organisation. The most prominent are DE, NL, ES, FR, and GB.

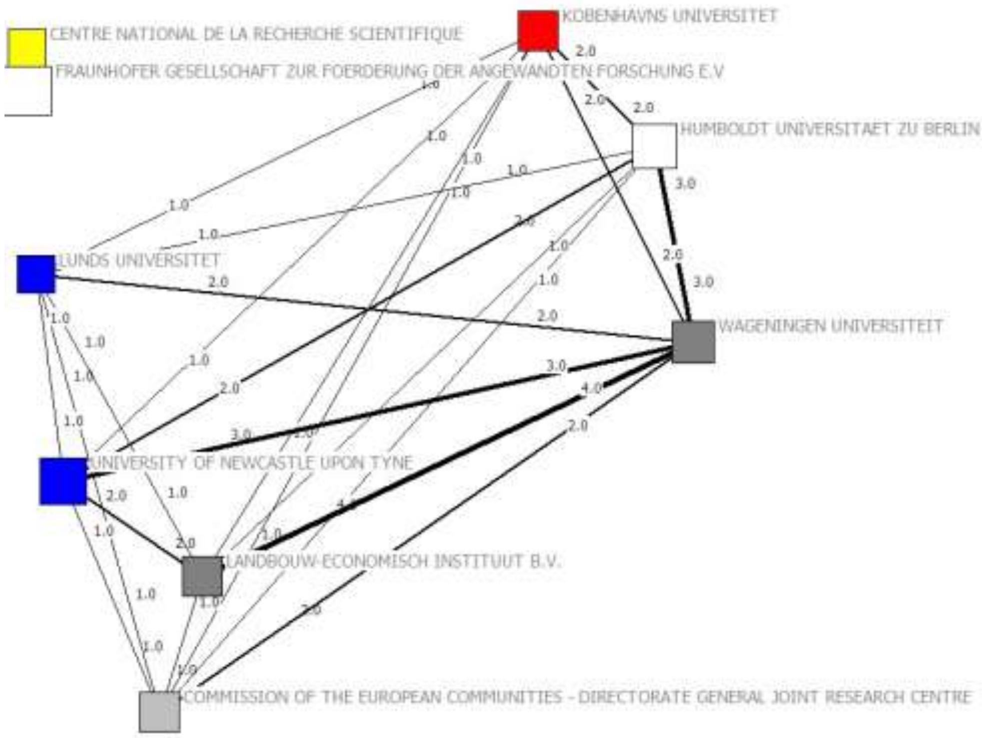

Figure 10 Overview of top networkers in Complex Social Systems

Organisations with the largest number of collaborations *(top networkers)* are depicted in Figure 10. The size of the node corresponds to the number of collaborations; the weights on the edges indicate multiple collaborations between the same organisations.

An analysis of players with strong ties has also been performed. Figure 11 depicts organisations with the highest numbers of joint project collaborations (i.e. highest weights on edges).

In the network analysis, the following organisations are of outstanding importance. These actors are top networkers, have strong ties, and many projects.

- Fraunhofer Gesellschaft zur Förderung der angewandten Forschung (DE)
- Wageningen Universiteit (NL)
- University of Newcastle Upon Tyne (GB)

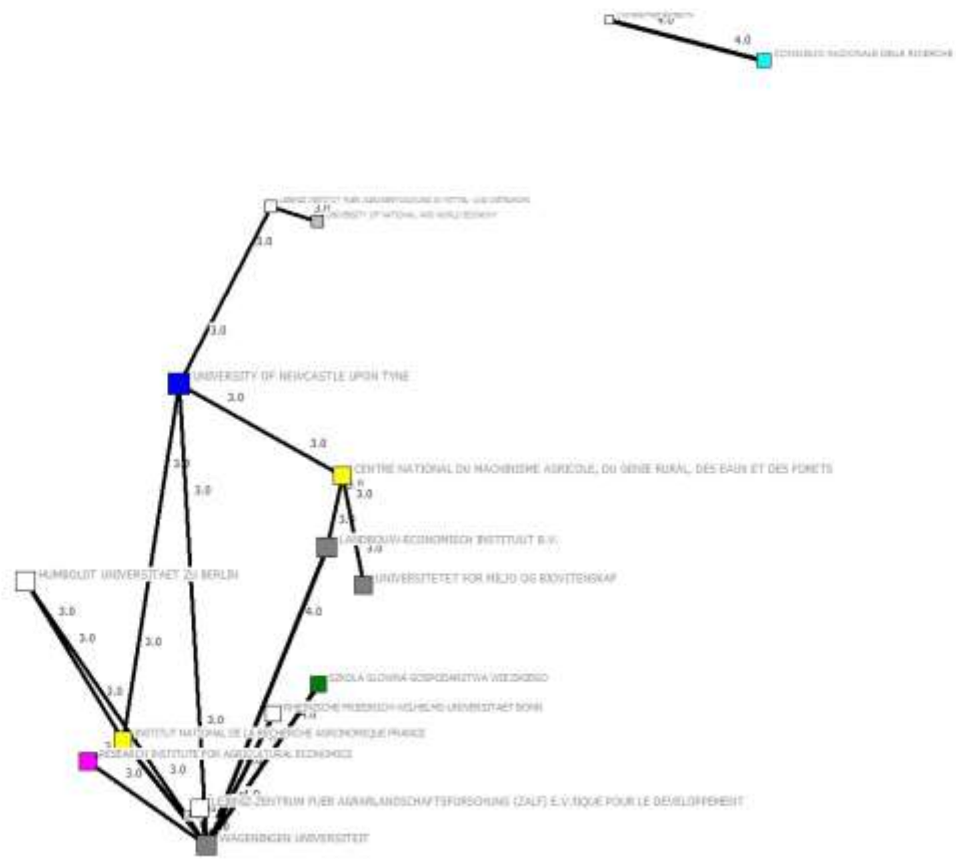

Figure 11 Strong ties for Complex Social Systems

The role of infrastructure in this domain was characterized as follows (Table 7):

	How important is…	Weight 1 (low)-10 (high)
4.1	the use of supercomputing for this flagship topic in general	**8**
4.2	a single joint supercomputing facility (rather than possibly smaller scale computers for each group)	**0**
4.3	much faster processing power than available today	**7**
4.4	a joint infrastructure for data collection and data management	**4**
4.5	facilities for storing very large amounts of data (e.g. Petabytes)	**8**
4.6	the use of cloud computing for this flagship topic in general	**7**

4.7	data bases to integrate mostly results from the projects	**0**
4.8	knowledge management infrastructure (e.g. for papers, reports, lab books, etc.)	**6**

Table 7 Assessment of the role of infrastructure for Complex Social Systems

Table 7 suggests that supercomputing and dealing with large amounts of data are predominantly important; but also cloud computing and generally faster processing of data are important aspects.

At the national level, countries with relevant programmes in the area include DE, NL, CH, ES. The existing ERA-NET Complexity net also addresses this topic. Prominent groups and research centres are to be found in NL, SI, ES and there are also some JRC activities in the area both in Ispra (IT) and Seville (ES). Important infrastructure exists with ECAS at the University of Essex (GB).

Figure 12 depicts connections of countries indicated also by the different colours.

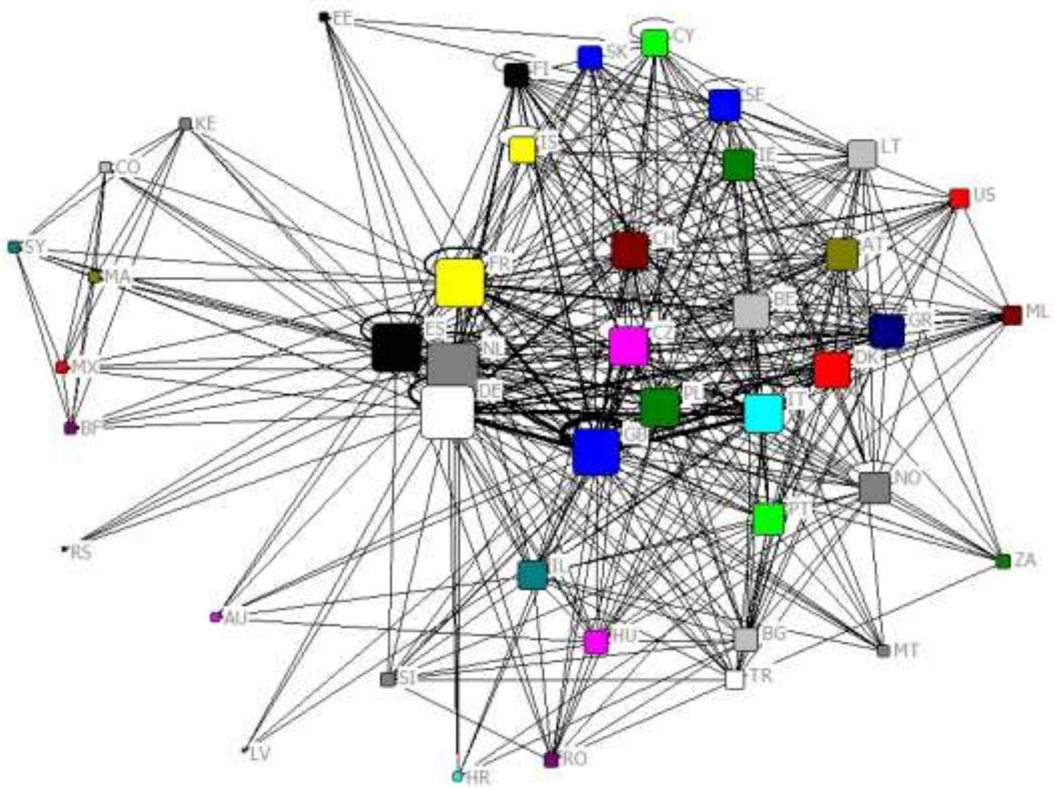

Figure 12 Connections of countries in Complex Social Systems.

In summary, the field of complex social systems consists of a large number of actors in the Framework programme. These acors are relatively fragmented in three larger clusters. Projects tend to be collaborative with an average of seven partners and there is a relatively small overlap with the other two topics. Key player nations include DE, ES, FR, NL and GB. The role of supercomputing in this area is very important, mostly due to faster processing requirements, but also concerning very large amounts of data. The community shows preference for distributed cloud computing.

3.4.4 Novel computing

Novel Computing differs from the other topics in using single institution and researcher grants as the primary funding source.[16]

Novel Computing is a medium-sized, highly active and integrated community with more than 200 actors. When integrating all areas into a single network Novel Computing is found at the centre and integrates well with other topics.

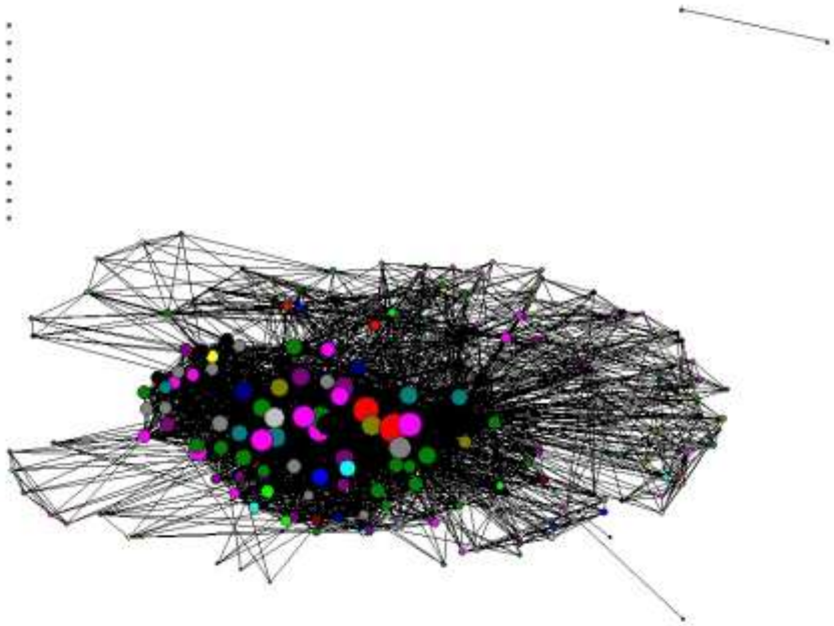

Figure 13 Result of the network analysis for Novel Computing EC project data

The Novel Computing community is exceptionally well integrated with the countries GB, DE, FR, IT, DK, AT at the core. Due to the high number of collaborations and integration there are also several key player institutions:

- Centre National de la Recherche Scientifique (FR)
- Københavns Universitet (DK)
- The Chancellor, Masters and Scholars of the University of Oxford (GB)
- Österreichische Akademie der Wissenschaften (AT)

[16] For example, ERC grants and Marie Curie researcher exchange.

- The Chancellor, Masters and Scholars of the University of Cambridge (GB)
- University of Bristol (GB)
- Imperial College of Science, Technology and Medicine (GB)

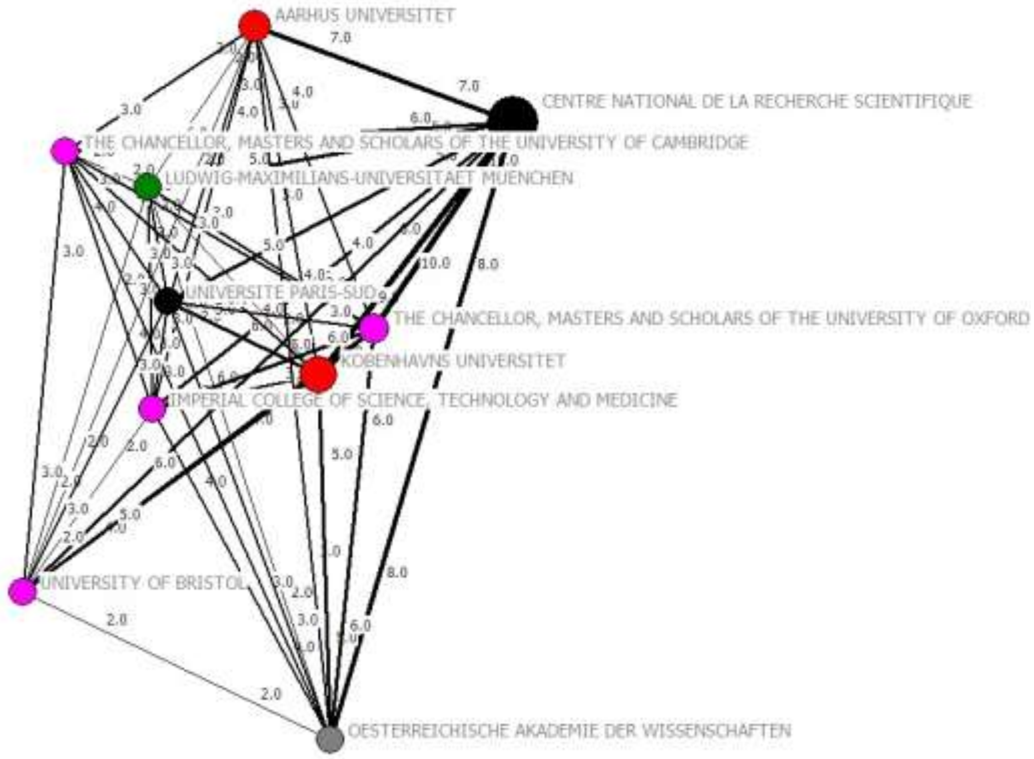

Figure 14 Overview of top networkers in Novel Computing

The players with strong ties are depicted in Figure 15:

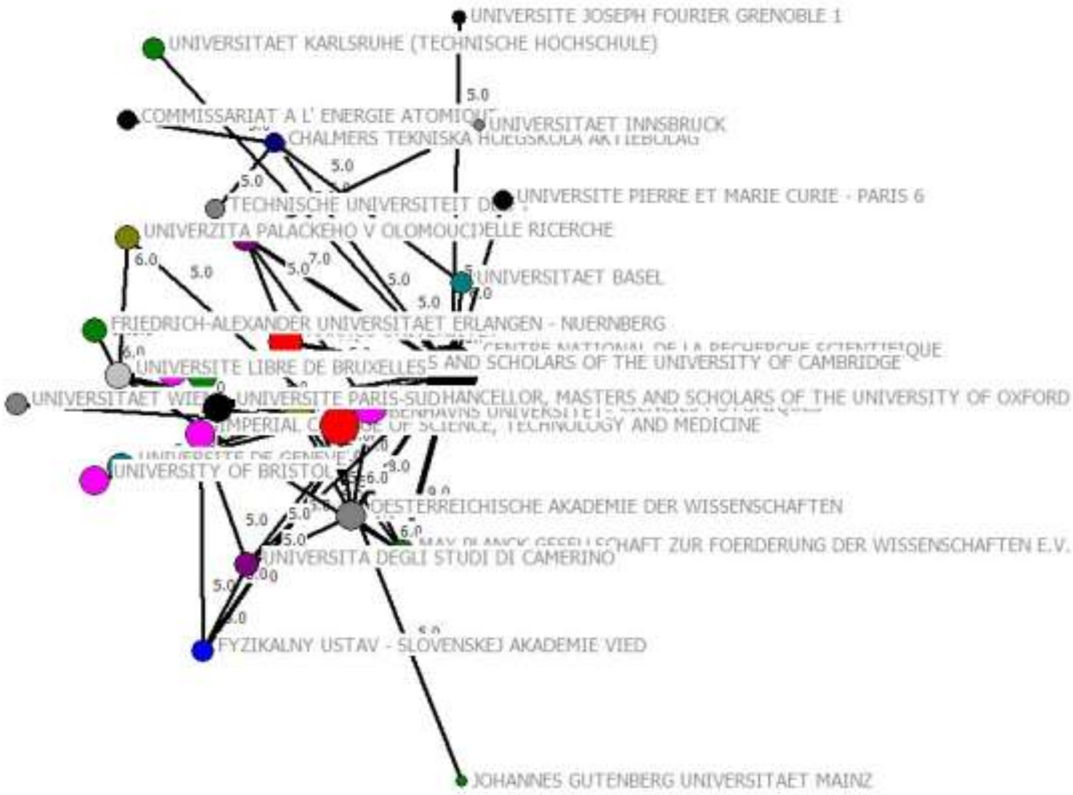

Figure 15 Players with strong ties in Novel Computing

The role of infrastructure in this domain was characterized as follows (Table 8):

	How important is…	Weight 1 (low)-10 (high)
4.1	the use of supercomputing for this flagship topic in general	**10**
4.2	a single joint supercomputing facility (rather than possibly smaller scale computers for each group)	**3**
4.3	much faster processing power than available today	**5**
4.4	a joint infrastructure for data collection and data management	**3**
4.5	facilities for storing very large amounts of data (e.g. Petabytes)	**6**
4.6	the use of cloud computing for this flagship topic in general	**5**
4.7	data bases to integrate mostly results from the projects	**3**

4.8	knowledge management infrastructure (e.g. papers, reports, lab books, etc.)	**5**

Table 8 Assessment of the role of infrastructure for Novel Computing

The use of supercomputers is highly important in this topic, but not necessarily in the form of a single facility. Knowledge management infrastructure is also considered important as well as dealing with large amounts of data.

