Helix Nebula – The Science Cloud

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Executive Summary

In the last three years, the Helix Nebula initiative has been part of the major changes to the cloud computing strategy in Europe.
By almost doubling the size of the consortium, from the initial 20 members to more than 40 today and several expressions of interest, the initiative has established a solid ground to attract a critical mass of users and providers across Europe.

Results from the initial pilot phase demonstrated the validity of the underlying strategy published in 2011[1], which aims to establish a very innovative Public Private Partnership for a Scientific Cloud Computing Infrastructure for Europe. Supported by an EC funded two-year co-ordination action, the partnership includes large European Research Organizations, pan-European e-Infrastructures and leading commercial providers in Europe, working together on a new hybrid cloud computing model to federate public and private resources to offer a secure and trusted cloud environment for Europe. Helix Nebula cloud architecture is based on open standards, to meet the high requirements of data intensive science and thus bolster the data driven economy.

Helix Nebula has been able to leverage the richness laying in the diversity of European suppliers and to match it with the expertise available in production e-Infrastructures, demonstrating the technical feasibility of interoperability between these players.
The shift from the pilot phase - focused on scientific use cases presented by CERN, ESA and EMBL plus the one planned for PIC- to the launch of a production platform (the Helix Nebula Marketplace), represents a great opportunity to seize momentum & boost the development and adoption of cloud computing services allowing Europe to lead the global scene.

Looking back at the launch of the Helix Nebula initiative, encouraging results have been achieved against the original objectives outlined in the 2011 strategy with the key support of the EC funded project 'Helix Nebula – The Science Cloud'.
A federated IaaS infrastructure was set up and put into production and significant progress was also made in the identification of appropriate policies for trust and security. Suitable

[1] http://www.helix-nebula.eu/index.php/news/30/61/Strategic-Plan-for-a-Scientific-Cloud-Computing-Infrastructure-for-Europe.html

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governance and business models for the future sustainability and growth of the Helix Nebula initiative and production infrastructure were identified and documented.
Further steps needed to complete achievements of these objectives and the emerging challenges in the long term are outline in this paper.

1. Introduction

This document highlights the results achieved by the Helix Nebula consortium in the last two years, in retrospect against the initial goals outlined in the strategy published in 2011.
It also considers the policy developments in Europe - including the key actions targeted by the European Cloud Computing Strategy in alignment with the long term objectives of the Digital Agenda for Europe - to identify areas requiring further effort and focus in the next three years.

The outcome of the pilot phase focused on the deployment of the flagships use cases, as well as the requirements that emerged and the solutions adopted and tested during the project, are summarized in this paper.

An outlook on the current policy framework for cloud computing in Europe is presented, as well as an overview on Helix Nebula's positioning in light of the most recent strategy documents and reports released by the European Commission, also based on the work of the European Cloud Partnership.

The future Helix Nebula strategy builds on the results of the deployments carried out during the pilot phase, the achievements in areas such as interoperability with existing pan-European e-Infrastructures, the adoption of sustainable and evolutional business models and the identification of possible lightweight multi-stakeholder governance models. The strategy also takes into account the need for definition of good and best practices for procurement of cloud services in Europe especially within public sector and research institutions.

The successes of the work towards the initial objectives have led a number of Helix Nebula partners to invest in the launching of the Helix Nebula Marketplace (HNX) in May 2014.

Prospects and plans for initial functioning of this marketplace and possible future developments have been included in this paper.

The Helix Nebula consortium's enthusiasm and motivation have facilitated the shift from a 'cloud active' to 'a cloud productive' phase to seize new opportunities and challenges.
The partnership continues its commitment to offer an open, secure and trusted Cloud Computing Infrastructure for European science, businesses and society, and to become a leader in a highly competitive global market.

2. Background strategy

In 2011, ESA and CERN published the document "Strategic Plan for a Scientific Cloud Computing Infrastructure for Europe", which sets a vision, a concept and a direction to form a European Industrial Strategy for a Scientific Cloud Computing Infrastructure to be implemented by 2020. The strategy was initially defined to serve the needs of the European Research Area (ERA)[2] and Space Agencies, with a potential reaching far beyond this initial user base in order to provide similar services to a broad range of customers including government and SMEs.
The strategy, consistent with recommendations laid in the 2010 report by the EC Expert Group "The Future of Cloud Computing - Opportunities for European Cloud Computing Beyond 2010"[3] was built around 4 main goals at the basis of the Helix Nebula initiative and was supported by a two-year EU funded project.

Goal #1 Establish a Cloud Computing Infrastructure for the European Research Area serving as a platform for innovation and evolution of the overall infrastructure.

The Helix Nebula project set the basis for a collaboration meant to integrate the resources of large cloud providers, technology suppliers and network operators into an open and scalable cloud platform capable of responding to the demanding requirements of prominent research organisations in Europe. The very innovative approach of Helix Nebula

[2] "ERA is composed of all research and development activities, programmes and policies in Europe which involve a transnational perspective." See
"2020 Vision for the European Research Area", 16767/08 published by the Council of the European Union in December 2008

[3] http://cordis.europa.eu/fp7/ict/ssai/events-20100126-cloud-computing_en.html

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lay in the federation with publicly funded e-Infrastructures based on open source solutions, to build a hybrid IaaS platform on top of which a competitive marketplace of European cloud players can develop services targeting a wider range of users, reaching beyond research and science.

