Helix Nebula – The Science Cloud

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Table of Abbreviations

APN	Amazon Web Services Partner Network
BM	Business Model
cf.	compare
CIO	Chief Information Officer
DORIS	Doppler Orbitography and Radio-positioning Integrated by Satellite
EO	Earth Observation
e.g.	for example
ESA	European Space Agency
EMBL	European Molecular Biology Laboratory
HN	Helix Nebula – The Science Cloud
IaaS	Infrastructure as a Service
INFOaaS	Information as a Service
ISV	Independent Software Vendor
IT	Information Technology
OBR	Overarching Broker Role
OIA	Open Innovation Alliance
PaaS	Platform as a Service
RBV	Resource-Based View
SaaS	Software as a Service
SI	System Integrator
UIS	UNESCO Institute for Statistics
VAR	Value-added Resellers

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1 Executive Summary

"[Value] co-creation represents one of the most important streams in the information technology (IT) value research area that will gain greater importance as firms expand collaborative relationships with other firms" (Grover and Kohli 2012, p. 231). In the IT industry and especially in cloud computing, partnership programs for members of a company's platform ecosystem establish as a popular form of inter-organizational cooperation (Ceccagnoli et al. 2012). Prominent owners of IT hardware and software platforms are Amazon Web Services (AWS), Salesforce.com, IBM, Microsoft, Oracle, and SAP. They consider "[…] the strength of the business ecosystems as a decisive factor in competition for tomorrow's distributed world of 'cloud computing' […]" (Williamson and De Meyer 2012, p. 32).

Information as a Service (INFOaaS) is a revolutionary platform ecosystem. This business model (BM) emerged to be the most promising cloud computing platform ecosystem BM. Capturing, processing, analysing, and archiving of highly attractive data from the European Space Agency (ESA) and the European Molecular Biology Laboratory (EMBL) occupies the potential to cooperate additional data providers in order to enrich the data in its context. The selling of resulting data sets and knowledge is evaluated as the most promising BM in terms of market need, impact on critical mass, differentiation, and thought leadership.

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

The land deformation prediction service offered by ESA is seen as a potential starting point and states a good example on how much customers benefit from economic efficiency (innovation, prosperity, productivity), social equity (poverty, community, health and wellness, human rights), and environmental accountability (climate change, land use, biodiversity). Those goals are a standard framework in literature for sustainable BMs (Fisk 2010) and were suggested by T-Systems and ESA. A business customer like Gazprom can buy the information in order to stop pipeline operations before a landslide and consecutive gas loss. Thus, Gazprom's economic efficiency is improved. As a gas leakage would yield in health risks and job loss in inaccessible and polluted areas, the social equity is secured. Finally, nature is protected as gas impacts on the biosphere are prevented.

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2 Introduction – Rethinking the Cloud

In preparing the rollout of the business model *Generic Infrastructure as a Service for European Science* for January 2014, European cloud computing providers position themselves strategically in a *first* European cloud computing partner ecosystem (cf. deliverables 7.2 and 7.3). Yet, the cloud market develops fast and the exploitation of even greater potentials beyond the first ecosystem setup already need to be prepared to remain competitive and to ensure a market differentiation on an on-going basis. Therefore, SAP elaborates a revised version of the BM named *Information as a Service* (INFOaaS) and provides qualitative information for an implementation of this BM. It extends the first BM *Generic Infrastructure as a Service for European Science*. The following three chapters introduce cloud computing partner ecosystems and the BM INFOaaS as the object of study and explain the motivation, problem statement, and structure of this research.

2.1 Motivation – Expected Supremacy

Within deliverable 7.2, seven BM options for cloud ecosystems were introduced. INFOaaS emerged to be the most promising BM based on the dimensions ease of implementation (what effort is required for the implementation of the business model), impact of the option on the market, revenue potential, and the objective technical feasibility (cf. *Figure 1*). Capturing, processing, analysing, and archiving highly attractive data from ESA and EMBL occupies the potential to cooperate with further data providers in order to enrich the data. The selling of resulting data sets and knowledge is evaluated as the most promising BM in terms of market need, impact on critical mass, differentiation, and thought leadership (cf. *Figure 2*).

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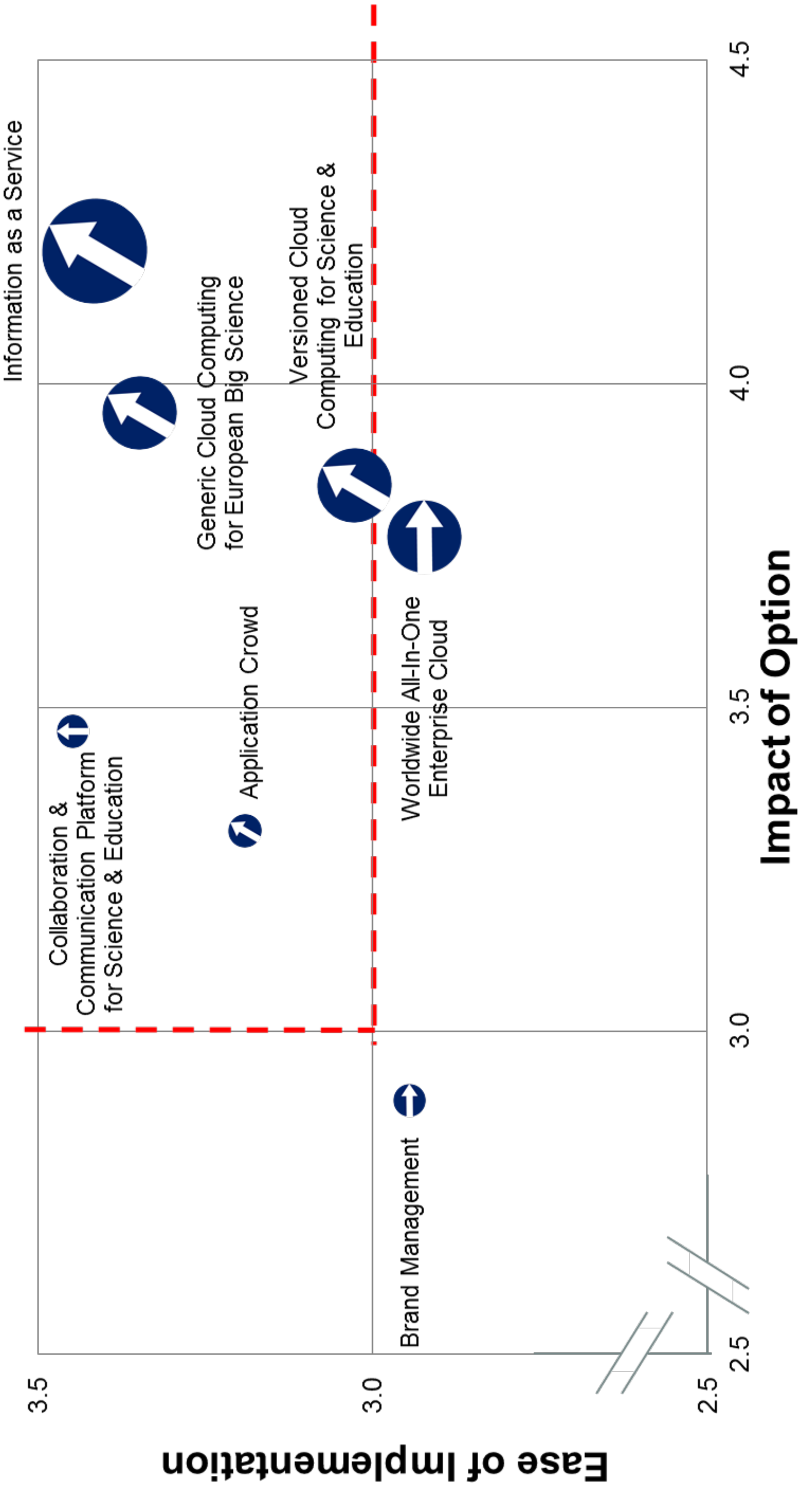

***Bubble size**: Revenue Potential | **Arrow direction**: Objective Technical Feasibility
1: very low / very critical **2**: low / critical **3**: medium / neutral **4**: high / positive **5**: very high / very positive

Figure 1 *Consolidation Matrix (Discontinuous Axes*)*

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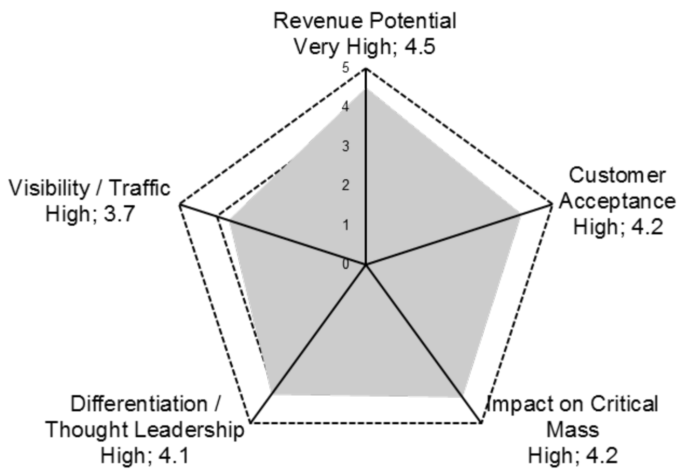
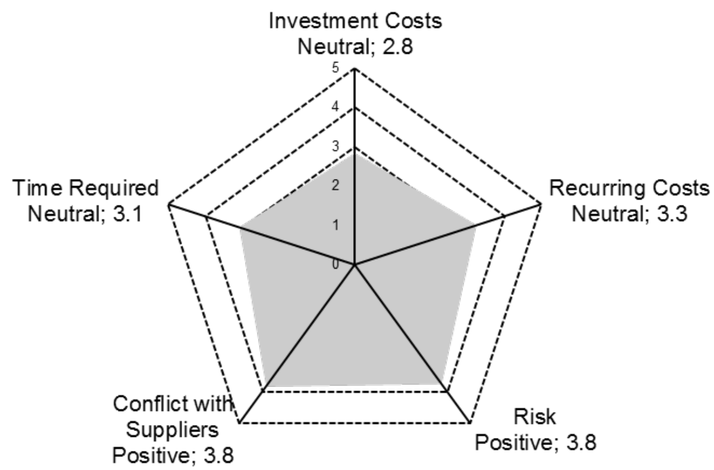
Impact of Option



Ease of Implementation



Impact		Revenue Potential	Customer Acceptance			Impact on Critical Mass	Differentiation / Leadership	Visibility / Traffic	Result
	Criterion		*Need*	*Effort*	*Security*				
	Weigthing	0.3	0.2	0.05	0.05	0.2	0.1	0.1	1
	Value	very high 4.5	very high 4.5	high 3.5	medium 3.4	high 4.2	high 4.1	high 3.7	high 4.2

Ease		Costs		Risk			Conflict with Suppliers	Time Required	Result
	Criterion	*Onetime*	*Recurring*	*Feasability*	*Expertise*	*Legal*			
	Weigthing	0.2	0.2	0.2	0.1	0.1	0.1	0.1	1
	Value	neutral 2.8	neutral 3.3	neutral 4.0	positive 4.2	neutral 2.8	positive 3.8	neutral 3.1	neutral 3.4

1: very low / very critical **2**: low / critical **3**: medium / neutral **4**: high / positive **5**: very high / very positive

Figure 2 *Expert Evaluation of Information as a Service*

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The **impact** of this BM was valued at 4.2, which is the highest value of all BMs. (cf. *Figure 2*). The reason why this value is not higher is the sub criteria effort and security within customer acceptance, which were evaluated as low. The customers' subjective acceptance of the migration effort to new data sources is actually high with a value of 3.5. But there is a tendency to be medium. We interpret this as being a potential non-adoption factor for some customers. The same counts for the customers' subjective acceptance of security issues which is medium with a tendency to high. We deduct that potential customers see the responsibility that some data sets bring along. As explained above the data can be misused for military, intelligence, or terrorist actions. HN's security process precludes this risk, but to keep that level of security, customers who buy data or knowledge must ensure the same security level, in case the data is downloaded to on premise infrastructure. An approach to solving this problem could be to encourage users not to download data and instead work with the data on the Helix Nebula cloud. This way, providers have more insight into understanding users` needs and can make investments to foster a better exploitation of data provided. The best value in the impact dimension is the revenue potential. It was judged to be very high with a value of 4.5, which is the highest revenue potential of all BMs. The same counts for the customers' need of fast access to high quality data or knowledge. The revenue potential is high because there is no commercial offer on the market of this scale yet, even a lot has been said about big data products and even the US National Security Agency with its *PRISM* project has proven that the handling of big data is technically feasible.

The **ease of implementation** was valued close to neutral with 3.4. The lowest values are (a) the neutral onetime costs with a result of 2.8 and (b) the neutral legal risk with a result of 2.8. These values aren't problematic, but experts highlighted them as potential obstacles on a neutral level. Concerning point (a), infrastructure investments to cope with the data volumes and the logic set up to deal with the data is expensive. Concerning point (b), the great responsibility of enriching data in its context/content with all the risks shall be pointed out.

We clustered the experts' **remarks** on the BM with the following outcome. Both HN supplier experts and SAP experts were quite enthusiastic about this BM, which is depicted in its very high revenue potential and its very high customer need. Selling enriched data sets and derived knowledge on this scale is a thought leading BM with a high differentiation and a very high revenue potential. Taking into account that experts are positive on objective

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feasibility and the required suppliers' expertise, we clearly advise to bear the critical onetime costs.

2.2 Problem Statement – Ecosystem Enforcement

There are three trends to believe that cloud computing partner ecosystem strategies will become more important for IT companies in determining future competitive success. On the contrary, if an ecosystem strategy is not applied, IT companies might lose market shares. Those trends are listed and explained more in-depth below.

- **Cloud Computing Enforcement**
- **Cloud Ecosystem Supremacy in Competition**
- **Contextual Ecosystem Drivers**

The information technology paradigm of **cloud computing** refers to software, platform and infrastructure services that run on a distributed network. The following definition underlies this research. "At its most basic, it is a form of outsourced shared-resource computing [...] in which computing is pooled in large external data-centres and accessed by a range of customers through the internet" (Venters and Whitley 2012, p. 179). Therefore, cloud computing is enabled by the technology of virtualization and accessed by common Internet protocols and networking standards. An on demand access to virtual and limitless resources of computing power on a pay-as-you-go basis distinguishes it from the other IT paradigms mainframe and client/server. Thus, cloud computing represents a real paradigm shift with the potential to fundamentally change the way in which information systems are deployed (Garrison et al. 2012). Quantitative market trends confirm the enforcement of cloud computing as an established future sourcing mechanism for administrations, businesses, and consumers. According to Gartner, the submarket of public cloud services, which is the object of study in this research is forecast to grow 18% in 2014 to $155 billion (Columbus 2013). Further, a predicted compound annual growth rate of 17% from 2011 through to 2017 results in a market volume of $244 billion by 2017 (Anderson et al. 2013). Important reasons for this growth are to be found in consumer and business markets. By the end of 2013, about 90% of consumer connected devices had access to the personal cloud (Escherich 2012) and the *cloud first* strategy will double to 70% from 2013 to 2016 among chief information officers (CIO) (McNally et al. 2012). Despite the accelerating adoption and growing attention concerning cloud computing, the migration to cloud computing and its operative deployment are still in its infancy in the opinion of many (e.g.,

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Dawei Sun et al. 2012 Loebbecke et al. 2012; Ranjan et al. 2013). Examples are migration complexity for customers or insufficient data security. The non-adoption of an ecosystem strategy might hinder the closing of the infancy gaps.

Figure 3 Magic Quadrant for Public Cloud Infrastructure as a Service (Leong et al. 2012)

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The second trend is the **supremacy of incumbents** in public cloud markets such as AWS, Microsoft, or Verizon Terremark, which apply ecosystem strategies to improve their service quality. The phenomenon is still rather new as practice and research have discovered only recently the true potential of cloud computing partner ecosystems (e.g. Bharadwaj et al. 2013; Sun and Wang 2012; Labes et al. 2013). For example, the most prominent cloud ecosystem Amazon Web Services Partner Network (APN) has only been launched in April 2012 (Amazon Web Services 2013a). Being the role model of expanded cloud ecosystems with the largest partner network, it has become the market share and thought leader in public cloud Infrastructure as a Service (IaaS) based on the dimensional completeness of vision and ability to execute (Leong et al. 2013) (cf. *Figure 3*). At the time of analysis, APN had 665 technology partners (Amazon Web Services 2013b) and 878 consulting partners (Amazon Web Services 2013c). Even though the phenomenon is still rather new, it already has a well-defined architecture as "An orchestrator's extended network of [numerous loosely coupled] partners" (Markus and Loebbecke 2013, p. 650). This form of inter-organizational collaboration is labelled with *ecosystem* throughout the document for the sake of simplicity. Large, powerful companies at the core of ecosystems act as orchestrators and assemble the partner network. The very basic idea is that the scale and complexity of an ecosystem reaches far beyond what can be provided by any single, vertically integrated company. The incentive for partners to participate in network programs can be the access to technical, sales, and marketing support. The orchestrators might benefit from a better service quality and market penetration. The concept of partner networks as such was researched in-depth (e.g. Adner and Kapoor 2010; Iansiti and Levien 2004; Williamson and De Meyer 2012). It is a concept that reaches beyond companies' isolated strategizing on product-market segments as introduced by Porter (1985).