From a national perspective, there is an outstanding relevance of the national science funds as the topic appears in nearly all national basic research or science funds. Some of these also have dedicated initiatives or fund larger projects including SK, SE, CH, NL. There is also an ERA-NET Plus Call in this domain. Important European infrastructure exists with the European laboratory for non-linear spectroscopy, for example.

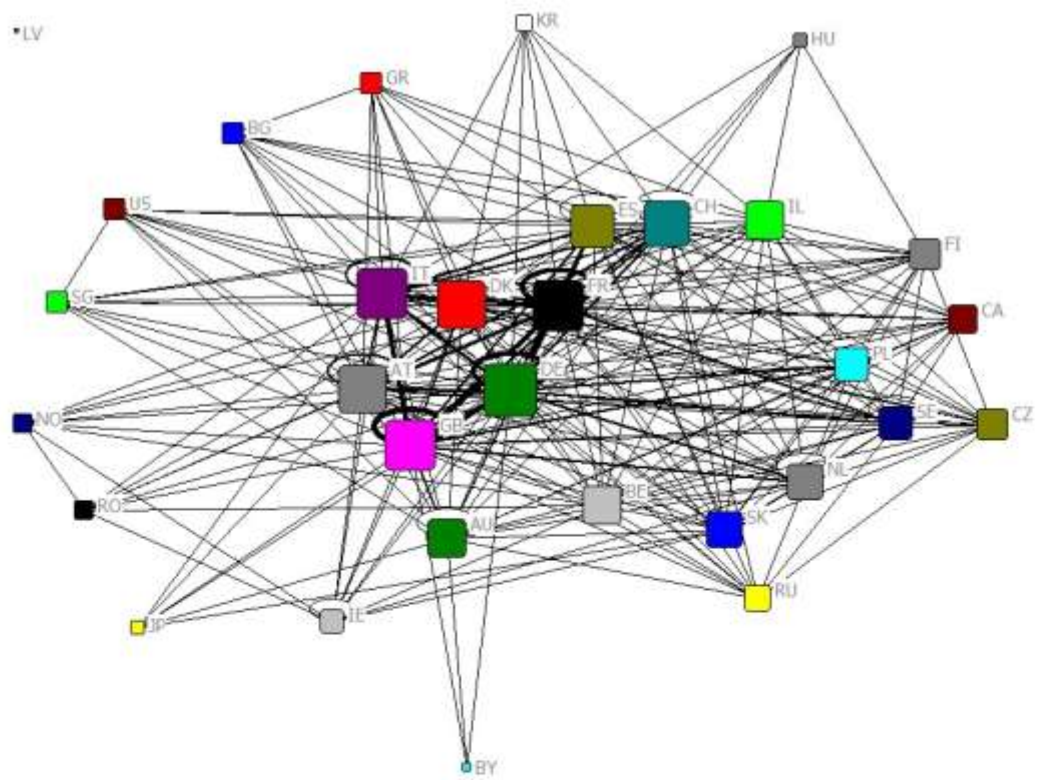

Figure 16 Connections of countries in Novel Computing

In the field of Novel (Quantum) Computing there are many single institute grants in the Framework Programme resulting in a small average number of participants. The scene is highly integrated and forms only a single cluster in our network analysis. For this area, the importance of supercomputing is highly ranked and single supercomputing facilities are also important here. Key player nations include AT, DE, DK, FR, IT, and GB. In many member states, national bottom-up programmes (mostly from academic research funds) have created dedicated initiatives in the field.

3.4.5 Integrating the three example topics in a single community

We also investigated the connection between the different groups of the three case study areas. When integrating all areas into a single network Novel Computing is found at the centre and integrates well with other topics. It becomes clear that most important institutions are active in Novel Computation and potentially other topics as well.

Understanding Cells does not form a consistent community but rather sits at the edge of the core. Complex Social Systems has concentrated centres outside the core and partially overlaps with Understanding Life. When integrating all areas into a single network Complex Social Systems has concentrated centres outside the core and partially overlaps with Understanding Cells.

The Centre National de la Recherche Scientifique is the organisation with both strongest ties and most connections and acts as integrator.

GB (5), DE (4) and SE (2) have several organizations amongst the key players.

- Centre National de la Recherche Scientifique (FR)
- Kobenhavns Universitet (DK)
- Eidgenoessische Technische Hochschule Zuerich (CH)
- Max Planck Gesellschaft zur Foerderung der Wissenschaften E.V. (DE)
- The Chancellor, Masters and Scholars of the University of Oxford (GB)
- The Chancellor, Masters and Scholars of the University of Cambridge (GB)

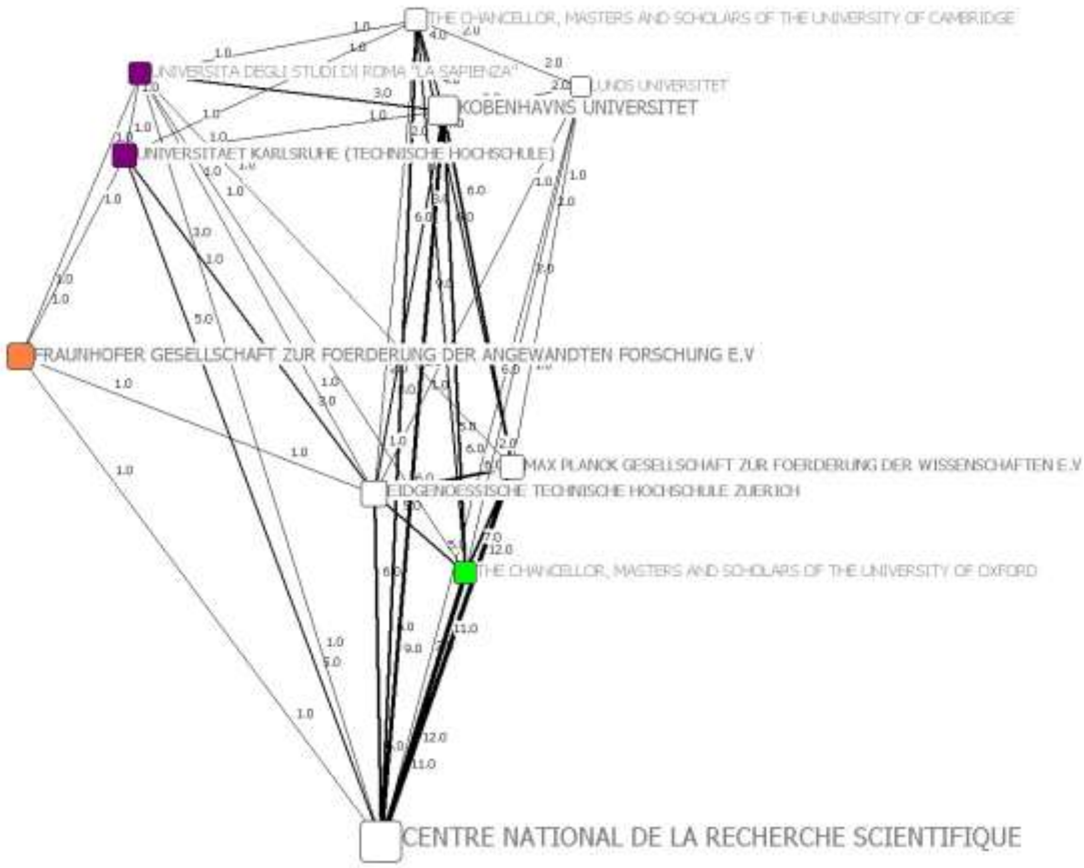

Figure 17 Top networkers in all three example topics together.

The following colour code is used. Each letter corresponds to a specific topic. Several comma-separated letters mean that the organisation is active in more than one field.

	C
	N
	U
	N,C
	N,U,C
	U,C
	N,U

U…Understanding Cells, C…Complex Social Systems, N…Novel Computing

3.4.6 Comparing the example topics

Table 9 provides an overview of the similarities and differences between the three different example topics:

	Understanding Cells	Complex Social Systems	Novel (Quantum) Computing
Characteristics			
main EU instrument used	collaborative projects	collaborative projects	single institute grants
actors in EU projects	145	378	209
nr. projects	23	56	102
average part./project	6	7	2
int. cooperation in EU projects	low	high	medium
structure of community	tight integration	broad, fragmented	highly integrated
clusters	4	3	1
overlap with other topics	low	low	high
Key player nations	CH, DE, FR, NL, SE	DE, ES, FR, NL, GB	AT, DE, DK, FR, IT, GB
National activities			
programmes	few, specific	few, specific	many general
other		EU infrastructure JRC	
centres, groups	generally in line with funding programmes		
	CH, DE, ES, IT, NL,S,	*CH, ES, NL, SI*	*AT, CH, DE, ES, FR, GB, IT, NL, PL, SE, SK*
ERA-NET		Complexity Net	CHIST-ERA,[17] ERA+ expected

Table 9 Main characteristics in the three different flagship case studies.

The following table summarizes the weighted infrastructure requirements for all three example topics.

[17] The objective of the ERA-NET CHIST-ERA (European Coordinated Research on Long term Challenges in Information and Communication Sciences and Technologies) is complementary to the scientific ambition of FET flagships. Therefore activities in this initiative, although not limited to specific fields of future flagships per se, should be closely followed and potential for cooperation assessed. Within CHIST-ERA, ten European funding agencies/ministries identify emergent scientific fields allowing European researchers to engage in high risk, high impact projects by launching each year one or two transnational calls for proposals. The first two calls are in fields also addressed by flagship candidate topics, notably Quantum Information Foundations and Technologies (QIFT).

	How important is… *(weight 1..10)*	Understanding Cells	Complex Social Systems	Novel Computing	Total
4.1	the use of supercomputing for this flagship topic in general	**8**	**8**	**10**	**26**
4.2	a single joint supercomputing facility (rather than possibly smaller scale computers for each group)	**4**	**0**	**3**	**7**
4.3	much faster processing power than available today	**5**	**7**	**5**	**17**
4.4	a joint infrastructure for data collection and data management	**3**	**4**	**3**	**10**
4.5	facilities for storing very large amounts of data (e.g. Petabytes)	**5**	**8**	**6**	**19**
4.6	the use of cloud computing (1) for this flagship topic in general	**3**	**7**	**5**	**15**
4.7	data bases to integrate mostly results from the projects	**6**	**0**	**3**	**9**
4.8	knowledge management infrastructure (e.g. for papers, reports, lab books, etc.)	**6**	**6**	**5**	**17**
Total		**40**	**40**	**40**	

Table 10 Overview of expert ratings for infrastructure requirements for the different example topics.

Looking at the relative individual rankings per topic or the totals for each criterion, the preferences in Table 10 suggest that the following aspects are of high importance in all areas:

1) Use of supercomputing in general

2) Dealing with large amounts of data

3) Faster processing of data

4) Knowledge management infrastructure

This suggests that both data processing as well as data storage and management are equally important which is confirmed by the sum of totals for corresponding requirements.

Differences between the topics lie in the following aspects:

- A joint supercomputing facility was generally not enthusiastically received. If at all, it is important for Understanding Cells whereas Cloud computing is preferred more for the other topics (with nearly complementary marks for 4.2 and 4.6).

- A result integration database is mostly requested for Understanding Cells and to some extent for Novel Computing but not for Complex Social Systems.

The different profiles for infrastructure are also depicted in Figure 18 for all topics.

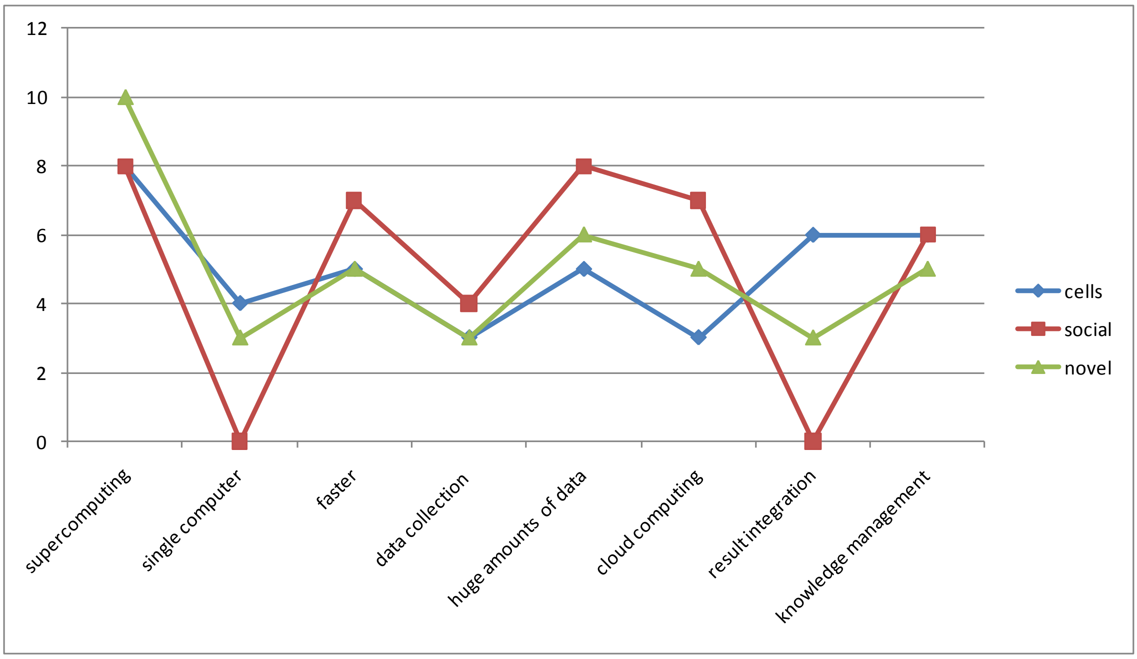

Figure 18 Infrastructure profiles for the different topics

It is worthwhile pointing out that “a single joint supercomputing infrastructure”, “a joint infrastructure for data collection and data management” and “data bases to integrate results” generally were ranked as less important. Potentially, this points to some general scepticism of the experts concerning “joint” facilities.

While the three topics are different in certain aspects, this does not necessarily mean that completely different instruments will be required to realize flagships in these areas. In fact, Figure 18 clearly points to a large overlap in requirements for infrastructure. To arrive at a suitability assessment for governance framework, experts for the different topics were also interviewed concerning their requirements for instruments, legal framework, and governance (see Sections 3.5.2, and 3.5.3.).

3.4.7 Conclusions

The network analysis shows that key actors in a field are very well networked. This implies that a flagship should involve such key players (e.g. top research institutes) and similarly countries where many actors are located. Otherwise there would a danger of duplicating efforts and not taking the key researchers on board.

The analysis has also shown that there is generally a good alignment of important research groups with countries that have dedicated initiatives in the area. In general, the project size of the largest projects is comparable throughout all areas (between 20 and 30 project participants).Germany (DE) and France (FR) are important countries in all analysed areas.

There is some variation between the topics concerning infrastructure requirements. In particular, there are differences in the degree to which joint facilities are appreciated by the communities. It should be noted that the general impression is that joint facilities are not highly appreciated. This could be a difficult point in the efforts to overcome fragmentation. Improving collaboration in flagships is a challenge to be addressed.

There are clear differences between the three example topics with respect to the following dimensions

- Degree of integration
- Size of the community
- Preferred instrument and average number of project participants
- Key player nations (with the exception of DE and FR) vary between the topics

These differences imply that there can be large differences between the structure, management approach, instruments used etc. for the different flagships. Despite these differences, the study team did not detect at this level of the analysis strong reasons to conclude that the fields would require completely different instrumental approaches for realizing flagships in these areas. Rather, the flagships are likely to make use of a set of instruments to varying degrees. This hypothesis received further support in the consecutive analysis and the assessment steps described below.

3.5 The legal and organisational framework

3.5.1 Methodology

One of the central aims of the present study was the collection and assessment of different legal and organisational frameworks with a view to their suitability for the implementation of FET flagships. The study team and experts for the different frameworks collected a large amount of information on thirteen existing governance models which were implemented for different purposes as European or multi-national initiatives. Joint Programming was also under consideration for closer analysis, but could not be included as this concept was still under development and no reliable document on its features was available at the time of the study. This information concerned the support for different aspects of the legal framework, the governance of the initiative, and the type of RTD instruments supported.

The study team also defined a set of criteria particularly important for FET flagships using a points weighting scheme. Similarly, for the three example topics, feedback from the community on particularly important instruments, governance models, and legal aspects for the different models was collected. In a final step these weights were used to judge the suitability of each of the thirteen model frameworks for implementing each of the three example topics (and compared with the overall flagship study team's weights).

The following initiatives were surveyed:

a) AAL (Ambient Assisted Living Joint Programme)[18]
b) ARTEMIS (Joint Undertaking)[19]
c) CERN (Nuclear research centre)
d) EIT KIC (European Institute of Technology / Knowledge and Innovation Communities)
e) ESA (European Space Agency)
f) ETP (European Technology Platforms)
g) EUREKA
h) EUREKA Cluster CATRENE
i) EUREKA-Eurostars
j) FoF (Factories of the Future, PPP (Public-Private Partnership) in FP7)
k) FP7 Cooperation
l) IMI (Innovative Medicine Initiative Joint Undertaking)[20]
m) ERA-NETs (using as a particular example the MNT ERA-NET)

For each of these initiatives, information was collected on governance and management at the level of design and implementation. This included descriptions of

[18] Based on Article 185 of the Treaty on the Functioning of the EU (ex Article 169)

[19] Based on Article 187 TFEU (ex Article 171 EC)

[20] Based on Article 187 of the Treaty on the Functioning of the EU (ex Article 171)

legal frameworks, governance in programme design, decision making mechanisms, instruments as well as initial estimations of strengths/weaknesses of the various case studies and their expected potential suitability for FET-Flagships.

