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Versie 1.0

Status Final

documenteigenaar
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datum
21 augustus 2014

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Executive Summary

A Data Center is a facility which houses IT equipment; including the necessary floor space, energy, cooling, security, network connections, etc., which are necessary to run systems that support departments in a reliable and secure way (housing). The opportunities Cloud offers require a reassessment of our current Data Center. Certain (standardized) services are suitable for a complete transition to the cloud, which means there is no need for an investment in a data center (housing) for that particular service. Other services are more unique and do not allow sourcing from the cloud, which leads to the question how we can best support those services with an underlying infrastructure. A clear answer to the question of the size, location and specifications of our Data Center should thus align with the services that will use the Data Center.

UvA/HvA envision a Hybrid Data Center, which consists of a rented/on premise data center, a community cloud and a public cloud. Services that do not differentiate UvA/HvA, can be delivered in standardized form and where physical location does not play a role will be moved to one of the clouds. This primarily involves services that support administrative (secondary) processes. This allows ICTS to increasing focus on supporting primary processes such as education and research. Services that allow differentiation require more specialized attention, to support Amsterdam's ambition to become the IT capital of the Netherlands. Facilities/services should be easily accessible and should be perceived as a commodity. This services usually will find a solution in either one of the clouds. Additionally we can find criteria where a commodity will not suffice:

- Differentiation of UvA/HvA
- Achieving maximum control over the service
- Dependency of geographical location

IT is possible that these services have such specific requirements that they have to be supported by a rented Data Center (Housing as a Service at Vancis) or through an on premise data center.

This data center vision provides a methodology which allows designing and sourcing of the data center through various relevant criteria. It is important to involve the system owners when establishing functional requirements and wishes. The system owner will take the decisions with the regards to the data center and its sourcing in collaboration with sourcing management, architecture and security.

This change has an impact on the operations department, which will see a transition from traditional maintenance/servicing to controlling services (sourcing competencies). This requires specialized support for education and research and will require investment to attain the right skillset. The management of services in the hybrid data center will also require more attention. For more detail about this, we refer to SURF's *From Service to Sourcing Management,* which will be published shortly.

We advise to establish a roadmap for the implementation of the data center vision. The guidelines for a successful implementation should be at the top of this roadmap. Additionally the methodology from this document should be used to collaboratively establish the most suitable data center solution for each of the core functions/services. The framework for this exercise can be found in chapter 6.

1 Introduction

A Data Center is a facility which houses IT equipment; including the necessary floor space, energy, cooling, security, network connections, etc., which are necessary to run systems that support departments in a reliable and secure way (housing). The introduction of the Cloud decrease the need for an on premise data center. The services that can be sourced from the cloud can range from hosted servers, to platforms or complete services. In addition to the cloud, we have the option of using an external data center. This concept involves renting physical equipment and infrastructure through a third party. The maintenance is still managed by the institutions.

The organizations of UvA/HvA have been working on merging their IT Departments to function as one shared service for both institutions. This process requires the assessment of individual services and their predicted development in the future.

The highest priority from a service delivery standpoint is that our basic services remain in order. Weaknesses will be actioned through investments and areas of sufficient quality will be thoroughly secured. Cost efficiency is of utmost importance with service delivery that:

1. Delivers stable, generic basic services to the largest group of students/employees possible,
2. Provides room for specific services for limited usage in educational/research environments.

Currently the data center solutions of UvA/HvA differ. However the future perspective of one single service portfolio for both institutions requires the data center to deliver integrated services to clients in both organizations. This document has been compiled to support that change using one common vision. This document supports:

1. The goals set out in UvA/HvA's document 'One IT organisatie for UvA and HvA'.
2. Taking funded (investment) decisions related to the data center and its sourcing.

This vision document is structured in:

- Chapter 3: Influences that apply to the design of a data center.
- Chapter 4:The role of the Data Center in central facilities.
- Chapter 5&6: a description of the methodology and its application to take decisions for the correct data center solution per service.
- Chapter 7: guidelines, requirements and next steps that apply upon approval of this vision.

2 Influences

In which way and form should UvA/HvA invest in an on premise data center? Which services will be sourced from the cloud and which ones will be kept in house? Which service will be moved to an outhoused data center? To answer these questions we need to understand which influences we should consider. These influences include:

1. The position and responsibility UvA/HvA want to take in Amsterdam as a knowledge institute.
2. The nationals and regional ambitions in information and communication technology.
3. The developments in privacy and data ownership
4. The changed focus of ICTS to Education & Research, related to the standardization of supporting processes.