However, first, *cloud* ecosystems still have a low degree of maturity and, up to now, the first European worldwide competitive cloud partnership named *Helix Nebula – The Science Cloud* is still in its roll-out. Second, cloud providers that do not implement an ecosystem strategy face the problem that incumbents expand their market supremacy as indicated in *Figure 3*. Third, numerous studies show that (a) still 30 to 70 percent of ecosystems fail (Bamford et al. 2003) and (b) the termination rate is higher than 50 percent (Lunnan and Haugland 2008). Fourth, the roadmap to the ecosystem BM INFOaaS is barley known. For those reasons, it is very important to underlay the first steps in practice with early, in-depth academic insights and a 360 degree understanding of the phenomenon. Moreover, the implementation roadmap is provided by this document.

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In the third scenario, **contextual drivers** caused by a changing global environment both foster and require the creation of ecosystems in any industry. Williamson and De Meyer (2012) introduce and discuss the implications of four changes in global markets on the importance of ecosystems. They are briefly summarized in the following:

The global market size of outsourced services measured in revenue has more than doubled from the year 2000 (45.60 billion U.S. dollars) to 2012 (99.10 billion U.S. dollars) (Statistica 2012). This development is only one indicator that "[…] many businesses face growing pressure to focus on fewer core activities in order to cope with rising investment demands and avoid increased costs of complexity" (Williamson and De Meyer 2012, p. 30). The conflicting goals of focusing on fewer core activities and being able to deliver complex solutions require ecosystems of heterogeneous partners.

The second generic ecosystem driver is the dramatic increase in product and service complexity in the 21st century's global markets. Product variety more than doubled between 1997 and 2012 (Roland Berger Strategy Consultants 2012). Today's customers demand individual, complex, and integrated solutions. Ecosystems are better forearmed for the megatrend of customization of industries, end customers, or countries. This opportunity was shown as an example of a global business software vendor with partners that sell, extend, and implement the packaged standard software (Sarker et al. 2012).

Furthermore, companies face increasing uncertainty and rapid change. Reasons are (a) the ever-growing competition caused by globalization and deregulation and (b) fast improvements in information, communication, and connectivity technologies (Bharadwaj et al. 2013). For instance, product life cycles shortened by about 25 percent from 1997 to 2012 (Roland Berger Strategy Consultants 2012). Ecosystems can absorb the uncertainty more effectively. Flexible collaboration through loosely and rapidly orchestrated development and experimentation enables quicker adaption to market changes with a lower time to market and distributed risks (Bharadwaj et al. 2013).

Finally, information and communication technology (ICT) advances both in power and especially in cost-effectiveness (Bednarz 2013). While prohibitive IT costs impeded networking between diverse and dispersed partners, ecosystems of this age are enabled "[…] to economically marshal diverse resources and knowledge scattered across the globe." (Williamson and De Meyer 2012, p. 31). Even though traditional corporate hierarchies are still more efficient than ecosystems in process-related and organizational terms, the trend of ICT advances and commoditization narrows the gap.

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2.3 Outline – The Document Structure

Following a structured process, (cf. *Figure 4*) we explain the document's objectives. The paper proposes a qualitative description for an ecosystem enrichment leading to the BM INFOaaS.

The **introduction** (cf. chapter 2) outlines the concept of cloud computing partner ecosystems and the BM INFOaaS as the object of study, and discusses the motivation, problem statement, and structure of this research.

Chapter 3 introduces the revised **business model** as compared to deliverable 7.2: Synthesis and Analysis of Overall Business Models, by first explaining the BM itself, followed by a description of how value is co-created in order to ensure a differentiation from similar competing BMs. Further, opportunities of the BM INFOaaS are outlined and finally, the service named "Doppler Orbitography and Radio-positioning Integrated by Satellite" (DORIS) is introduced as a starting point for the ecosystem enrichment.

The decisive question in each platform-based BM is how to reach an adoption and enrichment of the platform. In chapter 4, **network effects** are presented as the solution to trigger the platform adoption. It explains how the ecosystem can be enriched by leveraging network effects. After introducing the concept of network effects, a roadmap of best practices to leverage network effects in multi-sided and platform-based BMs is presented. Finally, we want to tackle risks and issues that technology, data partners and customers would induce if they left or did not adhere to the BM.

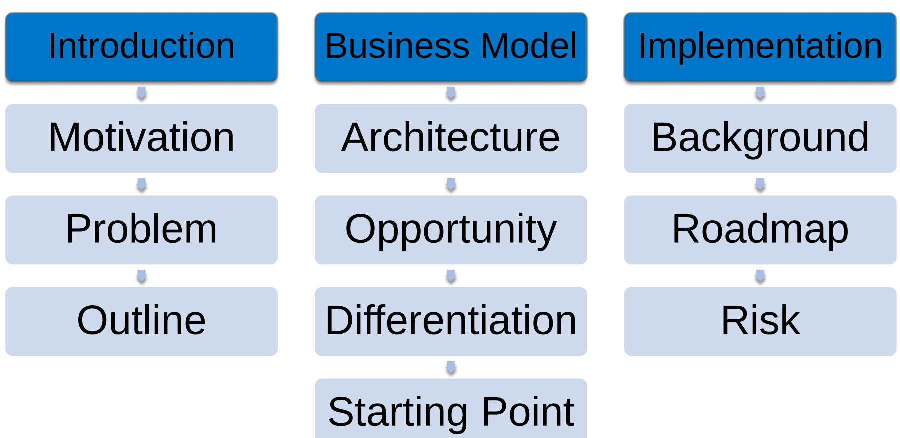

Figure 4 *The Document Structure of Deliverable 7.4*

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3 Information as a Service – The Revised Business Model

Chapter 3 introduces the revised BM as compared to deliverable 7.2 by first explaining the BM itself, followed by a description of how value is co-created in order to ensure a differentiation between equal BMs. Furthermore, opportunities of the INFOaaS BM are outlined and finally, the service named "Doppler Orbitography and Radio-positioning Integrated by Satellite" (DORIS) is introduced as a starting point for the ecosystem enrichment. DORIS is offered by the ESA Earth Observation (EO) Mission and "… is an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, at different temporal and spatial scales and in various physiographic and climatic […] environments" (Guzzetti 2013).

3.1 Data Enrichment – Business Model Explanation

A BM abstracts the complexity of a company, business unit, or platform ecosystem by reducing it to its core elements and their inter-relations. It specifies the core business logic relevant for its competitive advantage and has to be built according to the analysis of the unit (company, business unit, or platform ecosystem) strategy. It is an instantiation of the strategy and facilitates the description, analysis and innovation of the business. Every BM description should capture the key aspects of the model and its surrounding business network. The key aspects should answer four questions. What are the offered value propositions? Who are the customers? How do operations have to work? Why is the BM financially interesting?

BM descriptions can be adapted to the specifics of a company or for certain objectives. There are no right or wrong descriptions, only appropriate and inappropriate ones. SAP's BMI approach is based on SAP's specifically developed depiction. However, it can be easily transferred to other descriptions. In order to capture the key aspects of the model and its surrounding business network, SAP uses a network view (cf. *Figure 5*) and an enterprise view (cf. *Figure 10Figure 6*). Both representations are assumed to complement each other in a way for the **network view** to describe the value creation out of the perspective of the whole business network. It highlights the entirety of the business network and its inter-relations. The **enterprise view** on the other hand describes the value creation out of the perspective of a single company participating in the business network and shows how the networks value creation relates to and is implemented by its own business.

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3.1.1 Network View – The Ecosystem Architecture

There are many existing forms of inter-organizational collaboration in today's business world. During a structured review approach of top ranked research, we focused on articles that investigate inter-organizational collaboration as a key concept. The coded articles inevitably mentioned many forms of business-to-business cooperation. Very often it was the case that either (a) the same form of inter-organizational collaboration was defined with different terminologies or (b) the same terminology was used for different analysis units. On the one hand, *supply chain*, *franchising*, *marketplace*, *mergers and acquisitions*, and *joint venture* are used consistently with a long tradition in literature. On the other hand, some forms of collaboration are rather new, still blurred in their usage and difficult to distinguish. Table 1 provides definitions of those blurred terms to enable a consistent and distinguishable understanding, whereby we present the definitions applied to conceptualize the forms of collaboration.

Following the HN strategy in becoming a cloud computing platform for Europe in which more and more partners can participate, we designed the network of the BM as an ecosystem defined as "An orchestrator's extended network of [numerous loosely coupled] partners" (Markus and Loebbecke 2013), p. 650).

They key idea of the ecosystem is as follows:

Capturing, processing, analysing, and archiving of highly attractive data initially from ESA and the European Molecular Biology Laboratory (EMBL) provides the opportunity to (a) commercialise their data and to (b) cooperate with further data providers in order to enrich the data in its context. The selling of resulting data sets and knowledge is evaluated as the most promising BM in terms of market need, impact on critical mass, differentiation, and thought leadership. The multi-sided HN platform follows an M-to-N structure. M data providers' data is aggregated and sold to N customers in order to ensure economic efficiency for business customers (innovation, prosperity, productivity), social equity for citizens (poverty, community, health and wellness, human rights), and environmental accountability (climate change, land use, biodiversity). Yet, cooperation with such high-end partners requires incentives beyond money, as those organisations will not simply sell their most important strategic weapons: data and knowledge. "Ingredient branding" as explained in the following bullet might offer a solution. Those goals are a standard framework in literature for sustainable BMs (Fisk 2010) and were suggested by T-Systems and ESA. The complexity of ecosystems and a cost efficient value delivery require a structure of

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architectural roles (e.g. Dhanaraj and Parkhe 2006; Iansiti and Levien 2004b; Ozcan and Eisenhardt 2009). Partners' contributions drivers include "[...] components of a solution [...], operational capacity, sales channels, [...] complementary products and services, [...] and [a] source of technology and competence or of market and customer knowledge" (Williamson and De Meyer 2012, p. 35).

Analysis Unit	**Definition**	**Source**
(Platform) Ecosystem	"An orchestrator's extended network of [numerous loosely coupled] partners"	Markus and Loebbecke 2013, p. 650
Business Community	"Set of possibly overlapping ecosystems in a defined area of business activity"	Markus and Loebbecke 2013, p. 650
Value Chain	"The structured set of activities that take place in an industry [...] within [...] many co-specialized firms"	Jacobides 2005, p. 465
Closed Strategic Alliance	A small number of usually competing homogeneous industry incumbents with similar or equal roles (e.g. train operators or automakers) work together contractually to supplement offerings and pool resources, broaden coverage, and/or lower costs.	Mohammad Masrurul 2012, p. 23
Multisided Platform	"Products and services that bring together groups of users in two-sided networks are platforms. They provide infrastructure and rules that facilitate the two groups' transactions and can take many guises."	Eisenmann et al. 2006, p. 94
Open Innovation Alliance	"[...] Based on [...] open membership, transparency, self-regulation, and self-monitoring, OIAs typically consist of a collection of companies, operating on a 'module' basis with diverse roles	Han et al. 2012, p. 292

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(OIA)	and responsibilities. OIAs evolve dynamically over time in terms of member composition and pursued objectives."	

Table 1 *Instantiations of Inter-organizational Collaboration: Definitions*

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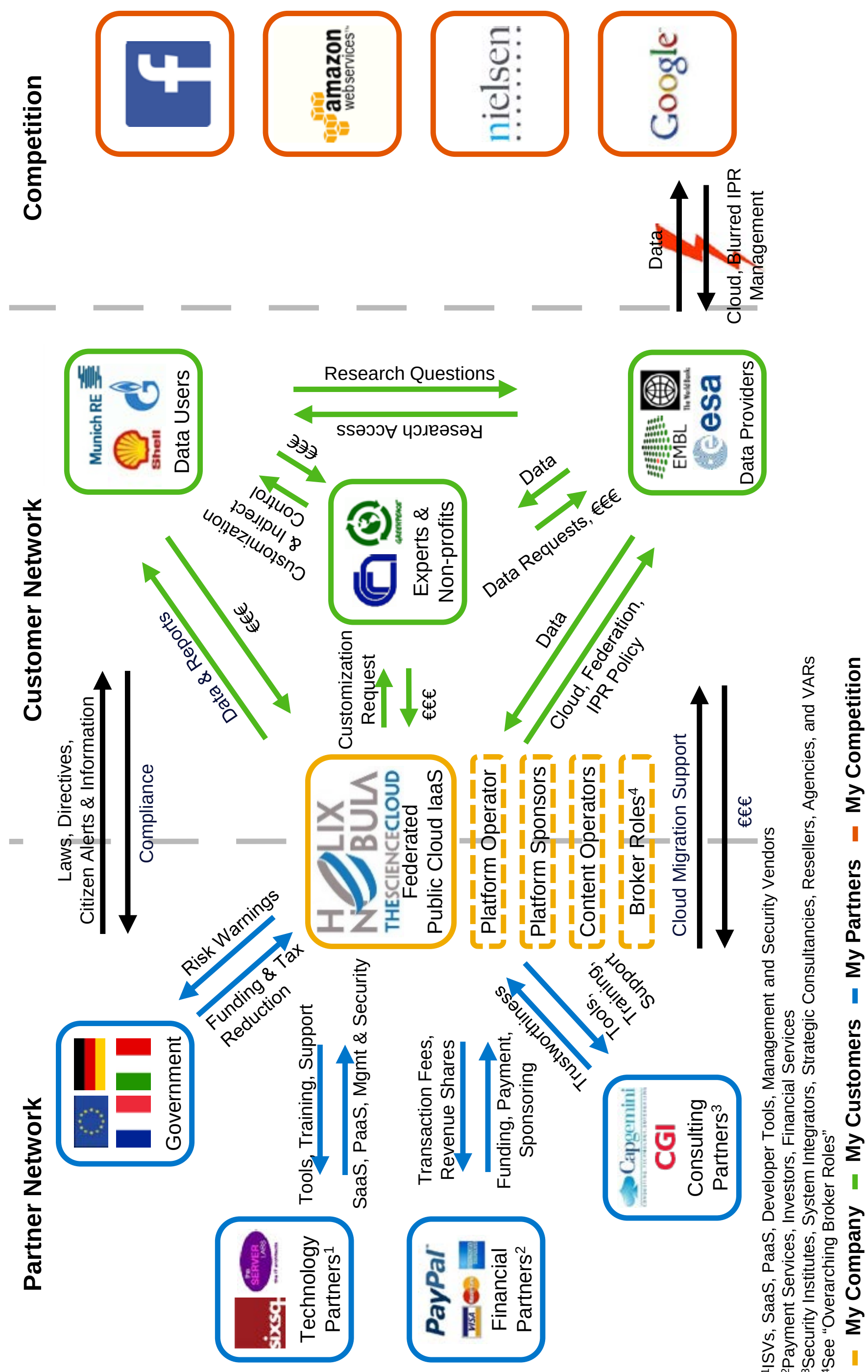

***Figure 5** Information as a Service (Network View)*

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The Platform

According to the network view (cf. *Figure 5*), we now explain the platform design (yellow boxes), partners (blue boxes), customers (green boxes). We suggest that the hub platform (yellow boxes) consists of the following roles.