These models were then studied and assessed with respect to the following 41 criteria:

Crit. 1	**Legal Framework** ***Does the legal framework facilitate:***
1.1	EU-wide cooperation
1.2	participation of international partners in projects
1.3	funding for international partners
1.4	usage of different funding sources (e.g. EU-FP, national, regional etc.)
1.5	flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding
1.6	multiannual commitment (e.g. concerning budgets)
1.7	longterm cooperation
1.8	research in teams in single member states
1.9	single researchers
1.10	competitions (awards/prizes)
1.11	competition between ideas or teams, i.e. competitive calls (with/without deadline)
1.12	flexibility in the structures (i.e. decision bodies, governance models etc.)
1.13	autonomy (i.e. making its own funding decisions)
1.14	rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)

Crit. 2	**Governance** ***Does the governance structure support:***
2.1	efficient management of different funding sources
2.2	interplay of public decision making bodies
2.3	simple, direct hierarchical structures with clear competences
2.4	responsibility of scientific leaders in the management
2.5	different channels to reach a broad acceptance by the public
2.6	quality control and continuous improvement
2.7	strategic development
2.8	long-term commitment of all partners including the funding providers (EU, member states)
2.9	transparency in the evaluation and selection process
2.10	an environment favourable to integration

Crit. 3	Types of RTD activities/ Instruments*Are there activities available or implementable that support:*
3.1	fundamental/basic research
3.2	industrial and experimental research
3.3	technology development/application-oriented research
3.4	studies and roadmapping activities
3.5	public relation actions
3.6	information exchange and cooperation between projects
3.7	involvement of all actors along the value chain (universities, research institutions, industry, users)
3.8	networking
3.9	co-operative RTD projects
3.10	international collaboration
3.11	exchange of researchers
3.12	conferences and workshops
3.13	PhD scholarships
3.14	research grants (single researchers)
3.15	(co)funding of joint infrastructure
3.16	centres in several EU locations
3.17	flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project

For each of these criteria a binary decision (yes/no) was made by experts for the different legal frameworks which in some cases required the assessment of a more practical perspective rather than what would be theoretically possible in any given model. Their assessment was critically reviewed and challenged by the study team. The resulting general table assessing the availability of a feature for all frameworks is annexed to this report (Table 18).[21]

The following Figure presents an overview of the methodology used for the suitability assessment (Figure 19):

[21] The tables should not be confused with a statistical analysis. They simply present the assessment from framework experts in a format convenient for later stages of the analysis.

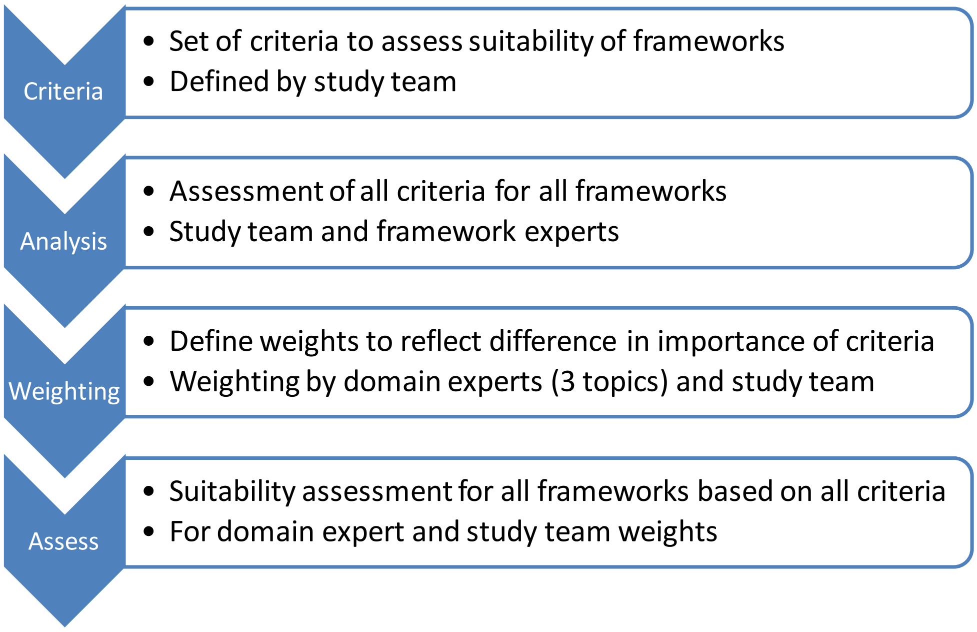

Figure 19 Methodological approach for the suitability assessment

3.5.2 Suitability assessment

The analysis of frameworks resulted in large tables[22] listing the availability of a funding instrument, governance principle or legal aspect as listed in the previous tables for each of the thirteen models. It is possible to assess the overall suitability of a framework by simple counts of available features. This results in the ESA, EIT-KIC, CERN, and Framework Programme models as overall leaders in the suitability assessment. Detailed results are annexed to this report.

Since some of the criteria are considered more important for FET Flagships than others, a weighting for the criteria was introduced. Taking into account feedback from the communities of the case study examples and the revised FET-F concept, and the recommendations from existing flagship-like initiatives, the following criteria were identified as most important for FET- Flagships.

The experts generally ranked the following criteria as very important:

Criteria 1: Legal framework

1.6 long-term cooperation*

1.7 multiannual commitment (e.g. concerning budgets)

1.13 autonomy (i.e. making its own funding decisions)

Criterion 2 - Governance

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[22] The tables consist of yes/no values for all 13 frameworks and all 41 criteria, i.e. 532 entries.

2.9 transparency in the evaluation and selection process*
2.7 strategic development
2.8 long-term commitment of all partners including the funding providers (EU, member states)

Criterion 3 - Types of RTD activities / instruments
3.1 fundamental/basic research*
3.3 technology development/application-oriented research*
3.4 studies and roadmapping activities

* … are also strongly supported by FET study team

While the top priorities of the domain experts are strongly supported by FET study results there are additional criteria ranked highly by the study team (e.g. from the recommendations from previous initiatives etc.) but not necessarily priorities for the domain experts:

Criterion 1: Legal framework
1.4 usage of different funding sources (e.g. EU-FP, national, regional etc.)
1.5 flexibility of funding mechanisms

Criterion 2 - Governance
2.4 responsibility of scientific leaders in the management
2.9 transparency in the evaluation and selection process
2.3 simple, direct hierarchical structures
2.10 an environment favourable to integration

Criterion 3 - Types of RTD activities / instruments
3.9 co-operative RTD projects
3.3 technology development/application-oriented research
3.15 Joint infrastructure
3.17 flexibility of consortia

Table 11 provides an overview of the weights by the domain experts for the different flagship topics (and the weighting of the study team):

		Weight (1-10)			
Crit. 1	Legal Framework Does the legal framework facilitate:	FET Study	Understanding Cells	Simulating Social Systems	Novel Computing
1.1	EU-wide cooperation	3	8	5	8
1.2	participation of international partners in projects	3	6	7	5
1.3	funding for international partners	3	1	6	3
1.4	usage of different funding sources (e.g. EU-FP, national, regional etc.)	9	2	3	8
1.5	flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding	9	5	7	5
1.6	multiannual commitment (e.g. concerning budgets)	6	8	7	8
1.7	longterm cooperation	9	9	7	7
1.8	research in teams in single member states	3	2	2	2
1.9	single researchers	3	0	0	2
1.10	competitions (awards/prizes)	3	3	7	1
1.11	competition between ideas or teams, i.e. competitive calls (with/without deadline)	6	3	0	6
1.12	flexibility in the structures (i.e. decision bodies, governance models etc.)	4	7	7	3
1.13	autonomy (i.e. making its own funding decisions)	6	8	7	7
1.14	rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)	3	8	5	5
	Total (Crit.1)	70	70	70	70
Crit. 2	Governance Does the governance structure support:	FET Study	Understanding Cells	Simulating Social Systems	Novel Computing
2.1	efficient management of different funding sources	3	3	7	5
2.2	interplay of public decision making bodies	2	2	4	4
2.3	simple, direct hierarchical structures with clear competences	6	5	0	7
2.4	responsibility of scientific leaders in the management	9	6	7	3
2.5	different channels to reach a broad acceptance by the public	5	5	2	6
2.6	quality control and continuous improvement	2	5	6	3
2.7	strategic development	2	6	6	6
2.8	long-term commitment of all partners including the funding providers (EU, member states)	5	6	6	5
2.9	transparency in the evaluation and selection process	10	5	7	8
2.10	an environment favourable to integration	6	7	5	3
	Total (Crit.2)	50	50	50	50
Crit. 3	Types of RTD activities/ Instruments Are there activities available or implementable that support:	FET Study	Understanding Cells	Simulating Social Systems	Novel Computing
3.1	fundamental/basic research	7	7	7	8
3.2	industrial and experimental research	7	6	6	5
3.3	technology development/application-oriented research	7	6	7	8
3.4	studies and roadmapping activities	4	8	7	5
3.5	public relation actions	4	4	1	4
3.6	information exchange and cooperation between projects	4	4	6	2
3.7	involvement of all actors along the value chain (universities, research institutions, industry, users)	4	6	6	6
3.8	networking	4	6	6	4
3.9	co-operative RTD projects	10	6	6	5
3.10	international collaboration	4	6	6	5
3.11	exchange of researchers	4	4	6	5
3.12	conferences and workshops	3	4	6	4
3.13	PhD scholarships	3	4	6	5
3.14	research grants (single researchers)	3	2	3	1
3.15	(co)funding of joint infrastructure	7	4	0	5
3.16	centres in several EU locations	3	4	0	6
3.17	flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project	7	4	6	7
	Total (Crit. 3)	85	85	85	85
	Total	**205**	**205**	**205**	**205**

Table 11 Weights for all criteria by domain experts for the example topics and weights of the study team.

3.5.3 Applying the framework to flagship examples

The weights described in the previous section were used to evaluate the suitability of each framework for the three flagship example topics. For the expert weights for all three topics, the point totals are depicted in Figure 13. High and consistent rankings are marked with *, highest value per column printed in bold. Detailed results are annexed as Table 21, Table 22, and Table 23.

Top ranked initiatives	Total points over all flagship topics	Crit. 1 Legal	Crit. 2 Governance	Crit. 3 Instruments
1. EIT- KIC	**492***	**170***	109	213*
2. ESA	466*	161*	119	186
3. CERN	464*	128	**135***	201*
4. EUREKA-Eurostars	437	158	118	161
5. FP 7 Cooperation	435	99	119	**217***

Table 12 Point totals for the top five framework models after using the weights from the experts in each of the three flagship example domains for the three sets of criteria

Also, using the study team weights to assess the suitability of the thirteen frameworks results in a ranking that is similar to Table 12 (results are listed as Table 20 in the annex). It ranks the framework models for EIT-KIC, ESA, and CERN and EUREKA-Eurostars highest with EUREKA and FP7 following. However, EUREKA does not achieve top ranking for any of the criteria.

Generally, there is very good agreement between the ratings for the different frameworks. There is some variation, however. Using the domain experts' weights, the AAL was highly rated for Criterion 2 (134) and rated as the best governance model for Novel Computing. FP7 was weighted highest for instruments for Understanding Cells and Complex Social Systems. The differences between the different aspects for specific topics are small, however. Figure 20 depicts the results. It shows the point score for all flagship models for the legal, governance, and instruments criteria based on the sum over all three flagship example cases. Figure 21 depicts these results separately for the three different criteria for the eight best ranking frameworks.

The ranking of the overall suitability of funding mechanisms is very stable and similar to the results when using the weights of the study team. Table 13 lists the complete results. (The results also remain similar, when scaling the three criteria to 100 points to eliminate the higher weight of the instruments criteria, see Table 24 in Annex.)

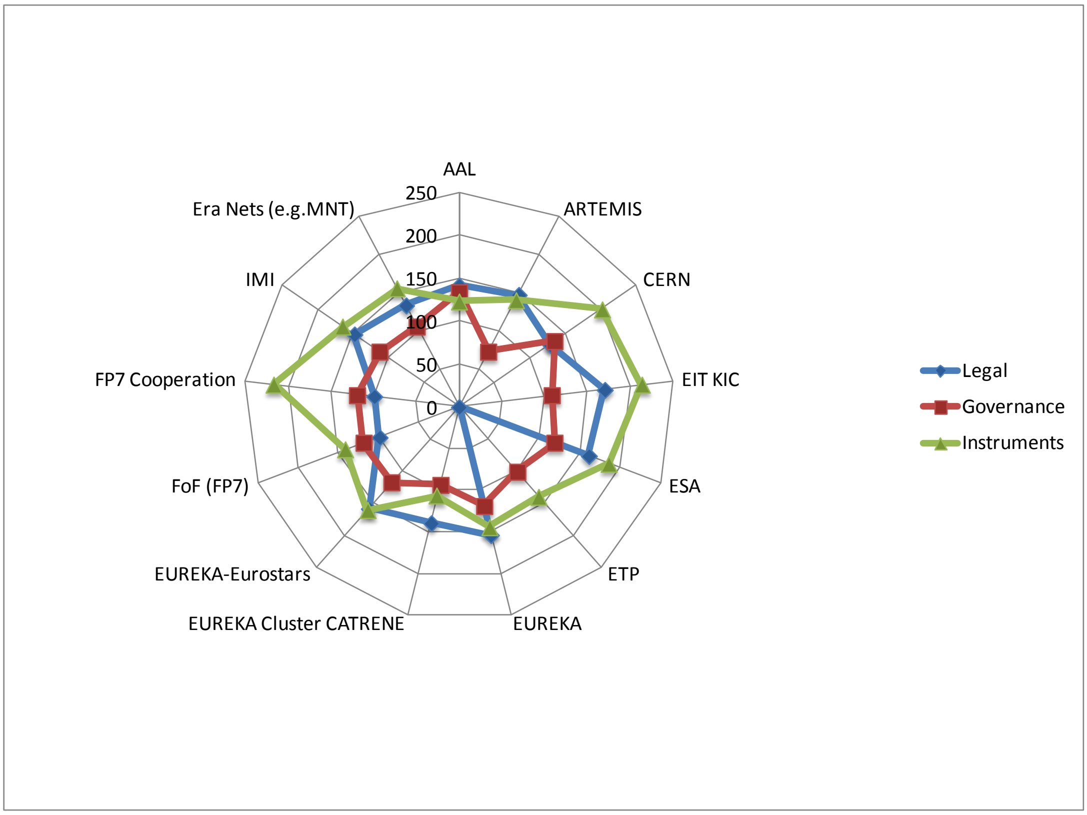

Figure 20 Suitability result for the legal, governance, and instrument aspects of all frameworks.

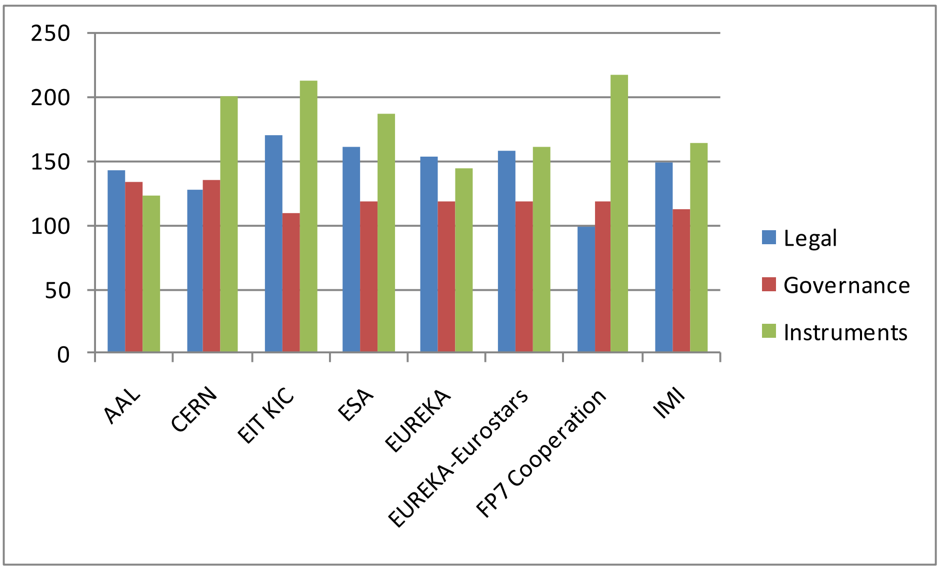

Figure 21 Results of the suitability analysis for all frameworks with a total score of 399 and above

Overview of the suitability assessment results for Governance Models, Legal Frameworks and Instruments

			AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
Crit. 1	Legal Framework	FET study	37	45	34	52	52	0	49	46	49	24	24	37	37
		Understanding Cells	48	52	48	61	56	0	51	46	55	34	34	56	48
		Simulating Social Systems	47	41	40	50	50	0	56	44	48	30	30	47	45
		Novel Computing	47	54	40	59	55	0	47	49	55	35	35	45	41
		Total (Topics)	142	147	128	170	161	0	154	139	158	99	99	148	134
Crit. 2	Governance	FET study	41	21	47	36	35	26	38	34	42	38	38	40	33
		Understanding Cells	44	26	47	39	37	34	41	30	41	41	41	40	36
		Simulating Social Systems	43	28	43	32	38	34	36	30	37	36	36	37	34
		Novel Computing	47	19	45	38	44	33	42	33	40	42	42	35	36
		Total (Topics)	134	73	135	109	119	101	119	93	118	119	119	112	106
Crit. 3	Types of RTD activities/ Instruments	FET study	44	50	65	72	64	44	51	39	55	47	72	57	54
		Understanding Cells	42	45	67	72	64	48	48	34	49	49	75	54	50
		Simulating Social Systems	43	50	69	69	60	50	50	37	59	46	70	59	58
		Novel Computing	38	46	65	72	62	42	46	36	53	46	72	51	48
		Total (Topics)	123	141	201	213	186	140	144	107	161	141	217	164	156
Total		FET study	122	116	146	160	151	70	138	119	146	109	134	134	124
		Understanding Cells	134	123	162	172	157	82	140	110	145	124	150	150	134
		Simulating Social Systems	133	119	152	151	148	84	142	111	144	112	136	143	137
		Novel Computing	132	119	150	169	161	75	135	118	148	123	149	131	125
		Total (Topics)	399	361	464	492	466	241	417	339	437	359	435	424	396

Table 13 Suitability assessment results using the weights of the flagship domain experts (results for study team weights are also listed). Green values refer to consistently high rankings, fields marked in yellow also achieve good results in some cases.

3.5.4 General strengths and weaknesses of all frameworks

A more detailed analysis of the weaknesses and strengths of all models shows that some criteria are fulfilled by nearly all frameworks while there are some aspects that only few frameworks support.