Position and Social Responsibility of UvA/HvA

The Amsterdam region is regarded as the IT capital of the Netherlands. Many global IT companies are housed in Amsterdam, partially due to the good connections through Amsterdam Internet Exchange (AMS-IX). AMS_IX is the most important internet hub in the Netherlands and the second biggest hub worldwide. This is being leveraged by the government and municipality.

Amsterdam and its 'Digital City' managed to attract a large number of organizations to the city in the pioneering ages of the internet and IT. Apart from scientific organizations like CWI, AMOLF and NIKHEF, the area has the SURFsara computing center and the Dutch e-Science Center. Other European/internet organizations based in the area are the European Grid Initiative, Terena, RIPE and NLnetLabs. Amsterdam emphasizes that it, much like Rotterdam's seaport, has the largest digital port. It is the ambition to position the area as the IT capital of the country.

UvA/HvA supports this ambition by delivering cutting edge education and research in IT. Several groups are global leaders with regards to developing and applying IT and Future Internet, as well as advanced applications for science and society. The UvA/HvA supports these initiatives of the government and municipality on multiple levels. The dynamic environment of IT research and education requires a suitable, flexible and advanced infrastructure: physical infrastructure, high capacity networks, data, computing, etc. and Human Resources. It is a question which investments should be done by UvA/HvA, which ones in a collaborative environment, and which ones will be sourced from the commercial sector.

Innovating IT is crucial to educational and research processes, which makes it an ideal theme for UvA/HvA to differentiate from other institutions. Especially by leveraging synergies in the surrounding area. The UvA/HvA has the goal to use ICTS to play a major role in this synergy, by delivering and adopting innovations for the surrounding organisations.

As an important research and educational orgnization, UvA/HvA have everything that is necessary to add value to the region's goals, by leveraging collaborations with other organizations and by ICTS supporting various national and European collaborations.

National and Regional Developments

The national agenda is dictated by the 'Top Sector Policy'. This policy is aimed at achieving a leading role on a European and global level. The Roadmap IT for Top Sectors is a foundation for full utilization of the opportunities of collaboration between public/private sectors and provides an image of the necessity of IT innovation and research now and in the future. It also clarifies that most Top Sectors will have a strong focus on IT innovation.

The real added value of the roadmap is the clarification of actions that are necessary for the effective use of IT in Top Sectors, such as trusting IT, the innovative role in manufacturing-/business processes, standardization, open data, smart exchange of large amounts of data, process innovation/reduction of administrative costs and investing in skills. These actions align to the government's Digitale Implementatie Agenda.nl.

IT allows efficient and effective execution of economic/social processes. In the past years the disruptive effect of IT has also become clear. An example is broadband connections that allowed outsourcing of services. Business models for the music industry have transformed to cloud-type services like iTunes.

NWO is responsible for executing on the Roadmap ICT for Top Sectors, which involves an investment of 30 Mio. in the upcoming years. This requires realignment of priorities within NWO. UvA can add value to these initiatives, whilst making the investment worthwhile for the organization. UvA/HvA should invest in the data center and sourcing (and the public/private collaboration) in such a way that it supports the IT goals of Top Sectors.

Uitwerking in de stad
The Amsterdam Economic Board (short: Board) stimulates innovation and collaboration between companies, knowledge institutes and the government. The aim is to achieve sustainable (green) economic growth in the Amsterdam region. This achieved through:

- Bringing companies, knowledge institutes and government together
- Trialling smart, innovative applications

The cluster ICT/e-Science functions as a meeting point for IT companies, knowledge institutes and governments, with the goal of strengthening the position of the sector in the region. This cluster develops innovative projects which primarily focus on open data, e-health and energy.

IT is part of every domain of daily life: from healthcare to safety, from education to arts. IT plays a vital role in the Amsterdam area. The strength of this area does not come from technology, but rather lies in the cross-overs between IT and other clusters. The IT cluster supports a sustainable society in 4 ways:

1. *Green IT*
   The IT sector uses more energy due to increased demand. There is an intense collaboration between multiple organizations to support Green IT. The Board works with the semi-public GreenIT consortium and the government to stimulate innovation and the execution of plans.
2. *IT as a part of the Energy System*
   The program Amsterdam Smart City uses IT to deliver alternative solutions to generate electricity and use electricity ad effectively as possible. Smart Grids play an important role.
3. *Increased process efficiecy through IT*
   Focuses on factories, supply chains and mobility. The Board has sustainability as a goal in both the open data program, and other programs.
4. *IT allows disruptive innovation*
   Disruptive innovation creates new markets and disrupts established markets and business models; examples are 3D printing, urban farming, quantified self and community based banking. The Board develops these elements in collaboration with other clusters.

By actively participating in the Board's priorities, ICTS can strengthen the collaboration between companies, knowledge institutes and government. ICTS can also support testing of new/smart technology that builds the green economic growth of the region. Investments in the Data Center should support these goals and should facilitate testing new applications by students and researchers.