- A **platform operator** manages the daily operations of the BM including marketing, on-boarding and administration of partners and customers, and the web front-end management. The finding and binding of further valuable data providers of e.g. financial data is a key factor for success. According to expert evaluation, extensive marketing is necessary and worthwhile as the "ingredient brands" ESA and EMBL are expected to raise high interest and attention. The value for HN is that one defined organization is responsible for managing the BM's operations. The quest for orchestration in platform ecosystems is high. The role is required as it is the nature of any platform-based BM to resolve the challenge of orchestrating the various offerings by forming and dissolving multiple types of relationships. Dhanaraj and Parkhe (2006, p. 659) define ecosystem orchestration intuitively accessible "[…] as the set of deliberate, purposeful actions undertaken by the hub firm as it seeks to create value (expand the pie) and extract value (gain a larger slice of the pie) from the network." In literature, there is a rich amount of terminologies, such as integrators, aggregators, keystones, platform owners, key actors, triggering entities, strategic centres, or flagship firms. Their competency of focal orchestration is as required as challenging because it needs to balance the tension between simultaneous cooperation and competition across different types of resources over time (Venkatraman and Chi-Hyon Lee 2004). Beyond that effect of coopetition (Ritala 2012), Dhanaraj and Parkhe (2006) propose a framework that captures the dimensions of orchestrating ecosystems. Firstly, the platform owners need to design the macro logic of network structure (membership, structure, and market position) by recruiting and aligning further partners. Secondly, they need to manage the micro logic of network processes (knowledge mobility, innovation appropriation, and network stability) required to operationally co-create value. We advise to assign the control of this task to a non-commercial organization (e.g. DANTE) because this ensures that the platform does not only focus on commercial exploitation, but also on the creation of knowledge. This desire was stated by CERN and ESA.
- The **platform sponsors** are the federated public cloud IaaS providers. At the current stage of HN, four leading European public cloud IaaS providers (Atos SE, CloudSigma AG,

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Interoute Communications Ltd, T-Systems International GmbH) federate in order to provide storage and processing capacities with a scale and complexity that reaches far beyond what can be provided by any single company. They host the data on their infrastructure and thereby enable what we name a federated community cloud. "This type of cloud provides an infrastructure that is shared by several [data providing] organizations, supporting a specific community with shared concerns. A community cloud may be managed by a participating organization or a third party, on-or off-premise" (Iyer and Henderson 2010, pp. 119-120). This role is required to gather the required storage and processing capacity in order to meet the overwhelming demand. Our field research data strongly indicates that value co-creation in cloud computing ecosystems is instantiated by the opportunity of resource pooling. One theoretical framework that we found instrumental in understanding pooling within B2B relationships is the resource-based view (RBV) of the firm. Going back to the early contribution of Penrose (1959), the RBV has become an influential framework in the strategic management literature. Resources can be defined "[...] as stocks of available factors that are owned or controlled by the firm" (Amit and Schoemaker 1993, p.35). Cooperating partners align their resources in a complementary or supplementary way, which are the two most common forms of alignment (e.g., Das and Teng 2000; Lavie 2006; Sarker et al. 2012). The case of *supplementary* resource alignment is characterized by firms that provide and pool similar kinds of resources. In case of such a substantial resource intersection of shared resource sets, literature identifies the ecosystem as *pooling* (Lavie 2006, p. 644), *supplementary* (Sarker et al. 2012, p. 319), *homogeneous,* or *horizontal* ecosystem (both Han et al. 2012, p. 296). The partners' intention is greater , enhanced competitive position, economic efficiency, and strategic, organizational, and operational compatibility in their industry, as integrated supplementary resources "[...] create more value [...] than the sum of the separate values of the resources with individual firms" (Das and Teng 2000, p.49). Especially in INFOaaS, the impacts of infrastructure pooling are gained. A potential use case is dynamic capacity utilization in which one partner facing peak storage demands cooperates with another partner who dynamically sells unused capacity (Bharadwaj et al. 2013). The formerly outlined aspect of improved economies of scale through *infrastructure pooling* is supported by one of HN's partners: "[...] the requirements of the existing demand side could not be handled solely by one of the [infrastructure] providers within Helix Nebula. So firstly, by working together, we are able to build towards a scale which, at the moment, no single cloud

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provider can offer. [...] So you may see the scale as being available on Amazon or, for example, Microsoft Azure, but a lot of the European providers, at the moment, do not offer that level of scale. So through Helix Nebula, we are able to offer large amounts of cloud computing resources, but also to encourage a rich and competitive market in which those cloud resources are being offered." Therefore, without the platform sponsor role, which is ideally assigned to the existing HN infrastructure suppliers, the required storage and capacity will not be achieved.

- The **content operators** are responsible for the data exploitation and are to be seen as data brokers. It ensures that money is earned. This role can be assigned to various organizations simultaneously. Revenues flow exclusively to the service originator. IaaS providers which do not act as content operator only receive revenues for hosting the data. If this IaaS provider has given discounts to data providers, he will receive a revenue share that matches the price cut. We assume that revenue streams for content operators as well as for IaaS providers to be fast growing as the data amounts are truly huge. The data remains property of the data provider. If ESA, for example, provides its data to the platform, the data will be commercially exploited there. Yet, ESA keeps the intellectual property. Each certified HN partner who intends to become a content operator will get free access to the data and may exploit it commercially. The challenge of identifying relevant potentials for data cross fertilization is tackled by any organization participating in HN. In case of an idea, the role is assigned to a partner at any time as soon as the partner sees a potential to combine data from heterogeneous sources in a value-adding, commercial downstream usage. Selling enriched structured data sets requires a data warehousing approach integrating data from one or more disparate sources encompassing structured, semi-structured, and unstructured data. The more profitable option of selling knowledge induces analytics using data mining methods at the intersection of artificial intelligence, machine learning, statistics, and information systems. Therefore, the content operators need to collaborate with the platform sponsors in order to meet the technology needs. INFOaaS requires this specific role that acquires, standardises, and combines new structured, semi-structured, and unstructured data, which is considered to be beneficial to the existing offerings. Key activities of this role are (a) central data warehousing to generate enriched structured data sets and (b) analytics to synthesise knowledge out of the data sets. Furthermore, this role could manage the security filter as explained above in designing challenge five.
  By managing these tasks centrally instead of having each supplier working on these

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issues in bilateral communication, the economies of scale effect grasps and, thus, operative costs decrease for each supplier. Yet, the role holder could receive a percentage of the revenues gained in this BM for lowering risks and costs. Of course, savings or revenues through this role have to justify its costs.

Indeed, we see high revenue potential in assigning a role, because it enables the greatest strength of this BM, which is the content/context enrichment of existing data. If there is no central broker role, data warehousing will not be possible and analytical methods are only possible for the isolated data sets hosted at each HN cloud provider.

Risks of a leader BM, data commitment by data partners, and data security/privacy are lessened as central management enables a lean and fast management of those issues. As the data broker role acts as an outsourcer, the HN partners will no longer be responsible for the outsourced tasks which results in dropped investment costs. Yet, all suppliers will want to be in control of their own fate, and to exercise some control over this entity *as well as* whatever else they are doing: it will become one more entity they need to sell to.

- SAP Research introduced the concept of **overarching broker roles** (OBR) in deliverable 7.2. HN's setting with various partners, platform roles, and customers requires such broker roles to act as a middle man to address the customers appropriately (cf. *Figure 6*). We classify technology brokers (transparency broker, integrator, orchestrator, aggregator, authentication broker) and business brokers (trading exchange broker, ex-ante purchaser, work group manager, up-/cross-seller, financial broker, law broker). There is a difference between the platform operator and the OBRs. The platform operator exclusively manages the daily operations of INFOaaS including marketing, on-boarding and administration of data partners and data customers, and the web front-end management (*data cooperation*). The OBRs manage the operations of the underlying community cloud consisting of federated public cloud IaaS providers and their technology and consulting partners (*cloud cooperation*). A detailed explanation of OBRs is to be found in chapter 4.2 of deliverable 7.2. We conducted a survey to identify the interest and claim for the assignment of those roles by the various HN participants. Operations necessary in all or many of HN's BMs are centrally provided, e.g., a blue box system including a portal, a catalogue of services that enables provider selection based on cost, time, and capability, as well as unified billing are designated. Such a single interface funnels the access. This ensures a consistent on-boarding, log-in, and market presence. Moreover, it can be combined with an

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authentication service. The assignment is required in INFOaaS, too.
It has to be mentioned that these roles are not considered as HN BMs because experts evaluated them to be mandatory to create a marketplace and to ensure the success potential of chosen BMs. Thus, there is a significant difference between OBRs and BMs. OBRs are to be assigned to parties that act as shared service centres. They are required for all BMs. This is why we chose the term *overarching*. Yet, we collected all OBRs in one BM enterprise view in order to understand them at once. This implies that ideally each OBR should be mapped to the best qualified party in order to cope with the requirements of a cloud computing ecosystem. E.g., the *up-/cross-selling*-role requires deep knowledge in databases, customer relationship management, marketing, and data mining. Depending on these requirements, the role holder is to be chosen. We identified one conflict of interest that limits this additive function for the *Yellow Strom*-role, i.e. that an organisation cannot manage more than one OBR without falling into interest conflicts. All OBRs are listed and explained in detail in deliverable 7.2. As you can see in the footnote (cf. *Figure 6*), the OBRs remain to be assigned. OBR functions are additive and can be undertaken by the same organisation, if for example one HN partner will take responsibility for such a role, he will partner with all *HN providers* to address end customers as a middle man. Moreover, the *European Commission Directorate General for Communications Networks, Content and Technology* provides funding pots called "Framework Programmes" and therefore is a partner. Concerning OBRs' customers, initially there will be the three initial flagships ESA, CERN, and EMBL. But as the HN customer base will expand, the OBR will consequently acquire more customers as well.
In order to identify the HN suppliers' claim to assign one or more of those roles, we did a poll and received three responses, from Atos, EGI.eu, and the Server Labs. Their claim is presented as follows (cf. *Figure 7*, *Figure 8*, and *Figure 9*):

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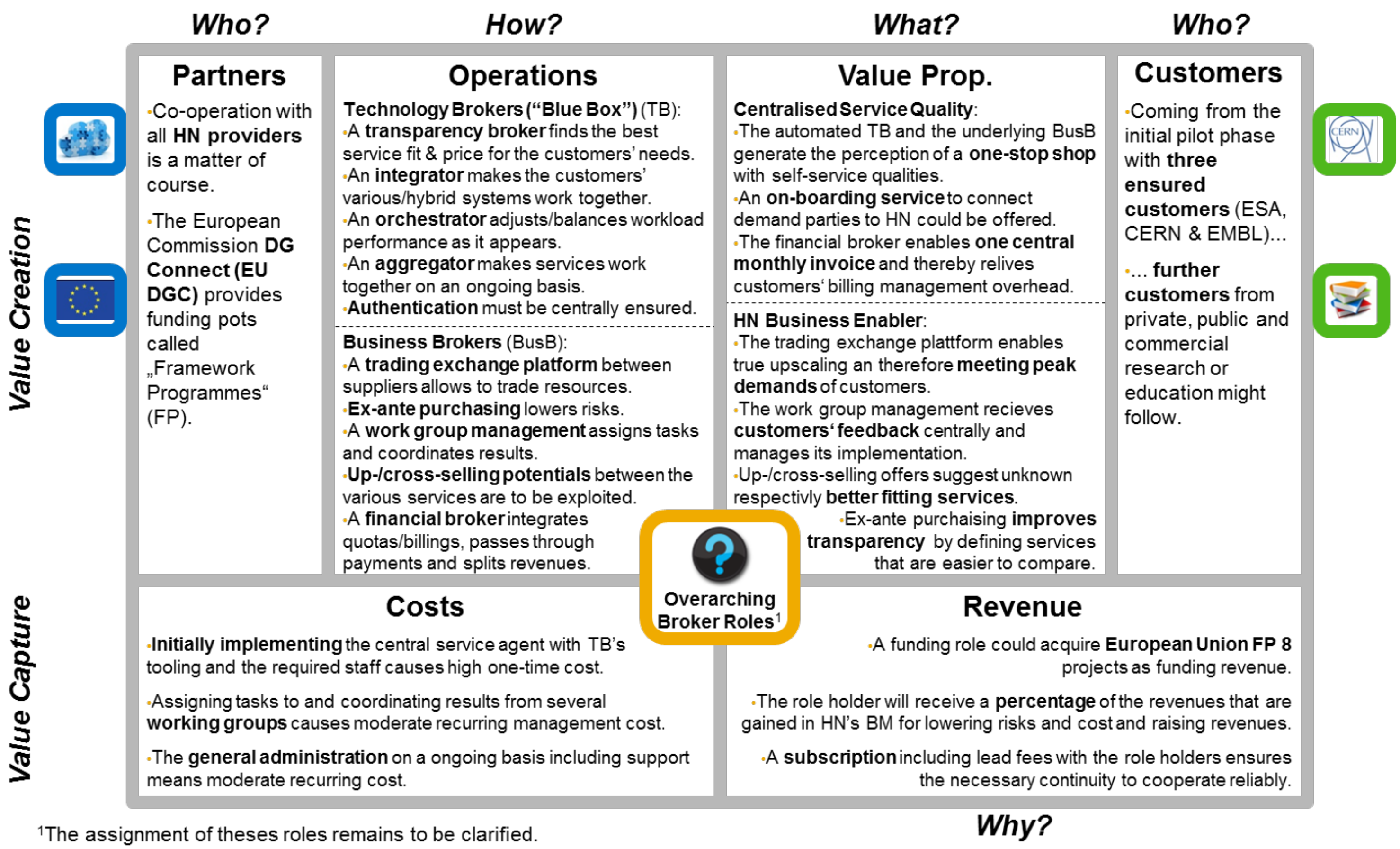

[1]The assignment of theses roles remains to be clarified.

Figure 6 *Overarching Broker Roles*

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Broker Role Category	Decision Point	Level of Claim
Overarching Technology	Transparency ("Blue Box")	Whilst Atos does have both the service and technology capabilities to fulfil this role, it is recognised that as also being an IaaS provider, we may not be seen as sufficiently in a multi-supplier environment.
	Integrator	Atos has a whole division that does system and service integration, with a wealth of experience in integrating different environments.
	Aggregator	As an experienced outsourcing provider, often performing a prime contractor role, Atos has a wealth of experience in delivering end-to-end services, supported by a number of other suppliers in a back-to-back construction.
	Orchestrator	Atos fulfils many roles across the demand-supply model, to fulfil customers' business needs by the delivery of integrated technology; this role is well within our capabilities and experience.
	Authentication	Atos has a Federated Identity Management service, based on our won software (DirX), first developed for and used by Siemens.
Overarching Business	Trading Exchange Platform	Atos' portfolio of companies includes Worldline, which is the largest deliverer of transaction-based card processing services in Europe, and this well- equipped for fulfilling such transaction business.
	Yello Strom	Although capable, this role does not appear to add sufficient value to be of interest to Atos.
	Working Groups Management	It is not yet clear whether there is a realistic opportunity to apply this role within Helix Nebula.
	Up-/Cross-Selling Potentials	It is not yet clear whether there is a realistic opportunity to apply this role within Helix Nebula.
	Financials	It is not yet clear whether there is a realistic opportunity to apply this role within Helix Nebula.
	Law	It is not yet clear whether there is a realistic opportunity to apply this role within Helix Nebula.
Business Model Specific	Information as a Service Broker: **Data Management**	Atos already has a fully-developed Data Analytics as a Service offering, to which this service equates. It uses the range of business and technology integration and development skills we have, and which we are already delivering to many customers.

Level of Claim: **Complete** | **With Limitations** | **None**

Figure 7 *Broker Role Claim: ATOS*

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Broker Role Category	Decision Point	Level of Claim
Overarching Technology	Transparency ("Blue Box")	EGI.eu has long term experience in transparent integration of independent resource providers into a federated service provision and is positioned as neutral and trustworthy partner in the scientific community.
	Integrator	An assignment to National Grid Initiatives (NGIs) affiliated with EGI.eu is more appropriate to meet the local customer's national legal, technical, and financial requirements.
	Aggregator	
	Orchestrator	EGI.eu positions itself as valid candidate through the consolidated federated operations, human network, and technical services.
	Authentication	EGI.eu already manages authentication processes, technology, and policies for a European-wide infrastructure with international reach; Helix Nebula can benefit from the established function within the scientific community.
Overarching Business	Trading Exchange Platform	EGI.eu is in advanced process to set up a federated resource allocation process and tool for the EGI resource providers; this can be expanded and enriched to include Helix Nebula supply side to evolve towards a general trading platform for cloud services for science in Europe.
	Yello Strom	EGI.eu is unwilling to take the business risks with this model.
	Working Groups Management	EGI.eu already provides the value creation of this role for the European area involving around 320 publicly funded resource providers; the function can be expanded to the Helix Nebula supply side; assigning the function to EGI.eu would produce economy of scale and re-use existing capabilities within e-Infrastructure area.
	Up-/Cross-Selling Potentials	EGI.eu is ready to manage this role within the proof of concept phase for now as experience in the area of customer relationship management (CRM) exists.
	Financials	These roles are not EGI.eu's core capabilities and there is no strategic fit.
	Law	
Business Model Specific	Information as a Service Broker: **Data Management**	This role might be more a fit for research communities to develop domain-specific information as a service businesses; EGI.eu can be a consultant and enabler.

Level of Claim: Complete | With Limitations | None

Figure 8 *Broker Role Claim: EGI.eu*

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Broker Role Category	Decision Point	Level of Claim
Overarching Technology	Transparency ("Blue Box")	TSL has been recommending cloud solutions for it's customers since 2008
	Integrator	TSL has been a systems integrator since it's creation and integrating cloud solutions since 2008
	Aggregator	No request.
	Orchestrator	No request.
	Authentication	Where possible we use solutions such as Google, SAML & OAUTH 2
Overarching Business	Trading Exchange Platform	No request.
	Yello Strom	No request.
	Working Groups Management	No request.
	Up-/Cross-Selling Potentials	TSL always recommends the best solution for the customer, this end up in an up-sell
	Financials	TSL does this for our customers, passing on cost-savings we get from bulk discounts
	Law	No request.
Business Model Specific	Information as a Service Broker: **Data Management**	No request.

Level of Claim: Complete | With Limitations | None

Figure 9 *Broker Role Claim: EGI.eu*

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The Partner Network

We advise that the partner's contributions be allocated to governmental, technological, financial, and consulting partners. Both the complexity of ecosystems as explained above and a cost efficient value delivery require the success factor and best effort of a structure of **architectural roles** (e.g. Dhanaraj and Parkhe 2006; Iansiti and Levien 2004b; Ozcan and Eisenhardt 2009). AWS served as role model with its best practice ecosystem structure (technology and consulting partners). We added financial and governmental partners. Partners' contributions are drivers, including "[…] components of a solution […], operational capacity, sales channels, […] complementary products and services, […] and [a] source of technology and competence or of market and customer knowledge" (Williamson and De Meyer 2012, p. 35). Those contributions need to be allocated to partner roles such as technology, consulting, financial, or governmental partners to reduce the complexity of hundreds to thousands of partners. This structure is a proposal and can be adapted. An argument that speaks for it is that it covers any potential partner by only requiring four categories.