General weaknesses (only supported by max. 3 frameworks):

- 1.5 Flexibility of funding mechanisms
- 1.9 Single researchers
- 1.10 Competitions (awards/prize)
- 2.1 Efficient management of different funding sources
- 3.16 Centres in several EU locations

General strengths (only missing in max. 3 frameworks):

- 1.1 EU-wide cooperation
- 1.2 Participation of international partners
- 1.6 Multiannual commitment
- 1.14 Rules of cooperation between partners and IPR regulations
- 2.2 interplay of public decision making bodies
- 2.3 Simple, direct hierarchical structures with clear competences
- 2.6 Quality control and continuous improvement
- 2.7 strategic development
- 2.8 Long term commitment of all partners
- 2.9 Transparency in the evaluation and selection process
- 2.10 An environment favourable to integration
- 3.2. Industrial and experimental research
- 3.3. Technology development/application-oriented research
- 3.6 Information exchange and cooperation between projects
- 3.7 Involvement of all actors along the value chain
- 3.9 Co-operative RTD projects
- 3.10 International cooperation
- 3.17 Flexibility of consortia

The following table shows the distribution of fulfilment for all criteria and defines categories:

%	≥90	≥80	≥70	≥60	≥50	≥40	0
Count	2	8	11	8	5	4	1
Category/symbol/count	Strong area/+/10		Medium/o/19		Weak area/-/10		

Percentages are calculated comparing the total for each category (using total weights provided by flagship topic experts) to the potential maximum. Table 14 illustrates strengths and weaknesses in the three categories: legal framework, governance and instruments. There is no framework which is strong in all three categories. The top ranking framework EIT KIC is the only one with strengths concerning legal issues. The only frameworks with strengths in two of the three criteria are EIT KIC, CERN and FP7.

Rank	Framework	Legal	Governance	Instruments
1	EIT KIC	+	o	+
2	ESA	o	+	o
3	CERN	o	+	+
4	EUREKA-Eurostars	o	o	o
5	FP7 Cooperation	-	+	+
6	IMI	o	o	o
7	EUREKA	o	+	-
8	AAL	o	+	-
9	Era Nets (e.g.MNT)	o	o	o
10	ARTEMIS	o	-	-
11	FoF (FP7)	-	+	-
12	EUREKA Cluster CATRENE	o	o	-
13	ETP	-	o	-

Table 14 Strengths and weaknesses of all frameworks concerning legal aspects, governance, and instruments

Table 15 summarizes the availability of the most important strengths and weaknesses (+,o,-) and special features, e.g. a features that a framework lacks which most other frameworks support, (L – legal framework, G –governance, I – instruments).

Rk.	Fw.	L	G	I	Supported	Not supported	Potential improvements
1	EIT KIC	+	o	+	+autonomy (i.e. making its own funding decisions) (L) +studies/ road-mapping activities (I) +(co)funding of joint infrastructure (I) **Special features:** +centres in several EU locations (I)	**Special features:** -interplay of public decision making bodies (G)	- scientific leaders in management - avoid conflict of interest in boards - stronger basic research component - selection not to be based on funding alone - seek synergies with structural funds - intermediate steps and goals - monitor development of KICs
2	ESA	o	+	o	+studies/ roadmapping activities (I) +(co)funding of joint infrastructure (I) **Special features:** +single researchers (L) +competitions (awards/prizes) (L) +efficient management of different funding sources (G) +centres in several EU locations (I)	**Special features:** -an environment favourable to integration (G)	- involve scientific leaders, e.g. in delegations or advisory boards - define topics with inherent international dimension to foster integration - topics with public procurement components offer the potential to integrate member state interests

3	**CERN**	**o**	**+**	**+**	+responsibility of scientific leaders in the management (G) +fundamental/ basic research (I) +studies/ roadmapping activities (I) +(co)funding of joint infrastructure (I) **Special features:** +single researchers (L)	**Special features:** -industrial and experimental research (I) -technology development/applicatio n-oriented research (I)	
4	**EUREKA-Eurostars**	**o**	**o**	**o**	+autonomy (i.e. making its own funding decisions) (L) +responsibility of scientific leaders in the management (G) +fundamental/bas ic research (I) **Special features:** +flexibility of funding mechanisms (L)	-longterm cooperation (L) **Special features:** -long-term commitment of all partners including the funding providers (EU, member states) (G) -information exchange and cooperation between projects (I) -involvement of all actors along the value chain (universities, research institutions, industry, users) (I)	- Seek synergies with other initiatives in the ERA - Examine and develop new evaluation approaches

5	**FP7 Cooperation**	**-**	**+**	**+**	+fundamental/ basic research (I) +studies/ roadmapping activities (I) +(co)funding of joint infrastructure (I) **Special features:** +centres in several EU locations (I)	-usage of different funding sources (e.g. EU-FP, national, regional etc.) (L) -long-term cooperation (L)	- Realisation of a specific Work Programme which is valid for the running time of the Framework Programme - long-term cooperation could be anchored in the work programme - implement new eligibility criteria: e.g. one partner sufficient - Implementation via IP´s and competitive Calls - widen autonomy of the core consortium; eg own selection decisions of additional partners or flexibel use of "budget in trust" - evaluation criterion: "political support and additional funding sources" - Combine projects with ERA-NET (plus) to include national funding activities. This should be realised in a lean and efficient way without the typical overhead of many ERA-NETs. - Weaken Art 111 of the Financial Regulations, to enable the compatibility of different EU funding resources - Combine large-scale projects with smaller activities and include single researcher actions where possible. Improve collaboration between projects through compulsory cooperation with a CA/SSA.

6	IMI	o	o	o	+autonomy (i.e. making its own funding decisions) (L) +responsibility of scientific leaders in the management (G)	**Special features:** -interplay of public decision making bodies (G) -usage of different funding sources (e.g. EU-FP, national, regional etc.) (L)	
7	EUREKA	o	+	-	**Special features:** +flexibility of funding mechanisms (L) +competitions (awards/prizes) (L)	**Special features:** -multiannual commitment (e.g. concerning budgets) (L)	- Synchronisation concerning funding rules
8	AAL	o	+	-	+autonomy (i.e. making its own funding decisions) (L) **Special features:** +efficient management of different funding sources (G)	-long-term cooperation (L) **Special features:** -technology development/ application-oriented research (I)	- adapt statutes and rules (e.g. long-term cooperation, basic research) - define topics as early as possible to establish a core group of countries required to set up the flagship organisation - involve scientific leaders, e.g. general assembly or advisory board - expand instruments to include networking, single researcher grants, structures etc.
9	Era Nets (e.g.MNT)	o	o	o	**Special features:** +flexibility of funding mechanisms (L) +competitions (awards/prizes) (L)	-usage of different funding sources (today mostly national, EC top-up in ERA-NET+) (L) -longterm cooperation (L)	- improve synchronization of national procedures with timing of transnational calls - increase security of financial planning (anticipated amount of national funds)

10	**ARTEMIS**	**o**	**-**	**-**	+autonomy (i.e. making its own funding decisions) (L) +responsibility of scientific leaders in the management (G) +fundamental/ basic research (I)	**Special features:** -simple, direct hierarchical structures with clear competences -long-term commitment of all partners including the funding providers (EU, member states) (G) -transparency in the evaluation and selection process (G)	- multi-annual budget commitments - harmonization of national funding rules - improved rules for proposal selection when national budgets are insufficient in some countries - widen the spectrum of funded activities like: studies - open regulation to use additional funding resscources - simplify organization structure e.g.: combine Governing Board and Public Authority Board
11	**FoF (FP7)**	**-**	**+**	**-**	+fundamental/ basic research (I) +studies/road-mapping activities (I)	-usage of different funding sources (e.g. EU-FP, national, regional etc.) (L) -long-term cooperation (L)	

12	**EUREKA Cluster CATRENE**	**o**	**o**	**-**	+autonomy (i.e. making its own funding decisions) (L) +responsibility of scientific leaders in the management (G)	**Special features:** -multiannual commitment (e.g. concerning budgets) (L) -rules of cooperation between partners and IPR Regulations (e.g. consortium agreement) (L) -quality control and continuous improvement (G) -an environment favourable to integration (G) -information exchange and cooperation between projects (I)	
13	**ETP**	**-**	**o**	**-**	**Special features:** +efficient management of different funding sources (G) +studies/road-mapping activities (I)	-longterm cooperation (L) **Special features:** -no (common) legal framework (L) -transparency in the evaluation and selection process (G) -industrial and experimental research (I) -technology development/ application-oriented research (I)	- ETP need to be refocused and reconsidered (e.g. interactivity with ETP members, different stakeholders is desired) - consider international dimension! - Establish and communicate clear rules and procedures - Focus on socio-economic challenges and more on implementation phase (relevant for industry) - involvement in policy preparation processes

Table 15 Summary of characteristics for all frameworks, including supported and unsupported features and potential improvements

3.5.5 Conclusion from the suitability assessment

In our analysis, the EIT KIC framework model has the highest overall potential for implementing FET flagship initiatives. Other recommended models include large-scale initiatives with a focus on infrastructures and involvement of physicists (incl. ESA, CERN). Thus, this community may have important lessons-learned for future flagship initiatives. Additional role models for specific aspects or topics are AAL (governance) and FP7 (instruments).

Note that EIT KIC is the youngest of all initiatives and still in its launch phase. The success of the large-scale initiatives ESA and CERN is perhaps not surprising as they were designed specifically for large research initiatives of a very special character. FP7 wins in the instruments, but suffers from its tight legal frame which also limits its flexibility. This will be particularly important when the flagships issue their own calls for proposals. Note that in the case of KIC the governing board is in a position to issue such calls very easily. In FP7, additional constructs are required such as AAL or ARTEMIS. The latter suffers from unbalanced funding between different countries, difficult co-ordination and long administrative procedures.

Common strengths of the top ranking instruments for FET flagship implementation

Generally, all three frameworks have specific strengths in the following aspects:

Legal framework

+ Long-term cooperation

+ Multiannual budget commitment

The **EIT** is being set up following an incremental growth path. An initial contribution from the EU budget (Euro 308.7 million) helps to launch the EIT and the KICs during the 2009-2013 period and will provide the support structure and the conditions necessary for knowledge transfer and networking.

Every 3–4 years, **ESA** member states agree on a budget plan for several years at an ESA member states conference. The last major conference was held at the end of 2008.

ESA's mandatory activities are funded by a financial contribution from all the Agency's Member States, calculated in accordance with each country's gross national product.

The total budget in 2005 amounted to about €3.0 billion, in 2006 to about €2.9 billion, in 2008 to about €3.0 billion, in 2009 to about €3.6 billion and in 2010 to about €3.7 billion.

CERN is run by 20 European Member States. CERN has an annual budget of around 1,000 MCH (724 million EUR) which is essentially covered by the Member States' contributions. CERN was founded in 1954 and the CERN Laboratory sits astride the Franco–Swiss border near Geneva.

Each Member State contributes both to the capital expenditure and to the current operating expenses of the Organization, in accordance with scale of contributions approved each year by the Council, based on the average net national income at factor cost of each Member State for the three latest preceding years for which statistics are available, except for specific determination of the Council.

+ EU wide cooperation (experts only)

+ Usage of different funding sources (e.g. EU-FP, national, regional etc.)

KICs are financed for only 25% through the EIT budget. The rest has to come from other sources, like FP7, Structural funds, etc. Apart from ESA budget coming from the Member states (note: not all EU Member states are members of ESA), since a few years also funding from EU is used: Member states money and EU's money is put into one single pot for relevant projects.

Governance

+ transparency in the evaluation and selection process

The **EIT KIC** selection process operates on the level of the *EIT* and includes the following 4 steps. Step 1: evaluation of the quality of the proposed work programme and business plan; Step 2: evaluation of the commitment, capability and combined strength of the partners involved; Step 3: Assessment by a final selection panel. At the end of step 2, a final panel examined the three top-scoring proposals from each priority area (9 proposals in total) together with their associated evaluation reports; Step 4: Hearings and designation of the first KICs. On the basis of the final panel recommendations, the Governing Board held hearings with representatives of the highest-ranked proposals taken in order from the respective priority area lists. At the level of the individual KICs, there are hardly any strict rules for the organisation of research and innovation activities. The KICs propose their own governance mechanism including any schemes for adding partners and projects to their activities (i.e. "calls" or other appropriate schemes). However, a common principle of the organisation of KICs is that they are organized around so-called *co-locoation centres.* These centres are restricted to a small number (5-7) of places in Europe to focus the KIC activities.

The **ESA** evaluation and selection process is defined very precise as well: In the Council each Member State each Member state has one vote, regardless of its size or financial contribution. Most decisions are taken by two-third majority, unanimous decision: level of resources.

There exist basically two ways for participation in the experimental programmes of **CERN**:

i. A newly formed collaboration of institutes submits a proposal to the appropriate Experiment Committee;

ii. An Institute wishing to join an existing experiment submits an official application to the Spokesperson of the Collaboration. Acceptance is normally approved by the Collaboration Board.

After consideration by Experiment Committee the experiment must be approved by the CERN Research Board and the Director-General, taking into account scientific interest, technical feasibility and the constraints imposed by available resources. The Research Board receives the recommendations from all the CERN Experimental Committees. Once approved, the proposals become part of the CERN experimental programme.

+ long-term commitment of all partners including the funding providers (EU, members states)

+ strategic development

+ Simple, direct hierarchical structures with clear competences

EIT, CERN, and ESA all have implemented hierarchical structures with clear responsibilities.

+ different channels to reach a broad acceptance by the public

Instruments

+ Support co-operative RTD projects

The **EIT** aims to give Europe's innovation capacity and its readiness for the knowledge society a much needed boost. Its overall goal is to create a new European way of delivering essential economic growth and societal benefits through innovation. The EIT responds to Europe's particular situation where the three sides of the knowledge triangle (excellent higher education, research and innovative business) are often still fragmented thereby hindering a free flow of knowledge. The mission of the EIT is to grow and capitalise on the innovation capacity of partners from the knowledge triangle from the EU and beyond, notably via highly integrated Knowledge and Innovation Communities (KICs).

The **European Space Agency** is an intergovernmental organisation dedicated to the exploration of space. The ESA is Europe’s gateway to space. Its mission is to shape the development of Europe’s space capability and ensure that investment in space continues to deliver benefits to the citizens of Europe and the world. By coordinating the financial and intellectual resources of its members, it can undertake programmes and activities far beyond the scope of any single European country. ESA’s job is to draw up the European space programme and carry it through. ESA's programmes are designed to find out more about Earth, its immediate space environment, our Solar System and the Universe, as well as to develop satellite-based technologies and services, and to promote European industries. ESA also works closely with space organisations outside Europe.

CERN has several possibilities to cooperate in research projects. CERN supports a Doctoral Student Programme. Candidates may already have a thesis subject defined, in the latter case, CERN proposes thesis descriptions which may then be discussed between the student, his/her home university and CERN. There exist basically two models of access to facilities and experiments for external users

i. A newly formed collaboration of Institutes submits a proposal to the appropriate Experiment Committee;

ii. An Institute wishing to join an existing experiment submits an official application to the Spokesperson of the Collaboration. Acceptance is normally approved by the Collaboration Board.

Concerning the cooperation with non-member states, some states (or international organizations) which have made significant contribution to CERN projects or programmes and for which membership is either not possible or not yet feasible are Observers. Over 40 other non-Member States have concluded Cooperation Agreements with CERN and are involved in the various research programmes of the Organisation.

In terms of activities along the value chain, the three initiatives differ significantly:

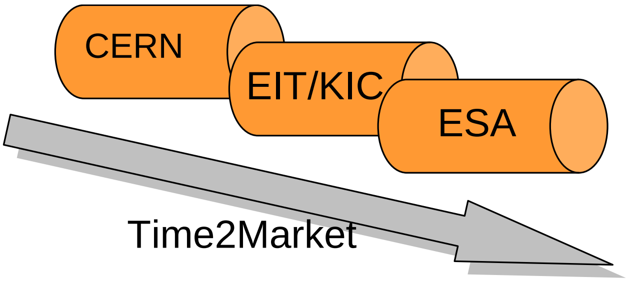

Figure 22 CERN, EIT-KIC and ESA differ with respect to their position along the value chain.

While in **CERN** activities mainly focus on fundamental research, **EIT** deals with industrial and experimental as well as application-oriented research and technology development while **ESA** focuses on application-oriented research and technology development.

+ flexibility of consortia (not so important for Understanding Cells)

+ studies and roadmapping activities (experts only)

+ involvement of all actors along the value chain (universities, research institutions, industry, users) (experts only)

+ international cooperation (experts only)

+ (co)funding of joint infrastructure (FET study only)

Strengths and weaknesses of the top three governance models

We now take a closer look at the characteristics of the EIT KIC, ESA and CERN frameworks for FET flagship implementation.

EIT KIC

+ long-time cooperation of at least 7 years according to the EC regulation[23] establishing the European Institute of Innovation and Technology.

+ an environment favourable to integration: cooperation is an eligibility criterion, excellence and international reputation of partner organisations is required. Partners from outside Europe are welcome when they help to build the excellence of the innovation network. However, participation of third countries is subject to the approval of the EIT Governing Board.

+ The interplay between research, education, and innovation is a particular advantage of the KIC's and one of its special features.

- single researcher: EIT KIC does not focus on single researchers, because the goal is to build up a new organisation.

- flexibility of funding: There is only very little flexibility of funding, because the Governing Board makes its annual funding decisions following an assessment of each KIC's individual performance and competitive review between the KICs.

- transparency: The decisions of the Governing Board have been criticised due to potential conflicts of interest of the Board members and the selected KICs.

Overall, KIC is a good starting point for further improvement as it is a winner in two of the three categories (cf. Table 12). It must be emphasized again that the KICs are only starting now and it remains to be seen whether they will succeed in acquiring the necessary funds.

ESA

+ long-term: Long-term cooperation as well as commitment are evident - ESA exists since 1975. In addition to that space projects are per-se long term oriented and not feasible without long-term investment.

+ single researcher: External users can be single researchers or institutes.

- lack of autonomy (funding decisions): No, because due to convention ESA's budget has to be transformed into contracts with industry from Member States.

- flexibility of funding: ESA is not a funding mechanism.

CERN

+ long-term: There clearly is long-term cooperation. The Convention also states that CERN shall organize and sponsor international co-operation in research.

+ scientific leadership: There is responsibility of scientific leaders in the projects

- only fundamental research

[23] Regulation (EC) No 294/2008 of the European Parliament and of the council of 11 March 2008

Specific strengths per selection criteria

Criterion 1: Legal Framework

KIC and **ESA** have advantages concerning the legal framework because:

- There is stronger competition between ideas (competitive Calls by independent experts versus decision of internal CERN Research Board)
- There also is multiannual commitment (CERN and its MS decide only on annual budgets)

Criterion 2: Governance

CERN's governance model is strong due to its scientific leadership in the management. The Scientific Policy Committee (SPC) is one of two subsidiary bodies to the CERN Council. It evaluates the scientific merit of activities proposed. Its members are scientists proposed by their colleagues on the Committee and appointed by Council.