Developments in Privacy and Data Ownership
Privacy and security is a question that is asked often with regards to cloud solutions. It is our responsibility to ensure the security of our data. This makes documenting data ownership and security an important contractual agreement in outsourcing projects. Cloud computing requires clear management of risks involved with integrity, security and availability of data. We refer to UvA/HvA's information security plan and SURFs legal norms framework to ensure required standards are met. It is important to establish a data classification model for information, which links to appropriate actions.

Changed Focus of ICTS
In recent years UvA/HvA and ICTS have invested in Basic IT Services, Concern Systems and Educational Logistical Systems, to effectively support Education and Research, management and administration. These are starting to prove their added value to UvA/HvA, with services maturing gradually. Innovation is implementing by leveraging new opportunities through the regular life cycle of the services in question. Investments in these technologies by domains are becoming less necessary, as there is an increased use of market ready solutions. As more technology

becomes available, ICTS will increasingly focus on the use of IT in Education and Research and management of Data. There is a need for control over data, whilst services are easily accessible and perceived as a commodity.

Management of scientific data is a new theme for the upcoming years. Data has to be stored and used in an effective way for multiple years. Edcuational processes and their content will experience big changes as online classes is becoming a global trend. This only adds to developments in social media and cloud. All these developments require constant strategic decision making for the use and development of IT.

A future proof data center vision is needed to invest effectively. The vision is needed to take the right decisions for IT services, to use commercial facilities, to use and leverage shared facilities or to build our own facilities. The current data center model requires modernization and will increasingly get a hybrid design.

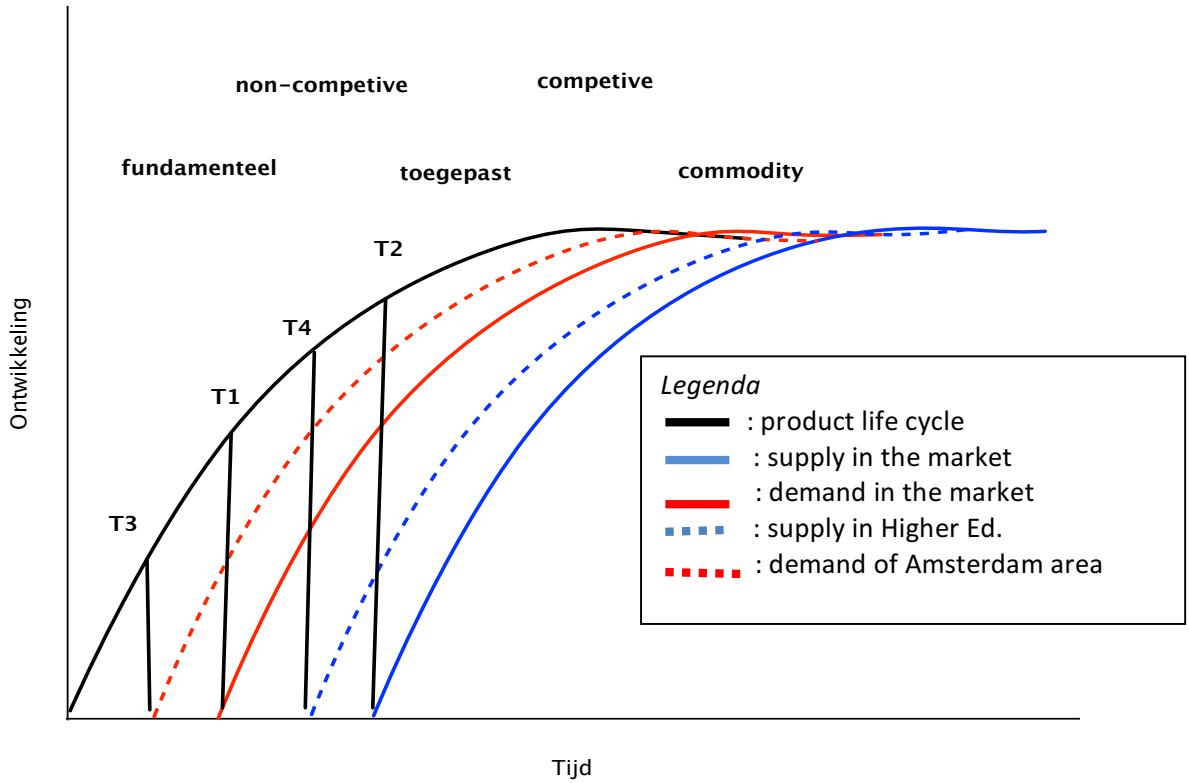
The next chapter describes how such a hybrid data center aligns with UvA/HvA's position in national and regional developments.