Goal #2 Identify and adopt suitable policies for trust, security and privacy on a European-level can be provided by the European Cloud Computing framework and infrastructure.

In the last two years, a number of Helix Nebula partners have actively participated in working groups established within the European Cloud Partnership, set up to help in overcoming barriers identified in the European Commission strategy "Unleashing the Potential of Cloud Computing in Europe"[4].

For the set up and development of the Helix Nebula marketplace, partners have been focusing on mechanisms to ensure trust, like the selection of an independent broker, the combination of service offerings tailored to customers' request, and recurring security testing performed in an environment federating the Helix Nebula suppliers' resources.

In the area of data privacy, Helix Nebula took stock of the innovative work carried out by Cloud Security Alliance, a Helix Nebula member, to outline a template for Privacy Level Agreement in order to guide service providers towards the delivery of trusted services in terms of data privacy and management, in alignment with the recommendations of the Art.29 working party[5].

Helix Nebula welcomed recommendations and guidance included in the memo "What does the Commission mean by secure Cloud computing services in Europe?"[6] opposing a "Fortress Europe" approach to cloud computing and supporting the effort of a single market to turn current widespread concern on cloud technologies into a "Europe-wide

[4] http://ec.europa.eu/information_society/activities/cloudcomputing/docs/com/com_cloud.pdf

[5] "All cloud providers offering services in the EEA should provide the cloud client with all the information necessary to rightly assess the pros and cons of adopting such services. Security, transparency, and legal certainty for the clients should be key drivers behind the offer of cloud computing services." Article 29 Data Protection Working Party, Opinion 05/2012 on Cloud Computing ("A.29WP05/2012"), p. 2; "a precondition for relying on cloud computing arrangements is for the controller [cloud client] to perform an adequate risk assessment exercise, including the locations of the servers where the data are processed and the consideration of risks and benefits from a data protection perspective (…)" p. 4 id.

[6] http://europa.eu/rapid/press-release_MEMO-13-898_en.htm

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opportunity: for companies operating in Europe to offer the trusted cloud services that more and more users are demanding globally."

Goal #3 Create a light-weight governance structure for the future European Scientific Cloud Computing Infrastructure that involves all the stakeholders and can evolve over time as the infrastructure, services and user-base grows.

Agreements in force among different categories had a different degree of engagement and rules, with suppliers committing to follow special Antitrust Guidelines and consortium members bound by the signature of a Non-Disclosure Agreement applicable to the exchange of information pertaining to the initiative in 2014.
Nevertheless, the launch of the Helix Nebula Marketplace, marking the transition from a pilot to a production phase, has required the set-up of ad hoc commercial agreements and the signature of a Memorandum of Understanding.

Helix Nebula partners decided that the initiative shall have a light, effective and flexible governance and structure. It shall be open to new partners and adaptations following evolution of technology, market and needs of the scientific and other user communities.
This shall be taken into account by the legal and contractual arrangements for establishing Helix Nebula and framing the provision of Cloud Computing services.

This governance scheme shall allow shared decision-making and a balance between demand and supply sides.

As the initiative and its subsequent marketplace are maturing, further work on governance shall be undertaken and adaptations are foreseen in future plans.

Goal #4 Define a funding scheme involving all the stakeholder groups (service suppliers, users, EC and national funding agencies) into a Public-Private-Partnership model to implement a Cloud Computing Infrastructure that delivers a sustainable and profitable business environment adhering to European-level policies.

Suitable business models and their planned evolution, tailored on peculiarities of the Helix Nebula Public-Private-Partnership, have been identified and are illustrated in D7.2 Synthesis and Analysis of Overall Business Models.

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Furthermore a set of possible innovative funding schemes, financial incentives and accelerators has been included in the document "Helix Nebula – The Science cloud: A Catalyst for Change in Europe"[7].

A crucial accelerator would be offered by definition of a framework facilitating a pay-for-use approach for the procurement of cloud services for research purposes.

3. Achievements of the pilot phase

During the first half of 2012, three demand-side flagship applications were ported and deployed to the cloud infrastructure platforms of the Helix Nebula cloud service providers infrastructure as part of the first Helix Nebula Proof of Concept (PoC) phase.
The complexities involved in deploying these flagship applications to multiple cloud providers, all of whom offer quite different platforms and setups have been particularly challenging.

One of the identified actions requiring future effort was the development of common APIs since currently each provider uses a different API. Furthermore, more mature releases of connectors for EGI resources, based on OCCI standard, as well as for major vendors like AWS EC2 will be needed in view of expected increase of diverse groups of users of the services offered through the Helix Nebula marketplace.

The flagship deployments greatly benefited from the active involvement in the Helix Nebula initiative of EGI and GÉANT. As EGI plans to start a production phase of the EGI Federated Cloud in spring 2014, joint task forces will be needed to continue work focused on ensuring a reliable hybrid platform for research communities and scientific users.
Promising discussions with EUDAT and PRACE started in the last year to achieve more integration among e-Infrastructures and Helix Nebula's platform. However this relationship has to be further developed in the future with an accompanying strategy, as also outlined in the position paper presented at Cloudscape VI event calling for the creation of an "E-Infrastructure Commons Marketplace"[8].

