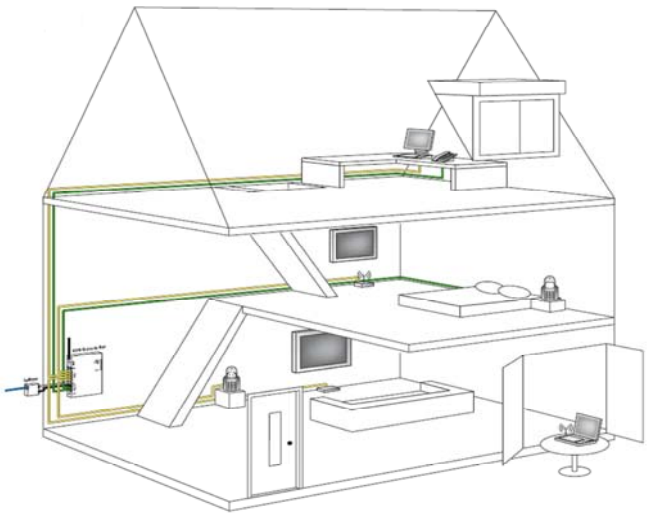
A business model for the Smart Home

Using the STOF method and scenario analysis to design a business model for KPN



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Preface

This thesis is the last part of my master's degree in Systems Engineering, Policy Analysis and Management (SEPAM) from Delft University of Technology. This research was conducted over 9 months within KPN in their headquarters in The Hague. This research was conducted with the help of many people and I would like to acknowledge certain individuals for this.

First of all I would like to thank the chairman of my commission, Harry Bouwman. Being known for giving critical feedback I was surprised at the usefulness of such feedback. Although the meetings where few, they gave me sufficient information and motivation to deliver something superior then I had expected.

The whole idea of writing my thesis about the smart home and the changes which will be seen within the home in the coming years came from Nico Baken. I want to thank you for the inspirational meetings which always left me a little flabbergasted, but hugely enthusiastic to go on and develop new concepts and ideas. I hope to have embodied a little of your vision within my thesis.

Throughout the process I was supported by Edgar van Boven, Mark de Reuver and Patrick van der Duin as my direct supervisors. Mark, thank you for your extremely clear feedback, and of course the time you spend to help in your free time and having just become a father! Edgar, in between your full time job, and your own research towards your PhD I was always able to bother you for brainstorm sessions, general advice, and of course more input and changes to my thesis. I don't think you are ever without another idea and this also helped me to deliver a better result. Patrick, your advice on futures research, and articles written in your time at KPN were a great help when I was stuck not knowing exactly what to do next.

Lara, my sister, who acted as my main editor, thanks for the immensely helpful and fast feedback you gave me! On multiple occasions did you spend the hours checking my work so I could continue in the morning. I don't think my thesis would be as readable if you hadn't suffered through all my spelling and grammar mistakes.

The hours spend in the office at KPN would not have been as much fun without the whole Technology and Innovation team within Wholesale and Operations. Thank you all for giving me ideas, asking me questions and having the patience before you finally get to see my results.

I would also like to thank all the people at KPN and outside whom I interviewed. Thank you for your time and ideas, a list can be found in the third appendix.

1 May 2009 The Hague,
Lars de Jonge

Executive summary

KPN is the Dutch incumbent telecom provider. Through the years it has turned into a multi service provider by offering such services as internet and digital television to its customers. Due to fierce competition from mobile operators and cable companies KPN is looking for ways to increase revenues through new services.

Within the home, technology and in-home networks are increasing the possibilities to provide new services. The home of the future or 'smart home' is an age old promise which still hasn't materialized. Currently there is reason to believe that the smart home is on the verge of becoming a reality, and this brings along chances for companies such as KPN. This has led to the main research question, namely:

What is a robust smart home business model design for KPN in the future, and which sectors play an important role?

The first step in answering this question was to do a full scan of the current possibilities within the smart home domain. This domain description has a strong technological focus. In this description I covered topics such as energy use, telemedicine, entertainment and home automation. Current standards, house cleaning robots and different forms of access technologies are named and discussed. To gain insight as to where the smart home is headed, research initiatives such as Philips ExperienceLab, two MIT research projects amongst other research initiatives, and even passionate hobbyists were visited and studied.

This led to the findings that ubiquitous computing, the idea that computers are becoming cheaper, faster and more abundant, is quickly becoming reality. Together with increased intelligence and more intuitive control interfaces the technology is not the most problematic component in the realization of the smart home.

Instead the greatest uncertainties lie in the standards that need to be agreed upon for such things as in home networking protocols. This standardization problem leads to integration problems of different areas within the home. Lighting, energy, media and communication are all based on their own standards and to make a complete smart home possible, these need to be integrated.

Concurrently market demand is also still uncertain. If one looks at the high end home automation companies it is clear that huge sums of money are currently being spent on increasing living comfort, while new developments within the energy sector are focusing on lowering peoples bills. Together these uncertainties overshadow the fact that the technology is no longer the main bottleneck in making the smart home a reality.

Moving forward I conducted futures research in the form of a trend forecast and scenario analysis. This was done based on my previous findings and the trend forecast served to create a vision of the possibilities of the future smart home, the so called future vision. Scenario analysis was used to find the most influential uncertainties over which KPN has no control. The scenarios gave an insight as to the forces which drive the factors that will affect the business model. These were

based on the previously found uncertainties, the first being market demand, otherwise known as the market push or market pull. The second uncertainty came in the way innovation will be taking place. The first axis within my scenario framework had one extreme in which organizations innovate together across sectors and boundaries to develop highly innovative and disruptive products. The other extreme is that companies continue to focus on their own segments and operate in isolation within their so called stovepipes. These scenario axes left me with four distinct scenarios which I used later on to test the business models viability and robustness.

The third step was to design the actual service and corresponding business model based on my findings surrounding the smart home domain. It was essential to create a service which, just as internet and television, can be sold to the masses instead of only being interesting for the early adopters and tech savvy individuals. To help me design a service concept I used a general design methodology. This service concept served as input for the STOF method, a business model theory which goes through the Service, Technology, Organization and Financial aspects to create a full business model. This method has been specifically created to design ICT based business models for new services.

The design is a service delivery platform, in which KPN offers smart home services to the customer in order to promote Smart Living. These services are to be provided by third party firms and can be browsed and bought by the customer from the comfort of their own home. KPN is responsible for providing the access network, and managing the technological complexity within the home through their 'ServiceThuis' service. By setting transparent and clear criteria they can offer service providers high quality access to their large customer base. Based around fiber to the home access technology and experts solving customers in home technology based problems, KPN offers its customers a one-stop-shop where they can pick and choose services to provide a custom built service feeling. The services to be provided over such a platform come in a large variety within all the sectors that play a role within the home. Examples are governments, energy suppliers, media providers, telemedicine firms and many more. KPN will be providing the platform to offer these services, sharing in the profits of the services sold over this platform by third party firms.

To make sure this business model is viable in the uncertainties the future holds, I evaluated its robustness in the different scenarios. Through critical design issues KPN can influence the critical success factors to maximize viability. The most critical success factor showed to be partner selection. The reason is that the selected partners define the services which are available over the smart home service delivery platform. Thus, in different environments it is crucial to select the partners which are going to deliver the services which are needed under the circumstances. The advice given in the end of this research gives an overview of in which sectors KPN needs to look for specific partners under the changing conditions. As an example, it is obvious that in economically uncertain times customers are less willing to purchase expensive entertainment and comfort increasing solutions, while electricity minimizing services can have a cost lowering impact.

In the end I provide KPN with a service concept of a smart home service delivery platform to promote Smart Living, this can be implemented at a later stage based

on their current strategy of fiber roll out and the 'ServiceThuis' products. In order to maximize the viability of this platform I have done futures research and designed a business model according to the STOF method. The most critical success factor according to this method is the selection of partners offering their services over the platform. This success factor has then been placed in the different scenarios in order to generate advice on which partners to select under the changing conditions. This advice is presented in the fifth chapter of my research.

The very last chapter reflects on my research and provides improvements. Furthermore, this chapter provides important information on further research directions and the largest shortcomings I found in my own research. The main advice is to further evaluate my business model through interviews inside, and with potential partners, of KPN. This information provides handholds from which to further develop the smart home service delivery platform.

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1 Introduction

In this thesis I will be presenting my research of the possibilities surrounding a business model for a smart home service by KPN. My research is based on data collected from various sources such as research initiatives, interviews and books about the smart home. In subsequent chapters I have looked into the future through futures research methodologies such as scenario analysis. I have designed a business model using the STOF method and tested its viability through the scenarios. In the end, I present what I have found to be a robust business model which KPN can implement in order to provide future households with innovative services.

In this first chapter I present the research problem and introduce the key elements of my investigation. This is followed by my main research question and the corresponding sub-questions. The third part of this first chapter outlines my approach. The last part explains the outline of this thesis, its structure and the way the chapters are organized.

1.1 Research problem

In the following section I will explain the reason and general information behind this research project.

1.1.1 Smart homes

Smart homes have been and still are of interest to many researchers and companies today. Massachusetts Institute of Technology has devoted a lot of time and resources to its Project Oxygen, Philips has their HomeLab research facilities, Georgia Institute of Technology has the aware home research initiative, while in Colorado students of the University of Colorado have installed the 'adaptive house' which is a home that learns from its inhabitants. Each of these examples are projects that are contributing to the knowledge available about smart homes.

A smart home can be described and defined in many different ways. A smart home today generally raises ideas about refrigerators that can tell you which products are expired and what meals you can prepare with the ingredients currently kept in your fridge [1]. Other so called future homes are completely integrated with media services so that music, movies, and pictures are available in every room of the house [2]. A prime example of this is Bill Gates' house where visitors wear a chip that identifies the person and plays their favorite music as they enter a room in the building [3]. Energy suppliers see something different in the smart home. They see complete energy efficiency being built into the new homes such as warm air that is leaving the home heating the cooler air that is replenished [4]. Special windows to isolate from the elements and water saving solution are all part of the energy efficient house of the future according to the energy suppliers. Other say the smart home will one day be something for everybody, not only the wealthy. With the prices of computers dropping and computers becoming readily available the future of ubiquitous computing becomes a reality [5]. Embedded chips into everyday objects allow for machine to machine communication and ambient intelligence being created by a whole host of sensors that are being implemented in the modern home [6].

Thus we see that the services and technologies that will be incorporated into the home of the future are ever changing and dependent on the perspective of the organizations supplying the products and services.

The descriptions of smart homes given above are different, showing how each sector innovates within their own area. Many smart home systems are technically feasible if they are viewed as a stand-alone service. This creates the challenge that the smart home is not being innovated as a whole. The problem is that for the complete future home to be something that is attractive to the consumer, organizations from different sectors need to work and innovate together. An example of a single sector innovation in a smart home is to connect a home with a high bandwidth fiber optics connection to watch high definition media, but this is a stand-alone solution. This connection can, and should also be used to send information to a decentralized energy grid about the homes current electricity usage for example. To get such a system operational, innovations that are being implemented in a specific sector need to be shared with other sectors [7]. Only by doing so will complete smart homes become a reality.

This still leaves me to define the smart home in order to give a clear and concise meaning throughout the research project. For this I have chosen the definition given in the second chapter of a book edited by Harper named "Inside the Smart Home". The definition is as follows;

"A "smart home" can be defined as a residence equipped with computing and information technology which anticipates and responds to the needs of the occupants, working to promote their comfort, convenience, security and entertainment through the management of technology within the home and the connections to the world beyond". [8]

The rest of this book is filled with chapters on different areas within the smart home. This shows how the author incorporates a broad scope of a complete smart home service. Thus the smart home is not solely based around the intelligence of the technology, the connection to the outside world, or the demands of a single type of user, but instead encompasses all the areas of life within the home.

1.1.2 KPN

KPN (Koninklijke PTT Nederland), the Dutch incumbent telecom operator, currently finds itself in a tumultuous market. Cable companies are delivering internet and high definition television, mobile operators offer wireless internet connectivity, and other telecom giants are looking for ways to increase their market share [9]. Given this information it becomes clear that any advantage needs to be used to stay ahead of the competition in such a cut-throat market. It is for this reason that the smart home as a service is of interest to KPN. As the CEO of KPN, Ad Scheepbouwer, wrote in an article for a Dutch financial strategy magazine, "the industry needs to focus on designing intelligent homes", and going on to say "The 'smart homes' of the future make it possible that people continue living in their own environments for as long as possible, with huge cost reductions and an increase in the quality of healthcare as a result"[10]. In the rest of the article the positive effects of the smart home in delivering a positive effect in energy efficiency, and interconnecting the household appliances are discussed.

KPN's business is closely related to ICT (Information and Communication Technology), which is often the basis for new solutions. These technologies are also changing rapidly. ICT can already be seen as the binding factor between current sectors [7]. It is therefore logical that a large telecom operator that supplies ICT services is involved in supplying the interconnectivity within, and the complete service of a smart home. This means that even though there is a different definition of a smart home within each sector, ICT is needed to interconnect and allow for a complete smart home, and thus KPN can play a large role.

Being in such a competitive market and surrounded by ICT solutions, KPN is looking to deliver new services. It is therefore important for KPN to find its added value in supplying a smart home service package to the consumer based on a robust business model. With this business model KPN can find the waypoints they need to visit to get to the point of supplying a complete smart home service to the customer. This is in line with current services KPN supplies to the average household in the Netherlands such as internet,

television with video on demand services and voice calls. KPN wants to make sure they can continue to generate revenue from households in the future by supplying the customer with the most up to date services and products.

When this information is combined with the predictions of the possibilities of a smart home, it becomes clear that the development of a business model for the future situation could lead to surprising innovations. For KPN this means that there are chances to supply innovative services over their current and new infrastructure to be able to generate new revenue streams.

1.1.3 Business model

There are many definitions of a business model. Since the idea is to design a business model, the question arises as to which definition of a business model is most suitable in providing a smart home service. Once this is clear the actual design of a business model can take place. The definition that fits within the context of this research and to be used here comes from the book 'Mobile service innovation and Business models' which states:

"A business model is a blueprint for a service to be delivered, describing the service definition and intended value for the target group, the sources of revenue, and providing an architecture for the service delivery, including a description of the resources required, and the organizational and financial arrangements between the involved business actors, including a description of their roles and the division of costs and revenues over the business actors." [11]

There are many different ways of developing such a business model. In this case, it is relevant to find a business model that is based around a technology oriented solution. The reason being that a smart home, as defined previously, is one where computing and information technology provide the service. Secondly, a business model is needed that incorporates a multi-actor environment. This is of importance since the smart home service is in need of many different actors in different sectors coming together to form one single user experience. This being said, the usefulness of such a business model theory needs to have been validated academically and with case studies to make sure it is useful in developing a smart home service. One model that is well suited to the problem in question is the STOF model from which the definition of a business model is taken. This model has been developed to methodologically create a business model for ICT services through the STOF method. Part of this model also incorporates the organizations needed to develop the specific model and thus fulfills the criteria of encompassing a multi-actor environment.

Once the chosen method has been used to develop a smart home service, the STOF model will also be tested if it is usable to design a business model that is to be implemented in the future. Instead of generating an exact plan, it seems more plausible that a design for the vital changes that need to take place will be produced. The theoretical relevance of this thesis will be generated by testing if it is possible to use the STOF model to design an ICT service that is placed relatively far in the future where a lot of components are uncertain.

1.1.4 Sectors and parties involved

As mentioned in the previous section, many different actors from different sectors are involved. Here the definition of a sector is one where a group of organizations can be classified by delivering uniform, homogenous and interrelated activities such as services and products. To get energy, healthcare, and telecom firms to work together, innovation needs to take place at different levels. Currently innovation takes place within companies and sectors and can be described as vertical innovation [12].

In this research the focus will be put where it seems most changes are taking place according to KPN. This is within energy distribution, telemedicine innovations and the distribution of digital media throughout the home. Proof that these areas are of interest to KPN come in the form of the soon to be implemented 'smart meter'. In this device KPN supplies the data connection between the electricity meter and the power company for daily usage readouts. Within telemedicine, KPN has recently bought a firm called IPT-Telemedicine which designs and implements mobile healthcare and telemedicine solutions. The third focus named above is that of content and media distribution into the home, which is what KPN already supplies in one way or another. This is done through offering digital video services such as video on demand, and high bandwidth internet connections supplying all sorts of digital content and services to the home.

As is often the case with new innovations in services, these are based on new technologies [7, 11]. From this perspective it becomes clear what the role of an incumbent telecom operator could be in this smart home environment. The technology behind the innovation of a smart home looks to be heavily dependent on new communications technologies and standards [13]. In other words it can be said that ICT forms the crossroads on which the other sectors can build their innovations. This then forms the bases for the innovation that will take place in the other areas that will be the focus in this research. In the design, new technologies will be covered and discussed. Concerning the development of a business model the focus will be on the services that KPN is able to offer and how these services can be packaged in various value propositions. The actual technology needed to implement the specific products in the smart home such as electricity generation or health monitoring equipment will only be discussed in the designs, but are not part of the service to be described in the business model for KPN.

1.1.5 Research problem conclusion

It has become clear that there are many knowledge gaps in the development of a smart home business model for a telecom operator. This begins with the problem of the meaning of a smart home itself and includes the uncertainties surrounding the companies and their respective sectors that need to be incorporated in making it a reality. The role of the telecom and ICT service provider needs to be made clear and in the end this leads to the final problem of putting it all together into a viable business model. The main problem resides in the fact that no firm provides a smart home service. The rest of this proposal will explain how my thesis on this subject will take form. In the end I will present my findings of a robust business model for KPN in supplying services to the smart home.

1.2 Research questions

Based on the problem defined in the previous chapter, the main research question that needs to be answered is:

What is a robust smart home business model design for KPN in the future, and which sectors play an important role?

1.2.1 Sub-questions

By answering the sub questions in a structured manner, it becomes possible to give an answer to the main research question above. In the next section I will give an overview of the research sub-questions and their relevance towards the main research question.

1.2.2 Domain description questions

These questions are of importance to this research by defining the domain of the research. By answering these questions a view is given of the current smart home market, its future and the uncertainties that exist. Once these have been answered they will form a basis for the rest of the sub questions. These questions form the data gathering part of my research, since they try to encompass the knowledge available about the current smart home situation. The information gathered by answering these questions will be used as input for the rest of my analyses.