Concerning Governance **AAL** can convince because of its efficient management of different funding sources and the well organized interplay of public decision making bodies.

Criterion 3: Types of RTD activities/ Instruments

FP7 instruments are strong, because it is possible to supports a broad range of different types of RTD activities along the value chain including general support actions.

KICs are characterised by co-location centres, so called nodes. Effective management and coordination of these nodes can only be achieved by strong networking activities**.** In relation to that, CERN lacks behind as it does not fund centres in several EU locations.

Recommendations for possible FET-F governance models

After cross-checking the suitability criteria with the characteristics of the governance models it turns out that the EIT/KIC model appears best suited for flagship implementation due to the following reasons:

- Long-term commitment: There is multi-annual commitment for 7 years and a dedicated budget for 4 years.
- Autonomy: At the level of the EIT, the governing board – consisting of independent experts – realizes the calls and makes its own funding decisions. Neither the EC nor the member states intervene with the realization of the KICs. The EC is only responsible for the evaluation of the new strategic programme every 5 years. At the level of the individual KICs, the different communities are largely autonomous. They

are only bound by their contractual relation with the EIT. Typically, the KICs from a legal entity such as an association in order to facilitate contract signature with the EIT. There is a large degree of autonomy in the design of the legal structure for the KIC and its precise functioning.

- Different funding sources: There is a strong bottom-up component. The member states are lobbied by the proponents. The members of the KICs are thus strongly motivated to acquire funding. This can lead to competition between MS.
- Efficient management of different funding sources: Although it is not yet fully clear which contributions are counted (for the 75% self-financing), the funding is very flexible with respect to funding sources. The EIT provides a share of 25%, the remaining 75% have to be raised by the KICs themselves. This leads to different funding sources for different KICs ranging from national to regional or industry contributions.
- Interplay of public decision making bodies: The EC does not get heavily involved and the member states typically do not intervene. There are no public authority boards, no mirror groups etc.
- The process of realisation was relatively quick. It took around 3 years (2006-2009) and this included the drafting of the regulation as well as the whole set up of the EIT.

The EIT model and the recommendations of the Sherpa report

At the initiative of Commissioners Potoĉnik and Reding, an expert group[24] was set up to take stock of the first experience with setting up Joint Technology Initiatives under the 7th FP. Although the JTIs are more industry oriented than FET flagships, many of its conclusions are also valid for FET flagships or their potential implementation. The group studied different alternative ways for implementing JTIs such as a private law entity, contractual partnerships, a separate “Community body” under EU Financial Regulation, or a special body for PPPs in the revised Financial Regulation.

The private law entity suffers from a lack of EC privileges (e.g. VAT exemption) and would be subject to national legislation. This would mean that JTI implementation would vary depending on the country in which the JTI was set up. Also, there would be limited scope for controls by the EC. A contractual partnership offers a great deal of flexibility. However, they cannot guarantee long-term commitment of partners and may also be seen to limit the visibility of the partnership compared to an incorporated entity. The creation of a completely new Community body on the other hand is a burdensome, slow, and resource-intensive administrative process. This is why the group recommends the recognition of PPPs as a special body for the case of JTIs.

In particular, the Sherpa group emphasizes a risk-tolerant and trust-based approach as well as the flexibility to adapt to the specific needs of the different sectors for the legal

[24] Designing together the ‘ideal house’ for public-private partnerships in European research, JTI Sherpas’ group, Final report, January 2010

structure. Concerning operational modalities, the Sherpa Group emphasizes openness, transparency, effectiveness, efficiency, and sound financial management as well as clear roles and responsibilities among partners.

The group also points out that long-term commitment and critical mass of funds are vital for the success of the initiative. It also recommends balanced funds matching. Finally, the Sherpa Group points out that member states should bring real added value and honour their commitments while accommodating national interests.

The Sherpa Group's analysis concerning the different legal entities and the principles for governance is also useful for the case of FET flagships. The analysis of the different legal structures for JTI implementation would largely also fit for the purpose of implementing flagships. Most importantly, the EIT-KIC model is in good agreement with the recommendations of the group.

For example, the EIT-KICs are recognized as bodies to which implementation tasks can be delegated while there are no specific provisions available to PPPs under the current Financial Regulation. Furthermore, due to the large degree of autonomy, KICs implement a more risk-tolerant and trust-based approach than what is the case in JTIs. They are able to react to changes quickly, for example to hire new staff and include new partners.

In a model that takes more inspiration from JTIs, it will be important to implement improvements for the participation of member states compared to the current JTIs. This concerns the harmonization of national funding rules, the shortening of time-to-contract, and the honouring of national budget commitments.

A model inspired by Art. 185 needs to have a core group of supporting countries which drive the flagship concept and initiatives. At the same time it is vital to ensure there is room for involvement of scientific leaders and support for a wide range of instruments.

Further improvements and adaptations of the model

To make the EIT/KIC Model even more suitable for the requirements of FET flagship implementation, the following adoptions and improvements are suggested:

- Different from the existing KICs where the Governing Board is mainly composed of experts from industry, scientific leaders should play a major role in the management in the FET- F management.
- Basic research will have to play a much greater role than in KICs.
- The precise structure and characteristics of co-location centres should be carefully considered. For management reasons, it is useful not to allow for more than 6 or 7 co-location centres per KIC. Within co-location centres there should be true cooperation, not just exchange of paper (also students and researchers). On the other hand, it may be necessary to allow for the involvement of additional infrastructure or resources in the vicinity of any given co-location centre.
- While different funding sources are very positive, it should be avoided that decisions and selections are made based on available funding only and not on subject areas and flagship goals.

- It must be ensured that governing board members are neutral with respect to successful KICs (e.g. they should not be rectors of universities involved in flagships) and have no potential conflict of interest.
- Structural funds should be taken into account as funding resources as early as possible.
- Very ambitious goals (such as to achieve world-leadership) are not sufficient. Quick successes and reaching intermediate targets are essential as well.
- Strong political drivers (such as Com. Barroso for EIT) and strong leaders (such as EIT chair Mr. Schuurmans) have proven beneficial to realize the initiative quickly. Similar support will be useful to realize the Flagships efficiently.
- Finally, it must be emphasized that the considerations in this report are based on the currently ongoing implementation of the EIT-KICs. The initiative is still in a relatively early stage and should be monitored concerning implementation details that could not be studied here.

3.6 Implementation

3.6.1 Implementation planning

An EIT-KIC inspired model for implementing the flagships is presented in Figure 23. The flagships are implemented through several centres. It is advisable to keep the number of centres easily manageable, i.e. not more than 7. The centres are means to implement the required infrastructure, joint services of a flagship and flagship management. It is conceivable that more flagship locations are networked into the fabric, e.g. through sub-nodes, although a completely distributed network is not likely to facilitate the desired integration of resources.

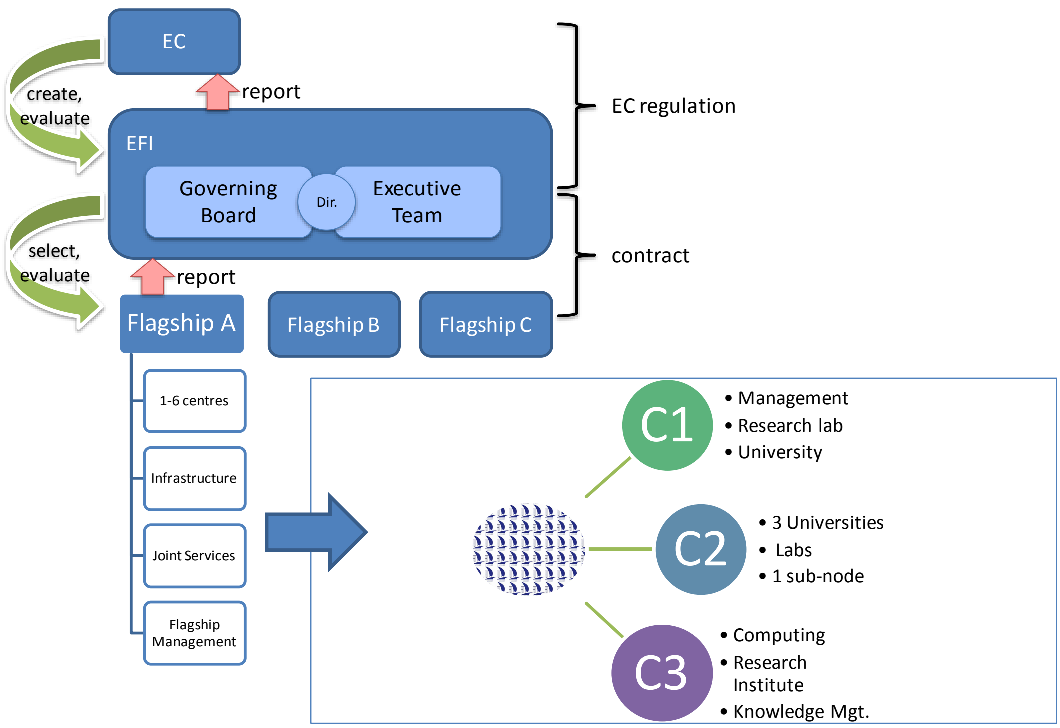

Figure 23 Adopting the EIT-KIC model as an implementation framework for the FET flagships

The overall flagship initiative (working title: European Flagship Initiative EFI) is managed through a governing board that is also in charge of flagship selection and evaluation. This body should consist of scientific experts acting according to well-defined management and selection rules. The members of the governing board must be independent from the flagship proposals to ensure that there is no conflict of interest.

It is conceivable that other experts e.g. from the EC, ISTAG or member states are members of the supervisory body. This will depend on the desired degree of scientific autonomy of the flagship initiative. In this set-up, two legal frameworks govern the flagship initiative:

- An EC regulation details the working of the flagship initiative as a whole.
- The flagships themselves act based on contracts with the body of the initiative.

The funding of the flagship is presented in Figure 24:

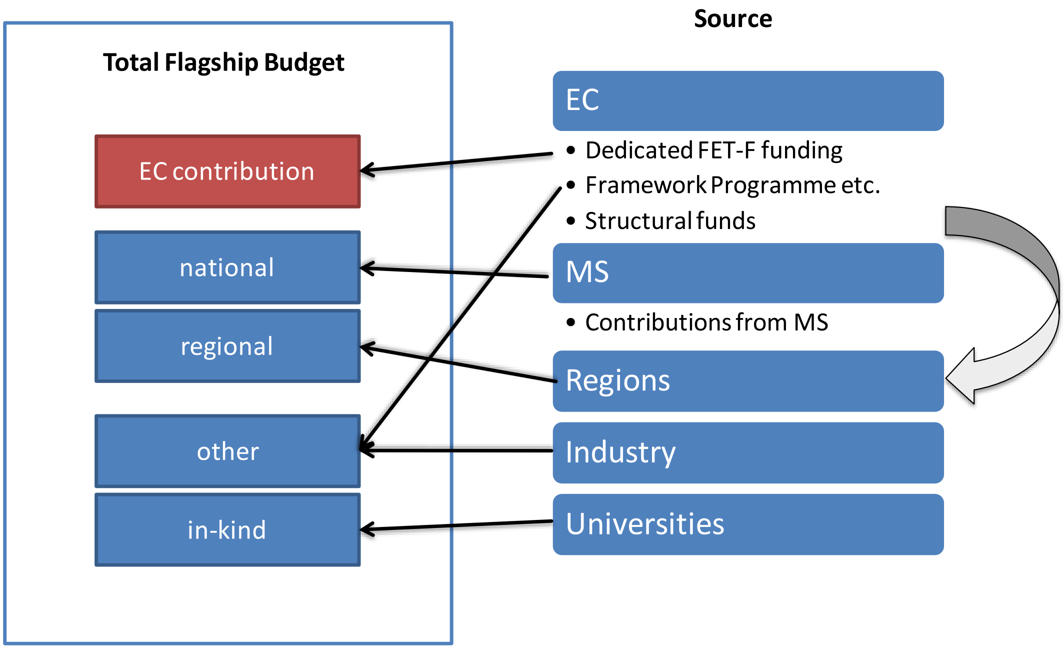

Figure 24 Financing of the FET Flagships using different sources of funding (EU, member states, regions, industry and universities)

The funding model depicted in Figure 24 brings together EU, national, regional, industry and university contributions. Note that not all of these budgets are handled at EC level. In-kind contributions from universities or research institutes, but also regional or national contributions are possible at the level of co-location centres or flagships as a whole. Industry, regional, national or university and research centre contributions are also possible purely at the level of the institution. This can also include dedicated infrastructure. The EC contribution in the EFI model would be a percentage of the total overall flagship budget.

Although this picture looks complex, it is in fact a relatively simple approach where funding can be easily included from different sources.

Table 15 shows the budget (and organisational) commitments necessary by different stakeholders.

EC	- Regulation for the flagship framework - Flagship budget (5-7 years) - Monitoring and control of the flagship organization

Member states	- Regulation for the flagship framework and budget - Flagship budget (4-7 years) - National infrastructure and other resources
Regions	- Synergies with structural funds
Researchers, Universities	- Setting up flagships - coordination with member states and regions - In-kind contributions of institutions - Management and strategic development

Table 16 Commitments necessary to implement the flagships using an EIT-KIC inspired model.

In order to realize the flagships under this model it is necessary to obtain these commitments from different stakeholders. This forms an essential element in realizing the roadmap described in Section 3.6.3.

3.6.2 An illustrative example: Quantum Computing Flagship

Based on the network analysis of the topic Novel (Quantum) Computing it is possible to create an illustrative example of what a flagship could look like (Figure 25). It is however most important to leave recommendations as to which countries, regions and institutions should be involved to the researchers.

For our example, countries which are most strongly connected based on our analysis of EU project collaborations are Austria, France, Great Britain, Germany, Italy, and Switzerland. In all those countries there are also complementary national funding activities. Based on a classification of institutions it is possible to identify areas of strengths and to list examples of matching institutions. We especially considered key players from our network analysis and universities with many FP projects.

Note that this list is exemplary and neither exhaustive (e.g. two key player universities in GB not mentioned because example area is industry) nor indicative of final flagship areas nor of potential players. Thus this illustration does neither suggest that there should be a flagship in said area or with said structure. The aim is rather to demonstrate that centres within a flagship could potentially focus on different aspects which might be of importance for the success of the flagship as a whole.

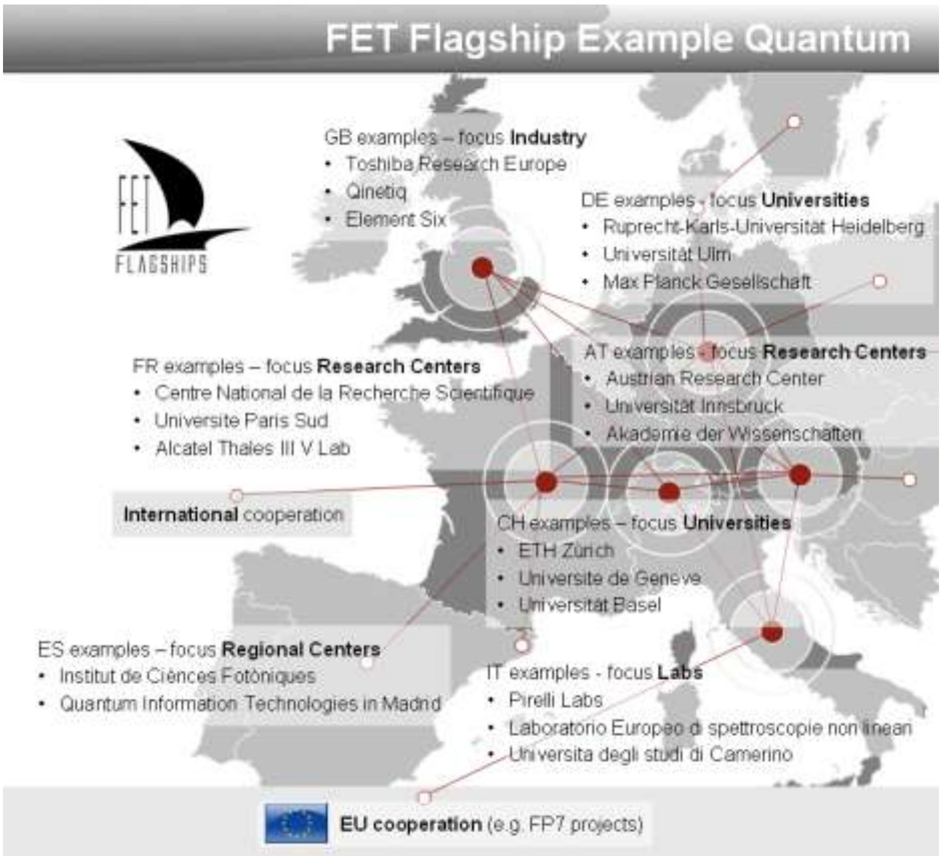

Figure 25 An illustrative example of a flagship in Quantum Computing

3.6.3 Roadmap

Based on the features of the EIT-KIC inspired model for a "European Flagship Initiative" and the necessary commitments for realizing such an initiative, Figure 26 depicts the steps necessary to create flagships.

Figure 26 Steps to implement FET flagships using an EIT-KIC inspired model.

The process of implementing FET flagships similarly to EIT-KICs *(e.g. as European Flagship Initiative EFI)* will benefit from the experience gained there as well as from the already existing legal framework. A draft roadmap is presented in Table 17.

Draft roadmap for flagship implementation using the EIT-KIC framework

Milestone				EFI Decision		Call EFI Gov members			EFI operational		FET-F Call			FET-F selection			Flagship Start
Stake Holder	Member states, regions	MS support	ICT directors support		call for EFI board members		select EFI Board members						Commit budget				
	EC		commit EC budget														
	EU Parliament, Council	involvement, information	EFI regulation														
	Scientific community	involve science forum										FET-F preparation			create legal entity	contract ne-gotiation	
	European Flagship Initiative (EFI)							set-up EFI		call preparati on							FET-F start
	year	2010	2011				2012										2013

Table 17 Draft roadmap for flagship implementation and the involvement of stakeholders

3.6.4 Policy recommendations

Stakeholder analysis

The following table shows the results of a first stakeholder analysis for the case of implementing flagships using an advanced EIT-KIC model. It lists the potential influence of stakeholders (high, medium, low), their interest and general attitude regarding the implementation process of FET Flagships.