[7] http://www.helix-nebula.eu/index.php/uploads/file/81/56/HelixNebula-NOTE-2013-003.pdf.html
[8] http://admin.cloudscapeseries.eu/Repository/document/PositionPapersCSVI/e-Infrastructure%20commons%20marketplace.pdf

All organisations involved in the development and operation of the Helix Nebula's Blue Boxes, the brokering tool allowing getting cloud services across different federated providers, have invested a significant amount of effort into securing their systems.
During the analysis of the developed brokers, some additional improvement opportunities have been identified.

For the Enstratius broker, the areas to be improved were those of Authentication, Authorization and Secure Software Development. The need to enforce multi-factor authentication for remote access combined with enforcing dual-control for critical operations has also emerged. The controls implemented to mitigate the effect of Distributed Denial of Service attacks were considered adequate for the then current development and deployment phase.

For the SlipStream broker, it was suggested to review Secure Key Management as well as Authentication and Authorization. Helix Nebula partners strongly recommended, during testing, to encrypt all keys used to access cloud service provider's services with the user password and to implement multi-factor authentication, especially for the super-user portal. The controls put in place to mitigate the effect of Distributed Denial of Service attacks were considered sufficient for the current deployment phase but should be reviewed during transition to production phase.

The penetration test on both brokers did not show any critical issues. The main concern is to ensure that valid SSL certificates are used, that no weak ciphers are supported and that the web servers are fully patched and properly configured.
Issues identified during the Security Challenge were to be addressed and resolved by both Enstratius and Slipstream by December 31st, 2013.
Since this assessment has been limited to a subset of areas it was strongly recommended to perform a more elaborate analysis and a full penetration test after the pilot phase.

In the area of Privacy Helix Nebula is taking stock of the work undertaken by CSA with publication of its "Privacy Level Agreement Outline".[9]
The implementation of such an agreement will require the specification of:

[9] https://cloudsecurityalliance.org/research/pla/

- Cloud Service Provider name, address, and place of establishment;
- Its local representative(s) (e.g. a local representative in the EU);
- Its data protection role in the relevant processing (i.e., controller, joint-controller, processor, or sub-processor);
- Contact details of the Data Protection Officer or, if there is no DPO, the contact details of the individual in charge of privacy matters to whom the customer may address requests.
- Contact details of the Information Security Officer, if there is no ISO, the contact details of the individual in charge of security matters to whom the customer may address requests.

To define a governance model for a federated environment, which includes partners that are sometimes competitors with different specializations, market share, corporate structure and business/revenue model, has been very challenging for the Helix Nebula initiative.
Initial relations, decision making process, conflict resolution and overall governance of the initiative have been regulated through specific agreements governing delicate balance and constraints given by:

- A Non-Disclosure Agreement,
- Anti-Trust Guidelines
- A necessary exchange of key information to deploy flagship use cases across heterogeneous resources
- A set up of a commercial offering through the establishment of a marketplace for cloud services.

Nevertheless, a governance structure for the Helix Nebula initiative and marketplace has been outlined and described in D8.1 “A story of governance models for public-private cloud partnerships” and key future directions are available later in this document.

The Helix Nebula partnership has demonstrated that it possesses all the expertise and technical building blocks required to offer generic cloud platform at the IaaS level as shows in the tested flagship deployments, but the shift to a production service must be fast and

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effective in attracting the needed critical mass to trigger the strong network effects expected.

The service is foreseen to start with public organisations in demand side as they have the necessary building blocks and elements to start their procurement processes. These would be independent, but based on a common technical specifications and contract terms and conditions for this initial generic cloud platform.
In this context, the need for an in-depth investigation of current practices for procurement of cloud services in Europe emerged and should be addressed in the near future.

Once the basic production system is in service, it can also act as a platform for innovation with other actors (SMEs, downstream industry etc.) using it to develop new services.
In addition, the Research Accelerator Hubs, as described in the EIRO forum e-infrastructure implementation plan[10], would allow operators such as CERN to perform aggregated procurement on behalf of their re-search partners thereby simplifying the overall procurement model.

By setting "Generic Cloud Computing for European Science" business model in production for 2014 work must progress in parallel with the supply-side and demand-side to develop higher-level services and expand to-wards the "Information as a Service" business model ideally to be achieved in 2015 with broadened scope and engagement.

For this wider goal, EU and national support in delivering some of the identified accelerators is needed soon, including a framework for procurement of cloud services under a pay for use approach across scientific communities.

4. Helix Nebula's positioning on the European Cloud Strategy

As a new computing paradigm presenting unprecedented challenges and opportunities, cloud has been under the spotlight for the last five years.
The EC Expert Group report "The Future of Cloud Computing - Opportunities for European Cloud Computing beyond 2010" recognised that "*Cloud technologies and models have not*

[10] http://zenodo.org/record/7592#.U2YLCVfePfQ

yet reached their full potential and many of the capabilities associated with clouds are not yet developed and researched to a degree that allows their exploitation to the full degree, respectively meeting all requirements under all potential circumstances of usage."
As explained above, the Helix Nebula Strategic Plan has worked around this scenario to define its four mid-term goals.

In 2012, a constructive debate around the Digital Agenda Assembly, Cloud Strategy and EU Data Protection Package further contributed to the European Cloud Strategy "Unleashing the Potential of Cloud Computing in Europe" published in September 2012 and focused on three key actions, namely, Safe and Fair Contract Terms and Conditions, Cutting through the Jungle of Standards and Establishing a European Cloud Partnership.
The Helix Nebula partners actively participated in activities and working groups set up by the European Commission to implement these actions throughout 2013 and 2014.