1. What does the current smart home look like?
2. What trends and developments do we see in the smart home?
3. What uncertainties exist in the smart home future?

1.2.3 Futures research questions

Once the data has been gathered in the previous subset of research questions this data needs to be analyzed. My research is based around uncertainties which take place in the future. For this reason it is important to find a way to deal with the future and the accompanied uncertainties.
Thus, the futures research questions should give an answer as to which method is best suited in dealing with future uncertainty of the smart home. Once it is clear which method is best suited to defining a future vision for the smart home and dealing with its uncertainties, these methods will be implemented to answer the two subsequent questions within the futures research area.

1. What methods are to be used when dealing with uncertainty in the smart home?
2. What is the forecast of the future smart home?
3. What are the smart home scenarios and what do they provide?

1.2.4 Smart home service design questions

After having answered the futures research questions I will go back to my data regarding the smart home domain. The next step is to use this information to make a business model, for which a service concept is needed. Thus this next section is based around designing a service and a corresponding business model. The design sub questions need to be answered in order to give an understanding of the possibilities within designing a new service concept and business model. By looking at different design methodologies it becomes possible to find the method best suited to the problem at hand based on the subject of the design, in this case

a smart home service. This first question will also identify the method that is suited to design a business model. The answer to the second design question will be the actual service concept developed by using the found method. This is also the case with the third design question where an answer is given in the form of a business model designed using the appropriate method.

1. Which approach is best suited to design a service concept and business model for the smart home?
2. What is the service concept?
3. What is the smart home business model?

1.2.5 Evaluation and advice questions

The last step in this research is to evaluate the business model that has been made. This will be done by answering the following questions, in order to see if the chosen models have been useful.

1. Is the business model robust?
2. What are the critical design issues KPN needs to focus on for a viable business model?

1.3 Approach

The approach I have taken in this project started with gathering information from different sources about the smart home in general. This research was based around answering the first set of sub-questions regarding the smart home description. My search started with the internet, and quickly led me to specialized forums and company websites promoting their all in one solution. From here I went on to speak to numerous people within KPN. I interviewed people from the business services innovation office, product testing, glass fiber, and the wholesale innovation offices to give me an indication of the general direction in which the technology is going. The list of people I interviewed can be found in the third appendix.

After having interviewed people within KPN, I also spoke to hobbyists and stand holders at the annual smart home fair in Eindhoven. This gave me a feeling for the direction the market is moving and the role people expect KPN to play in this market. An interview I had with Essent, an electricity supplier, gave me insight as to the way these types of companies are working together on projects, such as the smart meter, with telecom firms. During this period I was also keeping up to date with the newest technological developments through international websites such as www.engadget.com, which provides daily updates on anything technology related. Scientific papers, and research initiatives, although relatively few, often offered the most in depth analysis and companies such as Philips were helpful in sending me books on their innovation laboratories. This phase provided the information needed to answer the domain research questions in chapter two such as; what does the current smart home look like, what are the trends and developments and which uncertainties exist surrounding the smart home?

Once I had gathered sufficient data to answer my domain sub-questions I went on to find methodologies with which to structure the future uncertainties. Guidance from my committee and basic research led to the use of futures research. Scientific data-base queries regarding futures research gave me an insight as to the methods and options available to answer my research questions in chapter three. Specifically forecasting and scenario analysis formed an answer to my needs regarding the best methods to deal with the uncertainty the future smart home holds. The domain description delivers the basis from which to extrapolate the trends into a forecast. The forecast gave a starting point from which to develop scenarios, together with the uncertainties from the domain description. Brainstorm sessions and discussions with telecom and network experts from KPN were used in order to generate the scenario framework and the scenario Logic in chapter 3. The experts I contacted can be found in the third appendix. Thus I had 2 methods which left me with a forecast and scenarios which I could then use in the end of my thesis to deliver advice on the robustness and viability of the designed business model.

The design of a smart home service concept is realized in chapter four by using knowledge I had attained during my studies. The STOF model has been specifically designed to offer a method to design successful ICT services. With its focus on telecommunications, consumer electronics and innovative services it offered a manner to answer my service design sub-questions. The STOF model approach and design methodologies were a method used previously in smaller service design projects, and were the obvious choice. The design choices that had

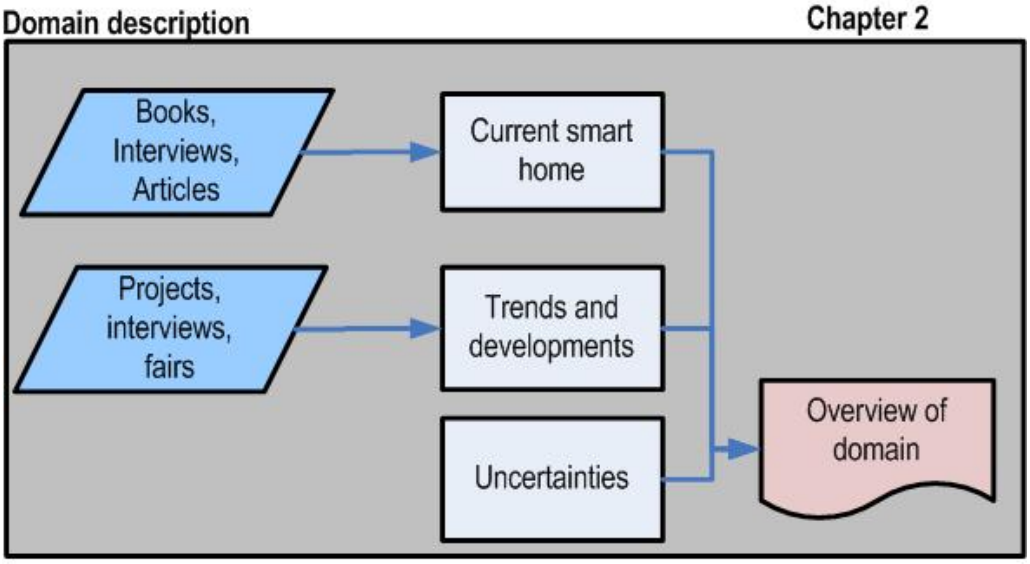
to be made in this chapter are based on the information gathered in my domain research. These design choices are based on information gathered through open interviews with different experts from within KPN.

In chapter five, the combination of using scenarios and the STOF model approach as an evaluation step is something which has been used before and proved to be a useful method of checking the business models viability. The final conclusions have been distilled from all the gathered data, analyses and methods.

1.4 Outline

My thesis is made up of 4 main components. I will give an overview of the way it is structured in order to gain a better understanding of the steps that have been taken and the order in which the research questions are answered.

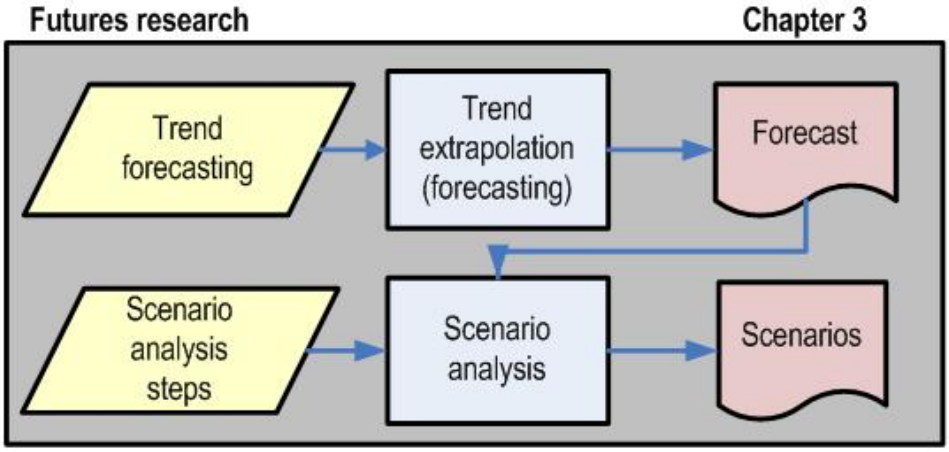
The first component encompasses the domain description in chapter two. This chapter is split up into to three sub chapters, where each sub chapter ends with the answer to the corresponding sub-question. Thus, chapter two is split up into 3 parts where each part answers one single question.



Sub-questions this chapter answers

1. What does the current smart home look like?
2. What trends and developments do we see in the smart home?
3. What uncertainties exist in the smart home future?

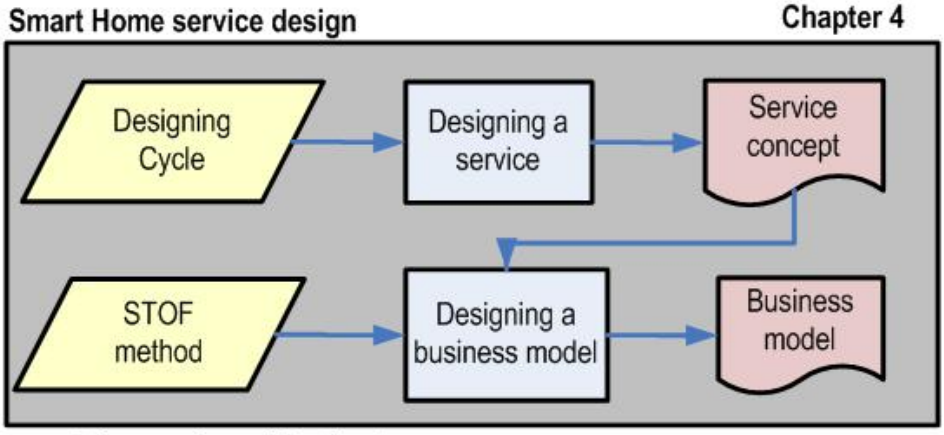
Chapter three incorporates my findings on the futures research activities. Here the sub chapters are ended by a conclusion that states my answer to the sub question within this component. Thus it starts with an overview of the futures research methods and the answer as to which method is best suited to my case. Next the forecast of the future smart home delivers an answer to the second sub question within futures research. The last question is answered by going through the scenario analysis steps and leaves me with 4 scenarios which provide a test-bed for the business models robustness in a later stadium.



Sub-questions this chapters answers

1. What methods are to be used when dealing with uncertainty in the smart home?
2. What is the forecast of the future smart home?
3. What are the smart home scenarios and what do they provide?

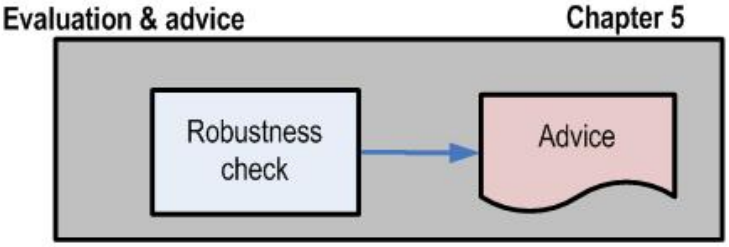
The fourth chapter answers my design questions such as the question what the service concept looks like? Again, each sub-question is answered in its own chapter conclusion. The first sub chapter discusses the methods to be used in making the design which is then followed by the actual designs.



Sub-questions this chapter answers

1. How do you design a service concept and business model for the smart home?
2. What is the service concept?
3. What is the smart home business model?

The fifth chapter is where my evaluation takes place. Here two sub-questions need answering. These are both answered before the last part of my thesis is presented.



Sub-questions this chapter answers

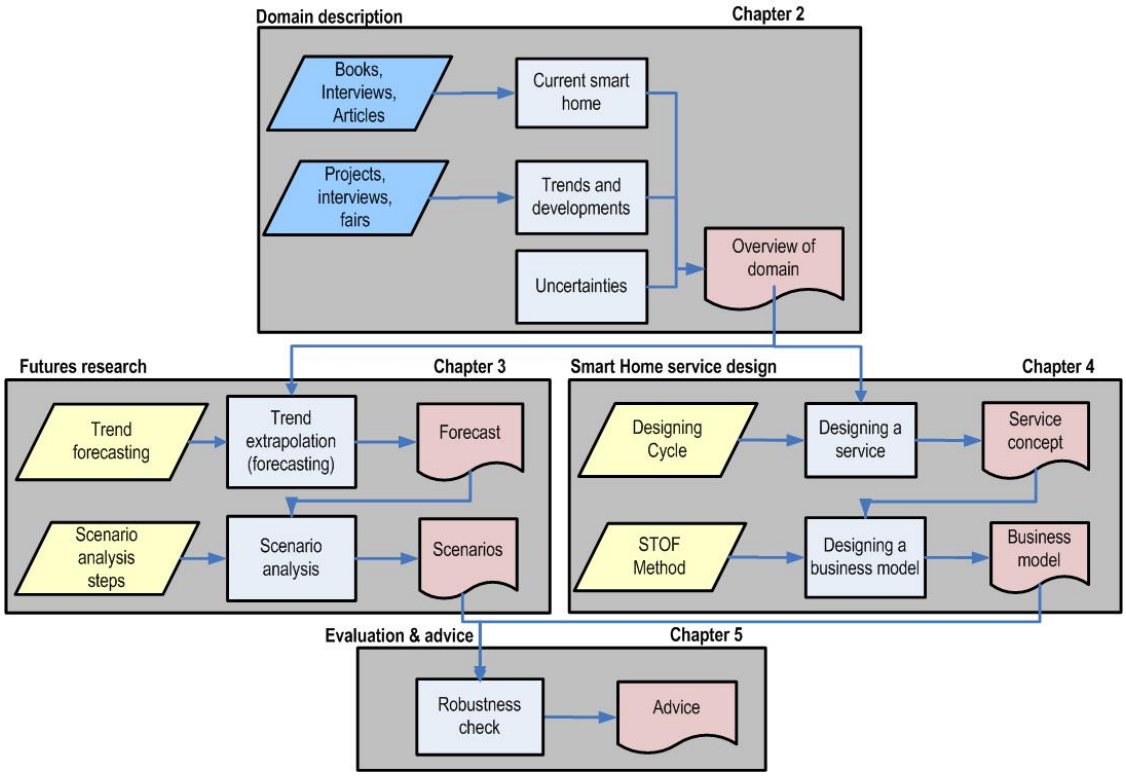
1. Is the business model robust?
2. What are the critical design issues KPN needs to focus on for a viable business model?

In chapter six I present my conclusion. This chapter answers my main research question based on all the previous answers I have given.

Chapter seven gives the reader an insight to the things I would have done differently, was I given the chance. Here my own criticism will encompass my thoughts as to how this research could have given a more concise answer to my main research question.

The last chapters are filled with appendices giving a deeper understanding of the steps I have taken and the list of references I have used during my research.

The following picture shows the four main areas of my research and the way in which the different parts interact. It is a graphical representation of the main chapters and gives a structural overview.



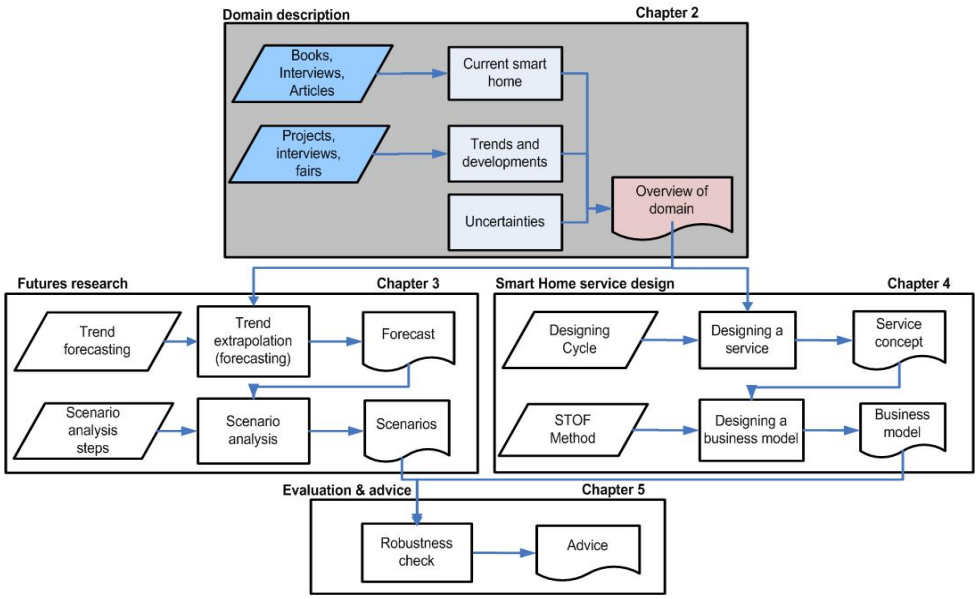
1-1 Graphical representation of research structure

2 Domain description

Currently smart home initiatives are widespread. In most developed countries universities and companies have built their own smart homes. These vary in many ways, with the focus of the smart home often being different. As mentioned in the introduction it is the perspective of the builder of the smart home that delineates the focus of the new technologies and services in the smart home.

In this first section I will cover the topics that are important to smart homes today such as: Broadband access technologies, residential gateways, in-home networks, home automation and standards. The chapter will give an overview of the most important technologies, for deeper and more in depth information the first appendix covers many technologies separately and in depth. In the end of this section I will give a complete summary of the current situation of smart homes today. Sub-chapter 2.1 ends with the answer to the first sub question of this thesis, namely, what does the current smart home look like? The second sub-chapter answers the question related to the common trends and developments I have found. Sub-chapter 2.3 names the uncertainties and in doing so answers the last sub-question of the smart home domain research.

The way I went about gathering this information was mostly through desk research as mentioned before. This included reading many books on this topic. Other sources of information were journal and magazine articles. Most of the information on access technologies, residential gateways and networking technologies was gathered through face-to-face meetings and internal documents at KPN. The information on standards is mostly based on information from the websites and documents provided by the specified standardization organization. Home automation information was mostly found in specific journals and magazines which are devoted to these subjects. Books and websites were researched in order to gain more in depth information on the subjects within the home automation chapter. For specific subjects such as security, telemedicine and entertainment solutions I used the opportunity to speak to specialists within KPN.



2-1 Chapter 2 answers the Domain description questions

2.1 Current smart home

When all the information I gathered (see appendix 1) surrounding the smart home today is put together it becomes clear that there is a large segregation still in place. Different organizations are working on different areas of the smart home and an integral solution that is available for the masses is still not available. Companies like Ecobee are providing alternatives to heating your home more efficiently, while lighting control companies are going their own way in supplying energy saving solutions.