3 The Role of the Data Center as a Central Service

As mentioned UvA/HvA aim to deliver world class Education and Research which ICTS should facilitate with suitable IT solutions. UvA/HvA's ambition is to leverage this as an opportunity to improve its competitive position. This chapter describes what this ambition means to the investments in ICTS and the data center.

The position of UvA/HvA in the Market

Based on WTR's vision from trend reports of 2008 and 2012 and the Cook Report of 2010, which clarify the vision of IT usage in scientific organizations, we established that the IT product cycle is as follows:



The black line visualizes the development of a product/service in time, which leads from trigger to commodity. This line is relatively generic and can be recognized in the development of email and data networks. The blue line visualizes commercial supply in the market. Vendors will only develop product when the demand (visualized by the

red line) is high enough and the product/service is standardized enough (T2). Supply will mature when demand stabilizes and the product/service is fully standardized, the business model will move into operational excellence. Every product/service moves through this model at its own pace. The dotted lines visualize the Higher ed. marker. The red dotted line is placed on the left side of the red line. This means that universities encounter demand/question articulation before other industries. This demand articulation originates from R&D in Top Sectors, governments looking for solutions to social issues and internally from the university itself. Universities have the unique position to fill this demand through its specialized knowledge and facilities. It is due to this that we regularly see the university to be the first to develop a solution for a product/service that is at the beginning of a life cycle.

The supply/offerings of the scientific organization of the university (T4) creates the differentiated value of UvA/HvA in the market space. To support this, ICTS should directly focus on the generation of supply/offerings by the scientific organization (red dotted line in the graph). An effective collaboration between the scientific organization and ICTS will create the differentiated position in the market. This applies to new products and a differentiated position to commercial organizations in particular, as UvA/HvA's unique scientific knowledge supports an area in the market where commercial organizations do not have a fitting IT portfolio.

Data Center Investments

The question UvA/HvA should ask is where and when the data center will deliver added value, and at which point the market will take over. The previous paragraph explains that the added value of the university is limited to the market where a product/service is moving towards commodity. We concluded that this forces UvA/HvA to implement its own data center which supports Education and Research. The accent should lean towards specialized support for Education and Research, as opposed to the widely available standardized administrative solutions. Since scientific applications have specific requirements that are readily available on the market, ICTS can maintain its added value and competitive position in the market. ICTS can achieve this by delivering services and specialized knowledge that allow scientific knowledge to develop products, which ensures UvA/HvA can excel in delivering world class education and research. ICTS will act as a system integrator and orchestrator for Basic Services (commodity) sourced through cloud solutions

Through the developments in technology, our ambition and the position of UvA/HvA described here, it is clear that future proof data center will take a hybrid shape.

- Part of the data center uses commercially available facilities. UvA/HvA leverages investments that the market has already made.
- Part of the data center will consist of an industry collaboration in which Higher Ed. institutions source and operate one common solution. This applies to IT services that is developed specifically for Higher Ed. purposes.
- Part of the data center will operate as a specific solution for UvA/HvA. This is supported by various arguments, such as the specialized support which is described in the previous paragraphs. Which allow further differentiation and positioning of UvA/HvA as a scientific institution. Additionally the level of control UvA/HvA aims to have over a service and its geographical location are a factor in the decision whether a service requires an on premise data center. A limited amount of cases will include these arguments as a dominant factor, justifying the case for an on premise data center.

All IT services have a life cycle. Support that is delivered for products that are not readily available on the market, could in time be copied by other organizations, which in turn cancels the uniqueness of the service in general (services become a commodity). As services are constantly being developed, it is impossible to define one restricted way of usage. The methodology (Chapter 5) in this document supports data center decisions for services that require replacement of updates.

Creating an optimal mix and a mechanism to effectively re-evaluate that mix over time, ensures UvA/HvA will have and keep an adequate data center. UvA/HvA maximizes the use of facilities in a consistent and transparent manner. It is necessary to make clear decisions that balance required functionality with cost. This aligns with the ambitions set out by ICTS, which includes optimal support of Education and Research and greater accessibility of IT infrastructure.

Institution Specific Support

Which insitution specific support can we consider, which is internally managed and could justify an on premise data center? Delivering tooling to analyze large quantities of data, which supports world class research, is one of those examples. Other examples include software for visualization or simulation. Delivering this support requires the right knowledge, which could be sourced through training or recruitment.

As stated before, improving the accessibility of our IT infrastructure is one of the ambitions. This follows an increased demand for complex facilities that do now require detailed technical knowledge. The current GRID-infrastructuur for example proves to be inaccessible for researchers.