A review of the DAE, published on 18 December 2012[11], identified seven key areas for future work to stimulate the conditions to create growth and jobs in Europe, including "Accelerate cloud computing through public sector buying power".
In 2013, at the end of the first year of the Helix Nebula project, the initial strategic plan was updated with the publication of the document "Helix Nebula – The Science Cloud: A Catalyst for Change in Europe" in which a series of identified accelerators, were illustrated.
A further review of the strategy in the political debate was published following revelations on foreign programmes of mass surveillance including data of European citizens, governments and businesses with involvement of data retained by large global cloud players, even more focus has been given to aspects related to governance, security, privacy and general policies for data management in the cloud with the aim to make Europe a "'trusted cloud region in the post-PRISM age".

In this context, the European Commission's memo "What does the Commission mean by secure Cloud computing services in Europe?"[12] *recognised that "While Europe is not the leading provider of cloud services globally, it is known for relatively high standards of data protection, security, interoperability and transparency about service levels and government access to information. These characteristics provide a solid basis for further development of*

[11] http://europa.eu/rapid/press-release_IP-12-1389_en.htm
[12] http://europa.eu/rapid/press-release_MEMO-13-898_en.htm

cloud computing in Europe, as users become more conscious of the need for cheap, flexible IT services, without wanting to compromise privacy."

The Helix Nebula Initiative intends to embrace the opportunities coming from the launch of the Horizon 2020 programme to deploy more effort towards the achievement of this goal.
The Helix Nebula partnership supports the recommendations of the recent policy vision document "Establishing a Trusted Cloud Europe"[13], prepared for the European Commission by The European Cloud Partnership Steering Board.

As highlighted from this report, a flexible common framework of best practices as well as guidelines at legal, technical and operational level are needed to achieve a trusted digital single market for cloud services in Europe.
This framework could only emerge from consensus building with participation of cloud providers and cloud users, including citizens, businesses –also SMEs – and public administrations.

In this respect, and for the specific challenges of science data in the cloud, the report acknowledges the fore-running contribution of Helix Nebula, suggested as one of the key public sector pilot cloud services at EU level, especially in the area of cross-border procurement.
To develop and sustain such vision, interesting prospects come from Pre-Commercial Procurement (PCP) or Public Procurement of Innovation (PPI), e.g. as part of Specific Challenges from Horizon 2020 work programme, areas on which Helix Nebula is also focusing its future strategy.

Further opportunities also come from strong collaboration with players involved in the public procurement area, such as the Cloud for Europe initiative, and from the launch of the Connecting Europe Facility for fast trans-European digital networks, including a series of innovative instruments such as EIB loans to leverage private investments, in association with traditional ones such as grants and procurement.

[13] http://ec.europa.eu/digital-agenda/en/news/trusted-cloud-europe

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Also in this area PPP represents an effective approach to overcome current gaps in broadband provisioning across Europe, a pre-condition for the uptake and development of cloud computing.

The guidelines[14] for the implementation of the Digital part of the CEF programme, stress the need to establish "*synergies and interoperability between the different projects of common interest [...], as well as with other infrastructures, including [...] relevant research infrastructures supported, inter alia, by Horizon 2020 and relevant infrastructures supported by ESI Funds , while avoiding duplication and undue administrative burden*".

The recent background report of the document "Unlocking the ICT growth potential in Europe"[15] underlined the relevance of HPC systems for Europe's competitiveness.

> *"HPC is used for a wide range of activities, such as product design and testing applications conducted in large industrial R&D labs, plant layout design, logistics and traffic monitoring, financial market pricing/trading/event monitoring, medical imaging/patient monitoring/disease tracking, as well as network traffic routing in telecom. Currently, only large firms tend to possess the scale for HPC systems, though this is likely to change as the cloud becomes more widely adopted and more vendors offer big data solutions. Providing HPC availability more broadly, especially to small and medium-sized businesses with intermittent needs, will undoubtedly require harnessing the cloud and other Internet "second wave" forms of communication.*
> *To optimise networked computing for business HPC computing, countries require a high-class communication infrastructure—both in general businesses as well as its publicly accessible networks—to harness the power of ICT. This will be crucial as the data traffic on those networks continues to grow exponentially. HPC itself is also a form of ICT infrastructure and it should be of concern to European policymakers and business leaders that Europe's capabilities in industry are lagging while its resources in the academic sector are rich."*

The same report acknowledges that:

[14] http://ec.europa.eu/digital-agenda/en/news/cef-telecommunications-guidelines

[15] http://ec.europa.eu/digital-agenda/en/news/new-study-unlocking-ict-growth-potential-europe-enabling-people-and-businesses

"pre-conditions for reaping the ICT growth benefits need to be secured by a high-quality and affordable infrastructure in all sectors, capable of supporting the growing cloud, big data, and including high-speed fixed and mobile broadband. This must be matched by investments in the soft infrastructure to equip people with the skills to analyse and synthesise big data and use them to create new business opportunities."

The activities developed within Helix Nebula also show consistency with what was stated in the 2013 Annual Growth Survey[16]. It recommends ensuring that "*the widespread, interoperable digitalisation of public administration, aimed at fostering user-friendly procedures for service providers and recipients, as well as administrative simplification and transparency. Cross-border interoperability of online services and research centres throughout the EU*" is considered of particular importance.