In the following section I will highlight the most important findings from the complete description in the appendix.

2.1.1 Home automation

Home automation is slowly making its way into the mainstream where high-end companies are leading the way to make more possible for the average consumer. Standards such as ZigBee and powerline technologies are giving hobbyists wired and wireless control interfaces to start connecting their homes lighting and white goods infrastructures. These trends are often driven by the desire for new gadgets, while energy efficiency and cost savings are leading the trend into the homes of less tech savvy individuals.

2.1.2 Access and networks

Broadband access technologies are easily accessible and relatively mainstream. Residential gateways are slowly becoming more capable and increasingly user friendly. The user friendliness of these devices is making it easier for homes to have their own internal network which in turn is creating a platform for sharing digital content within the home. This can be seen with the new standards such as DLNA and UPnP which are being incorporated into most new devices and take advantage of the possibilities digital content has created.

2.1.3 Actors

On the front of entertainment, telemedicine, security and energy things such as mesh networks and cheap sensors are increasing the capabilities of services for the consumer. Here we also see the amount of single purpose robots that are being sold growing. Thus the first steps towards a smart home are being taken on many levels in many different sectors across the home environment. This has an impact on the amount and variability of the actors involved.

2.1.4 Integration

The main problem however is still the integration. The question as to how all these different services, products, devices and standards are going to work together in the future is an area where specialists are not on the same line. Through all my interviews with people working at KPN whom are familiar and have an interest in this subject this was a common conclusion. Companies are still trying to create lock in effects and others have chosen proprietary standards which does not stimulate integration. That integration is necessary on the other hand is something that is obvious if the maximum potential is expected from the new technologies that have been defined in the past section.

2.1.5 Current smart home conclusion

This past chapter has given an answer to the first sub question. Here I will give an answer from my findings.

Domain description question 1:

What does the current smart home look like?

- Broadband access technology is in place in a large number of homes in the Netherlands, making a smart home service possible
- Residential gateways are gaining functionality, becoming an option for a service delivery platform
- Home networks are becoming common, and people are starting to take advantage of the possibilities such as sharing a printer or scanner, and digital media.
- Standards such as UPnP, DLNA, and OSGi are gaining ground and offering easy interoperability for digital media, and entertainment services.
- Home automation technology is within consumer reach, although it is segregated, and complete solutions are expensive.
- Integration of complete systems that include lights, heating, entertainment and security are not common, and still need specialized programming to make the separate systems interoperable.
- Current systems are not 'smart' and it is still the user that needs to control everything and have knowledge of system to make it work.

2.2 Trends and developments

In the next section, I will show where research projects and companies are putting their focus in order to gain an insight as to where the developments are leading us (in depth information to be found in appendix 2). It is in this section that it should become clear as to where the integration can take place, and how different parties are trying to find a solution to this problem. I will try to incorporate as many of the developments and research projects in the smart home arena in order to give a broad and complete picture of the industry at hand. In the next section I will identify the largest trends in the smart home domain. These are extrapolations of the research directions that will be described under the developments. The last section will provide my vision of the future based on the findings in the research trends and developments. In the end, this chapter should give an answer to the second sub question, which asks which trends and developments are taking place within the smart home domain.

In most of the research projects I was able to gather the information from the respective websites and the articles they have published. In addition to the information on the Philips' website, I received a number of books on request with further information on their research initiatives. The 'Living Tomorrow' project lent itself to an actual visit since it is situated in Brussels and is primarily a showcase home designed to be visited by interested parties. The 'hobbyist' section of this chapter was also an interesting part of my research since it gave me a chance to interact with people whom are personally very involved and devoted to the smart home. Thus my visit to Robert Hekkers house near Arnhem was a very inspiring and helpful event, where a long discussion confirmed my insights. Through this contact I was also able to visit the yearly Smart Homes fair in Eindhoven, this event gave an overview of the possibilities and direction of the market in its current situation.

As is the case with the previous section, the in depth information behind each research initiative, company laboratory and hobby project can be found in the second appendix named trends and developments. In the main body I will stick to naming the mayor findings I did according to this information. These findings lead to the answer to my second research question within the smart home domain chapter.

2.2.1 Developments

Current developments can be seen to be moving into the direction of the trends which will be further discussed below. What can be distilled directly from the information in the appendix, boils down to a couple of main points. Firstly, the fact that so much time and money is being spent on this research area shows that a number of people believe these homes will be a part of our future. Secondly it can be said that the technology is not the lagging factor. Instead it is the control, and sharing of capabilities where these developments are looking for breakthroughs. The idea that computers will be everywhere is omnipresent in all these initiatives. The third clear common research direction to be identified is that intelligence and contextual awareness is something that is still in its infancy, but will lead to much greater usability. Once technology is aware of our needs, the need for humans to spend time learning and interacting with the technology will actually change into people using the technology intuitively and naturally for its main purpose. This purpose is often still to make our lives easier, and more comfortable.

2.2.2 Trends

From the previously described developments it becomes possible to identify trends that are taking place in the area of smart homes. In the next section I will try to identify common research goals and the areas in which research is being done in order to form a direction in which the smart home trends are leading us. First I will explain how the enormous amount of computers surrounding us is leading to the vision of ubiquitous computing becoming a reality. Next I will go into more detail on how intelligence will be incorporated into these large networks of devices. The last trend to be identified and described is the movement towards more intuitive and user friendly interfaces, making the user more capable of extracting the full potential of the technology that we will be using in the future.

Ubiquitous computing

From the technology perspective and the background of the current smart home we see a large trend towards ubiquitous computing becoming a reality. The vision of moving from a single computer being used by many people as was the case in the early days of computing, to the single user per computer, to the future of many computers serving a single user is very near. As stated in the paper 'Ambient technology – now you see it, now you don't' an average UK resident will come into contact with over a 100 embedded processors each day. These processors can be found in our mobile phones, laptops, TVs, washing machines, microwaves and often over 150 in modern cars alone [14]. Thus the trend in modern devices is that they are becoming more capable, more intelligent, and cheaper as time goes on. This also means we will be seeing these capabilities moving to devices that previously had no such functionality, like television sets with Ethernet connectivity as an example that is on the market today.

The next step is to make sure these capabilities become shared by the separate small computers. This means networking the devices together into a system that uses the capabilities of each device into one seamless system.

Ambient intelligence

There is a clear trend in device manufacturers in trying to get away from the box that does it all, into networked devices that are integrated into everyday objects and use each others information to combine into meaningful systems. This type of setup allows for new services to be offered and content to be shared between such devices. Emile Aarts, the vice president and scientific program director of Philips Research, says "these ambient intelligent environments will be context-aware, personalized and able to adapt to and even anticipate our wishes, needs and behaviors." In the book 'The New Everyday' he goes on to name the 5 key elements of ambient intelligence being; embedded, context-aware, personalized, adaptive and anticipatory. By doing so the electronics are moved to the background while the user is moved into the foreground. This means the user will not need to conform to the input devices such as TV remotes and computer mice, but devices will adapt to our form of interaction providing more intuitive input mechanisms. Ambient intelligence will provide systems with contextual awareness in order to provide us with applications that give us what we want, when we want it [15, 16].

Intuitive control interfaces

The need for intuitive control interfaces has grown with the increased complexity of new technology. The computer interface has not changed a lot since the introduction of the mouse and keyboard. The functionality of the personal computer on the other hand has changed dramatically. From modern games, to surfing the web, typing letters, and editing video. The change from one system that can do it all to networked, single purpose devices has also brought along an uncompleted change in control interfaces. The game console market is a place where the changes are clearly visible. Most controllers are in the form of a type of joy pad. Specialized controllers are for sale in every mayor electronics store such as steering wheels for racing games and fictitious weapons for first person shooting games.

The Nintendo Wii controller made a huge impact in the market bringing movements associated with sports a lot closer to reality. This also seems the trend with home automation. Although voice control might not be the solution to controlling everything in the home, a well organized digital music collection would be easy to control by asking the system to play everything in the jazz category, or a specific album for example. If one looks at the way the digital music collection in the iTunes store is organized, it becomes clear that it is not necessary to select your music selection from a screen. Philips has been developing the Uwand for quite some time. This device, comparable to the Wii remote in its sensing capabilities, could be used to point at a light and by pressing a button turning it on or off. By twisting the remote in your hand, the light could be dimmed. This same remote could be very useful in shopping online from the comfort of your couch. This would be achieved by controlling a pointer on your television set by simply pointing at a movie in a line up of different titles. This works much like the way the Wii remote moves the cursor over a screen. This interface has been distilled from watching people worldwide and seeing how certain hand gestures are interpreted universally.

Imagine turning up the volume of a certain speaker by simply pointing at it and turning the remote in your hand, or being able to put a DVD into a device and instead of having to flip switches or reconnect wires, you could simply drag and drop from your player to the screen you want to watch the movie on [17].

The trend can be described as moving towards intuitive forms of interaction, where the user is central and conforming to the input mechanisms of the device is no longer necessary. This would also mean a move to the truly universal remote instead of one which requires the user to switch between which appliance they are willing to manipulate.

2.2.3 The future

The smart home future seems one that is inevitable. People are bringing more technology into their house and expecting these components to work together seamlessly. Visions and scenarios of people controlling their home from a distance can be found in abundance. In these stories they can open the door for a plumber after he has rung the doorbell and they have received a live video feed of the doorbell camera on their mobile phone. When the home owner later arrives, the home was already expecting them and the heating and lights have come on automatically. The music is turned on with a simple voice command and the TV starts downloading the new pictures of your digital camera which is still in your

briefcase over the wireless network.

Sensors in your walls will continually track your movements and activities in your house so that there is no need to spend time turning on or off your lights. To continue watching your favorite TV series in your bedroom, you simply walk out of the living room and the series is paused until you are ready to watch the rest from the comfort of your bed. While you sleep, your appliances will come to life. They will consult their online databases for new software updates and pass on information on their status in case any problems are due to arrive. Through the combination of your appliances, and the way they are used, you will receive customized service offerings that apply specifically to your circumstances.

The large energy consuming devices such as your refrigerator, dish washing and clothes dryer will conclude on a schedule for the next day in order to minimize the peak load on your electricity consumption. Once these communications have taken place the machines, lights and thermostat will go into sleep mode, ready for the next day, and turn off all unnecessary activities and electronics in order to minimize the energy that would otherwise be wasted.

2.2.4 Trends and developments conclusion

The previous chapter concludes my findings of the trends, developments and future in the smart home domain. With this chapter it becomes possible to answer the second sub question in my research.

Domain description question 2:

What trends and developments do we see in the smart home?

- Large amounts of resources are being spent by different institutions in smart home research.
- Technology is not a lagging factor in making smart homes a reality.
- Control interfaces are being researched extensively and still need to improve in order to manage smart home systems intuitively and add to promised increased living comfort.
- Ubiquitous computing is rapidly becoming a reality, allowing for relatively cheap networked systems with large computational power and sensing abilities.
- Ambient intelligence and contextual awareness are necessary but still in their infancy for a complete smart home.

The future vision is one where people no longer conform to computers, but instead computers will accept natural human interaction, and appliances, computers and other electronics will be present by their capabilities and not their physical presence.

2.3 Uncertainties

The trends discussed in the smart home domain give us an indication of what the future is going to look like. There are however still a few areas of uncertainty that have not been answered by my research. Uncertainties are a risk when choices need to be made, and thus they will be explained here. They are not only in the form of what kind of technologies we will be using, but on which standards they will be based, and how the market is going to accept these changes into their home. This is the age-old question within new technologies if it is a market pull, or the technology push that leads the way for new technologies into our homes.

In this next section I will explain the areas in which the uncertainties are the greatest, this results in the answer to my final domain research sub-question. This information is based on the previous sub-chapters, and the expert interviews in appendix 3. More specifically, the interviews with Peter Maarten Westerhout, Jan Kroon, Rob Visser and Theo Mol were used as input.

2.3.1 Standards

Standards have always formed a place for uncertainties to arise. In the past standard wars like VHS vs. Betamax and more recently Blu-ray vs. HD-DVD are examples which form divides between companies trying to gain the standard. Currently this is not any different. Although it seems that DLNA, and UPnP are getting wide adoption for in home wired networking protocols, this is only a small area of smart home integration. Other areas like wireless low power consumption standards like ZigBee are only slowly gaining adoption, and a total home control protocol is currently often self written or property of the installation company like AMX or Crestron.

2.3.2 Push/pull

Another uncertainty is the market value of the complete smart home service. In this case it is not clear if the demand for this type of technological integration is being pushed by the producers of the different devices and services or if the consumers are ready and asking for a smart home. The high-end installation market shows that wealthy individuals have created a market where huge amounts of money are spent on home automation systems. As mentioned, these systems do not conform to the total view of the smart home concept I have explained but can be seen as demand for such services.

2.3.3 Integration

The last, largest and most challenging uncertainty lies in the integration on different smart home products and services. From the trends in the current developments discussed before it is clear that computer technology will surround us with cheap, more capable computers. At the same time, companies and institutions are working hard at developing user-friendly ways to operate these systems. Lastly the interconnectivity is allowing for intelligence to be generated and ambient and context aware systems to emerge. The main challenge thus remains how to integrate this whole concept into the home of the future. Not only the physical integration into current buildings plays a role, but also the integration of different sectors that are not currently used to work together is challenging. Not until the device manufacturers, telecom industry, energy suppliers, home builders and healthcare industry, to name a few, start to work together towards a common integrated solution the smart home remains a concept.

2.3.4 Uncertainties conclusion

The past chapter on the uncertainties is one that has been distilled from the previous 2 chapters about the smart home domain. This last chapter concludes the complete overview of the smart home domain and presents an answer to the last sub question regarding the smart home arena being;

Domain description question 3:

What uncertainties exist in the smart home future?

- There are still uncertainties regarding which standards will become accepted in different areas of the smart home. These include low power communication standards such as ZigBee and digital media and network protocols like DLNA and UPnP.
- Market demand is uncertain and the question of the right timing is critical since a lot of initiatives rely on a technology push to get the smart home accepted.
- The main uncertainty is the manner in which the huge amount of technology and possibilities will become integrated with each other. This encompasses the actual in home physical integration, as well as the organizational integration of companies with very different backgrounds having to work together to provide a complete solution.

2.4 Domain chapter conclusion

Here I present a summary of all the conclusions of the domain description chapter. Since the domain information gathered here will be a starting point for the next 2 chapters, this overview is necessary to provide a clear indication of the total smart home domain.

Currently, most homes are connected to a broadband connection allowing for a growing amount of new services. Through new standards, in combination with improved residential gateways and common home networks, the end-user is accustomed to the increased amount of technology and the services this can offer. The main issue today is the fact that most systems do only one thing, and do not integrate such things as lighting, heating, entertainment and security into one package. Systems that do integrate all these systems are extremely expensive and based on proprietary, closed technologies.

The trends and developments in the technology can be distilled from all the resources being spent on research by many different institutions. This points to a future where faster, cheaper, and intelligent computers will allow us to use them intuitively while large cheap networks keep an eye on our contextual environment.

The largest uncertainties in this future lie within the standards that are needed to make integration possible. Thus the integration itself remains an uncertainty as it is difficult to foresee companies from different backgrounds working together to deliver one smart home solution. Once this is all in place, it is still uncertain if the market is willing to accept all these changes into their home.

3 Futures research

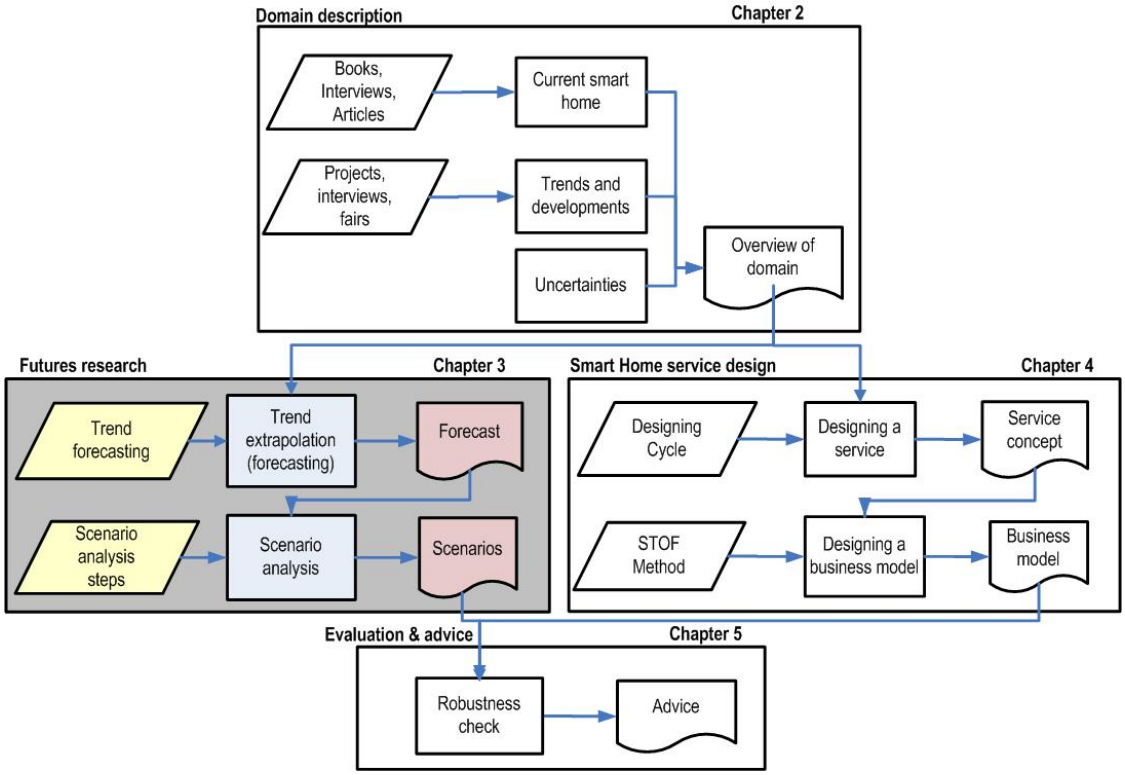
Why is it that we are still not living in a smart home? As my trend analysis shows, the smart home has been a research initiative for over 20 years. Why is the smart home still not a reality and what reason is there to believe that the current situation is different?