We also see a trend in which hardware becomes cheaper, faster and is renewed quicker. This means more time is needed to adapt research software to fit this new hardware, to allow optimal use of capabilities. Due to this, platform independence/flexibility is becoming a more important theme. Generic services often fit this profile through readily available cloud services. This however does not apply to specialized services. Capabilities that enhance accessibility (tooling) could initially be specific for UvA/HvA and enhance the position of Education and Research.

Investments in Human Capital

The transition to specialized support of Education and Research, and the effects on the compilation of a Hybrid Data Center, affects the ICTS department. Despite its continued focus on Basic Services, we expect a transition from employees that know Basic Service to those with knowledge of specialized solutions, such as visualization tools or techniques that support educational/research processes. This transition should be achieved through training and recruitment. Additionally UvA/HvA will reserve time for trendwatching and attending conferences, to ensure UvA/HvA's continued front line position in IT. Also UvA/HvA will have to construct a solid internal knowledge foundation to support specialized solutions, since there are very little external providers that can deliver support. This also requires close collaboration with IT experts of faculties, domains, other institutions and organizations that operate in the same niche market.

Sourcing services and managing internal/external providers requires a very different set of skills and knowledge than developing/servicing systems. This requires the implementation of structured processes, roles and organizations. One of the requirements to do this effectively is splitting demand and supply, aided by a strong control function. Demand management, architecture and governance will find its place in this model. SURF is currently completing a White Paper that describes this change.

The bottom line is that demand should be aligned with required functionality, which is supported by a separate demand/control department. This department translates a functional question from the organization to specific requirements that supply can use to source the required solution.

The next chapter describes the methodology UvA/HvA will use to design the new hybrid data center.

4 Methodology hybrid data center

The previous chapter described 3 Data Center component:

- Commercial component, with market sourced solutions managed by a third party
- Community component, which includes facilities that are owned and managed by a community of Higher Ed. institutions
- University component, which includes facilities that are owned and managed by UvA/HvA

This chapter describes the methodology we developed to determine with service is the best fit for these three components. The summary above has been elaborated on with possible specifications in the next paragraph.

Data Center Types

The following overview provides four data center types. The rows clarifies the various sourcing options within the data center type.

Data center type	Commercial Component	Community component	University Component
IT Service			
Application	Market solutions from public or community cloud: Software as a Service (SaaS)	Delivered by a community vendor or group of institutions: Software as a Service (SaaS)	In house delivery
Platform	Market solutions from public or community cloud: Platform as a Service (PaaS)	Delivered by a community vendor or group of institutions: Platform as a Service (PaaS)	In house delivery
Infrastructure	Market solutions from public or community cloud: Infrastructure as a Service (IaaS)	Delivered by a community vendor or group of institutions: Infrastructure as a Service (IaaS)	In house delivery
Housing	Market solutions: Housing as a Service (Hous-aaS)	Delivered by a community vendor: Housing as a Service (Hous-aaS)	On premise data center

Table 1 Data Center Types

Sourcing choices using various data center types can be compiled from this table to deliver a service. An application could f.e. be sourced as a SaaS solution from a public cloud, which eradicates the need of underlying types. Another option could be to deliver an application in house, which uses a PaaS platform from a public cloud. This ensures we do not need to manage further underlying types. In extreme examples UvA/HvA could even deliver on premise housing where the overarching types are managed by a third party.

Other services like infrastructure, platforms and application solutions could be delivered as a service in the name of a community of institutions. In that case the responsibility for that services lies with a non-commercial entity that acts on behalf of the Education and Research community (SURF), or with a (combination of) institutions. SURFdrive is an example of a service that is sourced by institutions from a non-commercial entity.

Going along these lines produces a large amount of combined options that find their place in the hybrid data center. In order to establish the correct mix for each service UvA/HvA can leverage the methodology in this document.

Criteria

Apart from the generic clustering in the previous paragraph (aligned with business functions), we will use criteria to further assess which data center type is most suitable for a particular service. This paragraph describes which criteria we can use to find the right combination of sourcing options and data center types. These criteria are described in the Higher Education Reference Architecture (HORA) (SURF, HORA (vs1.0; 2013).

The HORA distinguishes three types of criteria one should consider when choosing sourcing and data center types (public, community, on premise):

1. *Service Criteria*
   Criteria that provide a first indication of the most suitable data center type, based on the characteristics of the service, regardless of a possible solution/vendor. Examples are level of one time investments and commoditization of service.

2. *Product Criteria*
   Criteria that can be used to select a specific product from a vendor, which fills the need for an IT solution. Examples are requirements for security, interfaces, legal and exit strategies. These are operational criteria which should be checked for every product that might be sourced. These criteria are included in the appendix of this document.

3. *Critical Success Factors*
   Factors that increase the chance or are necessary to ensure successful outsourcing. This includes a control organization and information security. The criteria have been included in the appendix.