- **Governmental partners** encompassing the European Union, member states administrations, and public agencies are relevant to ensure that the BM does not singularly focus on commercial exploitation of the data to reach economic efficiency (innovation, prosperity, productivity) for business customers like *Gazprom*, *Munich RE*, or *Shell*. Firstly, governmental partners impose laws and directives so that commercial customers are forced to use their extended knowledge to foster environmental accountability (climate change, land use, biodiversity). Secondly, risk warnings coming from the content operators enable governmental partners to either broadcast citizen alerts or to publish information which fosters social equity for citizens (poverty, community, health and wellness, human rights). Thirdly, this partner category can provide funding and tax reductions to the HN platform roles. One exemplary funding pot is the EU eighth framework programme named *Horizon 2020* which provides an estimated budget of €80 billion for frontier research (Grove 2011).
- **Technology partners** are commercial software and internet service companies that build solutions running on, or complementary to, the HN platform. Technology partners include independent software vendors (ISV), SaaS, PaaS, developer tools, and management and security vendors. These partners whose incentive is to gain access to a variety of tools, training, and support that enable them to efficiently build solutions on the

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HN platform. They are required to meet the technological needs of data exploitation such as data warehousing or data mining,

- **Financial partners** can be (a) payment transaction services such as PayPal, VISA, MasterCard, or American Express. Further, (b) investors and (c) the financial services of banks and insurances belong to this partner role. Financial partners provide funding, payment transactions, and sponsoring to the platform. In return, the payment transaction providers receive transaction fees and investors receive revenue shares.
- **Consulting partners** are professional service firms that help customers of all sizes design, architect, migrate, or build new applications on HN. Consulting partners include security institutes, system integrators (SI), strategic consultancies, resellers, agencies, and value-added resellers (VAR). Consulting partners must gain access to a range of resources and training that will enable them to better help their customers deploy, run, and manage applications in the HN cloud. A special focus needs to be laid on security institutes.

The Customer Network

- The **data providers** are the basis for context enrichment. ESA already offers free and restrained datasets and explicitly pointed out its wish to offer its data to an even greater public. Within its earth observation activities, the Earth environment is monitored, which enables a reliable assessment of the global impact of human activity and the likely future extent of climate change. Data concerning the Earth topics agriculture, atmosphere, solid Earth, water, land, oceans and coasts, snow and ice, and natural disasters is available (ESA Earthnet Online 2013).

  "EMBL has joined the Global Alliance, a large-scale, international effort to enable the secure sharing of genomic and clinical data. The Global Alliance invites commercial and not-for-profit organisations to join forces with other leading data, health care, research, and disease advocacy organisations to establish an evidence base for genomic research and medicine ..." (European Molecular Biology Laboratory 2013) David Altshuler, Deputy Director of the Broad Institute of Harvard and MIT in the US, explained that "the ability to collect and analyse large amounts of genomic and clinical data [presented] a tremendous opportunity to learn about the underlying causes of cancer, inherited and infectious diseases, and responses to drugs" (European Molecular Biology Laboratory 2013).

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Alone, the combination of geographical and medical data might turn out to be of high need and revenue. Yet, in order to make the BM even more interesting, additional providers' data sets should be acquired and incorporated. Examples are the UNESCO Institute for Statistics (UIS), the World Bank, or the OECD. The UIS, e.g., is a source for cross-nationally comparable statistics on education, science and technology, culture, and communication for more than 200 countries and territories (UNESCO Institute for Statistics 2013). Beyond publicly available data, commercial data providers are also to be considered.

- The **end costumers** are manifold. An appropriate classification appears to be businesses, citizens, and public customers. The business sector including manufacturing, strategy consulting, finance, health, the oil industry etc. and the public sector including universities, the military, governments, schools etc. are customers in high need. The end customer benefits from two quality levels of data and report services. Firstly, the content operators of the HN platform provide generic services. Secondly, as explained in the following customer group, experts provide tailored data services. In any case, the value proposition for end customers are economic efficiency and common risk identification in a business community (businesses), environmental accountability (citizens), social equity (public sector), common risk identification in community, and easy data, knowledge, or tool access. As explained above, the three value propositions (profit, people, planet) were derived from a standard theoretical framework (Fisk 2010) for sustainable BMs. Each value proposition must be ensured so that the BM is successful on an ongoing basis.
- The customer group of **experts** is required to customize data services and to report services for the end customers. This is the case if a service request by an end customer cannot be satisfied as the content operators' offerings are too generic. We differentiate between subject-specific and methodological experts. Subject-specific experts demand and pay for more specific data from the data providers in order to enrich a generic data set. Methodological experts contribute knowledge in the areas of data mining, statistics, computer science, etc. to better exploit data sets. They are offered the value proposition of new business opportunities including new research instrumentation and research questions, requests for customization from the content operators, and value-added downstream usage of the data.
- **Non-profit organizations** like Greenpeace indirectly influence the laws and directives of governments so that the goals of environmental accountability (climate change, land

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use, biodiversity) and social equity for citizens (poverty, community, health and wellness, human rights) are actually achieved. Non-profit organizations ensure that governments and commercial data users meet the value propositions of environmental accountability and social equity. They are required as certified partners that control the upright usage of the data which is bought by enterprises.

Next, the enterprise view describes the value creation out of the perspective of the HN platform

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3.1.2 Enterprise View – The Insider's Perspective

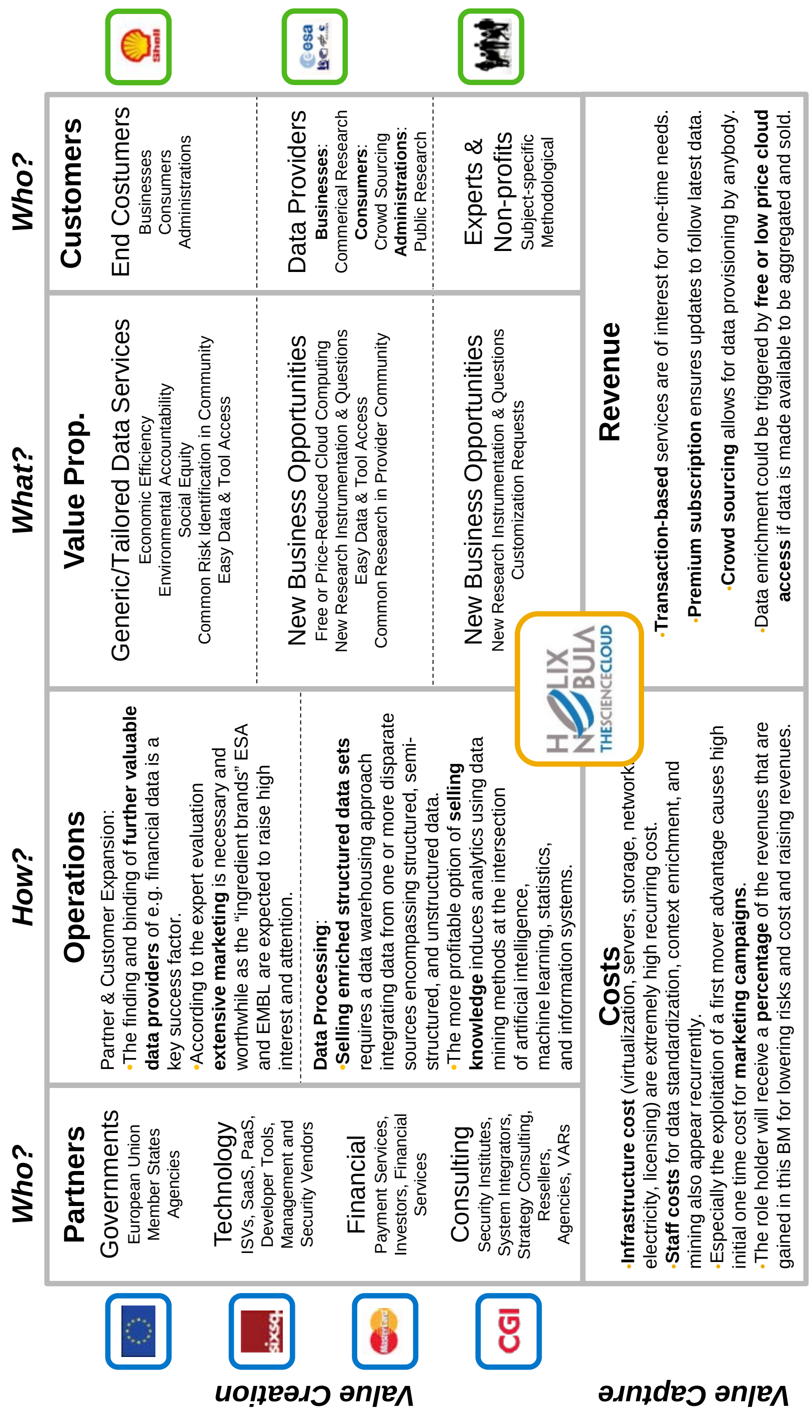

***Figure 10** Information as a Service (Enterprise View)*

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So far, who participates in the BM due to which value propositions has been explained. Let's now describe the operations, how value is captured, and by which revenues and costs (cf. *Figure 10*).

Operations

This BM's operations need to cover both the expansion of further data partners, respectively data customers and data processing requirements. Regarding *partner and customer expansion*, we identified the following:

- The finding and binding of additional valuable data providers of e.g. financial data is a key success factor. Chapter 3.3 describes within the section on *Cloud-based M-to-N Cross Domain Data Enrichment* in-depth how this can be achieved in the operations.
- According to the expert evaluation, extensive marketing is necessary and worthwhile as the "ingredient brands" ESA and EMBL are expected to raise high interest and attention. The risk of losing leadership advantages by not advertising this kind of service is too high. Ingredient branding is an appropriate BM pattern and marketing technique to create sustainable partnerships as well as establishing and maintaining unique sales propositions. It describes the branding of a product that will no longer be available on its own but only as part of another product (Gassmann et al. 2013). If, for example, the data of the World Bank is only exclusively available through the HN channel, it's a win-win-situation. On the one hand, World Bank data reaches the level of an ingredient brand as its data can only be sold as the "ingredient" of context enriched data. On the other hand, HN attracts more customers as it exclusively sells high quality data. Yet, in case a data partner insists on selling his data in parallel in its original form, there should be a negation to at least capture the data provider.
- Selling enriched structured data sets requires a data warehousing approach integrating data from one or more disparate sources encompassing structured, semi-structured, and unstructured data. The data stored in the warehouse are uploaded from various virtual storage areas of customers that host their data centres on HN. The efforts of continuously extracting data from outside sources, transposing it to the used data model, and loading the data to the data warehouse are considerable. Yet, the following benefits and the associated business opportunities might be worth the effort:
    - The data quality is improved by providing consistent codes and descriptions, flagging or even fixing bad data.

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- A single common data model for all data of interest regardless of the data source is enabled.
    - The data can be restructured so that it makes sense to the business users and delivers excellent query performance, even for complex analytic queries (Ponniah 2011).
- The more profitable option is selling knowledge. This induces analytics using data mining methods. Commonly used methods are at the intersection of artificial intelligence, machine learning, statistics, and database systems. Knowledge is a broad term. The required operations to synthesise knowledge depend on the desired outcome, the amount of data, and its quality.
    - Data with high quality are structured data sets with high information density as generated and explained in the above data warehousing-section. As it takes huge efforts to reach such a data quality, the quantity remains manageable. Business intelligence solutions using descriptive statistics are used to measure the data and to detect trends.
    - If data sets' volume and complexity exceed the abilities of commonly used tools, big data approaches are required. The term big data is still very vague in its definition, yet the characteristics, volume, variety, and velocity are used to define it (Zikopoulos et al. 2011).

Costs

- Platform costs (libraries, languages) and infrastructure costs (virtualization, servers, storage, networking, electricity, licensing) constitute the main recurring cost. Research on cost-models for operating hyper-scale data centres shows significant percentages of approximately 90 per cent for data centre operating costs (Miller 2011). Hamilton (2011) reviews costs assumptions for an eight megawatt AWS data centre, which could include 46,000 servers, and outlines monthly operating costs for a facility. He estimated the costs at $88 million (about $11 million per megawatt), which is dominated by the cost for servers (57 per cent), followed by power and cooling (18 per cent) and electric power (13 per cent).
- Staff costs for data standardization, context enrichment, and mining also appear recurrently. Both the approach of consolidating data with warehouses and the approach of analytics running on those data sets require considerable efforts. E.g., let us take a look on setting up an Oracle data warehouse system. One needs to prepare the

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hardware environment by sizing and configuring hardware. Then the Oracle database software must be installed and optimized for using a data warehouse. Next, you need a data integration product, which is in Oracle's case the Warehouse Builder software. Those costs solely constitute investment costs for software.

- Especially the exploitation of a first mover advantage causes high initial one-time costs for marketing campaigns. This BM has had high and very high impact. However, in order to make the market aware of new value propositions, marketing and branding are required. Marketing and branding are phenomena partly based on psychology and hard to structure as well as expensive to place. E.g., the core value proposition of core business improvements through better data quality deserves highly frequented advertising spaces.
- Without an explicit broker role, each HN supplier has to establish and maintain the knowledge and technologies for data warehousing and analytics, including big data itself. Furthermore, the data provider acquisition costs are higher than provided centrally.
- The role holder will receive a percentage of the revenues gained in this BM for lowering risks and cost, as well as raising revenues. The exact effects of this specific broker role are explained in criterion eight. We assess a percentage to be the right incentive for the role holder, coupling his success with the success of the platform

The Revenue

- Transaction-based services are of interest for one-time needs. Some customers have one-time data, information, or knowledge demands and only want to pay a single time for this specific demand. E.g., an academic research project that requires data to test a newly developed model would not be interested in regular updates over months or even years.
- Premium subscription ensures updates to follow the latest data. Other customers, especially within the business environment, require updates concerning their data, information, or knowledge demands as they want to ensure competitive advantages by improving products and services continuously. E.g., Siemens' business unit "Infrastructure & Cities" wants to follow urban development on a monthly basis.
- Crowd sourcing allows for data provisioning by anyone. Any data collection provided by individuals may contribute to the information pool. On the one hand, this includes structured data that was purposefully built and is given to the platform. On the other hand,

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anonymised and unstructured data sets gathered from individual footprints contribute to knowledge increase. E.g., potential sources for such data may be social networks like Facebook or digital marketplaces like Amazon.

- Data enrichment could be triggered by free or unexpensive cloud access, if the data is made available to be aggregated and sold. This is another win-win. On the one hand, customers from business, consumer, or administration markets can lower their IT sourcing costs even further. On the other hand, HN benefits from even more data. Additionally, this might state an access to data that would not be accessible otherwise.

Based on this, the BM description we identified compares advantages of the ecosystem architecture with other forms of inter-organizational collaboration (cf. table 1).

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3.2 Opportunities – The Ecosystem Market Supremacy

Here we identify several ecosystem opportunities which pertain to eight basic concepts. These are presented in the order of their frequency in literature, beginning with the least mentioned concept of **resource pooling**. Homogeneous partners in horizontal ecosystems competing within a common industry accumulate skills, resources, and experience. The economic efficiency is improved by an enhanced market power, economies of scale, and compatibility (e.g. Han et al. 2012; Williamson and De Meyer 2012; Lavie 2006). An example is dynamic capacity utilization. If one partner faces peak demands, another partner can dynamically sell unused capacity (Bharadwaj et al. 2013).

In the event that complementary resources from other niche partners or the focal orchestrator are leveraged, a niche partner can benefit from the typical **outsourcing** benefits quality improvement, external know-how, core competency focus, and cost reduction (e.g. Iansiti and Levien 2004b; Ozcan and Eisenhardt 2009; Sarker et al. 2012). Outsourcing is specifically advantageous in business markets facing pressure to both (a) shrink to a focused core for cost efficiency reasons and (b) deliver more complete, complex, customized product or service bundles to increasingly demanding customers (Williamson and De Meyer 2012).

Announcing, publishing, or marketing ecosystems can result in significant **signal effects** both for focal market incumbents who establish the ecosystem and for participants (e.g. Ceccagnoli et al. 2012; Han et al. 2012; Lavie 2006). The more partners a hub firm can gather in its partner program, the more it signals a rich service portfolio, de facto standards, high market coverage and importance. Partners can mitigate uncertainties in the eye of customers and third party investors. The reputation of a large, well-established incumbent is likely to increase a participant's visibility, reputation, image, and prestige demonstrates credibility (Ceccagnoli et al. 2012).

An ecosystem enables hub firms to execute strategies that result in a higher **industry control** as compared to isolated strategizing on product-market segments (Porter 2008). First, in case the industry blueprint of various partner roles defined and advocated by the hub firm is accepted, it will define unique interdependencies under the control of the hub firm. Second, it allows the orchestrator to coordinate unconnected and distant firms to exploit new service combinations. Third, the lead firm can orchestrate partners in order to adapt to or to prevent emerging industry uncertainties (e.g. Alexy et al. 2013; Gray et al. 2013; Ozcan and Eisenhardt 2009).

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Ecosystems can also be used to leverage **network effects,** especially if the partners' offerings are brought together on a marketplace. Such network effects are present in markets where "[...] value [is] derived from a network because other network participants are part of the network" (Golden 2013, p.20). If a provider faces the decision to offer a service or a product, it will make sense to provide it at a place where many users and providers are already located. Thus, users and partners naturally gravitate around an ecosystem and ensure market coverage and service portfolio are improved (e.g. Almirall and Casadesus-Masanell 2010; (Bharadwaj et al. 2013); Pagani 2013).