In this chapter I will be answering my future research sub-questions. First the question as to the methods which are most suitable to deal with the given uncertainties are answered. Next I will implement the methods and by doing so answer the two remaining futures research sub-questions.

It is interesting to look into the future, which is riddled with uncertainty, to see if this can help develop a robust business model. If an idea of the future of the smart home is known, it can greatly help to develop tactics in order to develop a viable strategy. While the trends are mainly based on technology changes, the futures research should also give an indication of surrounding influences over which KPN has no control. A way to deal with uncertainty is futures research. Futures research encompasses a group of methodologies, of which forecasting (or trend extrapolation) and scenarios are two commonly used methods [18].

In this case it is possible to use both methods of futures research. The remaining part of chapter 3 will dive deeper into the methodologies and their implementation.

The following picture gives insight as to which research questions this chapter answers.



3-1 Chapter 3 answers the futures research questions

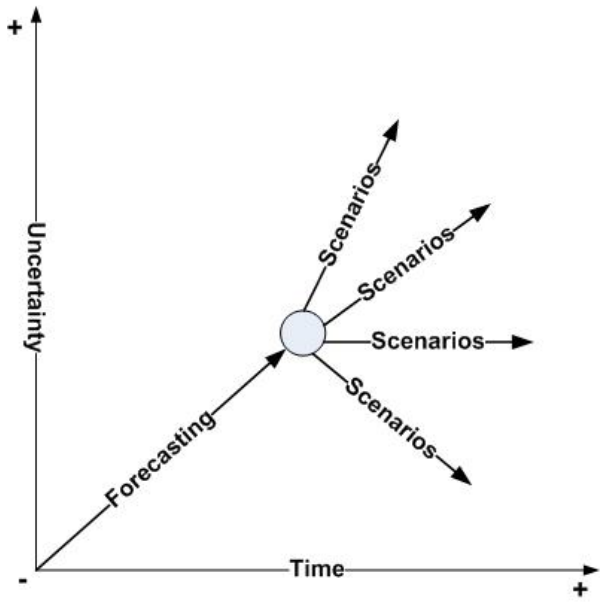
3.1 Futures research methods

The first sub-question asks which methods are to be used when dealing with named uncertainties in my domain.

The reason to use forecasting (or trend extrapolation) within a technological problem, is due to fundamental research in this domain being characterized by a number of general trends[19]. This is the case within my smart home domain and therefore the trend analysis which I have done in the previous domain chapter lend themselves very well to extrapolate and forecast into a future vision.

Next, scenarios will be generated to create a strategic insight into uncertainty. As input I will use the forecast made. "Technological forecasting provides valuable input for scenarios, as it is important to be aware of all the technical possibilities when constructing scenarios." [20] Another important reason to use scenarios is due to the increased amount of uncertainty outside of the technological domain. Within this research project it has become clear that a smart home does not solely rely on the technology to become available, but external factors play a role as well. Thus scenarios can shed light on various alternative futures. These futures will then be used in order to test the business models created with the STOF method in order to test their robustness at the end of my research.

In the following section I will go into more detail using the two methods, forecasting and scenarios, in order to analyze the uncertainty that the future holds. First I will explain the way in which the coming chapter will deal with uncertainty in general and on which theories this is based. The second section will explain trend extrapolation and my future vision. In section 3.3 scenario analyses will be explained and the scenarios generated.



3-2 Combination of both futures research methods[1]

[1] 20. Bouwman, H. and P.v.d. Duin, *Technological forecasting and scenarios matter: Research into the use of ICT in the home environment in 2010.* Foresight, 2003. **5**(4): p. 8-19.

3.1.1 Futures research methods conclusion

The previous section on futures research has given insight and an answer to the sub question related to this topic.

Futures research question 1:

What methods are to be used when dealing with uncertainty in the smart home domain?

- Trend forecasting is used in order to sketch a vision of the house in the future. From here it is suitable to use scenario analysis to form different futures in which to later test the business model for viability and robustness.

3.2 Trend forecasting

In my case, KPN is interested in the strategic choices it can make now in order to deliver services to the smart home of the future. This means that the first step is to identify the smart home of the future, and is called the 'future vision'. I will be using the data I have collected about the current smart home, the trends and developments, and the uncertainties in the smart home domain to extrapolate and make a forecast of what the future home will look like in the coming sub-chapter.

3.2.1 Forecasting the Future vision

The first step in developing a robust business model for the smart home from KPN's perspective has been to do a trend analysis of the smart home domain. In the previous chapters I have analyzed, explained and depicted the new technologies and the developments I see coming from these changes. The conclusions from these chapters are the answers to the following two questions

- What does the current smart home look like?
- What trends and developments do we see in the smart home?

It is the answers to these questions that are directly used in order to generate a vision of the home 10 years from now. They have been extrapolated from the following list of technologies and developments taken from conclusions of the domain research in chapter 2. Below I summarize the findings before going on to the future vision.

Current smart home technology

- Broadband access technology
- Residential gateways
- Home networks
- Standards such as UPnP and DLNA
- Home automation technology
- Home integration

Current smart home trends and developments

- New control interfaces
- Ubiquitous computing
- Ambient intelligence
- Natural human interaction with computers

3.2.2 Future vision

The next section will present the future vision as I see it based on the knowledge I have acquired. It is presented in a story-type section in order to make it more recognizable and realistic for the reader. Its goal is to present a realistic vision of what our future is going to look like.

Our homes in the future will be abundant with information. This information will be presented on screens which will be commonplace on all walls of our homes. Screens in the bathroom will show us the latest news while showering, or reminding people to take their medicine, while screens in the hallways can automatically show the holiday snapshots from your last vacation. Upon touching the screen or simply asking for further information the screen can provide you with the location and date the picture was taken. Screens in the living area will not only be used to watch movies but can also be used to have high definition video calls with loved ones across the globe. In the kitchen, screens will show you the family calendar, chore lists, or an interactive shopping list which the whole family can add to. Thus if the kids are at school and have had enough of the peanut butter sandwiches, they can propose to buy something different by sending a message to the digital shopping list. Mom can then check up on this list on her mobile device when she is in the supermarket, or simply check the list and press ok from her work and have the items delivered to their home. The same screens can later be used to watch cooking information while preparing the meal or video conferencing with the family on what time dinner will be served. These ultra thin, high definition flat screens will be in almost all our rooms, and unlike today, they will not mainly be used for entertainment purposes but also for information and communication purposes. Changing between screens will also become extremely easy allowing a person to continue a video conference while moving from one room to another or playing content on many screens simultaneously without having to flip switches or reconnect cables.

All these screens allow for information to be visualized very easily. The delivery of this information to the screens will also become easier then is currently possible. With Wi-Fi, and other wireless standards, screens will have no trouble finding content to be displayed. Personalized dashboards such as the ones on computers today will be provided giving people an easy interface from which to monitor their personal interests. The common information today such as sports news, stock prices, weather information and traffic updates will still be of interest but new information such as live electricity consumption and location based information on loved ones will become normal. This allows for much more user centric and user specific information being delivered then what we are currently used to. This allows for different advertising models with adverts of products we might really be interested in at that moment.

Through the easier interfaces and information, people will be better informed about their energy use and this will lead to better use of resources. Most homes in the future will be generating a part of the energy they are consuming and thus the general public will be much more conscious of the amount of energy they are using. The next generation of electronics are already being advertised with the efficiency and low power consumption as positive aspects. Led lighting, better isolated homes, smarter electrical products turning themselves completely off when not in use, and electrical schedules minimizing peak loads will all help to

consume less resources. Red or green glowing orbs that depict the amount of energy being used in comparison to neighbors have already shown to generate consciousness and can help in getting people to use less energy. Smart appliances will be doing their own shopping for energy online, finding the cheapest prices, this would make it possible for the fridge to wait till electricity prices drop in order to start the deep cooling cycle or the dryer to start its heavy usage process. A combination of more efficient products, more intelligent usage, better isolation, more aware consumers, and local generation of small amounts of electricity will all combine towards future homes using fewer resources.

The fact that computers are becoming cheaper and more powerful each year will lead to almost all products incorporating more processing power into devices. Our appliances will be connected to the internet 24 hours a day. Here they will download new software updates from their producers as our personal computers do today. Think of a washing machine going online to download new washing cycles, and even going to the local community site to find out the hardness of the water in your specific area. Other devices will be going online to find out the current price of electricity, and might even look into the weather forecast in order to decide to start heating the home, preparing for a cold front that is approaching. Our future machines will not only be using the internal networks to go online but also to communicate with each other. Installing a new machine will be as easy as plugging it into the electrical outlet. From here the machine will introduce itself to the network and install itself according to the other devices that are already in your network. Thus installing a new speaker set will automatically allow you to play music over them from your digital music player which is lying on the couch, or watch your favorite movie in full surround sound without connecting a single cable or having to change a configuration.

These intuitive controls will also be incorporated into the devices themselves. Changing channels on your TV won't need a remote control, and turning on a light can be achieved by simple pointing at it and snapping your fingers. This will be done by having all the devices around you use their information about the context of the situation. Lights will know it's dark in the house and be on alert when the front door senses you have entered. Tiny sensors know in which room you are situated and are constantly updating the network with your current movements. The kitchen will start the oven if it sees that you have taken a frozen pizza from the freezer. Mood lighting, music settings and television channels will all be able to be set by saying a certain keyword, or even guessing the setting you are most in need of in the current situation.

Your home will be aware of your location and context, so it can start heating your bedroom 30 minutes before it senses you have started your going to bed routine. In the morning, your alarm clock will tell the coffee machine what time it needs to start brewing a fresh batch, or even the bath tub to run a hot bath. Your robotic lawnmower and vacuum cleaner will wait till you have left the house to start doing their chores in order not to ever bother you with their cleaning. If you are coming home early, your mobile phone signals its approach and lets your home know that you are on your way. If you are on a phone call over the speaker phone system in your car, simply parking the car and walking into your home will allow you to continue the conversation over the speakers in your house. If there happens to be someone at home making a lot of noise, or if it is an important business call, the call will be automatically put on hold until you pick it up on your

mobile phone or one of the handheld devices you have at home. All this will be possible due to stronger processors and the intelligent systems running on them. The surrounding information gained from the devices communicating with one another over the abundant networks will supply enough contextual information that the best service is provided in the given circumstances.

With all these new smart devices in place, the actual complexity has increased while the intelligence built into the systems demands less knowledgeable consumers. In the future situation, fixing problems within the network or within specific devices will be something that can be done from a distance, dramatically reducing truck rolls. Companies can ask for updates from their devices in order to find out if certain parts are wearing down or if reservoirs need refilling. If this is the case the owner can be notified through email or mobile phone and a video displayed on the nearest screen explaining how to refill the salt content in the dish washer or clean the filter in the washing machine to fix the problem.

All this information is routed into the home through the residential gateway which has grown into a large hub between the outside world and the internal network. This gateway now provides the connection to the high bandwidth glass fiber connection provided by the internet service provider. This delivers high definition video, music and other entertainment services. Another service this gateway provides is user information on electricity, gas and water usage to the utility providers. With this information these networks can increase their efficiency and provide new services increasing the customer's awareness. The residential gateway will also coordinate the internal network, keeping track of all the devices you own and their communication links. It is also the storage device for all the stored digital content in the home. Once videos, pictures, and music is all centrally located all devices within the home can reach the same content in order to provide the owner with all their data in any place all the time. This also allows for the consumer to reach their data over the internet while they are on the road. Later this storage might move up the fast access line to the internet service provider giving the customer a safe back up location of all their data in the virtual cloud. The residential gateway will provide the safety features keeping the devices in the internal networks safe, while allowing the needed content to pass on through. Thus the future will see a growth in the importance and functionality of the residential gateway as a control center, storage device and safety net for the future home.

All these changes in the future home will lead to explosive and massive amounts of data to be transferred within, to and from the home. Imagine the bandwidth capacities needed to have online backups of a family's music, photo and video collection. Live high definition video conferences, video on demand services and online gaming all taking place simultaneously will be possible with next generation networks. In the meantime, appliances will be downloading and communicating with their manufacturers for updates and status information while energy companies will be maximizing the potential of their networks through the live usage information they are pulling from your devices. Thus data connections will not only be used for internet, television and voice communications as they are today. The current services will become more bandwidth hungry, while a whole new source of data requirements will sprout from devices going online and communicating with each other.

The changes that are coming our way in the future pave the way for the development of new services. Not only new services for consumers such as video on demand services which are only now becoming mainstream. But the future also holds many chances for services for companies willing to pay network operators in order to gain access to their customers and provide a better experience by updating and servicing their products. All this information will also lead to a huge amount of data for which advertising and data mining companies will be willing to pay in order to find out about their customers and the way they use their machines and the combinations of devices they tend to have in their homes. Obviously there is also a huge demand for capacity since most of these new technologies need internet connectivity, and this being the case simultaneously for many devices in the house.

3.2.3 Trend forecasting conclusion

Futures research question 2:

What is the forecast of the future smart home?

- The Trend forecast is in line with the smart home domain description and indicates an increased amount of technology in the home accompanied by complex services. The future within the technology can be described due to the extrapolation of the areas in which organizations are currently investing their resources. Within this forecast it should also be obvious that the technology itself is not the limiting factor, instead the usage and services are.

3.3 Scenario analysis

In this sub-chapter I will be using the trend forecast created from the extrapolation of my domain chapter and using this as input for the scenario analysis. The method being used for this chapter will be from the book by Peter Schwartz which includes a step by step guide to building scenarios. This then forms a point where scenario analysis continues my futures research where trend extrapolation has left off.

Scenario analysis is a way to look into an uncertain future. "The art of the Long View", peter Schwartz's famous book gives a step-by-step guide into the use of scenario analysis. In this book he also claims that scenario analysis is not only useful for huge companies such as the famous Shell and AT&T scenarios, but can help smaller companies and even individuals make strategic decisions on an uncertain future.

Scenario analysis will bring insight into the increased amount of uncertainty where the future vision has left off. Scenario analysis can be performed by following a number of steps in order to generate the scenario logic, the scenarios themselves, and to perform the evaluation in the end. These steps have been performed below. Where possible I have used expert opinions and discussions to generate and evaluate outcomes.

I have left out the last two steps, namely 'indications' and 'selection of leading indicators and signposts'. The reason is that these steps overlap with the last steps in developing a business model with the STOF method. For this research purpose the steps in the STOF method are better suited for developing a robust strategy and more exhaustive in checking for robustness in combination with the scenarios.

3.3.1 Scenario steps

From here I will present the scenario analysis starting with the first step.

Identify focal issue or decision

The first step is to define the focal issue or decision that needs to be taken. The focal issue in this case is the developments surrounding the smart home and the best way for KPN to deal with these circumstances in the future. It then becomes important to see which different futures really have an effect in the choices KPN should make. These are the differences I want to be focusing on. In this case the focus on the technological trend has already been covered by the forecast in the previous chapter.

Thus the main question is what KPN needs to do in the future to gain business from the smart home when it has become a reality. The issue can then be seen as 'which business model fits the future situation best'. This first step has already been taken in the beginning of this research, where the main research question is very similar to the focal issue.

3.3.2 Key factors and driving forces

Here the second and third steps are taken.

Key factors in the local environment

The second step requires me to list the key factors that influence the success or failure of the focal issue or decision in the first step. Thus these are influences from the environment, which will shape the outcome of the decisions to be made. These key factors have been identified and evaluated with two experts, Edgar van Boven en Nico van Belleghem, from KPN, more details can be found in appendix 3.

The first key factor in the local environment is **disruptive technologies**. As we have seen in the past with other forms of disruptive technologies, speedy and unannounced innovations can change markets in unexpected ways. Thus if one is able to somehow prepare for unexpected innovations the chances that these will completely throw a company off will be minimized. If surrounding companies are innovating at blistering speeds, the need for a service delivery company like KPN to keep up will increase.

The second key factor is named **integration**. This factor implies that integration of different technologies is needed in order to make the smart home a reality. If this continues to fail, the future of smart homes is an uncertain one. Thus the manufacturers and developers need to work together to generate solutions to find synergies and added value by working together. This also implies integrating this technology into the home, both newly built and existing houses.

A third key factor in the local environment is the **complexity of technology**. If this continues to increase, it will become unusable for the average consumer. If this is the case the smart home might never materialize, unless a huge growth is seen in firms offering services to deal with this complexity.

The **economic situation** will also be a key factor in the local environment. Not only is it of importance to the amount of consumer spending, but it will have an effect on the amount of developments taking place in the technology needed for the smart home due to demand.

The **type of home** makes a difference in the issue at hand. The differences between a new house and an old house can greatly reduce the options of smart technologies that can be implemented. The type of house will influence the choices made by the residents of that house.

Another key factor is user **usefulness**. In this case it is important to see if people actually think all these new technologies in their home will add to a better living environment. Some people might also come to think of some of these technologies as a necessity as time goes on, as is already the case with general internet connectivity.

The last key factor in the local environment is **demographics**. Demographic differences such as the amount of young couples living together or the amount of people over 65 can be a great influence on the adoption of the smart home. Parents living with small children will want and need different things from the future home then a single retired person. Thus this last key factor should not be forgotten in the scenario making process.

Driving forces

The next step in generating scenarios consists of finding the driving forces in the larger environment. These are the drivers behind the key factors listed in the previous paragraph. In a way these are also the forces which form when combining or clustering the previously mentioned key factors. Since clustering the surrounding influences into larger driving forces, these can be seen as the most uncertain areas of the environment which have an affect on the decisions made. For this reason the driving forces named here should be closely related to the main uncertainties identified in my domain chapter (chapter 2). These were the Push/pull uncertainty, the uncertainty surrounding the different standards and the integration uncertainty. These driving forces have been identified and evaluated with the same experts identified in the previous step on which more information can be found in the third appendix.

The first driving force can be named **consumer demand**. This is directly related to the Push/pull uncertainty named in chapter 6. This force also encompasses the key factors named 'economic situation' and 'user usefulness'. This means that if people actually want a product because they find it useful and they have the money to buy these products, the consumer demand increases. Consumer demand is a great stimulation for new technologies, as we often see the sector pushing new technologies without the consumers having ever asked for them. Even with technology push huge markets have been created. Having a high demand from the consumer side for smart home technologies would have a huge effect on the developments in this market. The 2 key factors named demographics and type of household also fit into the consumer demand driver. These two categories in type of consumers show what kind of factors play a role in demand. Thus the driving force named consumer demand is dependent on 4 named key factors including the person's age, their type of household, the products usefulness and the economic situation in which the consumer finds themselves.