Using these criteria will clarify how we can effectively implement cloud solutions. Service criteria can be used in strategy/planning phases, such as compiling the data center- and sourcing strategy. Since this document aims at defining a data center strategy, we will only include the assessment of services using the service criteria. The other criteria relate to tactical/operational levels making them less relevant at this stage. They will however be included to test sourcing decisions. Success factors will typically be used in implementation phases. Product criteria are usually applied in selection phases, such as a tender.

The table below provides a short description of the relationship between a service criteria and its usability in a data center type. We have added changes to the HORA criteria which are marked green.

Service criteria	Description
Commodity solution	Services that match this criteria re highly standardized, offer generic functionality and standardized interfaces. Functionality is not differentiating, users can easily replace the services and competition is reflected in pricing. This makes public cloud a suitable sourcing option for these type of services.
On time investment	Services that match this criteria require a high, one time investment, which can be split between various end users. These services are suitable for cloud sourcing (public or community), which allows sharing investment between community partners and chargeback based on use. This criteria should be normalized using the terms (time periods) of investment. If the service term (length of usage in time) or economic

	term (depreciation) is long, than this criteria receives a lower weighting due to the lower average cost.
Variable capacity/utilization	Services that match this criteria do not have consistent, balanced usage. The utilization or available resources is not stable. Using pay per use models in cloud solutions makes this service suitable for cloud sourcing.
High availability	Services that match this criteria require very high availability and are therefore suitable for cloud sourcing. Cloud vendors can guarantee a high availability and deliver support out of office hours.
Experience with public cloud service	Services from a public cloud create additional (security) risks and require more attention. Experiences from other organizations with sourcing a particular IT service contributes to mitigating this risk.
Industry specific	Service that match this criteria are industry specific making them unique to the HE sector. Some of these services cannot be sourced through pubvlic cloud due to limited scalability for the vendor. These services should logically be serviced by a community cloud.
University Specific	Services that match this criteria are unique to the university. These are cases where we require highly specialized solutions which cannot be sourced through public or community clouds, which justifies on premise delivery models. This concept applies in particular to services that strengthen the competitive position.
Location Dependent	Services that match this criteria are dependent of a certain geographical location of have to be in close proximity to other system in the area, which makes them unsuitable for cloud solutions. An example is specific performance requirements that a public/community cloud cannot fulfil due to their location. These type of services are managed by the university.
Differentiating value	Services that match this criteria deliver an added value to differentiating competencies of the university. If an organization follows a *best product strategy* it wants to be able to innovate internally. In this case cloud services are not an option as the university has limited influence over development.
Control	Services that match this criteria require full control by the university. This can be in case of product risks which the university wants to able to control directly (f.e. security) or in case of differentiation of the organization. These services are not suitable for cloud and will be managed by either the university or community.
Time to Market	Services that match this criteria require a short time to market, from design to delivery. This applies to services that will be used for a short amount of time due to quick developments or incidental changes. Public cloud is most suitable for these solutions as competition is fierce and time to market is short.
Human Capital available in-house	The internal human capital that can add value in IT servicing. A high level of internal human capital will lead to a costly transition from internal managed services to outsourced services (and vice versa). This criteria does not influence the long term Data Center plan, but does influence the transition plan.

Table 2 Service Criteria that shape the data center

Assessing services that the organization requires according to these criteria provides a first view of the Data Center- and sourcing decisions. The assessment of a service will rarely lead to a single form of data center- or sourcing decision. By weighting the various criteria according to their applicability it is still possible to find the right solution.

The criteria for Control, Differentiating Value, Industry Specific, University Specific and Location Dependancy are *exclusive criteria.* This means a service either matches them, or not. These criteria do not requires weighting as they are a knock out criteria, which excludes various options. We can then proceed with the weighting/matching of other criteria.

Matrix Methodology Data Center Type

The full criteria matrix for the assessment of services is:

Beoordeling voor keuze datacentervorm voor Dienst X						
	Public cloud	**Community cloud**	**Hous-aaS Community var (SURFSARA)**	**Hous-aaS UvA/HvA**	**Own Community var (Distributed)**	**Internal UvA/HvA**
Decision Tree & Service Criteria	**External datacenter**	**External datacenter**	**External datacenter**	**External datacenter**	**Partially In-house Datacenter**	**In-house Datacenter**
Knock out/Exclusive criteria						
Control	**NA**					
Differentiating Value	**NA**	**NA**				
Industry Specific	**NA**			**NA**		**NA**
University Specific	**NA**	**NA**			**NA**	
Location Dependant (infra)	**NA**	**NA**		**NA**		
Service Criteria for Final Sourcing Option						
Commodity solution	++ /--	++ /--				
On time investment	++	+	+		+	
Variable capacity	++	+			+	
High availability	++	+	+		+	
Experience with cloud service	+/ -					
Time to Market	++		+	+		
In-house Human capital present			+		+	+