In contrast to traditional supply chains in areas such as automotive, chemicals, or textiles, the speed of orchestration, formation, and adaption is faster in ecosystems resulting in a lower **time to market** (e.g. Bharadwaj et al. 2013; Gosain et al. 2004; Venkatraman and Chi-Hyon Lee 2004). In supply chain hierarchies and classic outsourcing relationships, contracts, deliverables, and functional specification documents need to be elaborated carefully. In contrast, loosely coupled partners in ecosystems orchestrated by *one* hub firm can collaborate, develop, and flexibly experiment. Thus, market-induced uncertainties and complexity can be absorbed more efficiently.

Knowledge sharing is considered in more than half of the coded articles. The facilitation of common platforms, electronic knowledge repositories, and analytic software in ecosystems improves the sharing of information and expertise. Aggregated data sets on products and customer behaviour throughout the ecosystem can contribute to better decision-making on strategies for co-creating products, services, processes, or standards (e.g. Dhanaraj and Parkhe 2006; Grover and Kohli 2012; Parker and Alstyne 2008). E.g., the hub firm Motorola better replenished its vendor managed inventories after sharing analytical data with mobile phone retailers (Grover and Kohli 2012).

The most frequent and probably most intuitive opportunity is **resource complementation**. As opposed to resource pooling, heterogeneous partners in vertical or complementary ecosystems are enabled "[...] to capitalize on resource diversities form which new, innovative products and services can be developed and commercialized" (Han et al. 2012). The resource multiplicity may significantly improve products and services and thereby help the participating companies in expanding their business territories (e.g. Grover and Kohli 2012; Jacobides 2005; Lavie 2006). E.g., the Nike+ ecosystem renews people's entertaining and exercising by launching a first of a kind fitness platform(Souppouris 2013).

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3.3 Value Co-Creation – The Market Differentiators

Coined by McKinsey & Co. in a much-noticed publication (Manyika et al. 2011), the term "big data" describes "large datasets that cannot be captured, managed or processed by commonly used software tools within a reasonable amount of time and at a reasonable cost" (Malhotra and Jain 2013). It is important to state that both the business opportunities and technology capabilities of big data are strongly growing partly in science and more specifically in practice for marketing purposes. Yet, if a critical review of big data and research of the true desires and realities, even conservative decision makers will agree that the success of a professional management of enterprise-wide information is critical in an information society. Furthermore, leaders need to acknowledge that big data has gained significant influence in recent years and is rapidly transforming the business, operations and technology landscape for a myriad of industries. Early adopters – particularly in retail and consumer products – have already derived significant business insights from big data management best practices, such as analysis of both the growing pools of structured transactional data from operations systems and the unstructured and semi-structured data generated by social media interactions (Malhotra and Jain 2013).

From a service point of view, this development is also reflected in the fact that the BM INFOaaS in its classic understanding in terms of content management, business intelligence, database services, and information integration already exists on the market. It is offered by consulting companies and managed service providers to improve the relevance and cost effectiveness of information. Thus, thinking about information and data as separate from the users' processes is key in this sort of BM. For that reason, we researched the INFOaaS market in order to find out which classic services are already offered. Thereby, content management builds consistent and reusable services for integrated content. Analytics and data warehousing services derive insights that give a competitive advantage. Database services manage, share and secure relational data using database management systems. Information integration enables real-time, integrated access to business information, regardless of location or format by providing a broad set of information integration capabilities to semantically align information across disparate sources (Jaggy 2013).

This portfolio of established services explains what already exists in the market and what should not be instantiated as HN would only be a follower competing with incumbents having a long track record. Yet, the portfolio also explains what the opportunities are for HN. To summarize this in one word, the difference is **value co-creation in a partner**

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ecosystem. In the following, we suggest, analyse, predict and justify three major differentiators to existing incumbents' INFOaaS BMs.

- **Open-source Algorithms-based Innovation Alliance**
- **Big Data-based Modelling & Predictive Analytics as a Service**
- **Cloud-based M-to-N Cross Domain Data Enrichment**

Open-source algorithms are one approach to instantiate an open innovation alliance (OIA) in which value is co-created. Despite their nascent stage of development, many contemporary business enterprises have jumped on the bandwagon of this emerging industrial trend, participating in OIAs to leverage purposive knowledge inflows and outflows. For example, in 2007, a group of leading IT companies, including Google, T-Mobile, Intel, Qualcomm, and Samsung, formed the Open Handset Alliance and launched an initiative called Android to develop an array of innovative infrastructure platforms and software applications for mobile technologies (Open Handset Alliance 2007). We use the following definition: "Such innovation driven open collaborations are frequently used by firms operating in the mobile phone industry, including handset manufacturers, software developers, and mobile operators. These collaborations facilitate the value co-creation through the joint design and development of technologically innovative devices, services, and standards. The collaborative manoeuvres currently being harnessed in high-technology industries could potentially reshape the competitive dynamics and alter the strategic positioning of the companies that operate within this vibrant and fast-paced environment. Moreover, the technological innovations cultivated through OIAs could enable the participating firms to develop and introduce an entirely new market, which would create substantial economic value and opportunities for all parties involved in such a collaboration" (Han et al. 2012). "[…] open-source software is gaining wide popularity for Internet and enterprise applications, and requires that the source code be distributed freely, so long as the licensee also agrees to make modifications or improvements freely available to others. This makes all subsequent improvements freely available to the entire community of users, who needs to pay only for support and maintenance provided by industrial contractors; the improved source code itself remains free" (European Space Operations Centre 2007). Leading information systems research investigated the economic and strategic value of open-source OIAs, in which collaborators and competitors cooperate in the pursuit of the co-development of technological innovations. Given that OIAs differ substantially from traditional, closed alliances in many aspects, including their strategic

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scope and scale, governing mechanisms, and member composition, it is important to understand and assess the potential value inherent to these new types of collaboration. Furthermore, OIAs evolve over time as the participating members are free to enter and leave(Han et al. 2012).

Predictive analytics services label data mining procedures which use statistical techniques such as multiple regressions to make forecasts in support of managerial decision-making. Data mining is typically conducted using software packages which access data warehouses or data marts containing historical and/or cross-sectional information culled from an *organization's* operational data sources (Kridel and Dolk 2013). The new thing about the BM INFOaaS is that the data source is *external*, cloud-based and enriched by many data sources from the various data providers. Thus, the organizations' internal warehouses may be augmented by external data sources, either publicly available (e.g., economic indicators from the Bureau of Labor statistics), or commercially available (e.g. demographic data from companies such as Experian) gathered on the HN cloud and combined for big data-based analytics. Well-known data mining software includes SAS Enterprise Miner, SPSS Clementine, and IBM Cognos. Effective predictive analytics require a significant degree of statistical modelling expertise coupled with a thorough understanding of the data which is being used as the foundation for modelling. Several process models for conducting predictive analytics have been proposed, including SAS' SEMMA (Sample, Explore, Modify, Model and Assess) (SAS Institute 2013) and the CRISP-DM (Cross-Industry Standard Process for Data Mining). Critical success factors include an established database infrastructure as well as modelling expertise in the form of statistical analysis and the use of data mining software to perform that analysis. Our motivation for predictive analytics as a service is that there are many organizations for which these resources are not available and for which there is limited or no modelling capability. Our assumption is that the smaller an organization is, the less likely it is to have resources available for meaningful predictive analytics.

Cloud-based M-to-N cross domain data enrichment is at the core of what is new about this BM. M cloud customers' data is unified either by experts or a data broker on the platform. The new service is offered to N customers who can be divided in three categories. The next chapter 3.4 provides an example of how far N customers profit in all three areas.

- Economic efficiency (innovation, prosperity, productivity)
- Social equity (poverty, community, health and wellness, human rights)

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- Environmental accountability (climate change, land use, biodiversity).

The finding and binding of further valuable data providers of e.g. financial data is a key success factor. In a first step, statistic institutions like the World Bank or Eurostat that offer publicly available, high quality and broad range data could be new partners. The offerings should ideally not simply be sold in parallel, but rather context enriched. Yet, in order to gain prominent commercial data providers, they should be able to use INFOaaS as a further channel where their data is sold on its own. We think of research departments of global concerns. Deutsch Bank Research, for example, focuses on macroeconomic analysis, economic policy issues in Germany and Europe, global research on the financial sector and its regulation, and natural resources - risks and opportunities, ensuring future supply (Deutsche Bank AG 2013). McKinsey Global Institute is a further example of data that might be important to complete the comprehensiveness of data services. Data on financial markets, labour markets, natural resources, productivity, competitiveness, growth, technology, innovation, and urbanisation are collected (McKinsey & Company 2013). Yet, cooperation with such high-end partners requires incentives that reach beyond money as those organisations will not simply sell their most important strategic weapons: data and knowledge. “Ingredient branding” as explained in the following bullet might offer a solution.

Coming to point (b), the great strength of this approach is the re-combination of data which reveals and contributes completely new causalities to the knowledge base. Therefore, persons that know how to ask the right questions are required. Their questions will show which data should be combined. These are extensive product and service management efforts in human resources.

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3.4 DORIS – A Potential Starting Point

After the academic insights in the functionality of the BM INFOaaS, ESA's service named "Doppler Orbitography and Radio-positioning Integrated by Satellite" (DORIS) is a concrete starting point for the ecosystem adoption. DORIS is offered by the ESA Earth Observation (EO) Mission and "… is an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, at different temporal and spatial scales and in various physiographic and climatic environments" (Guzzetti 2013).

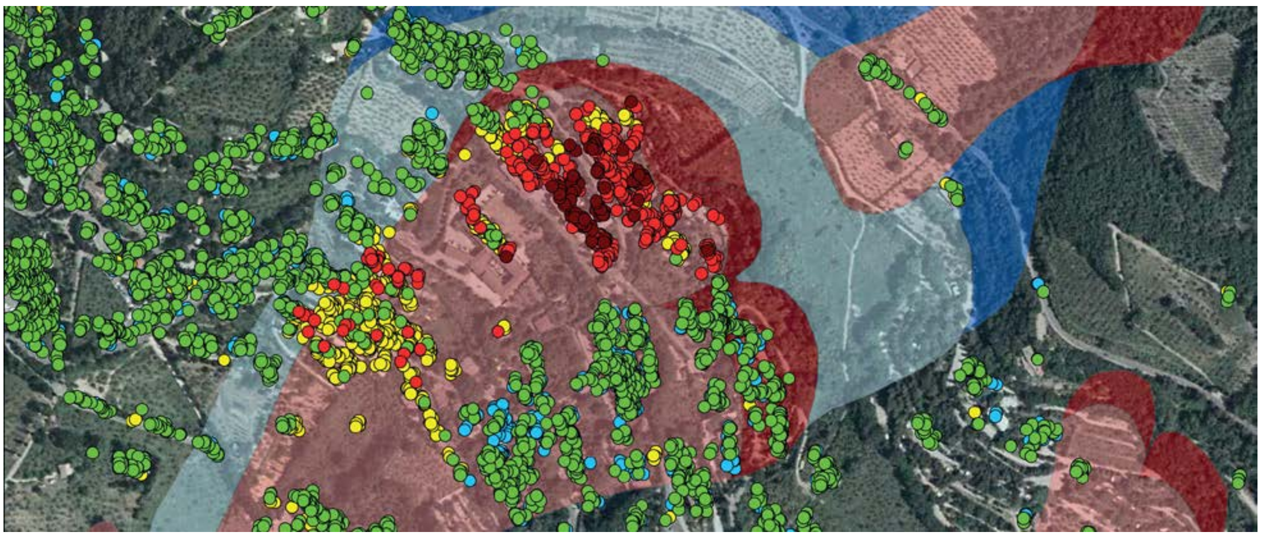

Figure 11 *Deformation and Deformation Velocity Map of Ivancich, Assisi (Italy)*

DORIS is an advanced downstream service for the detection, mapping, monitoring and forecasting of ground deformations, including landslides and ground subsidence, at different temporal and spatial scales and in various physiographic and environmental settings. DORIS integrates traditional and innovative Earth Observation (EO) and ground based (non-EO) data and technologies to improve our understanding of the complex phenomena that result in ground deformation, and to foster the ability of Environmental and Civil Protection authorities to manage the risks posed by ground deformations (cf. *Figure 11*). DORIS delivers innovative products at the regional and local levels, tailored on the needs of national and local Civil Protection authorities. To achieve this purpose, DORIS integrates state-of-the-art national technological and scientific capabilities with existing European upstream services. DORIS complies with guidelines provided by the EU Emergency Response Core Services, and is designed to be linked to existing Core Services.

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DORIS benefits from a unique partnership of leading research institutes and commercial providers, and is expected to stimulate European competitiveness and sustainable development.

- ESA potentially sponsors the project in order to get a fully operative INFOaaS to work. The service has a very large global commercial exploitation potential. Companies that already offer similar services within the conventional commercial environment achieve significant revenues. Most interestingly, only Europe has satellites that offer this very service. The following revenue streams are our proposal.
- Transaction-based services are of interest for one-time needs. Some customers have one-time data, information, or knowledge demands and only want to pay one time for this specific demand; e.g., an academic research project that requires data sets to test a newly developed model would not be interested in updates on an ongoing basis over months or even years.
- Premium subscription ensures updates to follow latest data. Other customers, especially within the business environment, require updates concerning their data, information, or knowledge demands as they want to ensure competitive advantages by improving products and services continuously. E.g., the Siemens business unit "Infrastructure & Cities" wants to follow urban development on an ongoing monthly basis.

DORIS is not only a good starting point for INFOaaS, but it states a good example on how far customers benefit from economic efficiency (innovation, prosperity, productivity), social equity (poverty, community, health and wellness, human rights), and environmental accountability (climate change, land use, biodiversity). A business customer like Gazprom can buy the information in order to stop pipeline operations before a landslide to prevent gas loss. Therefore, Gazprom's economic efficiency is improved. As a gas leakage would yield in health risks and job loss due to inaccessible and polluted areas, the social equity is secured. Finally, nature is secured as gas impacts on the biosphere are prevented.

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4 Network Effects – Triggering Ecosystem Enrichment

In two strategy workshops with the supply-side, comprising T-Systems, Atos, and EGI.eu, we collaborated on defining problems, objectives and challenges for the BM design and implementation (cf. deliverable 7.2 – chapter 3.2 – Section *Design Challenges*). Design challenge 13 asks how the generated HN BMs can be initiated successfully. Thus, after a short introduction to the term and theory of network effects (NE), we will outline four appropriate, systematic, and strategic steps towards the market tipping of INFOaaS in order to reach a critical mass of users. The complete topic of network effects is SAP's intellectual property, namely of Simone Scholten, SAP Senior Researcher. The material is exclusively presented and applied to HN. After a short introduction to the required background knowledge on NEs, SAP presents a four-step roadmap for implementing the BM. Finally, inherent deal breakers are listed to ensure success.

4.1 Background – Introduction to Network Effects

This chapter discusses SAP's BMI approach in the presence of NEs. In the context of BMI, it is imperative to understand whether the product or service is subject to NEs – and consequently – how to design BMs that leverage NEs. INFOaaS is a platform-based ecosystem and, therefore, the value of its services depends on the number of users. The users' willingness to pay is determined by their intrinsic interest and the number of other people using the services. Thus, in the context of BMI, it is imperative to understand whether the customers' validation of the value proposition is subject to NEs, indicating that the value of a product or service depends on the number of others using it. We define the term *network effects* as the increasing value of a product or service for each user as the number of users grows. Hence, a consumer's willingness to pay is determined by their intrinsic interest and the number of other people using the good – the larger the user community, the more willing they will be to pay. The decisive question follows:

In which BMs and where within this very BM are NEs present? Most value propositions are not subject to NEs as users probably have no interest in other users' purchases. NEs are present if users prefer a product or a service over another, as its value increases with the amount of users using it. Depending on whether the community around a product or service reaches critical mass, NEs might be a friend or an enemy to every BM (cf. *Figure 13* and *Figure 14*). We use the term *critical mass* as introduced by Rogers (2010) who defines it as the point in time within the adoption curve at which the adoption of the innovation is

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self-sustaining and network growth increases dramatically (cf. *Figure 12*). A community is expected to have enough momentum to become self-sustaining at about 15% from the target community opting in, whereby critical mass is linked to consumer's expectations regarding the performance of a product or service, and the expected final size of the network (Mahler and Rogers 1999). As long as the critical mass point is not exceeded, demand synergies can only develop to a limited extent (Schoder 2000).