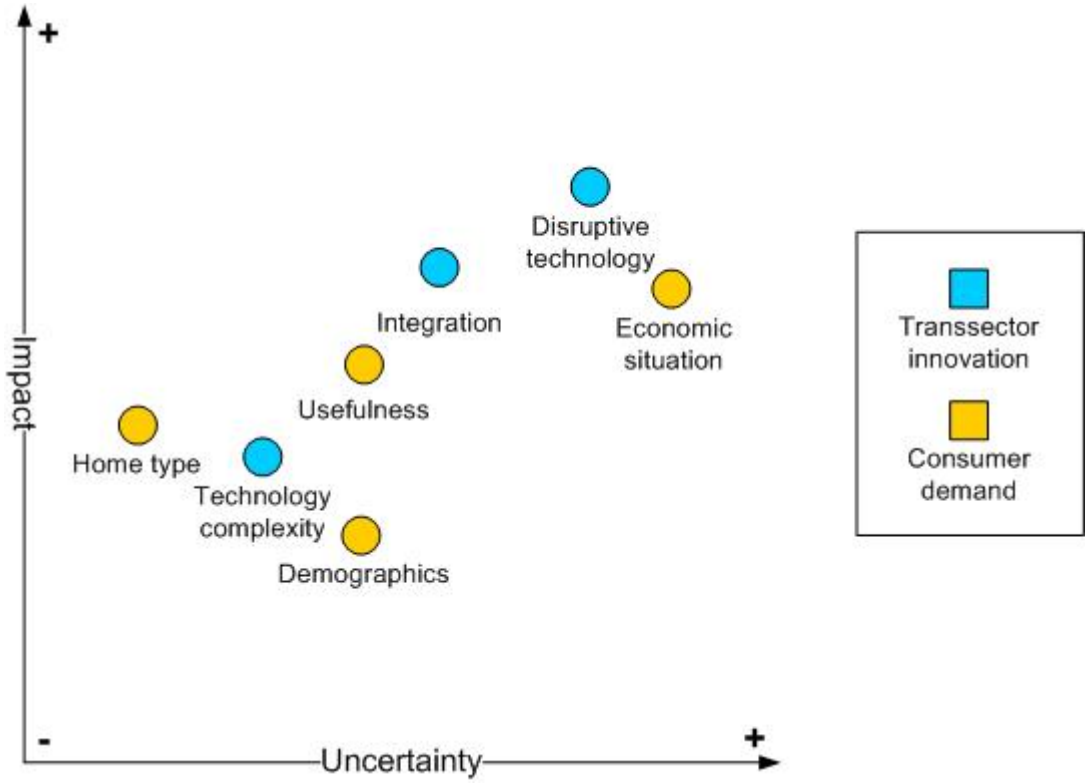
The larger driver in which disruptive technology, integration, and technology complexity are bundled into one is called **transsector innovation**. All these factors are of influence on the technology needed to make the smart home a possibility. These factors are also closely linked to the 2 uncertainties named in chapter 2, standards and integration. Standards are closely linked to technology complexity and the way they work together. Thus these all form a single uncertain element. Transsector innovation encompasses these elements by explaining the need for different types of companies to confirm on technology in order to decrease complexity and form standards. Only this will allow for integration of these systems, not only into the home itself, but within the different aspects of the home. Transsector innovation is also a place from which disruptive technology often sprouts as it breaks current frames of mind and single solution thinking. Transsector innovation takes place when firms decide to become transparent and share information creating a new innovation and a win-win situation. Thus with more transsector innovation taking place this increases the possibilities for the smart home.

Rank by importance and uncertainty

Having found the key factors and having categorized these into the main driving forces it now becomes important to plot these onto a framework to find the most important factors. This gives an indication of which factors are of greatest influence on the surroundings within their driving force, in order to vary the scenarios within the 2 main driving forces.

The ranking procedure is based on the level of importance a factor has, otherwise seen as its impact. The second criterion is the uncertainty factor. Thus factors with the largest amount of uncertainty while having the largest impact will be most important to include in the scenarios and form the axes of the scenario logic in the next step.

In this case I have plotted the key factors relative to each other as circles in the criteria matrix. The plotting was conducted with the help of experts Edgar van Boven and Nico van Belleghem, later, this was evaluated by another expert, Nico Baken. Further information regarding the sessions with regards to these experts can be found in the third appendix.



3-3 Key factors plotted in the matrix

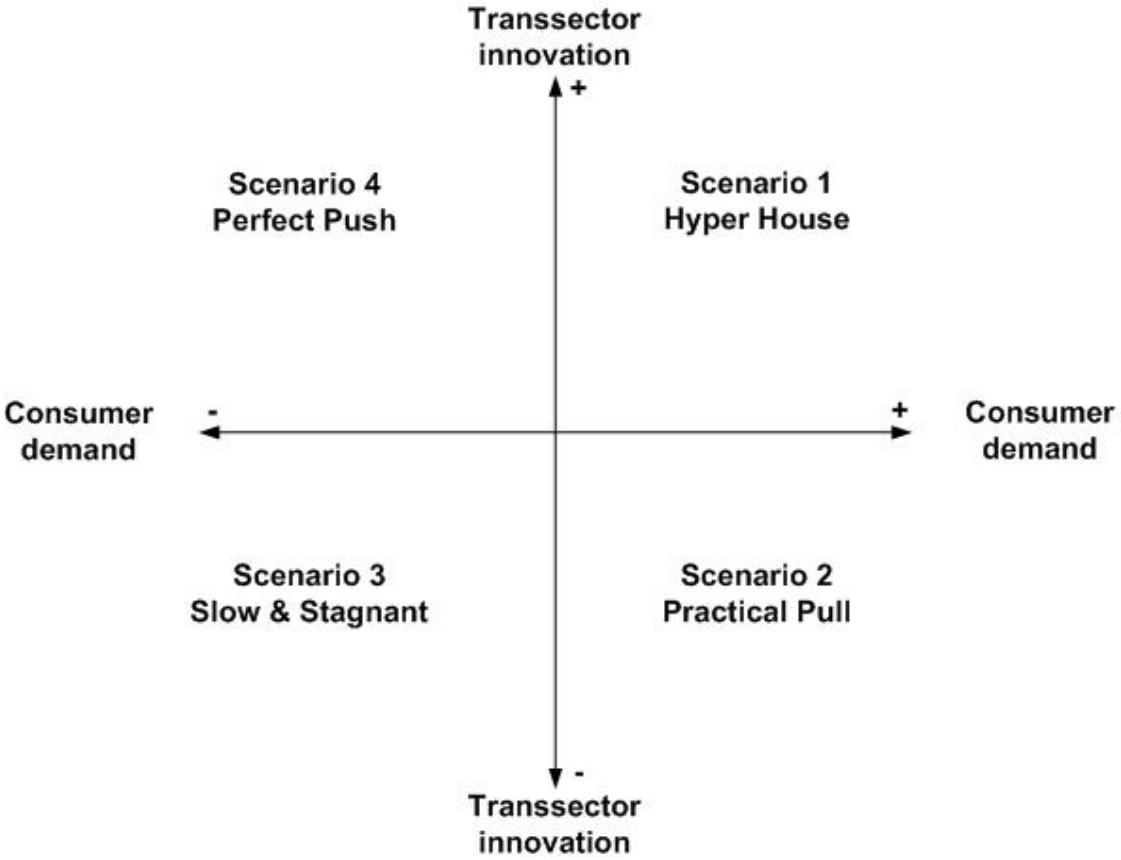
Here we see that the factor **disruptive technology** has the greatest impact on the smart home while also being the most uncertain. This is because disruptive technology can change the playing field in a short amount of time. This also implicates the high level of uncertainty disruptive technology scores since it is hard to predict when these changes will take place. The **economic situation** has a large impact in the uncertainty of the smart home becoming a reality since it is both a stimulus for the industry to develop new technology and the consumers to buy and use the new products and services. The economic situation also has a large impact on the chances of the smart home becoming a reality and the rate at which this will happen.

The **type of home** the consumer is living in forms the lowest uncertainty. This is due to the fact that the amount of houses being newly built can be found relatively easily and the amount of existing houses is known. The impact this factor has, is that it is much more difficult to install smart home technologies in existing houses and these form the largest part of the market. With **demographics** it is the other way around. The impact is relatively low since it is easier to find the smart home technologies in demand by the different groups of individuals. The uncertainty on the other hand is larger since the data regarding the different demographic groups is less certain and can change faster then the type of homes.

The **integration** factor scores relatively strong on impact since it is crucial to the innovation and actual probability of the smart home becoming a reality. Integration can be seen as a necessary aspect in order to get the smart home to become mainstream. It is however also uncertain if this is going to happen, and might need a lot of coercing firms to join resources in order to make it possible. The factor **usefulness** scores in the same area since it is as important that consumers find the new products and services valuable in order to make them viable. The last factor, the **complexity of the technology** does have impact, but as is the case today, people manage to work with it and are becoming more knowledgeable thus increasing its total impact on the smart home. Looking at the trends in the technology, the uncertainty is not as great as other factors since it is on its way to being managed by the technology itself.

Selecting scenario logic

The next step in developing scenarios is to build the actual scenario logic framework. This consists of the axes on which the main driving forces are plotted in order to find the extremes for which to write scenarios. In my case the use of transsector innovation on one axis and consumer demand on the other will lead to 4 separate scenarios that include the extreme combinations of these drivers. It is important not to forget the key factors I have identified in the previous steps. When developing the actual scenarios themselves it is very useful to use the key focal points to vary the scenarios in more ways then just the extremes in the scenario logic framework. By doing this the scenarios cover a greater scala of theoretical possibilities. Furthermore by covering an increased amount of possibilities the robustness check will be more accurate in a later stage.



3-4 Scenario logic matrix

This picture depicts the scenario logic for the driving forces that have been distilled from following the previous steps. It is clear that the different key factors each fall within the scope of one of the 2 driving forces. In this case the scenarios have yet to be filled in. This will be done in the next step.

3.3.3 Scenarios

In this step the actual scenarios have been written. This is based on the scenario logic framework from the previous steps. As mentioned in the previous paragraph, it is important to not only look at the extremes of the axes to come up with the 4 scenarios. By including the list of key factors within the scenarios where they add the most differentiation, 4 truly different scenarios are made that cover most possibilities in the future. The 4 scenarios are described below.

Scenario 1: Hyper House

In this first scenario the home is inundated with technology. The rapid speed at which companies have been working together has brought on a huge increase in disruptive, new technologies. Firms from completely different areas have been joining forces to invent new products which consumers are taking up immediately. The huge complexity of these systems has left consumers no clue as to what is going on in the background, just like many people not knowing what goes on under the hood of their car. What has led to this huge success is the fact that the complexity is increasingly being managed by the systems themselves as machines interconnect and communicate with each other over wired and wireless mesh networks. Consumers are spending more than ever of the household budget on technology as the prices have fallen and people are spending less on entertainment outside of the home. Instead of going to the movies people watch them in high definition streaming from the internet. Vacations to far away destinations are forgotten as people spend time playing online simulation sport games with their friends. Everybody has an online back up service which allows them to show their friends their party pictures while over at each others house without the need to bring them digitally. Everything from software, to music and private pictures and video files are in the so called cloud, where they are accessible at any time, any where on one of many different devices. People are spending less time out of their house going to work. Instead they are using the technology to simulate a working environment, having live video feeds of their colleagues on the screens surrounding them. Elderly people are using this technology to contact their relatives, and in case of a more serious problem, their doctors.

The home consumer can be called a prosumer, producing information, electricity, and added value services from their own homes. What all this brings is a huge flow of information, not only into the home, as many sources are downloading high definition content, music, updates, and location based information, but also upstream as devices are uploading information to their manufacturers and people are having worldwide video conferences. Electrical appliances will continually be uploading their electrical needs, and asking for the current energy prices in order to maximize their efficiency. All the money being saved on efficiency gains is being spent on digital services and high bandwidth access to the internet in order to be able to operate all these services. The one main problem remains, once something breaks down, nobody knows how to fix it and every service provider and device manufacturer point the other way. The one thing that hasn't changed is having to call your nephew in order to fix all your technology.

Scenario 2: Practical pull

In this scenario, named practical pull the main incentive for buying new technology is coming from the consumer side. Consumers are well informed and knowledgeable about the benefits new technology can bring them. These benefits

are usually simply increasing living comfort, while other new technologies allow for people to have more free time instead of doing daily chores. The average consumer is financially strong and willing to buy new devices and services. The main problem is that manufacturers are not equipped to deal with this demand. The innovation of new products has lost its pace due to firms not wanting to work together. Each company has their own protocols and wants the user to spend all their money on their product line. Devices and services are not interoperable and this has slowed innovation. People are locked into their previous products and continue to spend money on that single brand in order to gain from small service and product upgrades, without having to change their whole setup. Once a user has decided to stick with a single manufacturer their products use the internet connection to collect data on their customers and to deliver the service into their home. The focus in this scenario lies mainly with entertainment services and products since other areas have not innovated to bring new services such as healthcare, safety and energy saving solutions to common problems. In this case the chances are there, but no single company in this industry is able to gain enough market share on their own to make such services viable.

Scenario 3: Perfect push

In this scenario companies are increasingly being pushed towards new products and fast innovation. The market is changing rapidly with what is available but consumers are being very picky. Demand for extreme changes in the household is not high. Firms are doing their best to come up with hugely innovative products and services in order to create a market for their products. The consumer is focused on lowering their cost of living and is only interested in changes which help them out of the financial doldrums. Innovations which are being sold come in the form of energy efficient products and services which pay themselves back in a matter of years. This is either done by keeping the user updated on their current use of resources in order to minimize their costs, or producing their own energy to sell back to the grid. Technology is having to innovate towards highly efficient systems working together and being interoperable in order to get the most out of the expensive commodities such as gas, water and electricity. Low power sensors linked to mesh networks follow people around in their homes turning on and off appliances, heaters and other devices in order to spend less on these resources and only when the savings that can be gained are clear, are consumers willing to buy these systems. In other words, firms will have to be extremely efficient and innovative in order to sell their products to the wary and informed consumer.

Scenario 4: Slow and Stagnant

In this last scenario innovation and consumer demand are at their lowest point. Companies are not willing to work together to come up with innovative technologies and integration of different systems is cumbersome and expensive. Due to the economic situation, the demand from the consumer side is very small, and people are not seeing the added value these smart home services could bring to their lives. A growing population of elderly people has shown absolutely no interest in technological solutions to increase their livelihood. Even if this was the case, the installation of these systems in older type homes have proven to be more expensive then previously calculated. It will be extremely difficult to supply smarty home service in such circumstances, and even the basic services KPN is offering are selling with a small margin.

3.3.4 Evaluation steps

Schwartz names the seventh and eight steps as 'implications' and 'Selection of leading indicators and signposts'. As mentioned before, these steps have not been used, since the steps in the STOF method offer similar, yet more exhaustive way of checking for robustness in the developed strategy.

3.3.5 Scenario analysis conclusion

Futures research question 3:

What are the smart home scenarios and what do they provide?

The scenario analysis steps have led to 4 scenarios, based on 2 driving forces and their respective key factors. These are expressed below.

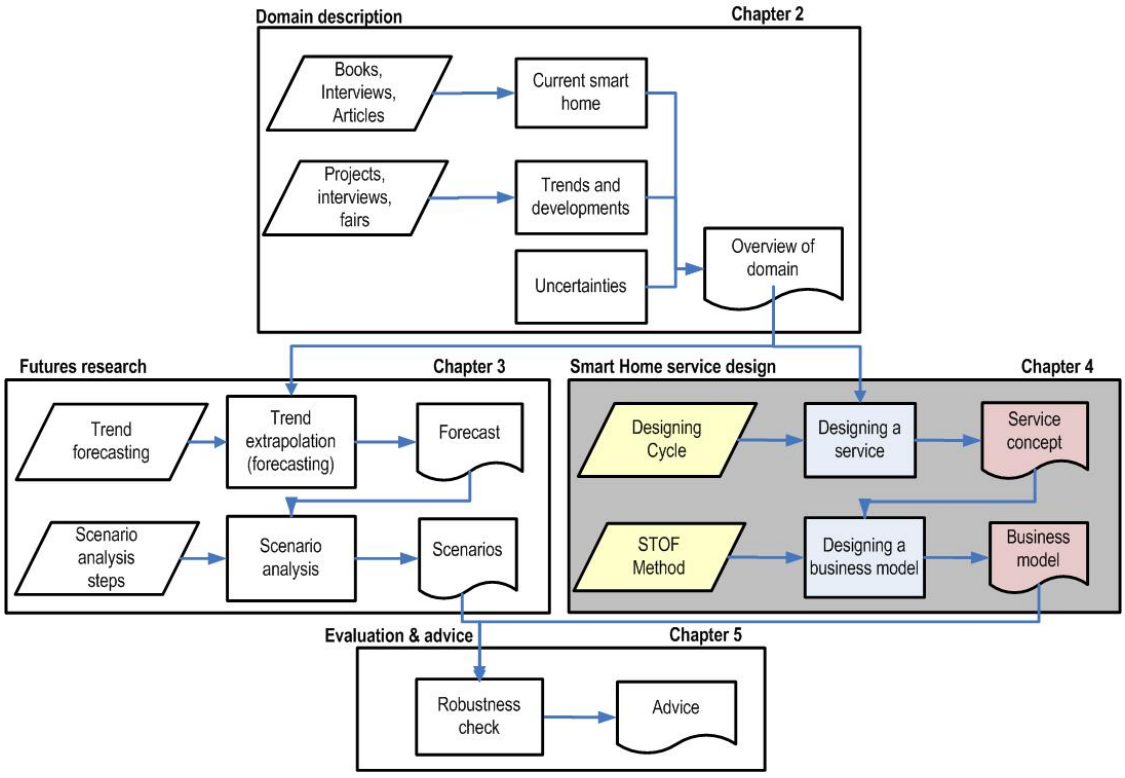
- The scenarios analysis has found the following key factors clustered into the main driving forces
  - Driving force: Transsector innovation is based around organizations from different sectors working together to break with current incremental innovations. These key factors are;
    - Disruptive technology: technologies which cause major changes within the industry.
    - Integration: the integration of different technologies and devices working together
    - Technology complexity: the complexity of such things as in-home networks and the devices that use them.
  - Driving force: Consumer demand is based around the factors that tell us if users are eager to use and purchase new products. This force is made up of the following factors;
    - Economic situation: the current situation in which the economy finds itself.
    - Usefulness: the need and use people see in these products.
    - Home type: old or newly build homes.
    - Demographics: average user age.
- The 4 scenarios based around the 2 driving factors as the main axes are:
  - Hyper house: Here trans-sector innovation and consumer demand are both very high, leading to fast innovation and consumer adoption
  - Practical pull: here the consumer demand is high and transsector innovation is at a low point. This leads to consumers demanding integrated solutions the market cannot create since organizations continue to innovate within their own domain.
  - Perfect push: In this scenario companies are innovating together based on open platforms and sharing of information. Consumers are not very interested in new technologies as the economic downturn does not allow for large consumer spending. Only innovative and cost cutting services can be pushed into the market.
  - Slow and stagnant: This scenario has a gloomy outlook where innovation is taking place nodally within the stovepipes companies are currently in. To make matters worse, consumers are not in the mood for new technology, being especially critical of the things the current market is producing.