Table 3 Matrix Service Criteria – Data Center Types

Various exclusive criteria have a NA rating. This means the data center type does not fit with that particular criteria. We conclude that a service which has one or more applicable exclusive criteria is not suitable for public cloud. This however does still allow a community cloud or one of the other data center types and requires assessing the service according to the other criteria. The + and – are used to rate whether that criteria is suitable for a particular sourcing option, which leads to a rating of a very positive or negative qualification of a sourcing option. If service is available as a commodity, than this will lead to a high (++) rating for public cloud. If there is no commodity solution, than it leads to a low (-) rating. Combining all scores lead to a score and advice for a sourcing option.

If a service is suitable for public cloud sourcing on the highest (application) level, then the process for that service is completed. If a service is suitable for internal delivery through PaaS, then we need to consider the IT service platform as a separate service according to the criteria. The same process applies to other services.

As previously stated, the service criteria provide a first indication of the most suitable data center type. During the selection process of an actual vendor, we will include product criteria, which are included in appendix 1. The assessment through product criteria can still lead to different choices in data center- and sourcing options. This could be the case for services where there is no vendor with the correct level of security, or if the cost of a vendor is higher than it would be for internal delivery.

System Ownership
Defining the functional requirements and wishes requires the involvement of a (functional user) representative of the service in question. The system owner is the person responsible for assessing a service according to the criteria. We will apply the role description of a system owner which is stated in 'optimization service management information systems collaborating services', which is:

The system owner is responsible for the quality and availability of the IV-services which are delivered through the information systems.

The role of the system owner extends beyond representing the functional side of an information system as this description is made in perspective of service/maintenance management of information systems. We have yet to asses if it is possible to combine these roles. The system owner has to show a certain level of flexibility to set requirements on a functional level, without setting requirements for sourcing options. The role of the system owner will change if a public cloud solution is selected. The level of change has to be assessed moving forward.

5 Application of Methodology

The previous chapter describes which criteria have to be assessed when selecting a data center type for any particular service. Combining all factors leads to a method where the system owner, supported by sourcing, architecture and security, collaboratively come to the selection of the most suitable data center- and sourcing option:

1. Determine component and strategic context of service
- *Determine vision (of the business function that sources the service). Leverage the described influences to determine vision.*
- *If supporting a primary process: clarify in which stage of development the service is.*

2. Criteria Weighting and Scoring
- *Determine which service criteria has higher weighting according to point 1.*
- *Clarify scoring in the table*
- *Complete this for all services and determine initial data center type(s)*

3. Determine current state and roadmap
- *Determine the data center- and sourcing option in the current state*
- *Determine roadmap: clarify the future path of development and necessary knowledge*

4. Determine product criteria, operational context of the service
- *Determine which product criteria the service has to fulfil to support the selection of a vendor (if applicable).*

We advise to apply these steps on a tactical level when determining the data center vision.

6 Next Steps

In the process following this vision document and it implementation we determined the following steps:

- **Preliminary assessment of suitable data center type for each Business Function (HORA)** Refer to appendix 3 for a full overview of business functions in the HORA model. We can make a more detailed assessment assessment per service per cluster afterwards.
- **Investigate the life cycle of on premise data center** to determine whether an internal data center is still required.
- **Test requirements with researchers** to see what the need for an internal data center is**.**
- **Communicate vision** and assess current programs and projects.
- **(Multi-)Sourcing organization is established.** This ensures demand and supply is represented.
- **ICTS has the knowledge needed for support of Education & Research.**
- **There is close collaboration with IT experts** of faculties and domains, and other institutions.

We advise to compile a roadmap for the implementation of this data center strategy. This includes establishing guidelines for a successful implementation and the application of the described methodology to determine the right data center type for each business function, using the framework described in this document. Our method by be updated based on new insights and development. Additionally we should cover maintaining and updating this method over the course of the data center life cycle.