Stakeholder	Influence	Interest	Attitude
European Commission	High	Improve European competitiveness in research and business; broad MS acceptance; broad political acceptance; societal impact; overcome fragmentation	Positive (EC COM)
DG INFSO	High	Ownership of FET-F concept; realizing ICT research strategies	Supportive
Other DGs	Medium	Participation for their communities in FET-Fs; access to additional funding	Neutral
FET Unit	High	Ownership of FET-F concept, establishment of adequate instruments in line with FET objectives, smooth implementation	Supportive
European Parliament	Medium/ high	Defend interests of European taxpayers	Neutral
European Council	High	Improve European competitiveness in research and business; broad political acceptance; societal impact	Unclear
ICTC (Programme Committee)	High	Push ICT research	Positive
ISTAG	medium	To see their recommendations being followed; overcome fragmentation	Supportive
Member States	High	Participation of MS researchers in FET-F activities; Strengthen national position (research priorities); avoid long-term commitment; avoid „common pot“ funding; closely manage earmarked contribution	Unclear
National ICT Research	High	Participation of MS researchers in FET-F activities; Strengthen national position	Positive

Directors		(research priorities); avoid long-term commitment; avoid „common pot“ funding; complement/protect national programmes	
Regions/Cities	Low during the process, medium for funding individual FET-Fs	Centres in their region; improvement of regional infrastructure; economic aspects	Unclear
Universities	Medium	Participate in FET-Fs; receive funding; international cooperation; improve scientific excellence; exploit FET-F infrastructure; education; representation of their priority topics; reputation/prestige	Positive
Individual researchers	Low	Participate in FET-Fs; funding; access to FET-F infrastructure; exchange of researchers; publications; breakthroughs; knowledge access; avoid bureaucracy & management overhead	Neutral to Positive
Scientific Leaders	High	Advance science and society; achieve breakthroughs; influence research direction; reputation	Supportive
Research Centres	Medium	Participate in FET-Fs; receive funding; international cooperation; improve technological excellence; exploit FET-F infrastructure; technology transfer	Positive
Industry	Low	Exploitable results; highly trained experts; funding; improve competitiveness	Unclear
High-tech SMEs	Low	Lightweight bureaucracy; exploitable results; access to new and niche markets; funding	Neutral
Third country research organisations	Low	Participate in top research; access to EU excellence and infrastructure	Neutral
Media	Medium	Simple messages; good stories; social and user aspects; information access	Neutral
Broad public (tax payers)	Low	Solutions, responsible use of money; transparency; information	Unclear

Tools for targeting stakeholders and implementing actions

These different stakeholders and actions can be channelled using a set of tools. For example, regular short FET Flagship Policy Briefings can be used for communicating with member states, ICTC, European parliament representatives, but also for CORDIS.

In line with the experience of previous flagship-like initiatives and the set-up of the EIT-KICs, a group of high-level experts from academia, industry, and policy can act as FET Flagship Ambassadors. The EC can support this group with information and also organisationally.

Stakeholder	Policy actions	Tool
European Commission	Demonstrate different ways in which FET-F support EU policies.	Dedicated analysis of policies and ways in which FET-Fs support them (Policy analysis)
DG INFSO	Demonstrate different ways in which FET-F support DG INFSO policies.	Policy analysis
Other DGs	Clarify potential advantages for non-ICT RTD communities.	Policy analysis
FET Unit	Communicate consistent messages	FET-F policy briefings Standard presentations
European Parliament	Start preparing concise information emphasizing social benefits of FET-Fs.	FET-F policy briefings Standard presentations
European Council	High level talks (ministers, working group participants, CREST).	FET-F policy briefings (selected) Standard presentations Engage with FET Flagship Ambassadors
ICTC (Programme Comittee)	Ensure regular updates for ICTC members.	FET-F policy briefing Collect ICTC input and opinions Adapt flagship concept
ISTAG	Keep major FET-F proponents closely involved and invite them as ambassadors.	FET Flagship Ambassadors
Member States	Emphasize stepwise, individual contributions and co-funding	Clarify options for financing

	and individual design options for MS. Ensure and communicate added value for as many MS as possible (also MSs without centres).	Develop options for co-location centres and infrastructure resources
National ICT Research Directors	Provide executive-level information as a basis of decision making. Emphasize advantages of common utilization of resources (access to infrastructure and excellence).	FET-F policy briefing Study benefits of improved infrastructure utilization
Regions, Cities	Interact with the Committee of the regions. Discuss options to exploit synergies with structural funds.	FET-F policy briefings FET Flagship Ambassadors
Universities, res.org.	Support university communication with MS	Assist research community in channelling communication from different (potential) FET-Fs
Individual researchers	Engage researchers to motivate their member states Support interfaces (researchers-MS, researchers-EC, etc.).	Assist research community in channelling communication from different (potential) FET-Fs Offer training for researchers on communication with stakeholders
Scientific Leaders	Install and support a group of outstanding scientists to promote FET-F concept (at EU and national levels)	FET Flagship Ambassadors
Research Centres	Take top EU research centres on board.	Assist research community in channelling communication with top research centres Embrace high-profile organizations to take on the flagship issue
Industry	Ensure backing from a small	FET Flagship Ambassadors

	number of high level industry representatives or bodies. Analyse industrial absorption capacity.	 Support selected FET-Fs in studying industrial absorption capacity; channel communication between different potential FET-Fs
High-tech SMEs	Consider results of the FET-SME study	
Third country research organisations	Explore options for collaboration and joint usage of infrastructure, researcher exchange, and co-funding with major centres and funding agencies.	
Media and broad public (tax payers)	EC should ensure transparent information flow for stake holders communicating with media but do not act as the public opinion leader.	Involve CORDIS FET Flagship Ambassadors Press kit Events and roadshows
General	Make sure FET-F pilots deliver well-founded, convincing arguments on scientific, economic, and societal impact. Embrace high-profile organizations to take on the flagship issue	Communicate with FET-F pilot actions This includes ERCIM, top research institutes and other European organizations

4 Summary and Recommendations

This study has performed an analysis and refinement of the FET flagship concept. There is room for further improvements and changes to this concept as suggested in this report. However, the general flagship idea has a high degree of originality. Although we studied a large number of flagship-like initiatives, there are hardly any initiatives around the globe now or in the past that are identical to envisaged flagships in terms of scale, budget, and also concerning the area of Information and Communication Technologies.

This high degree of novelty implies uncertainty and risk. However, there are also clear lessons learned from large and successful past initiatives; there has been strong and enthusiastic feedback from the scientific community, and there exist a broad range of options for efficiently implementing flagships. Still, the scientific community will also need further support as the formulation of the flagship vision and its aims is no simple task and there are apprehensions in the scientific community who will also have a major responsibility in communicating with other stakeholders.

The European Commission is advised to build on and further improve existing frameworks for an efficient implementation that easily and flexibly combines funding from different sources. The new flagship framework should avoid overloading bureaucracy, facilitate a high degree of scientific autonomy, and guarantee a long-term commitment to the flagship idea.

Recommendations concerning the flagship concept

Flagships should be designed as science-driven initiatives with inherent risks, but the goal-achieving character of flagships is of utmost importance. Their scientific mission should be complex, comprehensive and broad, but it must be clear when it is fulfilled. Emphasize the mission character of the initiative in the form of a very clear and easily communicable mission statement or vision. It is vital to involve the research community in the shaping of the program, but to balance individual researcher goals with those of the initiative.

Goals are important for alignment, for interdisciplinary integration, but also for funding agencies, politicians and a broad public. Flagships are special as they are focused, long-term initiatives. It is also important that flagships create impact, new technologies, and usable results along the way and not just at the end of the flagship.

Flagships require strong scientific leadership. This leadership also concerns the flagship content, not just management aspects. Leaders act as the glue binding people and projects together; they have to be identified at a very early stage and take responsibility.

The initiatives should benefit from efforts and infrastructure to integrate data between various research groups and from joint infrastructure. An environment rewarding integration is important as flagships must be more than collections of research projects.

A straightforward way of realizing collaboration is through a centre or closely networked co-location centres.

Flagships should perform scrutiny in regularly evaluating progress towards the goals and taking corrective actions.

Flagships will have to remain open to the participation of small groups or individuals as the origins of creative new ideas.

The integration of different ICT fields and of ICT with other scientific disciplines including the humanities is essential. ICT in a flagship is not just at the service of another discipline, however. It must be at the core with mutually beneficial cooperation for all fields.

Flagships should be managed by a small, possibly multidisciplinary team of top people. They must break down high-level goals to smaller aims and topics. This requires managing scientists, not just administrators. Management and the shape of flagships may be different for different topics.

Recommendations concerning implementation of flagship initiatives

It is important to clearly define the roles of stakeholders with a balance of top-down (e.g. mission, roadmap) and bottom-up (e.g. vision, research agenda) elements. If advisory bodies are implemented, their role and influence should be very clear.

Lean and transparent decision making are important. Therefore availability and commitment of members of decision making bodies is important. Similarly, decision makers must avoid any potential conflict of interest.

While contributions from member states can help to ensure commitment, funding cooperation and overcome fragmentation the aim should be to keep regulations and budget negotiations simple (e.g. money administered by EC without additional member state rules).

The study team recommends taking inspiration from the EIT-KIC model used by the European Institute of Technology. This model should be further improved and designed in line with the interests of all involved stakeholders.

The European Commission should support the scientific community in their preparation of the flagship topics (e.g. with the planned FET flagship pilots), but also in their communication with other groups and the member states.

It is advisable to prepare and disseminate clear and concise briefings about the expected characteristics of FET flagships, their expected impacts for science and society, and progress made toward their realization to the key stakeholders.

Realization of the flagship idea should be supported by a strong group of high-level authorities from industry, academia, and policy to act as FET Flagship Ambassadors.

5 Annex

5.1 Summaries of previous, flagship-like initiatives

5.1.1 DARPA challenge

Primary Location

United States

Overview

The DARPA Grand Challenge was a prize competition for driverless vehicles, funded by the Defense Advanced Research Projects Agency, a research organization of the United States Department of Defense.

Timeline

2004 - 2007

Funding Level

$5.5M US in total prizes awarded

The cost of developing, fielding, and insuring entered vehicles was the sole responsibility of the individual teams. DARPA did not provide funding for the purpose of Grand Challenge entry or participation.

2004 Prize (unclaimed): $1M

2005 Prize: $2M

2007 Prize: $2M for 1st place, $1M for 2nd place, $500,000 for 3rd place

Funding Source(s)

Department of Defense - US

Sector of Activity

Autonomous vehicles

Partners Involved

The competition was open to teams and organizations from around the world, as long as there was at least one U.S. citizen on the roster. Teams participated from high schools, universities, businesses and other organizations. More than 100 teams registered in the first year, bringing a wide variety of technological skills to the race. In the second year, 195 teams from 36 US states and 4 foreign countries entered the race.

Type of Partners Involved

High schools, universities, businesses and other organizations participated, in the US and international.

Legal Status

Funded and managed by the US Department of Defense, Defense Advanced Research Projects Agency (DARPA)

Planning Horizon for Research Activities

The U.S. Congress authorized DARPA to offer prize money ($1 million) for the first Grand Challenge in 2004, which took place in the Mojave Desert region of the United States, along a 150 mile (240 km) route. The prize went unclaimed as no vehicles were able to complete the difficult desert route.

Following the 2004 event, the prize money was increased to $2 million for the next event in 2005. All but one of the 23 finalists in the 2005 race surpassed the 11.78 km (7.36 mile) distance completed by the best vehicle in the 2004 race. Five vehicles successfully completed the race, with the fist place team receiving the prize money.

Building on the success of the 2004 and 2005 Grand Challenges, the 2007 event required teams to build an autonomous vehicle capable of driving in traffic, performing complex maneuvers such as merging, passing, parking and negotiating intersections. Called the DARPA "Urban Challenge", this event was the first time autonomous vehicles interacted with both manned and unmanned vehicle traffic in an urban environment.The first, second and third places in the 2007 Urban Challenge received $2 million, $1 million, and $500,000, respectively.

Result

Success

Impact

The Grand Challenge was a success, based on the fact that competition objectives were met. Deeper impacts, such as the underlying military objective of drones on earth, are difficult to assess.

5.1.2 Human genome project

Primary Location

United States

Overview

The Human Genome Project was designed to identify all the approximately 20,000-25,000 genes in human DNA; determine the sequences of the 3 billion chemical base pairs that make up human DNA; store this information in databases; improve tools for data analysis; transfer related technologies to the private sector; and address the ethical, legal, and social issues that may arise from the project.

Timeline

1990 – 2003

Funding Level

$3B US (total)

Funding Source(s)

Department of Energy - US

National Institutes of Health - US

Wellcome Trust – UK

Sector of Activity

Biomedical/Genomics

Partners Involved

Primary Human Genome Project Sequencing Sites:

US Dept. of Energy Joint Genome Institute, Walnut Creek, California, US

Baylor College of Medicine Human Genome Sequencing Center, Houston, Texas, US

The Wellcome Trust Sanger Institute, Hinxton, Cambridgeshire, UK

Washington University School of Medicine Genome Sequencing Center, St. Louis, Missouri, US

Whitehead Institute/MIT Center for Genome Research, Cambridge, Massachusetts, US

Other contributers (not comprehensive)

- 34 Institutions from throughout the world, including Australia, China, France, Germany, Japan, UK, and US

- The Human Genome Project also consisted of industrial partnerships, such as a Monsanto-University of Washington project that generated a draft sequence of the rice plant genome.

Type of Partners Involved

federal, university, non-profit, and industrial members; US and international participants

Legal Status

The Human Genome Project was a collaborative effort funded by the Department of Energy and National Institutes of Health. The Department of Energy's Human Genome Program research was directed by Ari Patrinos, head of the Office of Biological and Environmental Research. Francis Collins directed the National Institutes of Health National Human Genome Research Institute efforts.

Planning Horizon for Research Activities

The project's first 5-year plan, intended to guide research in FYs 1990-1995, was revised in 1993 due to unexpected progress; The second plan outlined goals in FY 1993-1998. The third and final plan (FY 1998-2003) was developed during a series of DOE and NIH workshops. Some 18 countries participated in the worldwide effort, with significant contributions from the Sanger Center in the United Kingdom and research centers in Germany, France, and Japan.

Result

Succcess

Impact

While the sequencing aspects of the Human Genome Project were realized, the promise of translating the genomic knowledge into biomedical cures has not yet occurred. Impacts of the project include inspiring a big-science approach to data generation and dramatically improving sequencing technology. The Human Genome Project also demonstrated the value of real unity in a geographically distributed project, aided at least in part by a competitive aspect of the Project as it raced against a team from the private sector.

5.1.3 Large hadron collider

Primary Location

CERN

Overview

The Large Hadron Collider (LHC) is the world's largest and highest-energy particle accelerator, intended to collide opposing particle beams of either protons at an energy of 7 TeV per particle, or lead nuclei at an energy of 574 TeV per nucleus. It is expected that it will address the most fundamental questions of physics, hopefully allowing progress in understanding the deepest laws of nature. The LHC lies in a tunnel 27 kilometres (17 mi) in circumference, as much as 175 metres (570 ft) beneath the Franco-Swiss border near Geneva, Switzerland.

Timeline

1994 - 2008

Funding Level

The cost of the accelerator only (without experiments and computing) but including manpower and material is 4.7 Billion CHF (approx. 3.03 billion euros)

Funding Source(s)

It is funded by and built in collaboration with over 10,000 scientists and engineers from over 100 countries as well as hundreds of universities and laboratories.

Sector of Activity

Physics

Partners Involved

Partners include CERN host states, Canada, China, Japan, India, Russia, and US

Type of Partners Involved

federal, university; international

Legal Status

The Large Hadron Collider is located beneath the CERN Laboratory, which sits astride the Franco–Swiss border near Geneva. CERN was one of Europe's first joint ventures and now has 20 Member States.

Planning Horizon for Research Activities

Initial experiments were approved in 1996 that were both aimed to discover the Higgs boson, which would explain how particles get their mass, and probe the mysterious missing mass and dark energy of the Universe. Construction of Collider completed and ready for experiments to begin in 2008.

Result

Successfully constructed;

Experimental success and impacts are yet to be determined.

Impact

Construction of the Large Hadron Collider involved a high level of international collaboration. In this regard, comparison between LHC and the failed US-based Superconducting Super Collider could be interesting and enlightening. It's too soon to assess research impacts. The first beams were circulated successfully on 10th September 2008. Unfortunately on 19th September a serious fault developed damaging a number of superconducting magnets. The repair required a long technical intervention, delaying research.

5.1.4 Long-term ecological network

Primary Location

United States

Overview

The Long Term Ecological Network (LTER) is a collaborative effort investigating ecological processes over long temporal and broad spatial scales.

The goals of LTER are to understand a diverse array of ecosystems at multiple spatial and temporal scales; create general knowledge through long-term, interdisciplinary research, synthesis of information, and development of theory; inform the LTER and broader scientific community by creating well designed and well documented databases; create a legacy of well-designed and documented long-term observations, experiments, and archives of samples and specimens for future generations; promote training, teaching, and learning about long-term ecological research and the Earth's ecosystems, and to educate a new generation of scientists; and reach out to the broader scientific community, natural resource managers, policymakers, and the general public by providing decision support, information, recommendations and the knowledge and capability to address complex environmental challenges.

Timeline

1980 – ongoing

Funding Level

~$20M annual budget

Funding Source(s)

National Science Foundation - US

Sector of Activity

Environmental

Partners Involved

Twenty-six research sites constitute the LTER Network at present. The Network includes a wide range of ecosystem types spanning broad ranges of environmental conditions and human domination of the landscape. The geographic distribution of sites ranges from Alaska to Antarctica and from the Caribbean to French Polynesia and includes agricultural lands, alpine tundra, barrier islands, coastal lagoons, cold and hot deserts, coral reefs, estuaries, forests, freshwater wetlands, grasslands, kelp forests, lakes, open ocean, savannas, streams, and urban landscapes. Each site develops individual research programs in five core areas:

- Pattern and control of primary production;
- Spatial and temporal distribution of populations selected to represent trophic structure;
- Pattern and control of organic matter accumulation in surface layers and sediments;
- Patterns of inorganic inputs and movements of nutrients through soils, groundwater and surface waters;
- Patterns and frequency of site disturbances.

Type of Partners Involved

federal, university, and non-profit partners

US and international collaborations

Legal Status

The LTER program is funded by the US National Science Foundation. Each LTER site encompasses unique ecosystems and research approaches, investigators, students and management systems. Each of the 26 sites works as part of the Network sharing expertise, data and a common mission. To coordinate efforts, the National Science Foundation created the LTER Network Office at the University of New Mexico.