4 Smart home service design

In this section it should become clear which service design methodologies exist and which method is most usable for the design question at hand, creating a service concept for KPN. The most suitable design methodology will be chosen and the approach this method offers will be explained. This is the first step in designing a business model. This is to say that without a service concept there is no starting point to design a business model. Thus once a service concept has been designed a corresponding business model approach needs to be realized to eventually lead to a service that has added value to the customers and KPN. The input for the services to be designed comes from the domain research performed in the first section of this thesis and the interviews with experts from KPN. This forms the surroundings in which the service is to be provided.

I will go into detail on the theoretical design methods in sub-chapter 4.1 and answer the corresponding sub-question. The following sub-chapter will use the found method to develop a service concept. Sub-chapter 4.3 will provide an implementation of the business model design in order to give a concise answer to the third sub-question in this section.

The following picture shows which research questions will be answered in chapter 4.



4-1 Chapter 4 answers the service design research questions

4.1 Design approaches

In my research I am looking for a way to design a service concept for the smart home for KPN. In the search for a viable business model the start is often with a market vision or a technological capability[21]. This market vision or technological capability is embodied by my forecast and scenarios, which serve as input in this design. In this case, as can be seen from the previous trends and developments, it is both. The market for smart homes is growing and the technology is becoming more capable of providing the vision of a truly smart home concept. To gain new business from these developments the first step is to design services surrounding the smart home from KPN's future perspective. Although service design is relatively new in the field of design, product design is something that has been around for a longer period of time[22].

The difference between a service and a product most often named is the intangible aspect of a service [11]. Another aspect, often overlooked in the difference between the two, is that a service is consumed at the same time as it is produced [23] [11]. This leaves us with a working definition of a service as mentioned in 'Mobile Service Innovation and business models' taken from Grönroos '*a process consisting of a series of more or less intangible activities that normally, but not necessarily, take place in interactions between the customer and service employees and/or physical resources or goods and/or systems of the service provider, which are provided as solutions to customer problems.'*

Now that the differences between a product and a service have been clarified, and a definition of a service is given, the need for a service oriented design approach needs to be fulfilled. Product development methods can be found within companies based on their own models or generally accepted innovation methodologies. With service design there does not seem to be a consensus, and many different approaches can be found [24]. For this reason I have chosen a method that does not focus on designing a service in particular, but takes a general approach to designing. This is due to the fact that I do not know beforehand if the conclusion of my design is closer to the definition of a product, a service or even a bundle of services.

In 'Evaluation in Design-Oriented Research' Verschuren and Hartog have made a systematic inventory of design processes and from this they have prescribed a set of six stages of a designing cycle. These stages provide a roadmap with which it is possible to develop a first hunch service idea through iterations and evaluation into a conceptual service idea. By combining design literature from different fields, Verschuren and Hartog have formulated a designing cycle which can be used as a framework in any type of design case. For my specific research I will be using the first 3 steps of their method. In the following section I will be explaining all the steps in the Verschuren and Hartog design methodology.

4.1.1 Service design method

In their research Verschuren and Hartog defined the first stage of the designing cycle as the first hunch. They name the most important part of this first step as defining a set of goals [G] that the product of the design should fulfill.

The second step, called requirements and assumptions, asks for a set of requirements [R] to be made around the set of goals [G] made in the previous stage. These requirements can then be subdivided into functional requirements

[Rf], user requirements [Ru] and contextual requirements [Rc]. Next to requirements which specify the desires of the service, the second stage asks for a set of assumptions [A] which should fulfill the qualities the service should offer. The assumptions are also subdivided in the same categories as the requirements. Namely; user assumptions [Au], contextual assumptions [Ac], and the functional assumptions [Af].

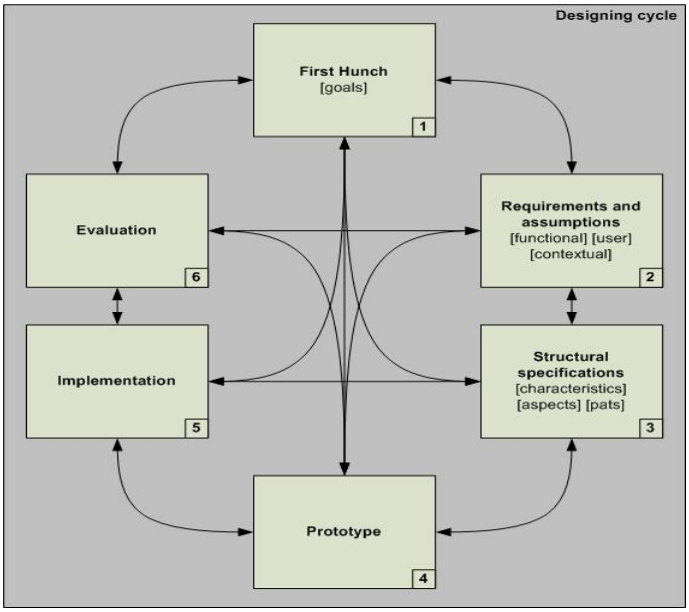
The third stage is designed to encompass the previously made requirements [R] and assumptions [A]. This is done in the form of so called structural specifications [S]. These structural specifications are composed of the characteristics, aspects and parts that the object to be designed must have.

The fourth stage is realizing or materializing the artifact into a prototype. This stage is simply named prototype, and requires the designer to clarify if all the structural specifications [S] from the previous step have remained intact. If this is not the case the changes have to be named and a reason has to be given for the either logical or functional changes.

The next stage requires the designer to put the prototype through its paces, and is aptly called implementation. This means having the prototype operate in a real world situation in order to perform the first steps towards the last stage.

This next, and last stage is the so called evaluation stage. Here iteration takes place and the prototype is revised according to the goals [G] from the first stage.

The designing cycle must be seen as an iterative process throughout all the steps.



4-2 Design cycle steps, and its iterative nature[2]

This research is looking to design a business model for a service to be offered to the smart home in the future from KPN's perspective. A large factor in this case is the uncertainty which the future holds about the type of specific services which

[2] 22. Verschuren, P. and R. Hartog, *Evaluation in Design-Oriented Research.* Quality and Quantity, 2005. **39**(6): p. 733-762.

can be offered. This is the first reason why I will only be using the first 3 stages of the design method named above. In the futures research I have performed I give guidelines as to what the future may hold. These do not offer enough specifications in order to go any further than the third step of this method. Furthermore, and thus the second reason why I will only use the first 3 steps comes from the conclusion made by the authors of this design methodology. "Design processes can be unraveled in a number of stages. Each stage should be evaluated with respect to designing rules and research methodologies on the one hand, and to the results (product) of this stage on the other." [22] This gives me a reason to unravel their method into its first 3 stages. These 3 steps will then leave me with a service concept based on the domain research which is what I need as input for the STOF method. I am expecting to develop 3 to 4 service ideas or concepts with my domain research as input and the named design theory as a method.

4.1.2 Business model design method

As mentioned in the previous section, a service concept is a starting point from which to create a business model for the specific service. Thus, it becomes important to look at the different types of business models in order to choose one that fits the service.

At this point, the service does not yet exist, but it is possible to look at the domain in which this service is to be provided in order to select a business model.

One obvious factor surrounding the provision of a smart home service is the technological aspect of such a service. This is not only due to the fact that these services are built on relatively new technological systems and networks, but also that the provider of this service is a telecom operator which has dynamically positioned itself into providing more services such as television and internet. So a business model theory which has been built around an information and communications technology perspective is ideal for such a service concept. Furthermore, as we have seen from the uncertainties in the future of smart homes, interoperability is a large key aspect of the future of smart homes. This means that providing a smart home service is not simply an offer one company can make alone. Instead, for providing such a service KPN has to work in a network of organizations with which they may previously have had no connections. For this reason it is important that these uncertainties and challenges are incorporated into the business model theory in order to create a successful one.

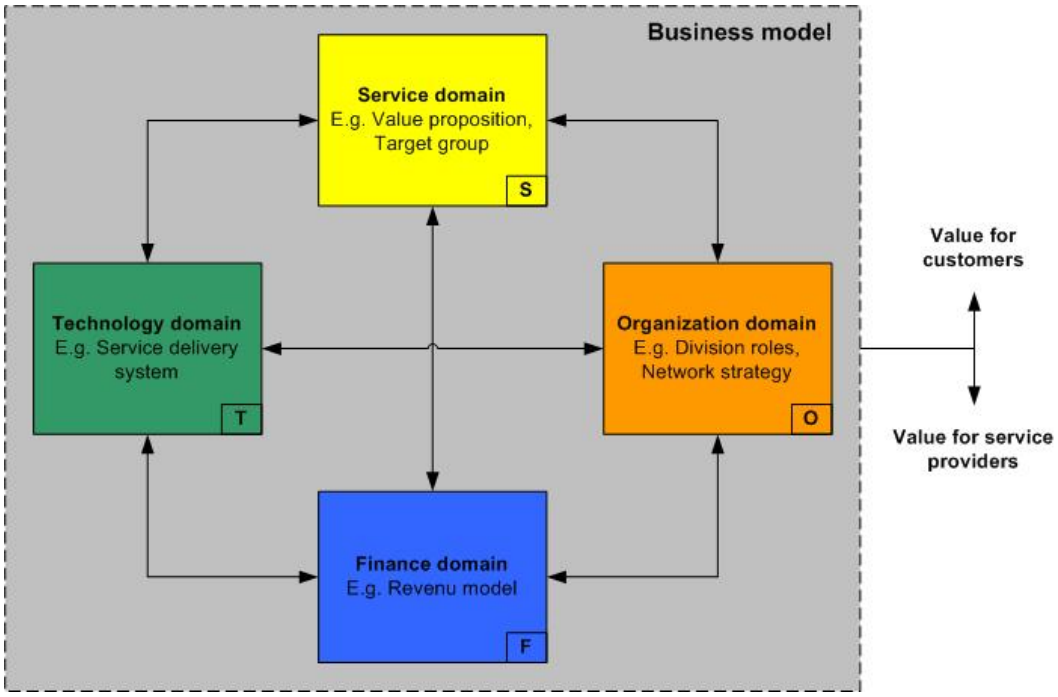
This then leaves me with the need for a business model theory in which information and communication technology is the underlying enabler of the service, and which also incorporates other organizations which cannot be left out in order to provide a smart home service.

The criteria from the previous paragraphs have led me to the following business model. The STOF business model, developed around business models for mobile services, names itself as focusing on "all kinds of innovative services that combine technologies and concepts from the area of telecommunications, information technology and consumer electronics". Furthermore this model also developed a framework for designing a business model in the form of the STOF method. These two reasons make the STOF model a very practical and logical choice from which

to design a business model for a service concept for KPN. The second aspect which was named in finding a relevant business model theory, was the multi actor environment in which a smart home service takes place. To realize why the STOF model fits this requirement a deeper understanding of the STOF model is necessary.

The STOF model

The STOF model has been designed through an iterative process in which case studies and literature on business model research played a key role. This process led to the term STOF which incorporates the most important elements in the model. These signify Service, Technology, Organization, and Finance.



4-3 Schematic representation of the STOF model[3]

In short, the service aspect defines the critical success factors needed to provide a service that has added value to the customer.

Next, the technology aspects of the model define the technological requirements the service offering needs. As is obvious from a smart home service, technology plays a key role in the way this service is provided and enabled by the service provider. This section encompasses the technology architecture, infrastructures, platforms, devices, data and applications which have been reviewed in the domain specification in the first chapters of this thesis.

The organization domain of the STOF model is where the collaboration with other organizations is integrated into the model. As mentioned in the uncertainties within the smart home domain, interoperability of a smart home service will be essential and thus a large interaction with other players is inevitable. Apart from the other organizations which will need to play a role, the organization domain

[3] 11. Bouwman, H., H.d. Vos, and T. Haaker, *Mobile Service Innovation and Business models*. Vol. 1. 2008, Berlin: Springer.

also includes the resources and capabilities the organization itself, KPN in this case, must provide.

The finance domain in the STOF model defines the financial arrangements such as the investment decisions and revenue models behind the service concept. In other words, the financial aspect covers the costs and revenues of the service concepts.

Business model definition

Now that a suitable business model theory has been chosen, which also incorporates a method for generating such a business model, it is helpful to set the definition of a business model.

In this case it is logical to take the definition for a business model that has been generated and used in the STOF model. This definition reads, "*A business model is a blueprint for a service to be delivered, describing the service definition and intended value for the target group, the sources of revenue, and providing an architecture for the service delivery, including a description of the resources required, and the organizational and financial arrangements between the involved business actors, including a description of their roles and the division of costs and revenues over the business actors."* [11]

This then defines a business model, and is in line with the vision of a service concept from the perspective of KPN.

4.1.3 Design approach conclusion

Chapter 4.1 has given a theoretical approach to the service design process and the choice of a business model suited to the development of a smart home service concept. This chapter has then given answers to the first sub-question.

Smart home service design question 1:

Which approach is best suited to design a service concept and business model for the smart home?

- Different design approaches can be found depending on what is being designed, an example is the difference between designing a product or a service.
- In this case, design methodologies are methods with which to outline a service or products concept. The chosen 'designing cycle' encompasses the basic steps found in many design methods in order to be a more general method with which a number of different artifacts, such as a service, can be designed.
- Verschuren and Hartog define 6 stages in the designing cycle that they have discovered through systematic inventory of many different design methods.
- The STOF method has been specifically designed to create successful ICT service business models.
- The STOF model, focuses on "all kinds of innovative services that combine technologies and concepts from the area of telecommunications, information technology and consumer electronics" which means it is an ideal and suitable model to develop a smart home business model.
- The STOF model fulfils the need for a model that comes in the form of a method so not only being a theoretical model, but providing a stepwise method for developing a service.
- The STOF model incorporates a focus on organizations, thus fulfilling the need to have a model that encompasses the collaboration between different companies with different backgrounds.

4.2 Service concept design

With the design methodology explained previously, and the smart home domain research as input, the next step is to turn this into a first hunch service concept. In this section it needs to be clear that the service is to be provided by KPN, and the customer base are the 6.5 million Dutch households. This is the starting position from which to design a first service idea.

In the following section I will conceptualize this idea and make it clear where the information has come from to make certain assumptions.

4.2.1 Service design steps

The service design steps explained in the beginning of this chapter are explicitly followed below, the in depth steps can be found in appendix four. From the design steps a service concept has been created. In this section I will sketch a first hunch idea of the service concept in order to serve as input for the STOF model. In the following section the main results are presented.

4.2.2 The service concept

Step 1: Goals

The first design step named goals shows that there is not a single concrete service which will fulfill all the objectives. In general KPN hopes to generate new revenue streams and attract new customers by providing innovative, market leading services. Specifically within the smart home domain, the goals have been identified as;

- Managing the in house complexity of technology
- Supplying an increased amount of bandwidth to keep up with future services and
- Adding value for the end-user by either increasing living comfort or decreasing costs

These goals have been defined in order to deal with and overcome the developments and uncertainties from the domain description section, and to fit within the current KPN strategy. As mentioned in the fourth appendix, these goals have been distilled from speaking to experts within KPN, these interviews can be found in appendix three.

Since the smart home is a very broad concept with a lot of different aspects playing a large role within the home, the smart home service that accomplishes all the named goals is hard to define. One might speak of a service bundle, a group of services which together make up a smart home. In this case, it seems like KPN is the player capable of supplying the platform for the services which make up the complete smart home concept. This service delivery platform will be made up of separate components based on the requirements from the design steps and in this way deliver a complete smart home. This concept will be explained in further detail in the following steps.

The previous goals are followed up by the subsequent requirements.

Step 2: Requirements
From KPN's perspective, the service needs to be delivered to the customer, therefore virtually and technically directly into their home and not just to the residential gateway. The service also needs to offer added value to the customer in the form of increased living comfort or fewer costs, and needs to work with the technology the customer currently has in their home.

The user will require the service to be easy to use and preferably be available at any time. This is due to the in home environment in which the services are being used. To be able to market the service to all Dutch households, the service needs to be available to all age groups, on different devices.

The next step is to work out the specifications.

Step 3: Specifications
To manage the complexity of the technology within the home, the first goal, KPN can assist its customers with its knowledgeable technicians. A service comparable to the American company called 'geek squad' could solve a lot of issues people are currently having. This means having people on call which can visit the customers home in order to make sure the systems behind the connection end point are working. The idea behind this is that these systems are becoming more complicated. If the problems, which are currently occurring more often keep occurring, they will slow down the adoption of new, even more complex services and devices. Such a service will accomplish the goal to offer new services by managing the in home complexity of technology.

Secondly the access requirements need to be arranged, this is in the form of a high bandwidth data connection. This can start with current broadband access technology and in the end needs to be based around a fiber optic connection that ends within the home. The reason being that huge data transfers need to be accompanied for certain services. Thus the goal to be able to deliver high bandwidth services is accomplished through this infrastructure. This provides a way to accomplish the second named goal.