7 Glossary (not translated- terminology described in text)

nr.		Description
1	Datacenter	Een voorziening waar ICT apparatuur ondergebracht kan worden; de benodigde vierkante meters, energie, koeling, beveiliging, verbinding met internet, etcetera, die nodig zijn om ervoor te zorgen dat systemen, ter ondersteuning aan verschillende diensten, betrouwbaar en veilig zijn (‘housing’)
3	Public cloud	Aanbod van publiek beschikbare schaalbare en elastische IT-diensten aan externe klanten met gebruik van internet technologie.
4	Community Cloud	Aanbod van schaalbare en elastische IT-diensten aan externe klanten, waarbij deze specifiek voor de sector wordt beheerd.
5	Dienstcriteria	Criteria die t.b.v. een datacenter en sourcingsstrategie, een indicatie geven welk datacenter concept het meest logisch is gebaseerd op de eigenschappen van een IT-dienst –zowel vraag als aanbod gedreven- los van een specifieke oplossing of leverancier.
6	Product criteria	Criteria die gebruikt kunnen worden om een specifiek product van een specifieke leverancier die invulling geeft aan een IT-dienst te selecteren.
7	Dienst	Van Dale: handeling waarmee je iemand van nut bent. UvA/HvA: Handeling bestaande uit één of meerdere processen welke gezamenlijk invulling geven aan een (deel van een) bedrijfsfunctie. Bijvoorbeeld de dienst ‘Inschrijving’, welke bestaat uit de verschillende processen zoals aanmelding, matching, inschrijving, her-inschrijving en uitschrijving.
8	Hybride datacenter	Een combinatie van verschillende datacentervormen met de daarbij behorende sourcingskeuzes.

9	Systeemeigenaar	De systeemeigenaar is verantwoordelijk voor de kwaliteit en beschikbaarheid van de IV-diensten die door het informatiesysteem geleverd worden.
10	Sourcingskeuze	Keuze uit de verschillende datacentervormen voor het type sourcing om een (deel van een) dienst te ondersteunen.

8 Appendix 1: Product Criteria

This paragraph describes criteria that can be used for a specific product that supports a service. They mainly include criteria that apply to cloud solutions and should not be used as a generic checklist for the procurement of products.

Security Measures
It is important to guarantee data integrity and protection. This means a vendor will at the very least offer functionality for authentication and authorisation. Sensitive data might require more specific measurements like encryption, authentication or placement in the European Economic Area. The institution should balance risks and security measures. Extremely sensitive data (like competitive research data) could lead to a risk high enough to keep data in house regardless.

Match Legal Requirement Framework (LRF)
The LRF sets clear regulations to the supervision on IT services that manage personal data. This is a methodology based on the requirements the government sets out on management of personal data, based on 4 subclasses. Privacy, ownership and security is secured through correct contracts with vendors.

Interface for SURFconext
Using cloud services requires and identity for authentication and authorisation. The industry has positioned SURFconext as the intermediate service between all institutions and vendors. If a product supports SURFconext, no further identity management will be required.

Interfaces using Open Standards
It is a general requirement that information systems are integrated. This requires interfaces between applications that are based on open standards, both at a technical and functional level. Standardized interfaces also minimize the risk of vendor lock-in.

Adaptability
It is required that a cloud service can be adapted to requirements which are specific to the university. This includes internal policies etc. The same applies to some extent to flexibility around process management.

Evolving
organizations do not want to rely on one vendor. Changes in a specific service should not impact the end user organization of the application landscape. This requires that vendors do not close services down immediately and allow a set time for migration to other services. Interfaces should have backward compatibility.

Exit Strategy
Sourcing choices are not set in stone and organizations should have the opportunity to select other products. This requires that organizations can receive the data from a service, to allow migration to a new product. Additionally there are legal requirements in case of bankruptcy etc.

Calculation Model
Cloud vendors have different pricing models for cloud services. Usually they include the amount of user, but sometimes also include the amount of data or computing capacity. This makes it important to consider which pricing model delivers the best deal for the university. This especially applies to public cloud solutions.

Service level agreement
It is necessary to set out clear agreements about the quality of service a vendor will deliver, and how any discrepancies will be handled. This could include disaster recovery and sustainability. Bigger vendors usually have a standardized SLA and negotiation as an individual is challenging. Leverage SURF as the industry body to negotiate on behalf of all institutions.

9 Bijlage 2: Succes Factors

The use of community- and public clouds is still new for many institutions. However, in many cases some services have already been placed externally. The necessary measures to do this effectively have not been taken in many cases. It is important to ensure the following success criteria are met to ensure successful cloud sourcing:

Sourcing Strategy
Every institution should consider its own context, priorities and choices in the assessment how/when cloud is an option. Strategic decisions should be clear before tenders. The criteria described in this document provide an initial direction.

Demand/Supply Organization
Sourcing and managing services from both interna land external providers requires other knowledge and competencies compared to internal delivery. This requires a purpose built organization with the correct roles and processes. It also requires a clear split between demand management and the supply organization. Demand management, architecture and governance are points of attention.

Information Security
Placing data and functionality outside of the on premise data center causes security risks that should be mapped and accounted for. This requires a highly professional approach to information security, including security policies, data classification and a list of standardized security measures.

1. Bijlage 3: Bedrijfsfunctiemodel (HORA)