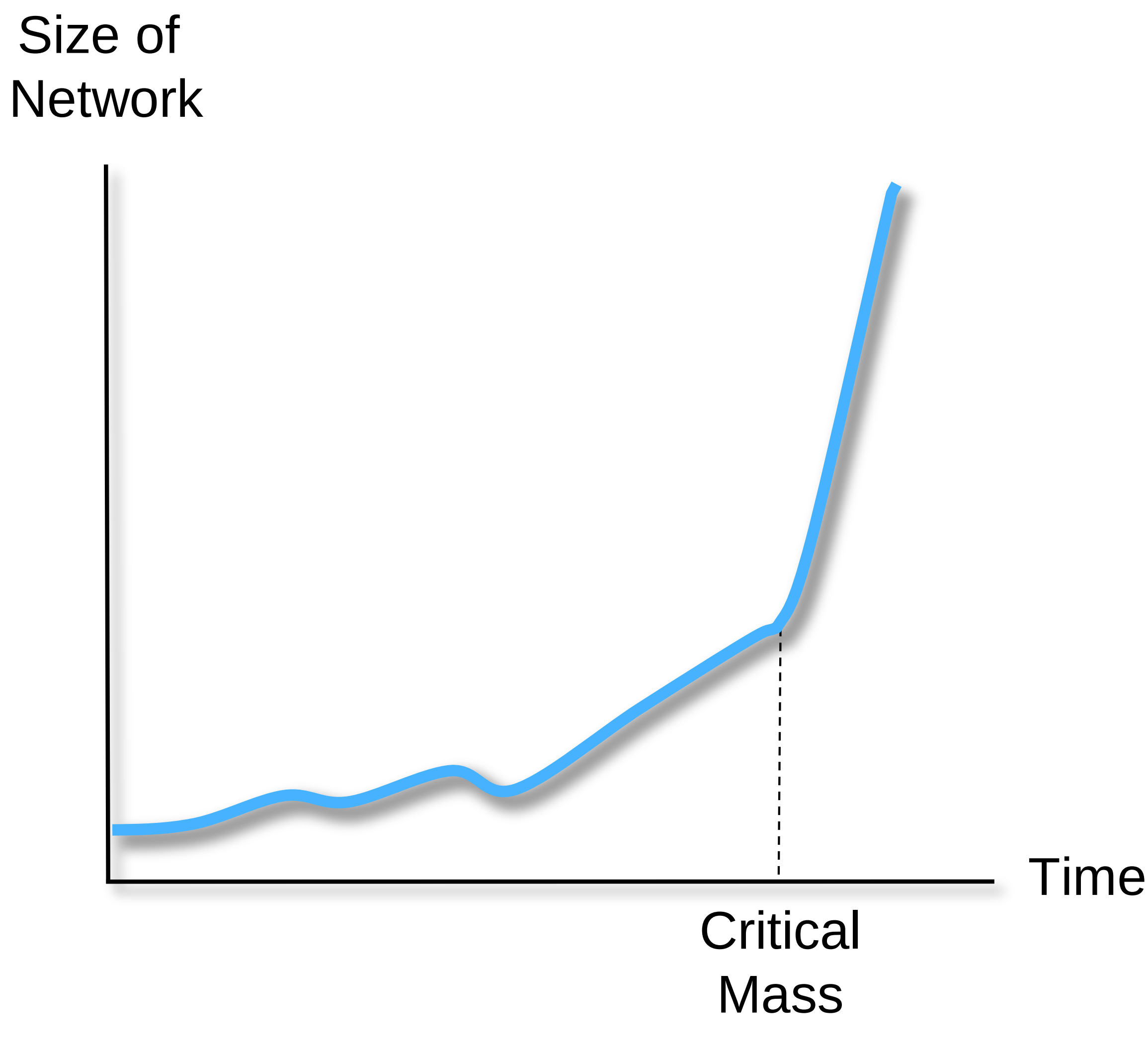

Figure 12 *Visualisation of the Term Critical Mass (Shapiro and Varian 1998)*

These are the following two types of NEs.

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- **Direct NEs**: Different members of a given group A enjoy interacting with one another through a network, so that value increases with new members. Examples are telephone systems, fax machines, or social networks – the more people use it, the more valuable it is to each user. Yet, this effect might turn to a pitfall through congestion. The presence of additional members of group A on a network reduces the value of the network to members of group A, e.g. limited bandwidth (cf. *Figure 13*).

Figure 13 *Positive and Negative Direct Network Effects*

- **Indirect NEs**: The greater the number of members of group A on a network, the more members of group B will be attracted to the network, which in turn increases the value to members of group A. Examples are game consoles which become more valuable as the variety of games available increases. In turn, this variety increases as the total number of gamers increases. Yet, the repulsion pitfall is a hazard. The presence of members of group A may repel members of group B even though the presence of members of group B attracts members of A, e.g. too many advertisers targeting an online audience. (cf. *Figure 14*).

Figure 14 *Positive and Negative Indirect Network Effects*

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SAP Research identified the following generic sources of NEs in any kind of BM.

- **Exchange/Interaction**: The value of networks increases as more people join (users might communicate with more people; e.g. Facebook). Exchange embraces any data stream, such as movies, music, money, video games, and computer programs. Exchange requires standards that allow interconnection to snare network effects.
- **Long-Term Viability**: Users aim at sustaining their investments, trying to avoid switching costs. Networks with greater numbers of users suggest a stronger long-term viability. Switching costs can strengthen the value of network effects as a strategic asset. The higher the value of the user's overall investment, the more likely they are to consider the long-term viability of any offering before choosing to adopt it (e.g. Microsoft).
- **Complementary Benefits:** Complementary products or services such as 'how-to' books, software add-ons, and even labour add additional value to the network (e.g. the variety and quality of software available for the Palm system expand as more users buy personal digital assistants that run Palm OS).
- **Pricing:** Finding the right price is of the utmost importance as high prices slow down market adoption and potentially create a market for competitors. Freemium models or high volume models combined with a modest commission seem to be a sustainable formula to attract users for products and services with network effects. Later on, opt-in payments might be included (e.g. bidding option of Google AdWords). At the beginning, it is more important to prove the platform as a viable and efficient distribution mechanism.
- **Innovation/Co-Innovation:** Continuous innovation on the core value proposition as well as on (third party) complements is one of the primary ways to differentiate from the competition in network markets (e.g. Google Labs).

The given theoretical foundation enables understanding of the following application composed of four appropriate, systematic, and strategic steps towards the market tipping of INFOaaS in order to reach a critical mass of users.

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4.2 Application – Implementing Information as a Service

After explaining the architecture of INFOaaS and triggers to enrich the platform, we finally focus on how to implement the model. The question is how HN can make a transition from *Generic Infrastructure as a Service for European Science* to *Information as a Service*. Therefore, we provide a **four-step roadmap** for implementing the BM.

Whenever a platform ecosystem like an AWS or HN is started, it runs into a life cycle challenge broken up into stages. The **first** stage is the implementation, which requires a sophisticated added value analysis. In the first phase, awareness and adoption by the first few thousand customers will be a critical component of success, and therefore a challenge. **Second,** when operations are launched after implementation; members are required to join and to be informed that it is a brand new service. They will therefore have much more scrutiny and risk checking to adopt a new service. **Third**: As it starts to mature, demands on the environment will grow. Demands based on volumes and usage, but also on new requirements. The challenge thus becomes scaling. The investment to create a highly scalable, trustable and, proven infrastructure will also be critical. If the system environment fails just once, confidence is at risk. **Fourth**, as it becomes more common, as Amazon Web Services today, both competition and innovation need to addressed, which can be challenging. The life cycle management of those three phases and putting a strategy in place to be prepared is essential.

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

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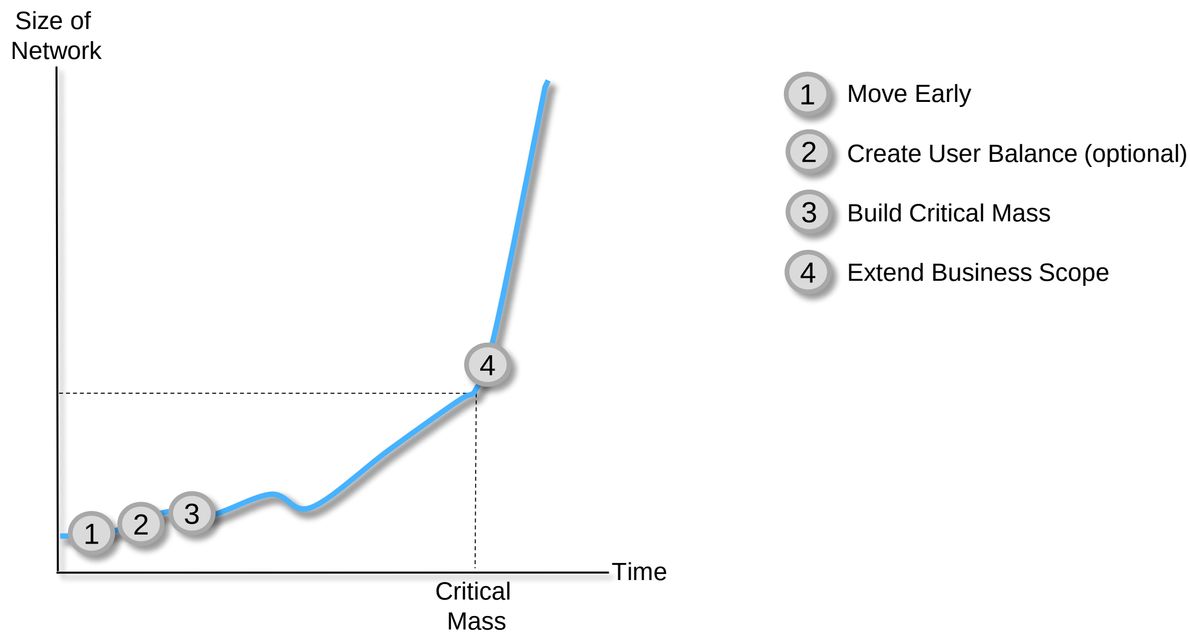

Figure 15 *Strategic Steps towards Market Tipping*

4.2.1 Fast Implementation – Move Early

Initially, it is important to clearly define and communicate towards customers and partners where, how, and with whom the market value can be co-created based on an **added value analysis**. The starting point of such an analysis must be the customers' requirements as they ultimately pay for the products or services and need reasons to decide against a competing vertically integrated supplier (e.g. Alexy et al. 2013; Gray et al. 2013; Venkatraman and Chi-Hyon Lee 2004). Understanding where value is co-created for the end customer enables the firm to define required partners and complementarities (Williamson and De Meyer 2012). In INFOaaS service, we see two potentials for value co-creation. These insights are taken from in-depth, semi-structured expert interviews.

First, there is the opportunity for **pooling** cloud resources in INFOaaS. Customers benefit from a tailored combination of diverse cloud resources, such as IaaS, PaaS, SaaS, integration (design, architecture, migration, building, and end-to-end account deployment), brokerage, consulting, or managed hosting which are all pooled on one platform. Orchestrators regard this pooling as a catalyst for their cloud platform's market exploitation as (a) inter-organizational, technological standards mitigate the vendor lock-in and (b) a platform-

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specific marketplace beyond infrastructure is founded. Partners (system integrators, consultancies, resellers, agencies, value-added resellers, independent software vendors, SaaS, PaaS, management and security vendors) contribute a breadth of brokerage, technology, financial, and consulting services populating the marketplace and, thereby, supporting market exploitation and vendor lock-in mitigation. External partners predict that pooling skills, resources, and experiences provide more effective adoption of cloud services, allowing for appropriate hybrid and multi-cloud deployment. Yet, pooling requires partners to be tested, certified, and trained to ensure an effective use by the partners that does not damage the platform's reputation. *Secondly*, there is the opportunity of **complementation** in INFOaaS. Customers aspire to complement their data in a community cloud or platform ecosystem to meet the United Nations' objective of supranational research advancement through data cross fertilization. For instance, the aggregation of earth surface data (ESA), outreach statistics (World Health Organization), and life science data (EMBL) fosters insights into criteria that enable epidemic outreach. Focal orchestrators highlight the novelty, market leadership, and differentiation potential of large-scale data complementation. Based on an internal survey, we learnt that selling data and knowledge on this scale is a thought leading BM with high differentiation and very high revenue potential. Partners differentiate between (a) the opportunities of selling generic, cross fertilized data sets and (b) offering on top data services to manipulate, aggregate, or transform data according to the users' specific needs. This would allow users to do things with that data that would not be possible if the data were not put on a common infrastructure. External partners consider data complementation to be highly profitable as external data are (a) customizable for specific needs that are not met by traditional analytics, (b) reusable, and (c) scalable through crowdsourcing.

1. Start with a niche by picking a specific target market and try to dominate it.

2. Target a small community, e.g. a specific geographical location, a demographic or niche interest and reach critical mass before spreading to a second, a third and, eventually, open up to the rest of the world

3. Envision how to logically expand into larger markets, but only do so when dominating the community. Recognition and momentum is needed to move into a larger segment. In established markets, focus on a single niche an incumbent is either over- or underserving.

4. Never drop below 15%. For example, Facebook reached critical mass within a single university before it spread to a second one, and beyond. Thus, Facebook never dropped

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below the critical mass and secured user value. Step-by-step, it built nationwide expectations for critical mass. Based on the results of our initial added value analysis, we recommend an appropriate potential niche to start with in chapter 3.4. DORIS seems to be a potential starting point for INFOaaS to SAP and ESA.

The HN consortium is the initial occupant of the INFOaaS market segment on that scale. A fast implementation is crucial to benefit from first mover advantages and to start the NEs snowball rolling. That way, HN might gain control of data resources and data provider communities that followers may not be able to match at a later point in time. The faster and the more consequent data providers are found and incorporated, the less data providers are available for followers. "In case the BM becomes institutionalized, early adopters that invested within the fashionable phase can realize over-proportional higher returns in comparison to late investors due to first mover advantages" (Moser 2011). An example is Sony's PS 2. It enjoyed an 18-month lead over Xbox and succeeded in the market, whereas the technically superior PS3 showed up months after Xbox 360 and resulted in losses for Sony. There are several reasons why a quick implementation is beneficial.

- *Technological leadership*: Looking at INFOaaS, selling enriched structured data sets requires a data warehousing approach integrating data from one or more disparate sources encompassing structured, semi-structured, and unstructured data. Selling knowledge induces analytics using data mining methods at the intersection of artificial intelligence, machine learning, statistics, and database systems. Thus, both options within this BM allow for differentiation in the competition.
- *Pre-emption of scarce assets*: The scarce asset is structured, of high quality, and on a large scale data from the few data providers CERN, ESA, and EMBL. If they decide to store and process their data on the HN cloud platform, a pre-emption of data usage can be assured.
- *Switching costs*: Of course, HN has the aim to lower its switching costs within the market of HN. But the switch to competitors outside HN states a possibility for raising switching costs. This would make it more difficult for competitors to get access to the data e.g., ESA would hesitate to switch to, e.g., AWS.
- *Buyer choice under uncertainty*: If uncertainty is high as in non-transparent markets buyers cannot make informed decisions, hence they might decide for the first mover in this segment based on its strong image. A well-known example is Apple. The market for smartphones lacks transparency as a high number of low budget to premium devices

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are offered. Thus, many will choose Apple's iPhone simply because they were the first mover for premium smartphones. Thus, HN suppliers should be highly motivated to be the first mover.

Establish a vivid community prior to launch by producing relevant content and fostering interaction among users! Create forums, advisory boards, meet ups and dedicated interaction tools to connect users. The HN cloud marketplace (HNX) is an ideal starting point for community development. One aspect of IaaS that was singularly mentioned by the hub firms during the expert interviews is the European cloud computing marketplace. They see their federated, pooled infrastructure platform as a layer on which additional services can contribute to the marketplace. This co-creation of value through layering is in line with results by Sarker et al. (2012) who terms it addition. In the INFOaaS service catalogue, the customers have to be able to find what they might want to use and it has to be comparable enough. What INFOaaS will end up with is in essence a marketplace where selected cloud vendors – again a small group to begin with, but eventually a larger group – will be able to offer wares and services in a way that will be understandable to the potential user community and will be governed by a set of service, business and technology rules. In this marketplace, a vivid community can develop before INFOaaS starts. This is ideal, as customers will rather be from science.

Scale and optimize the data sets or data services on the fly by learning from early customer feedback! It is most likely that many insights on further required data sets will come from the customer group of **experts** in INFOaaS. They are required to customize data services and report services for the end customers. This is the case if a service request by an end customer cannot be satisfied as the content operators' offerings are too generic. We differentiate between subject-specific and methodological experts. Subject-specific experts demand and pay for more specific data from the data providers in order to enrich a generic data set. The subject-specific experts will provide detailed information, which additional data sets are required to better serve the data users.

Both the complexity of ecosystems as explained above (cf. chapter 3.1.1.) and a cost efficient value delivery requires a structure of **architectural roles** (e.g. Dhanaraj and Parkhe 2006; Iansiti and Levien 2004b; Ozcan and Eisenhardt 2009). Partners' contributions are drivers including "[…] components of a solution […], operational capacity, sales channels, […] complementary products and services, […] and [a] source of technology and competence or of market and customer knowledge" (Williamson and De Meyer 2012, p. 35). Those

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contributions need to be allocated to partner roles such as technology, consulting, finances, or brokerage to reduce the complexity. We provided one potential architecture model for partners (cf. chapter 3.1.1)

4.2.2 Adoption – Create User Balance

Multisided platforms like HN's INFOaaS have to overcome the chicken and egg challenge. Data users want content and applications (SaaS) before they will use the platform, whereas data providers and technology partners want users before they will provide data, content and applications (SaaS). Each side expects the other side to commit before it will spend resources to adopt the platform. Convince one side! The following instruments to create user balance constitute a toolbox from which a subset can be chosen.