Planning Horizon for Research Activities

Since its establishment in 1980, the LTER enterprise has evolved from five sites with an annual budget of $1.2 M into a network comprising 26 ecologically diverse sites, an annual direct budget of $17.8 M in FY 2002 and some 1,100 scientists and students that generate approximately $44 M in LTER-related research. The LTER program has fostered interdisciplinary, interagency and international scientific collaborations, and 20 nations now have associated International LTER (ILTER) programs.

(1980-1990) Its first decade was devoted to long-term data collection and analysis in five core areas: primary production, nutrient flux, trophic structures, disturbances, and organic matter accumulation and decomposition.

(1990-2000) In its second decade, the LTER program incorporated the advice of NSF's ten-year review and dealt more with large-scale and cross-site ecological patterns and processes, as well as anthropogenic influences on ecological systems.

(2000-2010) The LTER program focused on synthesis science to lead to a better understanding of complex environmental problems and result in knowledge that serves science and society.

Comprehensive reivews of LTER were done in 1993 (10 year review) and 2002 (20 year review).

Result

Success and Failure

Impact

LTER has had success in establishing independent long-term ecological sites and gathering site specific data. As such, it has been an absolutely critical resource for understanding climate change impacts. However, it did not implement a true network of research and data for cross-site synthesis, leading the National Science Foundation to create the National Center for Ecological Analysis and Synthesis (NCEAS) to bring synthesis out of a discipline "drowning in a sea of data." LTER is now playing catch-up, trying to create network/interoperability/synthesis after the fact. Lesson: There is a major advantage to having the cyberinfrastructure for networked collecting, sharing, archiving, accessing, analysis, modeling, synthesis, etc. in place before collecting data.

5.1.5 Strategic computing initiative

Primary Location

United States

Overview

The U.S. government's Strategic Computing Initiative funded research into advanced computer hardware and artificial intelligence from 1983 to 1993. The initiative was designed to support all the various projects that were required to develop machine intelligence in a ten year time frame, from chip design and manufacture, computer architecture to artificial intelligence software.

Timeline

1983 - 1993

Funding Level

~$1B US

Funding Source(s)

Department of Defense - Defense Advanced Research Projects Agency.

Sector of Activity

IT/Defense

Partners Involved

Paricipants included about half from industry, half from universities and government labs

Type of Partners Involved

federal, university, and industry; US

Legal Status

Project was funded and directed by DARPA's Information Processing Technology Office (IPTO)

Planning Horizon for Research Activities

The initiative was conceived as an integrated program, similar to the Apollo moon program, where diifferent subsystems would be created by various companies and academic projects and all of them would be brought together into a single integrated system.

The project was funded by the Defense Advanced Research Projects Agency and directed by the Information Processing Technology Office (IPTO). By 1985 it had spent $100 million and 92 projects were underway at 60 institutions, half in industry, half in universities and government labs.

The project was superseded in the 1990s by the Accelerated Strategic Computing Initiative and then by the Advanced Simulation and Computing Program. These later programs did not include artificial general intelligence as a goal, but instead focused on supercomputing for large scale simulation, such as atomic bomb simulations.

Result

Mixed Success

Impact

SCI never acieved its goal of machine intelligence. However it did suceed in fostering significant technological successes. On the software side, the initiative funded development of the Dynamic Analysis and Replanning Tool, a program that handled logistics using artificial intelligence techniques. This was a huge success, saving the Department of Defense significant money during Desert Storm.

5.1.6 Assembling the tree of life

Primary Location

United States

Overview

The goal of the Assembling the Tree of Life project is to construct an evolutionary history for all major lineages of life.

Timeline

2002 – ongoing

Funding Level

~$8-12M per year in funded projects; total since 2002

Funding Source(s)

National Science Foundation - US

Sector of Activity

Biology/Genetics

Partners Involved

AToL is managed by the National Science Foundation, which awards competitive grants for research to qualified scientists, engineers and educators.

Type of Partners Involved

federal, university, non-profit, foundation; US and International collaborations

Legal Status

Program managed and funded by the US National Science Foundation

Planning Horizon for Research Activities

Projects for Assembling the Tree of Life are expected to be ambitious and large scale, and to include training, outreach, and dissemination components. When appropriate to the question under study, projects should include multiple investigators from multiple disciplines and multiple organizations. Tree of Life projects that are taxon-oriented will focus on phylogenetic resolution of large lineages or clades. This taxon focus is not intended to deflect interest in or attention to theoretical or analytical issues, particularly when the clade under study raises critical questions about the suitability or power of current phylogenetic methods of analysis, such as complexities caused by reticulate evolution and lateral gene transfer. Major taxonomic groups that have not yet been addressed by current or previous AToL projects are now an emphasis of this program. In addition to hypothesis-driven work,

Tree of Life projects may also be method or theory-oriented, in which case they will address major analytical or computational problems in phylogenetic research and phyloinformatics. Tree of Life projects may also synthesis-oriented, in which case they will address integration of current and future knowledge pertaining to the Tree of Life, and accessibility to that knowledge.

Result

Success (so far) in achieving implementation goals; but still too early to assess impact.

Impact

Combined with the iPLANT initiative, AToL represents a concerted determination to complete a grand challenge (the entire tree of life) using traditional and innovative cyber IT tools, with incalculable consequences for drug discovery and development, agricultural production, dealing with invasive species and zoonotic diseases, and stewarding the life support systems (and species) of the planet. Scientific challenge are high, thus near-term payoff is unlikely.

5.2 Framework assessment

Fulfillment of criteria for all flagship framework models (Table 18)

Crit. 1	Legal Framework *Does the legal framework facilitate:*	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA
1.1	EU-wide cooperation	1	1	1	1	1	0	1
1.2	participation of international partners in projects	1	1	1	1	1	0	1
1.3	funding for international partners	1	0	0	0	0	0	1
1.4	usage of different funding sources (e.g. EU-FP, national, regional etc.)	1	1	0	1	1	0	1
1.5	flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding	0	0	0	0	0	0	1
1.6	multiannual commitment (e.g. concerning budgets)	1	1	1	1	1	0	0
1.7	longterm cooperation	0	1	1	1	1	0	1
1.8	research in teams in single member states	0	0	1	1	1	0	1
1.9	single researchers	0	0	1	0	1	0	0
1.10	competitions (awards/prizes)	0	0	0	0	1	0	1
1.11	competition between ideas or teams, i.e. competitive calls (with/without deadline)	0	1	0	1	1	0	0
1.12	flexibility in the structures (i.e. decision bodies, governance models etc.)	1	0	1	1	1	0	1
1.13	autonomy (i.e. making its own funding decisions)	1	1	0	1	0	0	0
1.14	rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)	1	1	1	1	1	0	1
	Total (Crit.1)	**8**	**8**	**8**	**10**	**11**	**0**	**10**

Crit. 1	Legal Framework *Does the legal framework facilitate:*	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)	Sum
1.1	EU-wide cooperation	1	1	1	1	1	1	**12**
1.2	participation of international partners in projects	1	1	1	1	1	1	**12**
1.3	funding for international partners	1	0	1	1	0	0	**5**
1.4	usage of different funding sources (e.g. EU-FP, national, regional etc.)	1	1	0	0	0	0	**7**
1.5	flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding	0	1	0	0	0	1	**3**
1.6	multiannual commitment (e.g. concerning budgets)	0	1	1	1	1	1	**10**
1.7	longterm cooperation	1	0	0	0	1	0	**7**
1.8	research in teams in single member states	1	0	0	0	1	0	**6**
1.9	single researchers	0	0	0	0	0	0	**2**
1.10	competitions (awards/prizes)	0	0	0	0	0	1	**3**
1.11	competition between ideas or teams, i.e. competitive calls (with/without deadline)	1	1	1	1	0	1	**8**
1.12	flexibility in the structures (i.e. decision bodies, governance models etc.)	1	1	0	0	1	1	**9**
1.13	autonomy (i.e. making its own funding decisions)	1	1	0	0	1	0	**6**
1.14	rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)	0	1	1	1	1	1	**11**
	Total (Crit.1)	**9**	**9**	**6**	**6**	**8**	**8**	**101**

Crit. 2	Governance *Does the governance structure support:*	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA
2.1	efficient management of different funding sources	1	0	0	0	1	1	0
2.2	interplay of public decision making bodies	1	1	1	0	1	1	1
2.3	simple, direct hierarchical structures with clear competences	1	0	1	1	1	1	1
2.4	responsibility of scientific leaders in the management	0	1	1	0	0	0	0
2.5	different channels to reach a broad acceptance by the public	1	0	1	1	1	0	1
2.6	quality control and continuous improvement	1	1	1	1	1	1	1
2.7	strategic development	1	1	1	1	1	1	1
2.8	long-term commitment of all partners including the funding providers (EU, member states)	1	0	1	1	1	1	1
2.9	transparency in the evaluation and selection process	1	0	1	1	1	0	1
2.10	an environment favourable to integration	1	1	1	1		1	1
	Total (Crit.2)	**9**	**5**	**9**	**7**	**8**	**7**	**8**

Crit. 2	Governance *Does the governance structure support:*	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)	Sum
2.1	efficient management of different funding sources	0	0	0	0	0	0	**3**
2.2	interplay of public decision making bodies	1	1	1	1	0	1	**11**
2.3	simple, direct hierarchical structures with clear competences	1	1	1	1	1	1	**12**
2.4	responsibility of scientific leaders in the management	1	1	0	0	1	0	**5**
2.5	different channels to reach a broad acceptance by the public	0	1	1	1	0	0	**8**
2.6	quality control and continuous improvement	0	1	1	1	1	1	**12**
2.7	strategic development	1	1	1	1	1	1	**13**
2.8	long-term commitment of all partners including the funding providers (EU, member states)	1	0	1	1	1	1	**11**
2.9	transparency in the evaluation and selection process	1	1	1	1	1	1	**11**
2.10	an environment favourable to integration	0	1	1	1	1	1	**11**
	Total (Crit.2)	**6**	**8**	**8**	**8**	**7**	**7**	**97**

Crit. 3	Types of RTD activities/ Instruments *Are there activities available or implementable that support:*	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA
3.1	fundamental/basic research	0	1	1	0	0	0	0
3.2	industrial and experimental research	1	1	0	1	0	0	1
3.3	technology development/application-oriented research	0	1	0	1	1	0	1
3.4	studies and roadmapping activities	0	0	1	1	1	1	0
3.5	public relation actions	1	0	1	1	1	1	1
3.6	information exchange and cooperation between projects	1	1	1	1	1	1	1
3.7	involvement of all actors along the value chain (universities, research institutions, industry, users)	1	1	1	1	1	1	1
3.8	networking	1	0	1	1	1	1	1
3.9	co-operative RTD projects	1	1	1	1	1	1	1
3.10	international collaboration	1	1	1	1	1	1	1
3.11	exchange of researchers	0	0	1	1	0	0	0
3.12	conferences and workshops	0	0	1	0	1	1	0
3.13	PhD scholarships	0	0	1	1	0	0	0
3.14	research grants (single researchers)	0	0	0	0	1	0	0
3.15	(co)funding of joint infrastructure	0	0	1	1	1	0	0
3.16	centres in several EU locations	0	0	0	1	1	0	0
3.17	flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project	1	1	1	1	1	1	1
	Total (Crit. 3)	**8**	**8**	**13**	**14**	**13**	**9**	**9**
	Total	25	21	30	31	32	16	27

Crit. 3	Types of RTD activities/ Instruments *Are there activities available or implementable that support:*	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)	Sum
3.1	fundamental/basic research	0	1	1	1	0	0	5
3.2	industrial and experimental research	1	1	1	1	1	1	10
3.3	technology development/application-oriented research	1	1	1	1	1	1	10
3.4	studies and roadmapping activities	0	0	1	1	0	0	6
3.5	public relation actions	0	0	1	1	1	0	9
3.6	information exchange and cooperation between projects	0	0	0	1	1	1	10
3.7	involvement of all actors along the value chain (universities, research institutions, industry, users)	1	0	1	1	1	1	12
3.8	networking	0	0	0	1	1	1	9
3.9	co-operative RTD projects	1	1	1	1	1	1	13
3.10	international collaboration	1	1	1	1	1	1	13
3.11	exchange of researchers	0	1	0	1	0	1	5
3.12	conferences and workshops	0	1	0	1	1	0	6
3.13	PhD scholarships	0	1	0	0	0	0	3
3.14	research grants (single researchers)	0	1	0	0	1	1	4
3.15	(co)funding of joint infrastructure	0	0	0	1	0	0	4
3.16	centres in several EU locations	0	0	0	1	0	0	3
3.17	flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project	1	1	0	0	1	1	11
	Total (Crit. 3)	6	10	8	14	11	10	133
	Total	21	27	22	28	26	25	331

Table 18 General assessment matrix with yes (1) / no (0) decisions for all frameworks

Assessment of potential flagship frameworks (totals)

Highest rated initiatives	All criteria Total (41)	Crit. 1 Legal framework (14)	Crit. 2 Governance (10)	Crit. 3 Types of RTD activities / instruments (17)
1. ESA	32	11	8	13
2. EIT KIC	31	10	7	14
3. CERN	30	8	10	13
4. FP7 Coop.	28	6	8	14
5. EUREKA, Eurostars	27 (same total)	10 (9)	8 (8)	9 (10)

Table 19 Overview of the results of the suitability assessment for the top 6 model frameworks when evaluating only binary decisions (yes/no) for each criterion

Assessment of potential flagship frameworks (weighted results)

Crit. 1	Legal Framework *Does the legal framework facilitate:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
1.1	EU-wide cooperation	3	3	3	3	3	3	0	3	3	3	3	3	3	3
1.2	participation of international partners in projects	3	3	3	3	3	3	0	3	3	3	3	3	3	3
1.3	funding for international partners	3	3	0	0	0	0	0	3	3	0	3	3	0	0
1.4	usage of different funding sources (e.g. EU-FP, national, regional etc.)	9	9	9	0	9	9	0	9	9	9	0	0	0	0
1.5	flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding	9	0	0	0	0	0	0	9	0	9	0	0	0	9
1.6	multiannual commitment (e.g. concerning budgets)	6	6	6	6	6	6	0	0	0	6	6	6	6	6
1.7	longterm cooperation	9	0	9	9	9	9	0	9	9	0	0	0	9	0
1.8	research in teams in single member states	3	0	0	3	3	3	0	3	3	0	0	0	3	0
1.9	single researchers	3	0	0	3	0	3	0	0	0	0	0	0	0	0
1.10	competitions (awards/prizes)	3	0	0	0	0	3	0	3	0	0	0	0	0	3
1.11	competition between ideas or teams, i.e. competitive calls (with/without deadline)	6	0	6	0	6	6	0	0	6	6	6	6	0	6
1.12	flexibility in the structures (i.e. decision bodies, governance models etc.)	4	4	0	4	4	4	0	4	4	4	0	0	4	4
1.13	autonomy (i.e. making its own funding decisions)	6	6	6	0	6	0	0	0	6	6	0	0	6	0
1.14	rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)	3	3	3	3	3	3	0	3	0	3	3	3	3	3
	Total (Crit.1)	70	37	45	34	52	52	0	49	46	49	24	24	37	37
Crit. 2	Governance *Does the governance structure support:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
2.1	efficient management of different funding sources	3	3	0	0	0	3	3	0	0	0	0	0	0	0
2.2	interplay of public decision making bodies	2	2	2	2	0	2	2	2	2	2	2	2	0	2
2.3	simple, direct hierarchical structures with clear competences	6	6	0	6	6	6	6	6	6	6	6	6	6	6
2.4	responsibility of scientific leaders in the management	9	0	9	9	0	0	0	0	9	9	0	0	9	0
2.5	different channels to reach a broad acceptance by the public	5	5	0	5	5	5	0	5	0	5	5	5	0	0
2.6	quality control and continuous improvement	2	2	2	2	2	2	2	2	0	2	2	2	2	2
2.7	strategic development	2	2	2	2	2	2	2	2	2	2	2	2	2	2
2.8	long-term commitment of all partners including the funding providers (EU, member states)	5	5	0	5	5	5	5	5	5	0	5	5	5	5
2.9	transparency in the evaluation and selection process	10	10	0	10	10	10	0	10	10	10	10	10	10	10
2.10	an environment favourable to integration	6	6	6	6	6	0	6	6	0	6	6	6	6	6
	Total (Crit.2)	50	41	21	47	36	35	26	38	34	42	38	38	40	33
Crit. 3	Types of RTD activities/ Instruments *Are there activities available or implementable that support:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
3.1	fundamental/basic research	7	0	7	7	0	0	0	0	0	7	7	7	0	0
3.2	industrial and experimental research	7	7	7	0	7	0	0	7	7	7	7	7	7	7
3.3	technology development/application-oriented research	7	0	7	0	7	7	0	7	7	7	7	7	7	7
3.4	studies and roadmapping activities	4	0	0	4	4	4	4	0	0	0	4	4	0	0
3.5	public relation actions	4	4	0	4	4	4	4	4	0	0	4	4	4	0
3.6	information exchange and cooperation between projects	4	4	4	4	4	4	4	4	0	0	0	4	4	4
3.7	involvement of all actors along the value chain (universities, research institutions, industry, users)	4	4	4	4	4	4	4	4	4	0	4	4	4	4
3.8	networking	4	4	0	4	4	4	4	4	0	0	0	4	4	4
3.9	co-operative RTD projects	10	10	10	10	10	10	10	10	10	10	10	10	10	10
3.10	international collaboration	4	4	4	4	4	4	4	4	4	4	4	4	4	4
3.11	exchange of researchers	4	0	0	4	4	0	0	0	0	4	0	4	0	4
3.12	conferences and workshops	3	0	0	3	0	3	3	0	0	3	0	3	3	0
3.13	PhD scholarships	3	0	0	3	3	0	0	0	0	3	0	0	0	0
3.14	research grants (single researchers)	3	0	0	0	0	3	0	0	0	3	0	0	3	3
3.15	(co)funding of joint infrastructure	7	0	0	7	7	7	0	0	0	0	0	7	0	0
3.16	centres in several EU locations	3	0	0	0	3	3	0	0	0	0	0	3	0	0
3.17	flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project	7	7	7	7	7	7	7	7	7	7	0	0	7	7
	Total (Crit. 3)	85	44	50	65	72	64	44	51	39	55	47	72	57	54
	Total	**205**	**122**	**116**	**146**	**160**	**151**	**70**	**138**	**119**	**146**	**109**	**134**	**134**	**124**