Finally, the European Commission communications "For a European Industrial Renaissance" [17] reiterates that: "*A digital transition is underway across the global economy and industrial policy needs to integrate new technological opportunities such as cloud computing, big data and data value chain developments" and that "the infrastructure and connectivity software for industrial internet is a priority area in the light of its growing importance and should help integrate high performance processes including cloud computing*".

This strategic input confirms the appropriateness of the Helix Nebula original strategic plan, highlighting the potential of Public Private Partnerships among large research organizations, pan-European e-Infrastructures providing the needed horizontal capacity to European Research Infrastructures, and big commercial providers to boost competitiveness in Europe, leveraging huge benefits from cloud computing to link all innovation phases from basic scientific research to commercialization of innovative products and services.

[16] http://ec.europa.eu/europe2020/pdf/ags2013_en.pdf

[17] COM(2014) 14 final http://ec.europa.eu/enterprise/initiatives/mission-growth/index_en.htm

5. Future directions

With the end of the Helix Nebula EC funded project approaching, this document means to set the priorities for future works in light with the transition to a production environment and operational marketplace. Some of the achievements to-date and the actions still to be addressed in the upcoming future are detailed below.

5.1.Business development

A complex work of analysis of possible business models and assessment of the most suitable ones for the initial and maturity phases of the Helix Nebula production platform has been conducted in the last two years by SAP.

The potentially most-beneficial business models for Helix Nebula – "Information-as-a-Service" and "Generic Cloud Computing for European Science" – are both based on creating an ecosystem where users share elements of service as well as individually consume services "as-needed". The character of an ecosystem is that the benefits of the shared elements can grow strongly over time and make the ecosystem more beneficial for an ever larger community. Taking the existing procurement rules into account, the implementation should therefore provide a solution for both shared and individual elements. Since the most beneficial model of such an innovative ecosystem has not yet been determined in full detail, initially a PPP approach could be envisaged, that eventually could be transferred into a regular procurement process. However, the diversity in governance and stakeholders between the potential participants of the PPP (demand and supply-side) might lead to a long and time-consuming process to establish such PPP if available frameworks, e.g. the EU PCP and PPI, have to be further analysed for applicability.

By setting a "Generic Cloud Computing for European Science" business model in production for 2014, work must progress in parallel with the supply-side and demand-side to develop higher-level services and expand to-wards the "Information as a Service" business model, ideally to be achieved in 2015 with broadened scope and engagement.

To reach such objectives, the Helix Nebula project identified a four-step roadmap for implementing the business model detailed in D7.4 and D9.1.

INFOaaS is subject to network effects as its value increases for each user and the number of users grows. The more data providers share, the more complete the services will become. INFOaaS is a multisided platform ecosystem. This kind of ecosystem faces the lifecycle challenge of (1) fast implementation; (2) adoption, (3) scaling, and (4) competition (cf. Figure 15). These steps are now applied to INFOaaS in order to provide a roadmap for lifecycle management.

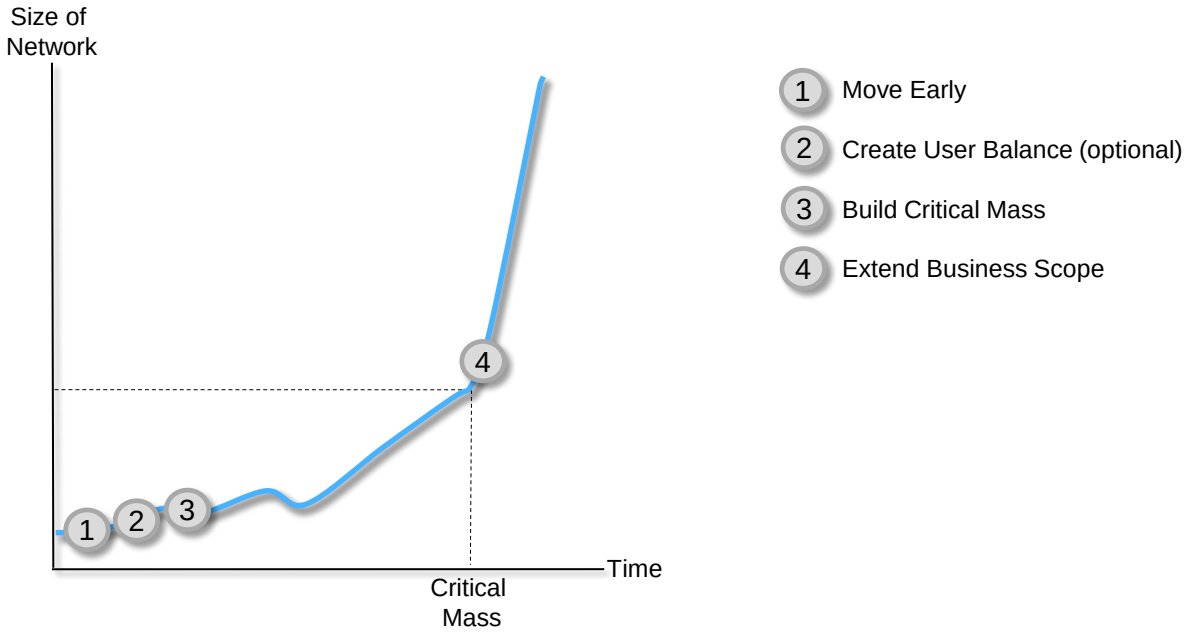

Figure 1: Strategic Steps towards Market Tipping

The very first step consists in starting the implementation with a niche by picking a specific target market to try and dominate. Opportunities from synergy with the DORIS project for the exploitation of Copernicus data seem to offer a potential starting point for an INFOaaS model, as explained in 'D9.1 - A roadmap of future developments'.