Establish flexible **governance** that ensures intellectual property rights! HN already has established a flexible governance structure for the first BM, *Generic Infrastructure as a Service for European Science*. It has been a key strategic pillar during the pilot phase to create a light-weight governance structure that involves all the stakeholders and which can flexibly evolve over time as the infrastructure, services and user-base grows. In INFOaaS, effective governance will be required as well. Concerning INFOaaS, it has to be a control structure (a) to limit the leakage and opportunistic exploitation of proprietary knowledge, (b) to reduce transaction costs due to the complexity of thousands of potential partners, and (c) to make incentives documentable, accountable, and calculable (e.g. Grover and Kohli 2012; Lavie 2006; Sarker et al. 2012). Concerning (a), self-reinforcing, informal mechanisms of co-evolving trust, goodwill, and commitment are ideal. Yet, the reality demands formal and wary isolation mechanisms such as patents, trademarks, or contracts to protect strategic resources (Lavie 2006). Therefore, INFOaaS can adopt the existing governance model, add additional required components, and focus on the issues regarding intellectual property rights!

Provide high quality content by seeding the platform with content or applications that are already in high demand or by building up a pool of freelancers or employees to create a sufficient base of content to attract the other side! For instance, at the time of its launch, the Apple App store had already 500 apps for iPhone, delivering additional value to the users. Concerning HN, the data already provided by ESA and EMBL may attract first data users.

Attract marquee data users and/or providers by providing them with better deals as the participation of *marquee users* such as exceptionally big buyers or high profile suppliers can

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be especially important for attracting participants to the other side of the network! If HN manages to win, e.g., *Munich Re*, *Suisse Re*, *Gazprom*, etc. as data users on the one hand, and, e.g., *The World Bank*, The United Nations, Eurostat, etc. as data customers, the INFOaaS platform attracts even more users and providers.

Signal long-term commitment to the platform success and competitive pricing!

Subsidize initial adoption of early adopters, such as price reductions, rebates or other give-aways! For instance, PayPal offered users a rebate as a sign up incentive to encourage adoption.

Encourage the development of complementary goods by offering resources, subsidized fees or development kits! Among others, Force.com is providing developers with dedicated development kits, development support and communities.

Provide seed funding so that monetary reasons convince one side to support the platform. For instance, the fbFund offers a $10M seed fund supporting developers and entrepreneurs on the Facebook Platform. HN could financially support data providers by reducing the cloud costs for small data providers.

Follow the rabbit strategy! Target a platform complement with a high probability of success and assist the developer in highly public and visible fashion. Other investors will follow after observing that the developers succeed.

Articulate whitespaces by showing the ecosystem partners where to invest and provide them with a 12-24 month roadmap of their own new developments occurring! This indicates what new features are coming, so developers know the functions upon which they can build and where the Platform Leader is not going to compete so developers feel safe investing. Intel, for instance, shares technical information about their own products and platform interfaces and even sends engineers to help partners build compatible devices. This way, Intel draws the attention of investors and partners to a potentially lucrative new market and signals that Intel aims to stay out of the complementary market.

4.2.3 Scaling – Build Critical Mass

The coded literature follows the economic concept of *homo economicus* (e.g. Dixon and Wilson 2012) and argues that partners were most likely to join if they received **incentives** such as business opportunities and value propositions (e.g. Adner and Kapoor 2010; Grover and Kohli 2012; Parker and Alstyne 2008). Such benefits are manifold encompassing

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primarily "[…] improved functionality, faster innovation, or higher levels of customization" (Williamson and De Meyer 2012, p.35), but also the hub firm's support in presales, sales, technical platform adaption, marketing and public relations, or a shared innovation roadmap (Amazon Web Services 2013b).

Create a critical mass sequentially (see paragraph p.57)

Actively manage expectations to achieve critical mass by influencing user expectations, e.g., vapourware, heavy advertising, or offering subsidies or lower prices to new members.

Lower entry hurdles by making the product or service easily accessible to more users!

Ensure compatibility with leading standard by making the product or service compatible with the leading standard in order to benefit from an instant base of add-on content already available for the leading standard. For instance, Microsoft's Live Maps and Virtual Earth 3D adopted the same keyhole mark-up language standard used by Google. The first BM, *Generic Infrastructure as a Service for European Science*, already offers a technical bridge to AWS Elastic Compute Cloud (Amazon EC2), which is a web service that provides resizable compute capacity in the cloud. It is designed to make web-scale computing easier for developers. As it is the leading standard in the cloud computing market (Leong et al. 2013), it is more likely to win many customers as the barrier of not being able to return to AWS is lowered. This needs to be continued in INFOaaS. Concerning INFOaaS, compatibility to competitors like Google is an option.

Facilitate switch by providing a better user experience than existing incumbents and facilitate switch of their users in order to piggy back traction from an established incumbent! Airbnb.com simplified listing for users on www.craigslist.org, while listing these offerings on www.airbnb.com as well. This way, they have been able to create user balance. Salesforce.com promises customers to "better" integrate with SAP backend systems. The switch can be facilitated by using the same data formats as the customers use.

Foster exchange between same-sided and cross-sided users by identifying common themes of interest and enable an exchange environment, provide a sufficiently high volume of content to exchange and establish accurate term of conditions and good governance to foster a vivid community! We modelled drivers of network effects that foster the exchange between the customers (cf. *Figure 16*). Don't forget to establish rules and regulations to protect integrity of exchange and trust and to take care of transparent surveillance and monitoring of activities! Continuously improve the exchange function! In certain cases,

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training and certification might help in meeting quality expectations. Geocaching.com is a good example. It supports a worldwide geocaching community, wherein more than 400 dedicated volunteers act as reviewers, ensuring that geocaches meet geocaching guidelines; moderators, guiding and monitoring participation in geocaching discussion forums or translating geocaching content.

Figure 16 depicts our modelling of direct network effects (A groups' value increases with new members, e.g. the telephone) and indirect network effects (The greater the number of members of group A on a network, the more members of group B will be attracted to the network, e.g. programmers for game consoles).

There are direct network effects within the group of data users. The simple question is: Why do purchasing data users benefit from data users that newly joined the INFOaaS platform? For instance, why will a Munich RE benefit if a Suisse RE joins the platform? We identified the following answers:

- **Transparency**: The more data users from the same industry adopt the platform, the more transparent the industry becomes.
- **Best Practices**: INFOaaS is a very new BM which no partner has experience with. Firstly, existing technologies, e.g. identity management, have never been applied in a one-to-many relationship. One company has identity. One university has identity. Up to now, identity has always been a one-to-one relationship. But in HN, a customer wants to use such technologies consistently across the federated hub firms and their partners. Thus, the more data users join, the more it will emerge how *one* identity can be accessed and managed consistently across *many* suppliers. For instance, if Munich RE as a data user has one identity for HN, all HN partners need to be able to cope with that single identity so that Munich RE will not have to create several identities for each partner. Secondly, as a result of the inexperience, the consideration and definition of INFOaaS is inconsistent across all HN participants. The biggest challenge that HN faces is that INFOaaS is not copying anything, but rather pioneering here. The whole idea of a federated public community cloud ecosystem for selling data and reports is new, revolutionary thinking without known processes or best practices to be applied. It is challenging to solve problems that could not have necessarily been anticipated well in advance. But the more data users adopt the platform, the clearer best practices and processes will be.

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- **Gap Identification**: Our research strongly indicates that value co-creation in INFOaaS is instantiated by the opportunity of complementary resource alignment. Being also routed in the RBV of the firm (Penrose 1959), complementation is the opposite of supplementary resource pooling. In contrast to pooling with an *economic efficiency* perspective (Han et al. 2012), firms with a diminutive resource intersection establish complementary ecosystems, "in which firms seek to achieve synergies by employing distinct resources that are difficult to accumulate in combination by any given firm" (Lavie 2006, p. 644). Partners in INFOaaS affiliate in vertical ecosystems to reach a level of completeness to the resource requirements of the ecosystem (Hill and Hellriegel 1994). Companies with a strong technological team, for instance, may join an ecosystem in which the hub firm can provide sophisticated marketing skills and sales channels that help such technology partners to easily tip the market with its technological product (Sarker et al. 2012). In such a *resource multiplicity* view, the notable goals are to create new, innovative products and services, which is why "heterogeneous partners can widen a window of opportunities in the form of new product and market expansions, which are not easily facilitated in the case of the horizontal integration with homogeneous participants" (Han et al. 2012, p. 296). Thus, complementation is superior to pooling, as benefits resulting from *resource multiplicity* outweigh those generated from *economic efficiency* (e.g., Grover and Kohli 2012; Jacobides 2005; Lavie 2006). Complementary resource alignment appeared to be the central opportunity of INFOaaS, a revolutionary community cloud platform model. Thus, the more data or reports users buy, the more potential for complementation will become obvious as they will express the gaps in the data they wish to be closed.
- **Core Competency**: The more data users from one industry adopt the platform, the more HN and the experts will be willing to concentrate on that specific industry. Therefore, the industry, e.g. the re-insurance business, will be enabled to better concentrate on its core business instead of information gathering.
- **Economies of Scale**: The more data users adopt INFOaaS, the higher the economies of scale will be as the same data and reports might be sold to more data users, which might yield in lower price as the fixed costs are distributed to more customers.
- **Governance**: The more data users adopt INFOaaS, the more complete, mature, and simple the governance model will become. Both the structured literature review on business partner ecosystems and our empirical data convey in quantity (most

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mentioned concept) and quality (clear, enthusiastic statements) that "[…] the number one top enabler […]" for value co-creation was governance. An effective governance defines a control structure with "[…] enforcement mechanisms that can counter the threat of opportunism inherent in an alliance and safeguard partners' interests […] [by focusing] on the maintenance of order within the relationships" (Sarker et al. 2012, p. 320). There are two categories of instruments to limit the leakage and opportunistic exploitation of proprietary knowledge. Ideally, self-reinforcing, *informal* mechanisms of co-evolving trust, goodwill, and commitment are the foundation of the cooperation (Sarker et al. 2012). The reality demands *formal* and more warily isolation mechanisms, such as patents, trademarks, or contracts to protect strategic resources (Lavie 2006). Ecosystem governance assumes even greater significance when the value co-creation involves thousands of potential partners. APN, the role model of cloud computing ecosystems, had 665 technology partners (Amazon Web Services 2013d) and 878 consulting partners (Amazon Web Services 2013e) at the time of analysis. Co-creation with such a high number of firms in a *loosely coupled* cooperative arrangement requires a stabilizing structure to be defined by the orchestrator (Dhanaraj and Parkhe 2006). In a fundamental contribution, loose coupling is defined as "[…] a situation in which coupled elements are responsive, but retain evidence of separateness and identity" (Weick 1976, p.3). A third aspect that was revealed by our data is that good governance ensures documentable, accountable, and calculable distribution of revenue streams amongst all partners involved in a deal.

- **Knowledge Sharing**: Not only data providers share their knowledge by complementing their data, data users can equally share their knowledge in a data user community. For instance, if Munich RE mathematicians know how to calculate risks in a different way with new data, they can discuss that idea with experts from Suisse RE. Therefore, the more data users adopt the platform, the better knowledge sharing will work. Thereby, knowledge sharing involves sharing of information and expertise that can inform decision-making and strategies for co-creating new or better products. Clearly, a good IT infrastructure and processes for sharing knowledge can enhance absorptive capacity – or the ability to recognize, assimilate, and exploit external (partner) information. Additionally, the right incentives must be in place for firms to share their proprietary knowledge for a collective good. All partners must perceive mutual value from knowledge sharing and use. The capacity

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of an information technology to capture, store, and analyse information and to disseminate knowledge offers many opportunities for the co-creation of business value. Furthermore, the absorptive capacity of the firm can be made scalable with IT such that it offers greater opportunities for knowledge availability, sharing, and assimilation.

There are direct network effects within the group of data providers. The simple question is: How do existing data providers benefit from data providers that recently joined the INFOaaS platform? For instance, how will ESA benefit if WHO Research joins the platform? The answer is an improved quality of research realized in a data provider community. Data providers are primarily willing to adopt the platform as the community cloud enables them to follow a strategy of inter-organizational research. For instance, research in the life science domain (EMBL) and certainly in several areas of science has come to a complexity where individual institutes and individual labs are very much challenged by the complexity to drive new insights and news and to generate new knowledge. Many areas require aggregation of information and data from very different sources, which is something that cannot be done by a single company or organization. Thus, each new data provider further enables this vision.

Indirect network effects between the group of data users and the group of experts (data and report customization) will leverage platform adoption. The more experts, the more tailored services will be offered, which in return, attracts more data users as they will receive more industry-specific data and reports. On the other hand, the more data users are customers of the HN platform, the more (a) data and report customization will open up new business opportunities (value-adding downstream usage of the platform's generic data) and (b) the experts will better understand the industry knowledge problems and, therefore, identify new research questions and missing research instrumentation to gather the missing knowledge.

Indirect network effects between the group of data providers and the group of experts (data and report customization) will leverage platform adoption. The more experts adopt INFOaaS, the more detailed data and research requests will providers receive, the more likely will they be to fill in the data base gaps. Research organizations need this to know what to research.

Indirect network effects between the group of data providers and the group of data users are to be leveraged. More data users will yield in more detailed research questions

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for the data providers. Further, the data providers will get an enhanced system insight, meaning they have a better picture of what their data is used for.

Figure 16 summarizes those findings and provides a list of network effects to be leveraged once INFOaaS is started.

Continuously demonstrate the value that users achieve by showing off the value that is provided by the data sets or data service as publicly as possible to ensure that the message is passed on to others. Photos, leads, connections, friends, "likes" or any other statistic represent a feasible way to encourages others to join in and to trigger competitiveness amongst some users, further increasing the rate of adoption. Google, for example, in its early days frequently published its URL index, e.g. in 2000 they announced the first billion-URL index and claimed being the world's largest search engine. In 2002, the American Dialect Society members voted "google" the "most useful" Word of the Year for 2002.

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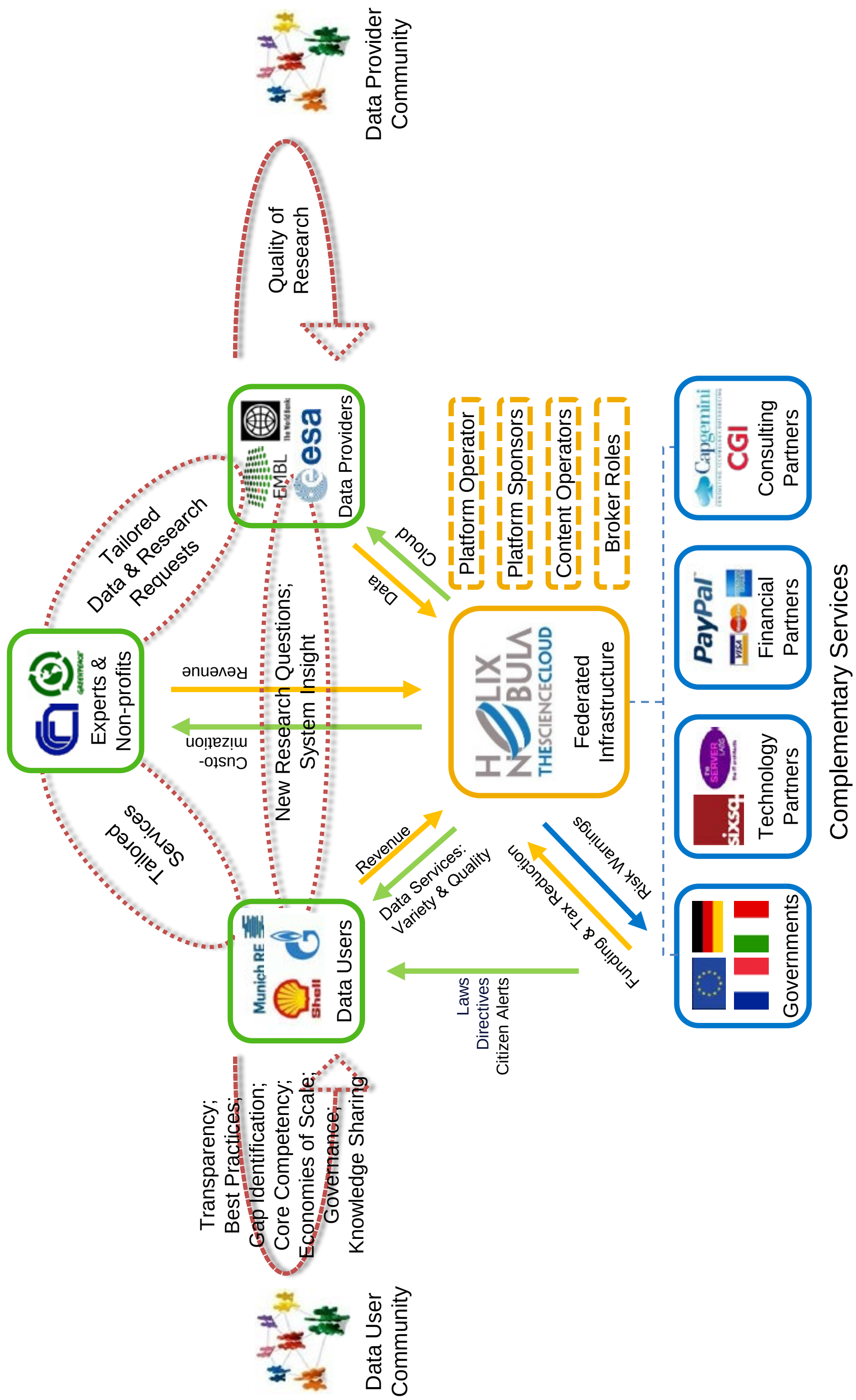

Figure 16 Drivers of Network Effects between Same-Sided and Cross-Sided Users

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4.2.4 Competition – Extend Business Scope

Extend business scope sequentially by leveraging the user base as an asset to expand into adjacent markets! Remember to never drop below critical mass! Amazon expanded away from an online bookstore towards an online retailer of books, movies, music and games etc. eventually, moving to the cloud business with AWS.