In the third place, once the access and devices within the home are up to par, it becomes important to add value by making it easy for the consumer to buy and use the new services. This should be in the form of easy delivery and access. A person should literally not have to get up from their couch in order to invoke a new service. Once they have bought this service, they should also not have to deal with many different parties and the complexity on the service delivery side. This means that the customer should have a single bill and a single contact point when it comes to all of their smart home services. This specification satisfies the third goal.

Combining the steps: First hunch concept
These three separate products or services can be seen together as supplying a platform to deliver the smart home services. In this case the total service which KPN then supplies is making it possible, and more importantly, easier for content and service providers to reach the end user with innovative and new services. In return KPN will need to find their added value, not only towards the customer but towards the content and service provider in order to keep their position within the value chain. Recapitulating, the service concept is a '*service delivery platform*' provided by KPN.

The design steps have defined the goals based on the developments and uncertainties found in the domain chapter. KPN related goals have been named in the introduction such as the interest to form new revenue streams and offer innovative solutions to their customers. These goals led to the requirements which in the end were specified in order to generate a service idea. In the next chapter, the business model for this service concept will be described in more detail, but first I will give some examples of the services that could be offered in the service store which were created through a brainstorm session with Edgar van Boven. Methodological information on this brainstorm can be found in appendix 3.

4.2.3 Service ideas

In having defined the service KPN is going to offer, the actual content of these services are not mentioned. To give an idea of the services that can be delivered through the service delivery platform, a number of first hunches for specific ideas are mentioned below. These have been generated through a brainstorm session with Edgar van Boven. Information on this session can be found in appendix 3.

- Allowing for a transportation truck to be chauffeured by somebody whom is situated at home. The person at home will be using large screens and live video feeds to maneuver the truck as is common with current driving simulation video games. Once the driver decides to stop, somebody elsewhere can take over the wheel, keeping the truck rolling at all times. The high bandwidth connection would be necessary for the large amount of video information. Having a driving station at home, controlled and serviced by KPN will allow many different types of companies to hire truck drivers when and where they are needed.

- The smart home is full of sensors which track the users movements and has gathered a lot of information about the user over time. This allows the home to know the average walking speed of the person, and take a look in their agenda. Going online to find the nearest public transport information the home could signal the user a minute ahead of time that they need to leave the house within a minute to catch the bus at the nearest bus stop down the road. This live information is calculated on the fly. Thus if the user usually rides his bike and the house notices it has a flat tire, it will take this into account, allowing for more time. This service would be developed together with public transport companies and offered at a fee to the user as a home plug-in. It would use the sensors in the home to interact with the user.

- A service allowing the user to watch a live video feed on their mobile when the doorbell rings could make home deliveries more efficient. The user, currently out of their home, could allow the placement of the new washing machine by controlling the identity of the person at the door through electrical identification. Next the home owner could tell the house to lock all inside doors, except for the path from the front door to where the machine needs to be installed. The in home technology such as the automatic door locks and the video cameras have been previously installed and can be used for a multitude of different services once they are all connected to the network.

4.2.4 Service concept design conclusion

Smart home service design question 2:

What is the service concept?

- The service design consists of 3 main, separate parts in order to form a service delivery platform. This platform is intended to offer smart home services by third party organizations that increase living comfort and/or lower costs.
    - The infrastructure needs to be sufficient for high bandwidth applications. It suffices to say FTTH will be necessary. The end point should no longer be at the residential gateway of the user but continue into the home. Thus the service delivery platform infrastructure includes the digital store which can be browsed on many devices.
    - The complexity of the technology within the home needs to be managed. This can be done through offering a service which installs and controls the systems within the home. This service will try and fix any technology related problem in the home and give advice on devices to incorporate. This service needs to at least cover its cost with the prices asked for the service itself. Thus no cross subsidizing this service with income from smart home services offered over the platform should be necessary.
    - The services need to be easily accessible and clear to the end user. A one-stop-shop, from which you receive a single bill, and be specified to the technology they already own. This store needs to be accessible to all age groups, in all types of households, and provide a plethora of different types of services.

4.3 Business model design

The next step is to use the STOF method to get from a conceptual design to a business model. The STOF method is a 4 step process based on the STOF model in which an initial value proposition is refined until the last step checks the robustness of the model.

The STOF method, part of the STOF model, is made up of four steps which I describe in minor detail before I perform the actual steps in the following section. The financial part of the STOF model will not be covered in my thesis. The reason being that the information needed to make assumptions about the costs of the services and products are outside of my research scope.

4.3.1 Quick scan

In this first step the service concept is used as input into the quick scan step. In this step, the four domains of the STOF model are covered to see if the concept is sufficiently worked out in order to give a better insight into the idea. Thus the concept is put through its paces according to the service concept, the technology aspects and the organizational and financial factors. This should end with a general idea of the business model and its viability.

The service concept to be broken down within the STOF model is as follows.

The future home will be full of technology which can be used in combination with specified services to increase living comfort or decrease costs for its residents. These services will often be based around high amounts of data transfers between devices inside and outside the home. These services can be seen as the next step into the services KPN already delivers to over half of all Dutch households.

In finding a business model for the smart home for KPN there is a specific role in which KPN can add value to the concept of the smart home. The next sections will give an overview of my findings using the STOF method. For a complete overview and a step-by-step walkthrough of the STOF method one can turn to appendix 5 and 6. The main components and most important findings are summarized below.

Service design

The service that is being delivered by KPN is that it allows users to easily browse, access and purchase smart home services in their home. This service is to be broadly accessible. Concurrent with current service offerings by KPN, the service should be aimed at the whole population. At present the Netherlands has 6,5 million households of which 5,6 million have an internet connection[25] of which 1.1 million are provided by KPN [26]. Almost half of the Dutch households (3,1 million) have a form of digital television. This information gives an indication of the popularity of digital services and the large range of customers these services attract. It should be made clear that the smart home service is to be provided to all households, such as internet is, and that the usage patterns will vary according to the household as is the case with internet connectivity today. This means that a single older resident might use the healthcare features such a service can provide, while a young family might make more use of the entertainment services delivered by the platform. In essence, intended value is that each user can pick and chose the services it wants in order to create a ‘custom built experience’ for the user, with a generic delivery platform.

For the content providers of the service, KPN offers a manner in which to reach a large amount of customers and make sure that the technology needed to run the service is in order. Thus a company willing to supply a security service, can offer this in the service store which the consumer browses from their TV or computer. Once the service is selected, it looks for active webcams the user already owns and allows for them to watch these from any internet connected device. The first bill they receive the coming month will show the monthly fee they are paying for the use of this service on their KPN bill, reducing the need for the company providing the service to bill the customer separately. A portion of this fee will be kept by KPN for the delivery platform. In return KPN can offer information based on the user profiles it has of its customers and the different services they are using. KPN also provides the central point for the consumer to turn to in case of a problem taking away a large part of the problems related to service provisioning.

Technology design

The technology will rely on a high bandwidth connection towards each home. Within the home, a residential gateway will manage the services which are being provided. Once the user decides to buy a service, it is pushed from the KPN main service server down to the user's residential gateway. From here the service performs the necessary actions required for the specific service. Within the home, a local area network, based on Wi-Fi will transport data for high bandwidth services, while mesh-network technologies can suffice in order to control smaller, simple operations such as turning on and off electrical equipment and reading energy requirements from machines. The internal infrastructure within the home is working properly due to the KPN specialists which have solved the users problems when they could not solve them themselves.

KPN will accumulate and aggregate services in their services database and make sure each service is working as it should be. Theoretically, any type of organization can deliver a service. In this case, KPN has set a number of rules based on standards and quality controls for a service to be provided over the delivery platform. Once a service has been tested and deemed adequate, the service will be added to the service database. It is in KPN's best interest to be open and transparent in their criteria for a service since this will make it easier for third parties to develop new services. In the end, a large number of services should be available to browse and buy through the users television or computer. Once purchased, these services will take advantage of the home network and devices to provide the actual service.

Organizational design

It is in the organizational domain where KPN needs to provide the most effort in order to accomplish the goal of providing smart home services. Here KPN needs to look at its own role within a network of different actors. It needs to be clear on the reason it is taking this role and the resources the other parties bring to the value network. Once this is clear, third party providers of services need to be identified and their specific strategic insight as to why they would want to provide their services over the KPN network. All this needs to be done with the added value this provides to the customer in mind, after all, if the customer does not benefit from the value web, the business case will not be viable.

The network infrastructure in this service concept is based on glass fiber optical connections into each home. This infrastructure is owned and managed by KPN.

For this reason it is KPN who can decide to offer extra services over this network. As is the case today, television and internet are services later added over the same copper cable which used to only supply voice services. Thus KPN should play the orchestrating role in providing other services. By opening up their medium to third parties, KPN can greatly increase their service offerings and stimulate innovation across different sectors. Since many different services either need special content, such as local weather information, or hardware, such as security services based around webcams, KPN should not provide these alone. By allowing third parties to use their infrastructure they can offer more complete, specialized, custom built solutions to their customers. The main role for KPN is to control the quality, privacy, and ease of use for their customers, both private individuals at home, and the organizations providing the services over their network. In this case some companies might be able to provide their services over the internet. By doing so, they have no quality control, have to manage their own billing, and have to find their own customer base instead of using the relationship KPN already has with its customers.

To give an idea of the type of organizations that could benefit from providing their services in combination with KPN I will provide an overview of some organizations within certain important sectors surrounding the home. These sectors have been picked from the domain research where they were found to be the most active within the smart home environment.

Energy

In the energy sector, companies that supply electricity such as Nuon and Essent can provide energy monitoring solutions to their customers. Not only will the individuals be more aware of where they are using and consuming the most electricity, but the energy providers can gain large amounts of information about usage patterns making their distribution and generation process more efficient. Companies such as previously mentioned Plugwise are also offering device based solutions to customers to manage their electricity usage. Once electricity starts to be generated decentralized on and around the home, these organizations will need to gain information in order to implement the 'smart grid' features to streamline their production. The huge cost savings that can be reached by producing electricity more efficiently is a driver for these firms to benefit from using the information infrastructure KPN has in place. The smart meter mentioned in my domain research is a first example of this already taking place.

Device manufacturers

Device manufacturers, such as Philips, Apple and Sony, are looking for ways to make their products more interesting by supplying extra services. Apple and Sony deliver video on demand services through their hardware which currently use the customers internet connection to download the movie. Once this becomes mainstream, quality issues such as buffering and not having to wait for the movie to download before starting to watch it, will become important. KPN can guarantee these companies quality of service which they currently do not have over best-effort internet. Another factor is that the user now has a separate billing issue, meaning they are paying KPN for internet and Sony or Apple for the movie. This could be circumvented by paying just KPN who already has the customers billing information and providing this in an easy bill for overview at the end of the month. The charges will then be past on to the respective third party. This paves the way for more entertainment services such as online games, or later, watching

sporting events, such as a soccer match, together with your friends in another location virtually through a live video connection. In this case the third party receives quality guarantees while making the whole system easier to reach, and bill the customer through a single party.

Financial institutions

In the financial sector this type of delivery platform can open up a new revenue stream. Instead of the user having to identify themselves with every purchase they make from their home internet connection as is the case today, KPN can offer specialized privacy and safety payment services. The user can simply shop online and press the purchase button, having KPN provide a secure connection to the online store the customer is using. Dependent on the user information KPN already has, the amount can be deducted from the users bank account. By allowing this service to its customers, banks can differentiate their service offerings and stimulate online purchases. Thus in this case, KPN can make it easier for the user when purchasing products online from within their home by supplying a secure environment, without having to identify oneself with every transaction.

Healthcare

In the healthcare industry peoples lives can be changed by offering more efficient healthcare solutions. The strategic advantage for healthcare institutions is that they can benefit by having doctors use their time more effectively. KPN can provide high quality, encrypted video conferences between patients and doctors. This gives the opportunity for doctors to help patients across the country. The next step is to monitor vital statistics remotely, in order to prevent certain problems before they occur. The devices to make this possible are easily installed within the patient's home, in such a way that a single press of a button could contact a family member, doctor or nurse. Automatic billing would make the whole process much more efficient for the patient, and the healthcare organization. Apart from this, it would save the customer the hassle of having to physically go and see the doctor and allowing them to live unaccompanied for a longer period of time.

Government

The government is also an actor which would want to stimulate the use of supplying smart home services over the KPN delivery platform. The controlled privacy and quality KPN offers can greatly reduce costs for government organizations for certain services. In this case it is interesting for KPN to supply services which are free of charge to the end-users of the delivery platform. The governmental institution providing the service can lengthen parking permits for the customer through the smart home platform as an example. This would be based on customer and location information KPN can supply once the customer has entered their digital personal identification number. This type of service would reduce the costs for the government institution providing the service while making it easier and more convenient for the citizen. KPN would be paid by the government for supplying the services and benefits from a governmental institution by strengthening its platform.

KPN

In order to get such named third party actors to join the initiative, KPN needs to set clear guidelines as to what services need to accomplish in order to be offered

to their customers. It should be clear that KPN will benefit from providing these services, thus that they are willing to help by being transparent and flexible when accepting new products. From the third party perspective it should be clear that KPN is taking care of a lot of problematic issues. These include the actual physical transport layer. Another issue is the billing and customer contact which KPN will be providing. Thirdly, the simple fact that KPN already has a large customer base should be interesting for new service providers, especially since KPN can offer quality of service versus general internet best-effort offerings. For third parties it becomes interesting to join together with like minded companies enforcing the platform by supplying multiple services. Through the information KPN gains from its customers regarding the different services being sold, it can provide specified user profiles towards its service providers. Thus KPN, by providing the delivery platform, to be seen as a smart home infrastructure, can create a situation in which the customer, KPN and the organization providing the service can all benefit.

Financial design

As mentioned before, the financial design falls outside the scope of this research.

4.3.2 Evaluation with critical success factors

The second step regards the critical success factors of the specified business model. In this step the business models viability is checked according to the most influential factors. Thus, if this evaluation fails to deliver a positive analysis, the business model is seen as unviable and the process either starts over or is stopped.

In the sixth appendix complete answers are given to the customer and network value propositions from the STOF method. These critical success factors can be influenced by the critical design issues which are specifically named and discussed in the following refinement step of the STOF method in part 4.3.3.

These critical success factors for customer value check to see if such things as;
The target group is clearly defined, there is a compelling value proposition, unobtrusive customer retention and acceptable quality of service. On the network value side, the success factors come in the form of; acceptable risks, acceptable profitability, sustainable network strategy and an acceptable division of roles.

In this section the concentration lies on the value creation for all other players. It is this value which creates the binding factor between organizations working together. Thus if organizations from different sectors see value in the business proposition, the possibility of working together arises. Furthermore, it is this possibility which allows for transsector innovation to take place. Thus the value network is a very important part of creating a basis for transsector innovation to become possible.

Together KPN can promote smart living within the smart home by offering the most innovative services from third party organizations. This would put KPN in an orchestrating role, making sure the services work on the network provided and increasing their revenues in doing so. The following list of factors is important to the design and specifically focused on the service which is to be provided in this case.

Factors for network value:

Quality: KPN can guarantee and manage different levels of quality over their infrastructure to guarantee the minimal bandwidth the service needs. This is not possible over internet where best effort can lead to quality loss.

Customer base: KPN offers a large base of customers, having already connected over half of all Dutch households KPN has a strong market position

Billing: By handling all the billing through the contracts KPN already has with its customers, service providers will not have to deal with that.

Factors towards customer value

Privacy: The in home identity needs minimal clearance since the user is known. The customer needs to feel completely safe in using the service.

Service choice: A large amount of services are offered in one easy to browse place. Within this service store, KPN can deliver custom services to customers based on their current service package.

Costs reductions and increased living comfort: Certain services can actually save the customer in other costs, such as electricity saving services. Other smart home services can be seen as to improve living conditions for the end-user.

Billing: By providing the customer with a single bill and already having their billing information the customer doesn't need to deal with paying different parties for the services supplied.

4.3.3 Specification of critical design issues

In the third step, the viability of a business model can be traced back to the critical success factors. It is these critical success factors which need to be impacted upon through the critical design issues. In other words, the critical design issues are the things KPN can manipulate in order to have a positive effect on the critical success factors, and thus make the whole business model viable.

In this step the critical design issues that impact the viability of the business model will be found for each critical success factor.

The critical design issues are split into the same two categories. The first being customer value, and the second network value which can be seen as the wholesale interface. In this case customer value is provided by allowing the user to pick and chose from a group of services, the ones which they feel are worth paying for. It is mostly up to the service providers to develop the different types of services within their specialization and knowledge. KPN is more interested in providing a working delivery platform then the actual content of the exact service itself. This is due to the fact that it is the services themselves which will be providing the end user with added value over the service delivery platform. The aspect of network value is much more important from KPN's perspective since it dictates whether the platform will be a success or not. The network in this case encompasses the organizations which are needed to make the business case a success and not the network in the technical aspect of the word.

Customer Value

The viability of specific services depend on the services themselves, which will be offered by third parties. The viability of the service delivery platform for KPN is based around the value for the network of actors involved, thus this section will only list the important factors KPN wants to deliver to their customers through the delivery platform. The added value each service delivers to the end-user can only be analyzed once these services are known. The critical success factors is named, followed by the description of the critical design issue which impacts upon it.

Compelling value proposition: Pricing and branding.

The value for the customer, as mentioned before, should come in the ability to increase their living comfort, or smart living. It is also not unthinkable that certain services will offer users cost reducing measures within their energy usage. KPN should not charge the customer for the use of the actual delivery platform since the firms providing the service are giving up a part of their revenues instead. Furthermore, the customer is already paying KPN for the connection for their voice and internet services. In this way KPN can use its name to brand the services and the platform while each separate service is provided and named by the company providing it over the KPN network.

Clearly defined target group: Targeting the right audience.

By delivering many services to every connected household, KPN can target almost every household in the Netherlands, as is the case with internet today.
It is critical KPN deliver on their part of the deal to keep the network and technology within the home working properly in order to guarantee quality of service to their customers, both the end-users and the service providers.

Acceptable quality of service delivery: Security, system integration, QoS.

The service which promises to fix in home technology related problems will deliver an acceptable quality of service. Customers are used to technology related problems, but expect these to be solved quickly. By doing so, and thus allowing them to make better use of their technology, the services which are being delivered by third parties through KPN will give the user a high quality service.

Unobtrusive customer retention: User profile management.