5.2.Governance model

We take as a definition of governance the following quote from D8.1 "A story of governance models for public-private cloud partnerships":
"*Governance is the processes, structures and organizational traditions that determine how power is exercised, how stakeholders have their say, how decisions are taken and how decision-makers are held to account.*" [1]

The legal and contractual arrangements plan to follow a step-wise approach following the different phases:

- Initial phase
- Operational phase
- Long-term evolution

Implementation of the initial phase is already on-going based on the Helix Nebula Strategy. Contractual arrangements in this phase basically include a Non-Disclosure Agreement (NDA) signed by all partners and a Memorandum of Understanding (MoU) between the service provider partners for the Helix Nebula Marketplace.

The operational phase has started in spring 2014 and will evolve towards an established framework and operational services some time towards the end of 2014. Contractual arrangements for this phase will be on four different levels:

- Helix Nebula Initiative
- Cloud Services Provision
- Helix Nebula Marketplace
- Outreach, Cooperation and supporting projects

To ensure long-term evolution the Helix Nebula initiative plans to adopt the following governance structure:

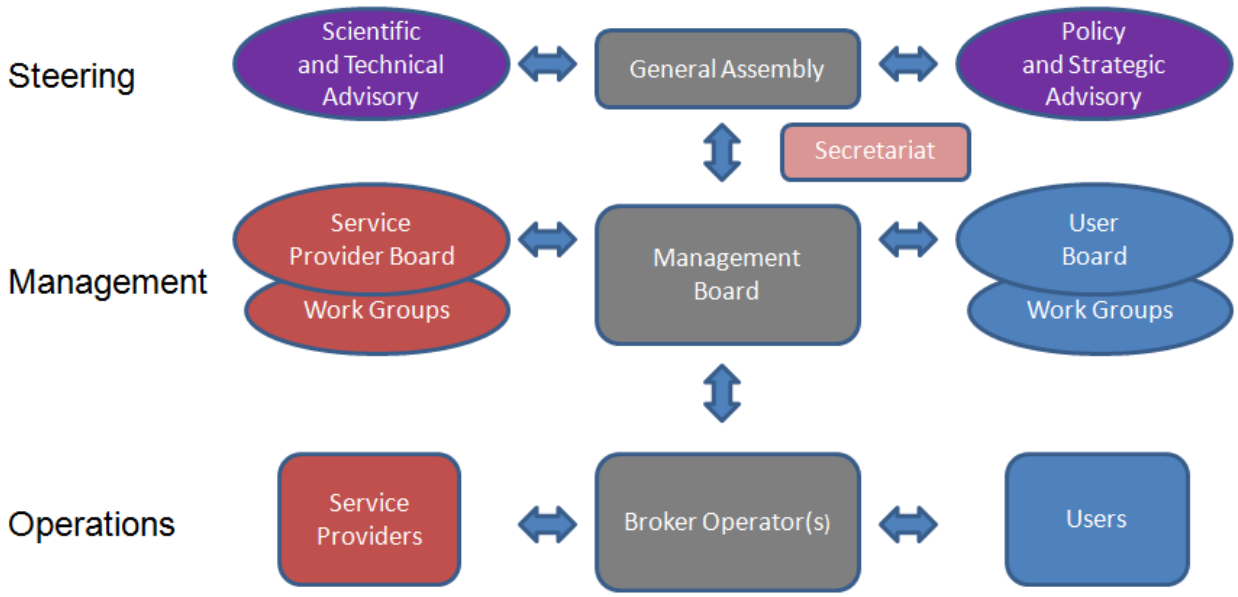

Figure 1: Proposed governance model for Helix Nebula

With entry into the phase of commercial set up of a commercial production platform, governance aspects are critical for the successful deployment of the Helix Nebula marketplace, its effectiveness, sustainability and ability to deliver added value service to customers and end users.

As it is expected that the Helix Nebula consortium will rapidly expand in the next few years, the proposed steering level of the Helix Nebula governance may need to be adapted to ensure effectiveness and efficiency in the decision making process.

A point clearly emerging is the need for independent broker(s) for the marketplace and further level of detail and clarification of envisaged roles, responsibilities and decision making mechanisms within the marketplace.

Following analysis of governance principles in force in existing EU and European intergovernmental organisations, in international enterprises and in European public-private partnerships, a set of objectives that should be applied to Helix Nebula's governance have been identified:

- Enable integration of existing e-Infrastructures with commercial cloud computing effectively and efficiently
- Ensure alignment with the Digital Agenda for Europe, foster coherence, equitability and inclusiveness
- Ensure participation of all stakeholders and fair balance of their needs and interests
- Ensure transparency, openness and responsiveness
- Ensure value for money and fair incentives and returns
- Continuously manage legal compliance and other risks
- Ensure accountability and responsibility of stakeholders and decision makers
- Manage and retain the identity and brand of Helix Nebula
- Ensure sustainable innovation and growth of Helix Nebula

The process and key performance indicators to measure achievement of these objectives are documented in the Helix Nebula deliverable D8.1.

5.3.Interoperability roadmap and integration of e-Infrastructures

In interoperability with publicly funded e-Infrastructures lays the innovative added value represented by the Helix Nebula initiative and marketplace, especially for services targeting research, education and scientific communities, as well as for services of wider public interest.