Table 20 Framework suitability assessment (weighted criteria of FET study team)

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FFG

Assessment of potential flagship frameworks (Understanding Cells)

Crit. 1	Legal Framework *Does the legal framework facilitate:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
1.1	EU-wide cooperation	8	8	8	8	8	8	0	8	8	8	8	8	8	8
1.2	participation of international partners in projects	6	6	6	6	6	6	0	6	6	6	6	6	6	6
1.3	funding for international partners	1	1	0	0	0	0	0	1	1	0	1	1	0	0
1.4	usage of different funding sources (e.g. EU-FP, national, regional etc.)	2	2	2	0	2	2	0	2	2	2	0	0	0	0
1.5	flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding	5	0	0	0	0	0	0	5	0	5	0	0	0	5
1.6	multiannual commitment (e.g. concerning budgets)	8	8	8	8	8	8	0	0	0	8	8	8	8	8
1.7	longterm cooperation	9	0	9	9	9	9	0	9	9	0	0	0	9	0
1.8	research in teams in single member states	2	0	0	2	2	2	0	2	2	0	0	0	2	0
1.9	single researchers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1.10	competitions (awards/prizes)	3	0	0	0	0	3	0	3	0	0	0	0	0	3
1.11	competition between ideas or teams, i.e. competitive calls (with/without deadline)	3	0	3	0	3	3	0	0	3	3	3	3	0	3
1.12	flexibility in the structures (i.e. decision bodies, governance models etc.)	7	7	0	7	7	7	0	7	7	7	0	0	7	7
1.13	autonomy (i.e. making its own funding decisions)	8	8	8	0	8	0	0	0	8	8	0	0	8	0
1.14	rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)	8	8	8	8	8	8	0	8	0	8	8	8	8	8
	Total (Crit.1)	70	48	52	48	61	56	0	51	46	55	34	34	56	48
Crit. 2	**Governance** *Does the governance structure support:*	**Weight 1-10**	**AAL**	**ARTEMIS**	**CERN**	**EIT KIC**	**ESA**	**ETP**	**EUREKA**	**EUREKA Cluster CATRENE**	**EUREKA-Eurostars**	**FoF (FP7)**	**FP7 Cooperation**	**IMI**	**Era Nets (e.g.MNT)**
2.1	efficient management of different funding sources	3	3	0	0	0	3	3	0	0	0	0	0	0	0
2.2	interplay of public decision making bodies	2	2	2	2	0	2	2	2	2	2	2	2	0	2
2.3	simple, direct hierarchical structures with clear competences	5	5	0	5	5	5	5	5	5	5	5	5	5	5
2.4	responsibility of scientific leaders in the management	6	0	6	6	0	0	0	0	6	6	0	0	6	0
2.5	different channels to reach a broad acceptance by the public	5	5	0	5	5	5	0	5	0	5	5	5	0	0
2.6	quality control and continuous improvement	5	5	5	5	5	5	5	5	0	5	5	5	5	5
2.7	strategic development	6	6	6	6	6	6	6	6	6	6	6	6	6	6
2.8	long-term commitment of all partners including the funding providers (EU, member states)	6	6	0	6	6	6	6	6	6	0	6	6	6	6
2.9	transparency in the evaluation and selection process	5	5	0	5	5	5	0	5	5	5	5	5	5	5
2.10	an environment favourable to integration	7	7	7	7	7	0	7	7	0	7	7	7	7	7
	Total (Crit.2)	50	44	26	47	39	37	34	41	30	41	41	41	40	36
Crit. 3	**Types of RTD activities/ Instruments** *Are there activities available or implementable that support:*	**Weight 1-10**	**AAL**	**ARTEMIS**	**CERN**	**EIT KIC**	**ESA**	**ETP**	**EUREKA**	**EUREKA Cluster CATRENE**	**EUREKA-Eurostars**	**FoF (FP7)**	**FP7 Cooperation**	**IMI**	**Era Nets (e.g.MNT)**
3.1	fundamental/basic research	7	0	7	7	0	0	0	0	0	7	7	7	0	0
3.2	industrial and experimental research	6	6	6	0	6	0	0	6	6	6	6	6	6	6
3.3	technology development/application-oriented research	6	0	6	0	6	6	0	6	6	6	6	6	6	6
3.4	studies and roadmapping activities	8	0	0	8	8	8	8	0	0	0	8	8	0	0
3.5	public relation actions	4	4	0	4	4	4	4	4	0	0	4	4	4	0
3.6	information exchange and cooperation between projects	4	4	4	4	4	4	4	4	0	0	0	4	4	4
3.7	involvement of all actors along the value chain (universities, research institutions, industry, users)	6	6	6	6	6	6	6	6	6	0	6	6	6	6
3.8	networking	6	6	0	6	6	6	6	6	0	0	0	6	6	6
3.9	co-operative RTD projects	6	6	6	6	6	6	6	6	6	6	6	6	6	6
3.10	international collaboration	6	6	6	6	6	6	6	6	6	6	6	6	6	6
3.11	exchange of researchers	4	0	0	4	4	0	0	0	0	4	0	4	0	4
3.12	conferences and workshops	4	0	0	4	0	4	4	0	0	4	0	4	4	0
3.13	PhD scholarships	4	0	0	4	4	0	0	0	0	4	0	0	0	0
3.14	research grants (single researchers)	2	0	0	0	0	2	0	0	0	2	0	0	2	2
3.15	(co)funding of joint infrastructure	4	0	0	4	4	4	0	0	0	0	0	4	0	0
3.16	centres in several EU locations	4	0	0	0	4	4	0	0	0	0	0	4	0	0
3.17	flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project	4	4	4	4	4	4	4	4	4	4	0	0	4	4
	Total (Crit. 3)	85	42	45	67	72	64	48	48	34	49	49	75	54	50
	Total	205	134	123	162	172	157	82	140	110	145	124	150	150	134

Table 21 Framework suitability assessment for Understanding Cells (domain experts)

Assessment of potential flagship frameworks (Complex Social Systems)

Legal Framework *Does the legal framework facilitate:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
EU-wide cooperation	5	5	5	5	5	5	0	5	5	5	5	5	5	5
participation of international partners in projects	7	7	7	7	7	7	0	7	7	7	7	7	7	7
funding for international partners	6	6	0	0	0	0	0	6	6	0	6	6	0	0
usage of different funding sources (e.g. EU-FP, national, regional etc.)	3	3	3	0	3	3	0	3	3	3	0	0	0	0
flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding	7	0	0	0	0	0	0	7	0	7	0	0	0	7
multiannual commitment (e.g. concerning budgets)	7	7	7	7	7	7	0	0	0	7	7	7	7	7
longterm cooperation	7	0	7	7	7	7	0	7	7	0	0	0	7	0
research in teams in single member states	2	0	0	2	2	2	0	2	2	0	0	0	2	0
single researchers	0	0	0	0	0	0	0	0	0	0	0	0	0	0
competitions (awards/prizes)	7	0	0	0	0	7	0	7	0	0	0	0	0	7
competition between ideas or teams, i.e. competitive calls (with/without deadline)	0	0	0	0	0	0	0	0	0	0	0	0	0	0
flexibility in the structures (i.e. decision bodies, governance models etc.)	7	7	0	7	7	7	0	7	7	7	0	0	7	7
autonomy (i.e. making its own funding decisions)	7	7	7	0	7	0	0	0	7	7	0	0	7	0
rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)	5	5	5	5	5	5	0	5	0	5	5	5	5	5
Total (Crit.1)	70	47	41	40	50	50	0	56	44	48	30	30	47	45
Governance *Does the governance structure support:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
efficient management of different funding sources	7	7	0	0	0	7	7	0	0	0	0	0	0	0
interplay of public decision making bodies	4	4	4	4	0	4	4	4	4	4	4	4	0	4
simple, direct hierarchical structures with clear competences	0	0	0	0	0	0	0	0	0	0	0	0	0	0
responsibility of scientific leaders in the management	7	0	7	7	0	0	0	0	7	7	0	0	7	0
different channels to reach a broad acceptance by the public	2	2	0	2	2	2	0	2	0	2	2	2	0	0
quality control and continuous improvement	6	6	6	6	6	6	6	6	0	6	6	6	6	6
strategic development	6	6	6	6	6	6	6	6	6	6	6	6	6	6
long-term commitment of all partners including the funding providers (EU, member states)	6	6	0	6	6	6	6	6	6	0	6	6	6	6
transparency in the evaluation and selection process	7	7	0	7	7	7	0	7	7	7	7	7	7	7
an environment favourable to integration	5	5	5	5	5	0	5	5	0	5	5	5	5	5
Total (Crit.2)	50	43	28	43	32	38	34	36	30	37	36	36	37	34
Types of RTD activities/ Instruments *Are there activities available or implementable that support:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
fundamental/basic research	7	0	7	7	0	0	0	0	0	7	7	7	0	0
industrial and experimental research	6	6	6	0	6	0	0	6	6	6	6	6	6	6
technology development/application-oriented research	7	0	7	0	7	7	0	7	7	7	7	7	7	7
studies and roadmapping activities	7	0	0	7	7	7	7	0	0	0	7	7	0	0
public relation actions	1	1	0	1	1	1	1	1	0	0	1	1	1	0
information exchange and cooperation between projects	6	6	6	6	6	6	6	6	0	0	0	6	6	6
involvement of all actors along the value chain (universities, research institutions, industry, users)	6	6	6	6	6	6	6	6	6	0	6	6	6	6
networking	6	6	0	6	6	6	6	6	0	0	0	6	6	6
co-operative RTD projects	6	6	6	6	6	6	6	6	6	6	6	6	6	6
international collaboration	6	6	6	6	6	6	6	6	6	6	6	6	6	6
exchange of researchers	6	0	0	6	6	0	0	0	0	6	0	6	0	6
conferences and workshops	6	0	0	6	0	6	6	0	0	6	0	6	6	0
PhD scholarships	6	0	0	6	6	0	0	0	0	6	0	0	0	0
research grants (single researchers)	3	0	0	0	0	3	0	0	0	3	0	0	3	3
(co)funding of joint infrastructure	0	0	0	0	0	0	0	0	0	0	0	0	0	0
centres in several EU locations	0	0	0	0	0	0	0	0	0	0	0	0	0	0
flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project	6	6	6	6	6	6	6	6	6	6	0	0	6	6
Total (Crit. 3)	85	43	50	69	69	60	50	50	37	59	46	70	59	58
Total	205	133	119	152	151	148	84	142	111	144	112	136	143	137

Table 22 Framework suitability assessment for Complex Social Systems (weighted domain experts)

Assessment of potential flagship frameworks (Novel Computing)

Crit. 1	**Legal Framework** *Does the legal framework facilitate:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
1.1	EU-wide cooperation	8	8	8	8	8	8	0	8	8	8	8	8	8	8
1.2	participation of international partners in projects	5	5	5	5	5	5	0	5	5	5	5	5	5	5
1.3	funding for international partners	3	3	0	0	0	0	0	3	3	0	3	3	0	0
1.4	usage of different funding sources (e.g. EU-FP, national, regional etc.)	8	8	8	0	8	8	0	8	8	8	0	0	0	0
1.5	flexibility of funding mechanisms ; e.g. (annual) basic funding, project-/program funding, open competitive bidding	5	0	0	0	0	0	0	5	0	5	0	0	0	5
1.6	multiannual commitment (e.g. concerning budgets)	8	8	8	8	8	8	0	0	0	8	8	8	8	8
1.7	longterm cooperation	7	0	7	7	7	7	0	7	7	0	0	0	7	0
1.8	research in teams in single member states	2	0	0	2	2	2	0	2	2	0	0	0	2	0
1.9	single researchers	2	0	0	2	0	2	0	0	0	0	0	0	0	0
1.10	competitions (awards/prizes)	1	0	0	0	0	1	0	1	0	0	0	0	0	1
1.11	competition between ideas or teams, i.e. competitive calls (with/without deadline)	6	0	6	0	6	6	0	0	6	6	6	6	0	6
1.12	flexibility in the structures (i.e. decision bodies, governance models etc.)	3	3	0	3	3	3	0	3	3	3	0	0	3	3
1.13	autonomy (i.e. making its own funding decisions)	7	7	7	0	7	0	0	0	7	7	0	0	7	0
1.14	rules of cooperation between partners and IPR Regulations (e.g. consortium agreement)	5	5	5	5	5	5	0	5	0	5	5	5	5	5
	Total (Crit.1)	70	47	54	40	59	55	0	47	49	55	35	35	45	41
Crit. 2	**Governance** *Does the governance structure support:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
2.1	efficient management of different funding sources	5	5	0	0	0	5	5	0	0	0	0	0	0	0
2.2	interplay of public decision making bodies	4	4	4	4	0	4	4	4	4	4	4	4	0	4
2.3	simple, direct hierarchical structures with clear competences	7	7	0	7	7	7	7	7	7	7	7	7	7	7
2.4	responsibility of scientific leaders in the management	3	0	3	3	0	0	0	0	3	3	0	0	3	0
2.5	different channels to reach a broad acceptance by the public	6	6	0	6	6	6	0	6	0	6	6	6	0	0
2.6	quality control and continuous improvement	3	3	3	3	3	3	3	3	0	3	3	3	3	3
2.7	strategic development	6	6	6	6	6	6	6	6	6	6	6	6	6	6
2.8	long-term commitment of all partners including the funding providers (EU, member states)	5	5	0	5	5	5	5	5	5	0	5	5	5	5
2.9	transparency in the evaluation and selection process	8	8	0	8	8	8	0	8	8	8	8	8	8	8
2.10	an environment favourable to integration	3	3	3	3	3	0	3	3	0	3	3	3	3	3
	Total (Crit.2)	50	47	19	45	38	44	33	42	33	40	42	42	35	36
Crit. 3	**Types of RTD activities/ Instruments** *Are there activities available or implementable that support:*	Weight 1-10	AAL	ARTEMIS	CERN	EIT KIC	ESA	ETP	EUREKA	EUREKA Cluster CATRENE	EUREKA-Eurostars	FoF (FP7)	FP7 Cooperation	IMI	Era Nets (e.g.MNT)
3.1	fundamental/basic research	8	0	8	8	0	0	0	0	0	8	8	8	0	0
3.2	industrial and experimental research	5	5	5	0	5	0	0	5	5	5	5	5	5	5
3.3	technology development/application-oriented research	8	0	8	0	8	8	0	8	8	8	8	8	8	8
3.4	studies and roadmapping activities	5	0	0	5	5	5	5	0	0	0	5	5	0	0
3.5	public relation actions	4	4	0	4	4	4	4	4	0	0	4	4	4	0
3.6	information exchange and cooperation between projects	2	2	2	2	2	2	2	2	0	0	0	2	2	2
3.7	involvement of all actors along the value chain (universities, research institutions, industry, users)	6	6	6	6	6	6	6	6	6	0	6	6	6	6
3.8	networking	4	4	0	4	4	4	4	4	0	0	0	4	4	4
3.9	co-operative RTD projects	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3.10	international collaboration	5	5	5	5	5	5	5	5	5	5	5	5	5	5
3.11	exchange of researchers	5	0	0	5	5	0	0	0	0	5	0	5	0	5
3.12	conferences and workshops	4	0	0	4	0	4	4	0	0	4	0	4	4	0
3.13	PhD scholarships	5	0	0	5	5	0	0	0	0	5	0	0	0	0
3.14	research grants (single researchers)	1	0	0	0	0	1	0	0	0	1	0	0	1	1
3.15	(co)funding of joint infrastructure	5	0	0	5	5	5	0	0	0	0	0	5	0	0
3.16	centres in several EU locations	6	0	0	0	6	6	0	0	0	0	0	6	0	0
3.17	flexibility of consortia (e.g. mechanisms for changes in the structure of partners and involvement of third parties (associated partners) during the project	7	7	7	7	7	7	7	7	7	7	0	0	7	7
	Total (Crit. 3)	85	38	46	65	72	62	42	46	36	53	46	72	51	48
	Total	205	132	119	150	169	161	75	135	118	148	123	149	131	125

Table 23 Framework suitability assessment for Novel (Quantum) Computing (domain experts)

Ranking for equally weighted criteria

The top three frameworks remain stable when scaling individual values to 100 points per category (i.e. the legal, governance, and instruments weights) and then adding up totals for study team ranking and all experts together. In this ranking FP7 and Eurostars have changed rank.

Rank	Framework
1	EIT KIC
2	CERN
3	ESA
4	FP7 Cooperation
5	EUREKA-Eurostars
6	IMI
7	EUREKA
8	Era Nets (e.g.MNT)
9	AAL
10	ARTEMIS
11	FoF (FP7)
12	EUREKA Cluster CATRENE
13	ETP

Table 24 Ranking for equally weighted criteria sets (governance, legal, and instruments).

5.3 List of figures

5.4 List of tables

5.5 Suggested checklist for setting up a FET Flagship Initiative

Objectives

- Does the flagship have a clearly defined, understandable and highly ambitious goal?
- Is there a clear "mission" for the flagship initiative?
- Is the character of this mission such that it cannot be achieved by any other means than a Flagship Initiative in Europe?
- Does the flagship support regular progress evaluation towards reaching its goal?
- Will the flagship have clear and demonstrable societal or economic impact?
- Will the flagship deliver demonstrable results along the way (and not just at the end)?
- Is there a good balance between top-down (programme) and bottom-up (researcher) goals?
- Will the area of Information and Communication Technologies clearly advance with the flagship?

Approach

- Is there a clear view and understanding of how to approach the probem including a plan or research agenda?
- Have interdisciplinary aspects been considered?
- Is there a good balance between scientific and non-scientific activities such as technical work, demonstration, public relation…?
- Is there room in the flagship to support creativity, e.g. in the form of small teams?
- Will there be a strategic planning process supporting the further development of the research agenda?

Management

- Is there strong scientific leadership in the flagship?

- Are the leaders trusted by the community and willing to act for the benefit of others?
- Is there a strong team of small size with a multidisciplinary background overlooking flagship implementation?
- Does the flagship have a lean governance structure with clear responsilities?
- Is there a data management plan?
- Have important risks been considered?

Integration

- Does the flagship include the most important countries in terms of organizations located in that country?
- Does the flagship include the most relevant top research institutions?
- Is the flagship focused on areas of European excellence?
- Does the flagship reward integration between different teams/projects/actors etc.?
- Have the opportunities of bundling resources in a small number of research locations been considered?
- Have the opportunities for joint infrastructures been exploited?
- Is the flagship likely to influence a large number of groups in Europe and the research area as a whole?

Other aspects

- Has complementary international expertise been considered?
- Has the sustainability of the initiative been considered?