Complementation and *knowledge sharing* are ideally enabled by measures that improve the **flexibility and co-learning** to cope with changing, loosely coupled partners (e.g. Gosain et al. 2004; Jacobides 2005; Ozcan and Eisenhardt 2009). Therefore, the focal firm should avoid relying on fixed structures, partner roles, or relationships in which case it would interfere the process of "[…] learning by bringing together a diversity of partners with different capabilities and experiences" (Williamson and De Meyer 2012, p. 40).The orchestrator should proactively link unconnected partners from distant parts of the ecosystem (Ozcan and Eisenhardt 2009).

Start to innovate! Competitors like Facebook, AWS, Nielsen, or Google will follow fast. When any given company becomes successful and begins to grow, competition emerges and the strategy to launch a business is often different from the strategy to maintain a business within a growing competitive environment. So, the challenge of competitiveness, understanding the competition, and continuing to differentiate is critical. The differentiation as part of INFOaaS becomes more mature and more common, not only its prices commoditize because others are offering similar things; but HN needs to create new innovation to provide profitable products, not only to differentiate from competitors, but to compensate for the commoditization of some of the services HN provided initially. HN needs a process of continuous change and improvement. As INFOaaS matures, participants' demands grow. Thus, innovation is needed to simply keep existing customers committed while also winning over new customers.

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4.3 Deal Breakers – Tackling Inherent Risks

This BM presents risks of being the **first mover**. Providing data sets and knowledge on this scale are a much discussed issue, no one ever tried to start commercialising it. Intelligence agencies, e.g. the American National Security Agency with its "PRISM" project, have technological experience, but as they are funded with tax money, there are no actual BMs.

It is also problematic that the **final commitment** of ESA, CERN, and EMBL to make their data available to be aggregated and sold is still missing. As the realisation of this BM takes long and can only be started when such a commitment is legally confirmed, the leader's opportunity decreases day by day. E.g., if AWS works on similar plans and is ready to market sooner, first mover advantages are lower or even obsolete.

The most crucial point in the adoption of this BM is **data security** (Miller 2013). As the success of this BM depends on the willingness of data providers to host their data on the HN infrastructure; those two most critical factors of non-adoption need to be dispelled. E.g., as cloud computing is an internet technology, inaccessibility to the cloud is a frequent fear.

SAP identified numerous challenges in platform ecosystems pertaining to six basic concepts. They are presented in the order of their count beginning with the least mentioned concept of **network stability**. The knowledge base describes architectural, economic, and service-related factors that endanger the long-term viability of an ecosystem. First, its loose architecture might not solely bring about fast adaption and agility, but also erosion in the forms of isolation, migration to competing networks, creation of cliques, and attrition (Dhanaraj and Parkhe 2006). Second, if partners struggle with economic problems like insolvency, supply bottlenecks, or supply shortages, they might affect the ecosystem's viability or competitive advantage (Singh and Mitchell 1996). Third, if each service critical role in an ecosystem is not assigned, the performance of the entire ecosystem can be undermined (Iansiti and Levien 2004b). A helpful instrument to reach better network stability is a strict partner certification program. With the accelerating adoption of cloud computing and INFOaaS around the world, customers are increasingly seeking ways to identify individuals with demonstrated knowledge of HN best practices. A HN certification program would recognize IT professionals that possess the skills and technical knowledge necessary for designing, deploying and managing applications and data on the HN platform. Earning certification helps them gain visibility and credibility for their proven experience working with HN, as well as contribute to the proficiency of their organization with HN-based applications. The advantage for HN is that a strict filter ensures that only partners

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that truly commit and adapt to the platform are inbound. Moreover, their economic health can be checked.

Ecosystems are not based on altruism but rather on *coopetition*, a neologism and portmanteau of cooperation and competition "[…] meaning that firms not only either collaborate or compete with certain stakeholders, but they often do both simultaneously" (Ritala 2012, p. 307). This can lead to a clash of interest resulting in **power and politics**-enabling conditions encompassing hub firm domination, political behaviour, and status differences between the partners (Sarker et al. 2012). If the hub firm's natural and powerful position coined as "keystone advantage" (Iansiti and Levien 2004b, p. 6) is used to (a) inequitably split revenues, (b) take over the ecosystem, or (c) drain value from it, an implosion and market losses will result. Further, delaying tactics, hold-up behaviour, and preferences for certain partners with different status will challenge the ability to cater to customer needs (Sarker et al. 2012). A solution to this problem may be the merge of the participants' BMs. For example, some of the hub IaaS providers want to be able to offer a service that is low cost, while a large consulting company (e.g., Accenture) needs to be able to offer a service that is guaranteed because what their customers ask them to do is guarantee the outcome of the delivery of work that they do within the defined scope of a project. If the consulting or technology partner cannot get a guarantee from that public cloud provider, then they cannot use their service. Therefore, strategic alignment and partner certification that filters unfitting partners is required (cf. next section).

A challenge that goes beyond the tactical behaviour of *power and politics* is **opportunistic behaviour**. It aims to systematically exploit unintended knowledge leakages of partners, respectively the hub firm and use it to replicate products or services in order to offer it competitively and to ultimately improve the own competitive position (e.g. Ceccagnoli et al. 2012, Han et al. 2012; Lavie 2006). On the one hand, there is the possibility that all or most companies in the ecosystem act opportunistically, in which case they engage in what Lavie (2006) describes as a *learning race*. On the other hand, only one partner or a minority of partners can hold such objectives of exploiting partner's core assets, which can be referred to as *Trojan Horses* (Hennart et al. 1999). In both cases, the joint value creation is affected significantly. Opportunistic behaviour is a risk that clearly needs to be tackled by the governance structure (cf. 4.2.2). Both a structured literature review on business partner ecosystems and our empirical data convey in quantity (most mentioned concept) and quality (clear, enthusiastic statements) that the number one top enabler for value co-

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creation was governance. An effective governance defines a control structure with "[…] enforcement mechanisms that can counter the threat of opportunism inherent in an alliance and safeguard partners' interests […] [by focusing] on the maintenance of order within the relationships" (Sarker et al. 2012, p. 320). There are two categories of instruments to limit the leakage and opportunistic exploitation of proprietary knowledge. Ideally, self-reinforcing, *informal* mechanisms of co-evolving trust, goodwill, and commitment are the foundation of the cooperation (Sarker et al. 2012). The reality demands *formal* and more warily isolation mechanisms, such as patents, trademarks, or contracts to protect strategic resources (Lavie 2006). Ecosystem governance assumes even greater significance when the value co-creation potentially involves thousands of partners. APN, the role model of cloud computing ecosystems, had 665 technology partners (Amazon Web Services 2013b) and 878 consulting partners (Amazon Web Services 2013c) at the time of analyses. Co-creation with such a high number of firms in a *loosely coupled* cooperative arrangement requires a stabilizing structure to be defined by the orchestrator (Dhanaraj and Parkhe 2006). In a fundamental contribution, loose coupling is defined as "[…] a situation in which coupled elements are responsive, but retain evidence of separateness and identity" (Weick 1976, p.3). Good governance ensures documentable, accountable, and calculable distribution of revenue streams amongst all partners involved in a deal.

The concept of **ecosystem orchestration** does not only belong to the most frequently mentioned challenges, but some researchers also put it into the centre of their research as single concept (e.g. Gray et al. 2013; Williamson and De Meyer 2012; Venkatraman and Chi-Hyon Lee 2004). This concept encompasses the challenges of maintaining and increasing the ecosystem stability (Dhanaraj and Parkhe 2006), mitigating the tensions caused by coopetition, and simultaneously focusing on both "[…] the macro logic of network structure […] and the micro logic of network processes […]" (Venkatraman and Chi-Hyon Lee 2004, p. 890). Further, managing the strategy, architecture, partner incentives, governance, co-learning, value co-creation and capture, and common processes can become complex. The removal of the hub firm will in many cases result in a collapse of the ecosystem (Iansiti and Levien 2004b). This responsibility clearly lies in the hands of the four IaaS providers. Through their *infrastructure pooling*, the scale and complexity of the HN platform reaches far beyond what a single company can provide on its own. Be it complementary or supplementary resource alignment, both bring along the challenge of orchestrating the various offerings by forming and dissolving multiple types of relationships. Dhanaraj and Parkhe (2006, p 659) define ecosystem orchestration intuitively accessible "[…] as the set of

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deliberate, purposeful actions undertaken by the hub firm as it seeks to create value (expand the pie) and extract value (gain a larger slice of the pie) from the network." In literature, there is a rich amount of terminologies describing hub firms, such as integrators, aggregators, keystones, platform owners, key actors, triggering entities, strategic centres, or flagship firms. The competency of focal orchestration is as required as challenging because it needs to balance the tension between simultaneous cooperation and competition across different types of resources over time (Venkatraman and Chi-Hyon Lee 2004). Beyond that effect of coopetition (Ritala 2012), Dhanaraj and Parkhe (2006) propose a framework that captures the dimensions of orchestrating ecosystems. First, the platform owners need to *design* the macro logic of network structure by recruiting and aligning further partners (membership, structure, and market position). The macro logic asks how a portfolio of relationships is structured for resource access as a whole. Second, they need to *manage* the micro logic of network processes required to operationally co-create value (knowledge mobility, innovation appropriability, and network stability). The micro logic considers the selection, cultivation, and dissolution of individual relationships. Managers require the competency to simultaneously focus on both dimensions (Dhanaraj and Parkhe 2006). To abstract even more, the macro and micro logic is observed and expressed by top management in various industries as to both "see with a microscope and a telescope" (Barton et al. 2012)

Participation in an ecosystem can inheres the challenge of **interdependencies** between the hub firm and non-orchestrators. Even though the architecture of an ecosystem has been rather loosely coupled than stipulated for years, a common value co-creation still requires (a) the partners' adaptation to multiple hub firm's platforms and process or technology standard variations as imposed by the hub firm and (b) passing through quality assurance processes to officially attain partner status (Markus and Loebbecke 2013). Both requirements lead to adaptation costs that can cause situations of lock-in, lock-out, and/or a loss of strategic control and autonomy especially for partners as their financial scope is reduced (e.g. Alexy et al. 2013; Gosain et al. 2004; Markus and Loebbecke 2013). Interdependencies also exist due to exogenous factors in supply chains, such as mobility infrastructure or weather problems. In our opinion, interdependencies are a necessary risk in such a synergistic mode of value co-creation in an ecosystem. In this mode, the partners have to (1) work together with each other, in a mutually reinforcing on another, (2) surrender some of their own autonomy, (3) have trust in the other to do what is in the interest of both sides of the relationship, and (4) invest in the relationship rather than just

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look to gain out of it (Sarker et al. 2012). There is often a recursive element to the value addition process, which can result in significantly higher levels of value being synergistically co-created in comparison to models in which no autonomy is given up, such as exchange or platform addition.

The hub firm faces increasing costs due to the **complexity** of orchestrating its growing network of hundreds or even thousands of partners (e.g. Alexy et al. 2013; Lavie 2006; Pagani 2013). At the time of analysis e.g., APN had 665 technical partners (Amazon Web Services 2013b) and 878 consulting partners (Amazon Web Services 2013c). Further, it is possible that homogeneous market incumbents build an ecosystem around them as a pooling alliance, meaning that the ecosystem has more than one hub firm. In this case the complexity is even enhanced as can be seen in the case study. In both cases, broker tasks such as integration, orchestration, aggregation, a common up- and cross-selling, financials, and law-related tasks raise what literature refers to as *transactions costs* encompassing search and information costs, bargaining costs, policing and enforcement costs (Dahlman 1979). Both the complexity of ecosystems as explained above (cf. chapter 3.1.1.) and a cost efficient value delivery requires a structure of architectural roles (e.g. Dhanaraj and Parkhe 2006; Iansiti and Levien 2004b; Ozcan and Eisenhardt 2009). Thus, we see it as instrumental to define a partner structure during the adoption phase (cf. chapter 4.2.4).

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5 Conclusion

The document explains that INFOaaS is subject to network effects as its value increases for each user, as the number of users grows. The more data providers share data, the more complete the services will become. INFOaaS is a multisided platform ecosystem. This kind of ecosystems faces the lifecycle challenge of (1) fast implementation, (2) adoption, (3) scaling, and (4) competition. Those steps were applied to INFOaaS in order to provide a roadmap for lifecycle management. In summary, we presented the following steps.

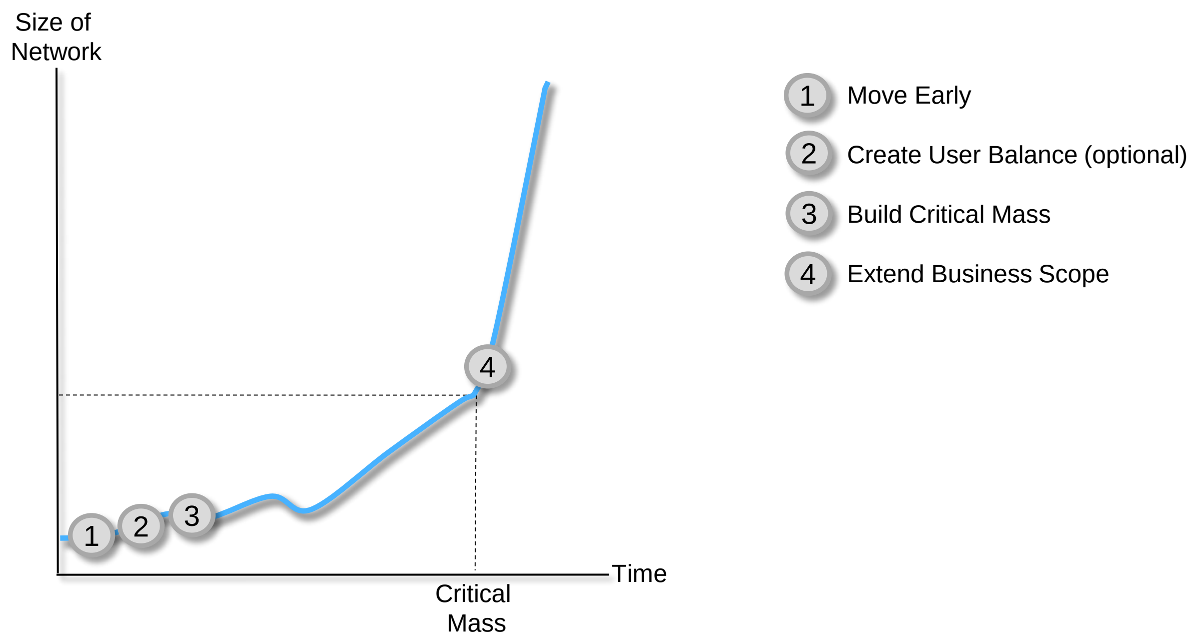

Figure 17 *Strategic Steps towards Market Tipping*

1. Implementation

Starting the implementation with a niche by selecting a specific target market and trying to dominate it was described to be the very first step. DORIS seems to be a potential starting point for INFOaaS to SAP and ESA.

- Do an added value analysis (pooling or complementation)!
- Start with a niche!
- Be the initial occupant to exploit leader advantages!
- Establish a vivid community prior to launch the HNX marketplace!

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- Scale and optimize the data sets or data services on the fly!
- Define architectural roles to simplify the partner portfolio!

2. Adoption

Whenever a platform ecosystem like an AWS or HN is started, it runs into a life cycle challenge broken up into stages. When started after the implementation, members are required to join and need to be informed that this is a brand new service. So they will increase scrutiny, much more risk checking to adopt a new service. In the first phase, awareness and adoption by the first few thousand customers will be a critical component of success, and therefore a challenge.

- Extend the existing governance model!
- Provide high quality contents!
- Attract marquee data users and/or providers!
- Articulate whitespaces and explain how you intend to close them on a roadmap!
- Signal long-term commitment to the platform!
- Subsidize initial adoption of early adopters with price reductions, discounts or other give-aways!

3. Scaling

As the environment starts to mature, demand based on volumes, usage, and on new requirements will grow. So the challenge becomes scaling.

- Incentivize more partners with business opportunities and value proposition!
- Create a critical mass sequentially!
- Ensure compatibility with leading standard!
- Actively manage expectations to achieve critical mass by influencing user expectations!
- Facilitate switch!
- Foster exchange between same-sided and cross-sided users and identify common themes of interest!
- Continuously demonstrate the value that users achieve!

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4. Competing

As the platform becomes more common, as for Amazon Web Services today, both competition and innovation have to be addressed, which can prove challenging.

- Extend business scope sequentially by leveraging the user base as an asset to expand into adjacent markets! A community is expected to have enough momentum to become self-sustaining at about 15% from the target community opting in, whereby critical mass is linked to consumer's expectations regarding the performance of a product or service and the expected final size of the network (Mahler and Rogers 1999).
- Remain innovative through complementation and knowledge sharing, which are ideally enabled by measures that improve the flexibility and co-learning!

The life cycle management of those four phases and putting a strategy in place to be prepared is key. The investment to create a highly scalable, trustable, and proven infrastructure will also be critical. If the system environment fails just once, they can lose confidence.

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