Strong and fruitful collaborations with pan-European e-Infrastructures such as EGI and GEANT, as well as collaboration with PRACE and EUDAT, represent a big opportunity to strengthen the European Research Area and to boost European competitiveness by also facilitating knowledge transfer and innovation process from scientific research to implementation and time to market for innovative products and services across Europe.
The Helix Nebula vision aims to achieve an integrated offering under an e-Infrastructure commons marketplace[18] fully interoperable with commercial offering through the Helix Nebula marketplace.

[18] http://admin.cloudscapeseries.eu/Repository/document/PositionPapersCSVI/e-Infrastructure%20commons%20marketplace.pdf

The identification, during the first year of the project, of interoperability recommendations, in line with the guidelines of the European Interoperability Framework 2.0[19], followed by the definition and implementation of specific interoperability actions, led the Helix Nebula partnership to achieve highly satisfactory results on interoperability between publicly funded e-Infrastructures and commercial cloud providers.

The main outcomes have been the deployment of the ESA SSEP use case on the EGI Federated Cloud after a successful proof of concept based on commercial resources, and the promising test deployment of the CERN ATLAS use case in a hybrid cloud environment, combining publicly funded and commercial cloud resources.
With an outlook to the next three years, the Helix Nebula partners should continue and extend this collaboration, especially in areas of common interest such as management and exploitation of big data, implementation of effective service management in a hybrid federated cloud environment and establishment of strong security measures for trusted cloud service offering.

The following steps are hence suggested for the future in the area of interoperability within Helix Nebula:

- Ensure information exchanges and set up of task forces among representatives of commercial suppliers and publicly funded e-Infrastructures in areas such as security, support, incident management. Such activities should be foreseen in the individual roadmaps of HNX, EGI and GÉANT.

- Engage with main e-Infrastructures for an agreed roadmap towards the establishment of an e-Infrastructure Commons Marketplace to boost the European Research Area.

- Identify key e-Infrastructures events, involving a wide range of user communities over the next few years, to discuss further alignment and integration of respective development plans according to the users' need.

[19] http://ec.europa.eu/isa/documents/isa_annex_ii_eif_en.pdf

- Investigate deriving economies and synergies by sharing horizontal legal, economic, and policy expertise, common training and communication activities, when such aspects invest the overall Helix Nebula initiative and are of common interest to a number of its members.

5.4. Building the marketplace – pulling it all together

The fruitful work conducted within the project around the relevant pillars described above made the partnership ready to face the challenge of setting up the first release of the Helix Nebula cloud marketplace in 2014.
Yet, this is only a first step that must be sustained by a clear long term strategy and solid governance contributing to further enlargement of the marketplace and, potentially of the overall Helix Nebula initiative as well.

The D9.1 "A roadmap of future developments" reports on future steps to be undertaken by the initiative and the players of the Helix Nebula Marketplace in the coming three years.

Further actions should be taken regarding policies, tools and procedures to increase trust and security of overall cloud infrastructures and services. In addition, effort must be also devoted to achieving a more advanced automatic and dynamic deployment and a more effective configuration and management of cloud services.

Effort on standards, certification and on safe and fair contract terms for cloud computing, including active participation in EU and national working groups/task forces, such as the ones established by the European Cloud Partnership (ECP), should increase to better meet customer needs in delivering services through the Helix Nebula marketplace.

It will also be crucial to face the challenges and opportunities arising from Big Data, both for scientific and wider public use, as well as those that will be gathered through Copernicus, ITER, ESFRI and more general Public Sector Information. To offer cross domain added value cloud services is important to focus future attention to analysis and revision of procurement rules of scientific and public organization around Europe, further extending and developing the work undertaken by Cloud for Europe project, to make sure they are fit for cloud services.

A sound strategy should be implemented to increase critical mass of the initiative, to upscale capacity, and to attract more industrial partners, including SMEs, also operating at higher levels of abstraction (PaaS and SaaS). This action should not be limited to Europe but also engage at the international level, taking stock of joint EU projects in progress with Japan, Brazil and the US in the cloud area.

This strategy will need support of a sound and flexible business model suitable for a federated infrastructure aligned with EU-wide rules, and based on widely used open standards capable of guaranteeing a fair level-playing field for all players, ensuring trust and security for users and customers, thanks to transparent orchestration of one or more independent brokers.

The overall objective is to achieve a globally competitive cloud ecosystem for Europe where commercial cloud players can offer cost efficient, scalable and high quality services, interoperable with an e-Infrastructure Commons marketplace (engaging players such as EGI, EUDAT, GEANT, and PRACE), under an overall Helix Nebula ecosystem characterized by an advanced InfoaaS model, as referred in the agreed roadmap[20].

To develop this vision, governance should also evolve and target more ambitious goals in order to keep pace with fast developments in the cloud business at the global level, and it should explore opportunities offered by the possible support of a long term European contractual Public Private Partnership.

[20] D9.1 A roadmap of future developments

The Helix Nebula project is co-funded by the European Community Seventh Framework Programme (FP7/2007-2013) under Grant Agreement no 312301

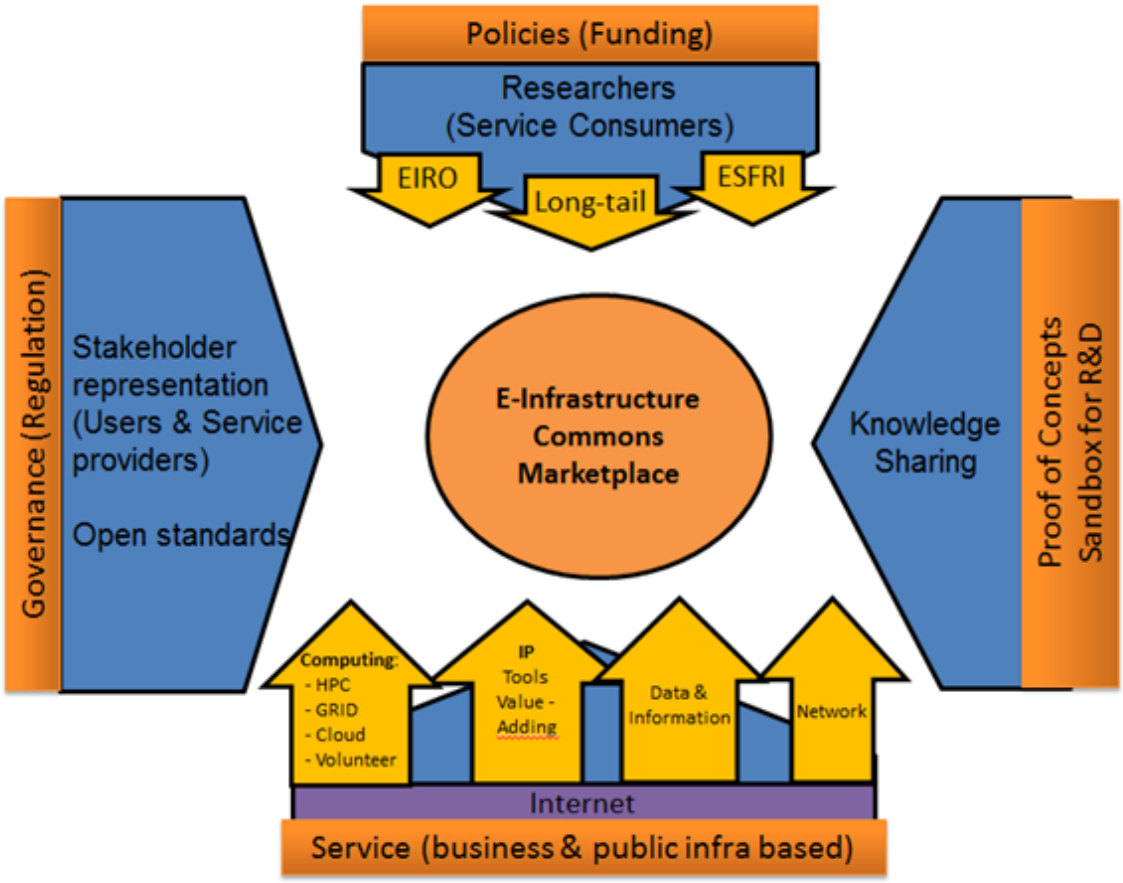

Figure 3 A proposed e-Infrastructure Commons Marketplace for Europe

6. Conclusion

This document has reviewed three years of the Helix Nebula initiative and confirmed the relevance and validity of the forward-looking objectives established in 2011 by the "Strategic Plan for a Scientific Cloud Computing Infrastructure for Europe".

The overall activity of the Helix Nebula project and initiative during the pilot phase facilitated a high level of insight, helped partners to comprehend each other's views and constraints and set the ground for the establishment of an advanced open cloud platform for European Science, with a potential exploitation extending to public services, and research activities by industry, including SMEs.

The work carried forward proved the appropriateness of the Helix Nebula initial strategy, supported the identification of needed actions to meet agreed objectives and to face new challenges emerging in a fast changing scenario driven by the cloud computing market.

The Helix Nebula initiative has demonstrated its potential and intends to pursue a role of catalyst to facilitate cloud take up, by promoting a hybrid cloud paradigm suited to establish a leadership role for Europe in this sector.

This vision has the potential to slash the 'Europe is lagging behind in cloud' assumptions and it proposes a new reference model for cloud computing, with a similar impact to what the adoption of GSM at an early age of mobile telecommunications.

Experience gathered by world leading research organizations, working on large scale deployments, showed that migrating to the cloud is not an ultimate step of dismissing on premise facilities. Benefits and added value of both approaches can be safeguarded in a hybrid and dynamic cloud model triggering innovation among commercial suppliers and optimizing the use of key publicly funded e-Infrastructures providing fundamental services to the European Research Area.

Future steps for the Helix Nebula initiative are also linked to the complementary strategy for the establishment of an "e-Infrastructure Commons Marketplace" presented at the Cloudscape VI event in Brussels, aiming to overcome gaps and aspects of fragmentation among European e-Infrastructures and focusing on business models for sustainable services and interoperable solutions based on open standards implementation, and in line with the vision described in the paper "e-Infrastructures for the 21th Century"[21] elaborated by the EIROforum.

Nevertheless, the work completed to date has also legitimised the demand for needed *accelerators*, some of which have been illustrated in the document "Helix Nebula – The Science Cloud: A Catalyst for Change in Europe" and the needed establishment of a reference framework for public procurement of cloud services in Europe.

[21] http://zenodo.org/record/7592/files/e-Infrastructure_Report_11_2013_FULL.PDF

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