Customer retention is measured on different aspects in this business model design. Customers pay for the physical connection separately from the services they use over this connection. KPN needs to offer the best services over its network through partnerships with the companies able to deliver these services. In doing so, customers automatically need to have a KPN connection, and customer retention takes place on both aspects. On customer retention of the services themselves, the organizations providing the service will have a large incentive to help KPN with customer retention since it will affect their revenues directly once customers do not use the service. In this case KPN has partners with which to share the costs of customer retention.

Network value

The critical design issues within network value are of extreme importance in this case. Due to the nature of the smart home involving many different sectors and type of firms, delivering a positive network value for all participants is important for the business models viability. In this case the critical success factors which can be achieved through the critical design issues are named. From KPN's perspective this is seen as the wholesale interface towards the actors within their network.

The following are named in the STOF method and will be applied to the Smart home service.

Acceptable profitability: Value contributions and benefits through division of costs and revenues, and the pricing issues.

The acceptability of the profits needs to be clear for all parties involved. KPN is already and will continue to invest in FttH, even without the Smart home Service delivery platform. This also holds true for the service in which they solve problems within peoples homes, since this is also currently being initiated. Thus the costs for the platform are with KPN. The development costs for the actual services to be sold over this platform lie with the service provider. This leaves a clear boundary between the costs for each party, decreasing the complexity of investments. The only place where revenue sharing takes place is the margin KPN receives from the service provider. This is a fixed percentage of the price of the service. KPN is in control of the network, thus the technical aspects such as security, quality, and the systems integration. It is only in the organizational aspects that most complexity arises as to how the actual billing towards the service providers works once KPN has billed the end-user. The only remaining question is the percentage which is deemed fair for KPN to ask for the use of their delivery platform. Thus the pricing issue is most important.

Acceptable risks: Division of investments.

As mentioned before, KPN will be making the large infrastructural investments, most notably in FttH. With regard to risk factors, the players are not heavily intertwined. Since each actor invests in their own area, such as KPN in their core infrastructure, this is purely an extra service delivery platform which can be made with relatively small investments. Once the technology is in place it is up to third parties if they are willing to make the investments in developing a service. This is a business decision like any other, without the complexity of shared investment costs. In the end the risk is greatly reduced for third parties, which gives an incentive to develop services and share in the profits.

Sustainable network strategy: Based upon network governance and orchestration.

As mentioned in the STOF method handbook, "Sustainable network strategy involves the balancing of partners interests and the capabilities required for partners to work together in a network". This is highly related to the earlier mentioned idea behind transsector innovation and the specific sectors named in the organizational design. It is critical that the right partners are selected to take part in providing services to promote smart living within the smart home. Once these partners are selected it becomes important to see how these partners can contribute, which information is to be shared, and who is in charge of

orchestrating the so called network governance. This is the most important critical design issue within the smart home service. KPN must play the role of orchestrator since it is the owner of the physical network and provider of the platform. To gain acceptance and partners, KPN must be open about the requirements they have of services and the fact that any type of organization can join in order to take advantage of the investments made by KPN into the delivery of the platform. Once the amount of services starts to grow, a special team from within KPN must manage the complexity within the network of companies supplying services. They must make sure that competitors reach agreements and device manufacturers allow for software services to make use of their equipment. As seen in the previous organizational part of the STOF method many different actors from different sectors will be involved and a participant such as the government will have different interests, resources and expectations as a small start-up firm.

Acceptable division of roles: partner selection.

Together with the design issues related to sustainable network strategy, the selection of partners is a crucial issue which KPN must take into consideration to make the business case viable. In the beginning it is easiest to select and contact organizations from different sectors in order to have a broad service bundle. KPN, being the largest incumbent network operator in the Netherlands, can use this to work together with strong partners such as Philips and the Dutch government. It is also important to stimulate small firms which can develop innovative services with a relative low budget since they stand to benefit from the huge network KPN can offer. It is crucial to select partners in such a way that a small amount of coercing is needed before companies and even government organizations start to ask to use the platform. Once a group of companies has joined, it will be unavoidable that companies which see each other as competitors join the network. In this case it must be clear that differentiation with new, innovative services is favorable over delivering the same services for a cheaper price. Thus a first come first serve aspect could help to increase the incentive to join early.

4.3.4 Evaluation and robustness check

The previous three steps are internal evaluation steps, where the focus lies with the factors that can be influenced and controlled by the stakeholder. The fourth step however, also focuses on the external evaluation. This means that such things as outside influences of competition, partners and political changes are taken into account to evaluate the robustness of the business model.

It is in this stage that my research has used a specific approach. Due to the setting of the business case being set in the future, scenario analysis has been used to determine robustness which is named as the last step in the STOF method.

The robustness check in the STOF model is an evaluation step to see if the business model is sustainable and viable in a changing environment. My findings from the futures research section in chapter 3 give a future reference in which to place the business model design from this chapter. The robustness step is analyzed and concluded in the following chapter, where the scenarios are used in combination with the critical design issues.

4.3.5 Business model design conclusion

Smart home service design question 3:

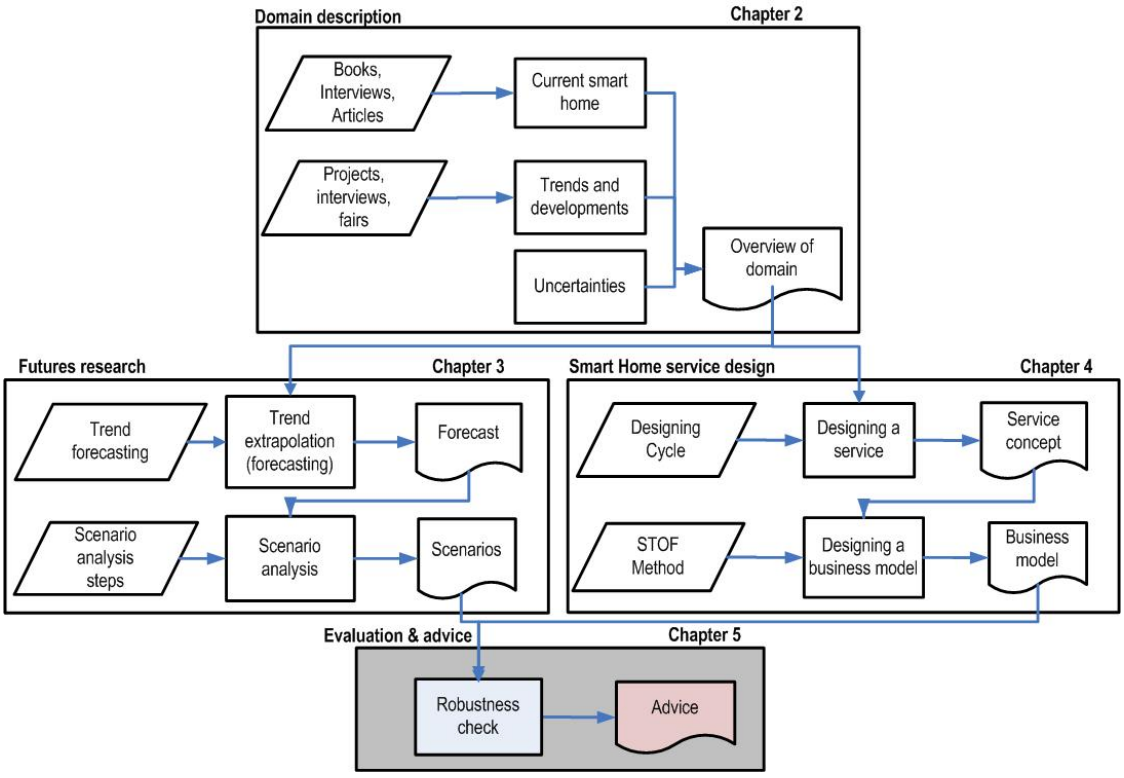
What is the smart home business model?

- The business model of the smart home is built around a service delivery platform which includes three main things:
    - Managing the complexity of in home technology through a service similar to the American 'geek squad' which sends specialists to your house to fix technology related problems.
    - A high bandwidth, in the form of FTTH, connection in order to be able to supply a large amount of different types of services and their bandwidth specifications.
    - A simple and user-friendly digital store is supplied as the platform through which smart home services are sold. This could be as simple as an extra TV channel or internet page where the user can browse through services. Added value would be in supplying services based around the devices and functionality the user already has in their home.
- The business model from KPN's perspective would generate revenue in the following manners:
    - The FttH connection would be a flat fee as is the case with broadband connections today. The user will most likely already have this in order to watch digital television, internet and for voice calls. Thus this part of the service can be seen as self sufficient.
    - The 'geek squad' service needs to be profitable, or at least covering its costs as a stand alone service. This service gives people a trusted, and quality oriented company they can call in order to fix common in home network, and other technology related problems. The added value from KPN's perspective is that they can offer the service providers a clientele base where the in home situation is known to be working correctly. This is an incentive to start offering services based around more complex in home situations.
    - It is in the actual services itself where KPN generates extra revenues. Service providers share a percentage of their profits in order to sell their product through the KPN smart home platform. The service provider receives a large audience to sell their product to. KPN has the customer contact, providing a single monthly bill with an overview of the services being provided.
- The critical design issues which KPN needs to focus on were found to be;
    - Managing and selecting the right partners to develop services for the delivery platform in order to provide many services for different needs. KPN needs to take an orchestrating role.
    - The most important sectors in which to find partners in the first instance are; energy suppliers, device manufacturers, financial institutions, the healthcare industry and the government.

5 Evaluation and advice

In this chapter I present the final analysis of my thesis. The STOF model names the fourth step as the robustness check. As mentioned before, this relates to the business models ability to withstand and adapt to changes in the business model environment. In this case, a truly robust business model holds its value, even in a changing environment. The STOF model indicates different ways to test robustness. This research, being based on a service to be provided in the future, lends itself to testing robustness through the scenarios I have built. As Bouwman et al. mentions in his book, "Business model evaluation with scenarios is relevant when future market circumstances, technology developments, regulations etcetera, are uncertain." He goes on to say, "Generally speaking, it is our impression that scenario analysis helps establish the robustness of a business model." [11] This next section is the final analysis of my research.

The following picture shows which question will be answered in this chapter.



5-1 Chapter 5 will answer the advice and evaluation research questions

5.1 Robustness check

Once a business model has been designed and its critical success factors found, it does not mean the concept will be an immediate success. For this reason, the STOF method incorporates a robustness check before the actual implementation of a new service. Since the STOF model is being used, the definition of robustness that accompanies this model will be used. It is defined as;

"Robustness (or sustainability) of a service and a business model refers to the ability to cope with changes. A business model that is considered to be robust is not influenced by external changes, but maintains its value for customers as well as for business partners, even when external circumstances change." [27]

The exact implementation of scenario analysis into the STOF method takes place in the fourth step of the STOF method. Here it is useful to follow the first six steps of the scenario analysis method as it is described by Schwartz in chapter 3. The first step, where the focal issue needs to be found, can be taken from the first step of the STOF method where the quick scan is performed. The following steps up until the actual scenarios are written, can be followed as they are described. The reason not to implement the last two steps of the scenario analysis method is that these are closely related to what the fourth, evaluation step in the STOF method is trying to accomplish. In the process I propose, the critical design issues that have been found in the third step of the STOF method are evaluated in each of the scenarios that have been created. This gives an insight as to the changes that the critical design issue needs to undergo to be successful in the different situations.

By finding a strategy within the business model that works in the different scenarios, I am generating a business model that is robust according to the definition given above. This then satisfies the question Schwartz asks in the second to last step of developing scenarios. Namely "Is the decision or strategy robust across all scenarios, or does it look good in only one or two of the scenarios?" [28] So by finding a business model that seems viable in each scenario I am fulfilling the robustness criteria in both the last stage of the STOF model and the used scenario development method.

The following section will answer the question regarding the robustness of the designed business model in chapter four based on each separate scenario. Subsequently, the next section will give advice on the critical design issue within each scenario.

5.1.1 Robustness per scenario

I will go through each scenario in turn, starting with the scenario named slow and stagnant and working my way towards the hyper house scenario.

Scenario Slow and stagnant

In this scenario consumer demand is at its lowest, while organizations are not innovating trans-sectorally. In this case the customer value proposition and the network value proposition are in danger of not being viable.

The customer value proposition is strongly linked to the horizontal axis, customer demand, which is negative in this scenario. This means the market must push its technology, making the value proposition less positive. On this axis, we can still say that the market might be interested in services which are specifically geared towards increasing efficiency for the consumer. In this case, energy related services could make the only viable business case since the economic situation stimulates people to lower their monthly bills. Thus the most critical success factor is a compelling value proposition, which in turn is based on the pricing, branding and value elements of the service. These aspects are not to be decided upon by KPN, but the service provider using the delivery platform.

On the vertical axis we see companies continuing to work in their so called stovepipes trying to improve incrementally on existing products and services. In this situation KPN has no orchestrating role and cannot increase the network value. Since actors are closed, and non-transparent, the most critical design issue, partner selection and network governance do not allow KPN to influence the success of the business case.

When comparing the 2 axes, the viability of this business model in this scenario is very weak. In order to deliver the services which are most important to such customers, it is crucial to have companies come with highly innovative services in order to help the customer increase their efficiency. These innovations will not be accomplished without an orchestrating actor to select the partners capable of doing so. In this case KPN would have to make even larger investments than already done in the infrastructure, thus taking more risk upon itself, in order to create a compelling value proposition. Thus this extreme point within the scenario matrix makes it very difficult to deliver a viable business model.

Scenario Perfect Push

In the perfect push scenario the consumer demand has not shifted and is still at a low level. Innovation on the other hand is taking place rapidly, and organizations are working together across industries delivering new services. The consumers in this environment are wary, being in an economically unsecure situation. The customer value in this case is based on a compelling value proposition. Can the market supply the needed services in order to push the innovations towards a non receiving market?

On the vertical axis, transsector innovation is taking place on a large scale. The value for the network is no longer hampered by the complexity of the network. KPN is able to stimulate its partners to share information and resources to come up with innovative services which can be delivered to the customers without a problem. In this case the biggest problems lie with the acceptability of risks. Partners should be involved in sharing the risk in order to maximize the chances of a viable business model.

In this environment there is a large chance for smart living to take off as a viable business case. The focus lies with improving the customer value proposition. This can be done by stimulating investments which will cut consumer costs in the long run, or providing services which help consumers save on monthly expenses. Thus if KPN selects the partners capable of delivering service which benefit customer efficiency in the home, and provide the ability to work together, over different sectors, this business model is viable. Within the home, cost lowering services are to be found with the energy companies where efficiency can be increased with user awareness and other better informed and connected devices.

Scenario Practical Pull

In this scenario the customer is well informed and in anticipation of the next service. People are willing to buy any new service since money is abundant and consumers in general can be seen as early adopters of any new technology. For this reason the value for the customer is not of great importance since any service delivering smart living promises will be adopted.

On the horizontal axis, the industrial players are not working across their stovepipes in order to generate new services. The market is being saturated with mediocre services which consumers are still buying due to the high level of demand. This leaves KPN with the critical, yet difficult situation to pick the right players and stimulate innovation sessions in order to build a sustainable service offering.

This scenario is not likely since markets are often quick to follow demand. If the situation does occur, the focus needs to increase the network value proposition. Summarizing this scenario, a viable case can be made by being extremely picky in partner selection and slowly building a network of companies which work against the trend of nodal innovation. Since customers are in high demand of new services, flexible, energetic businesses such as Hyves, Joost and Ilse Media offer the most chances in which to build a valuable network to increase the sustainability of the business case. In this situation it is possible to take more risk with innovation and partner selection since consumer demand is high.

Scenario Hyper House

This scenario scores positively on both axes of the scenario framework. In this case the consumers are in high demand for new services. The economic situation is positive and all types of users are interested in smart home applications. On this axis, the customer value proposition can be influenced by selecting the type of partners that can deliver the required services. The focus should be in comfort increasing services, and services with a high 'wow' factor, since money is abundant.

The network value viability issues can be compared to the positive transsector innovation taking place in this environment. It is up to KPN to chose its partners and allow as many potential service providers onto its platform. This due to the fact that the market is in high demand for services and niche products will be found by consumers. First, large partners need to be found to make the platform interesting for others to join. This creates leverage. The largest challenge in this environment is to manage the complexity of the large amount of actors willing to join the network. Government organizations, high tech firms such as Google and large behemoth device manufacturers such as Philips and Sony will all need managing and contacting in order to keep the value within the network. In this case KPN needs to spend more resources on managing this network in order to get the most out of the environment they reside in.

5.1.2 Robustness check conclusion

Evaluation and advice question 1:

Is the business model robust?

- Three of the four scenarios allow for a viable business model albeit with some adaptation in the partner selection for KPN. In answering the question if the business model is robust there is no definite answer, but the analysis shows it is close. The definition states that the viability is not influenced by changes in its surroundings.

- **Slow and stagnant:** As the first scenario shows, in a very negative scenario for both the customer and network value, the business case becomes very difficult, and not likely to be sustainable. The amount of innovation needed in such an environment in order to overcome the negative demand from customers cannot be delivered through the nodal, and incremental innovation of organizations.

- **Perfect Push:** If on the other hand the innovation landscape changes and companies work in a more open environment, the viability becomes positive. In this case it is critical however that KPN involves the precise partners which can overcome the difficulties in this specific scenario in order to supply the services which can stimulate the consumers into purchasing. Thus the critical design issue is partner selection. In this case partners which can deliver services which cut costs for the customer would be more interesting then comfort increasing services, thus energy reducing, and awareness increasing services should be provided.

- **Practical Pull:** The scenario in which consumer demand is high while innovation is taking place nodally, also deemed the business model viable although the focal point is somewhat replaced. Here KPN is playing a stimulating role between flexible fast moving companies in order to deliver the services the market is asking for. Since demand is high, there is a market, although large organizations are too slow to supply this market. Internet start up firms, young entrepreneurial companies, spin offs and other such flexible, fast moving groups should be found to partner with.

- **Hyper House:** When both driving forces, consumer demand and transsector-innovation, are positive in KPN's surroundings, the business case remains viable. Here the focus is still with partner selection, while network governance will play a much larger role since a larger amount of actors are providing services over the delivery platform. In this case, all types of services require KPN to partner with organizations in all the named sectors. By starting with large organizations the platform gains momentum and leverage. This situation leads to the fastest and most profitable realization of the smart home.

Thus the business model can be seen as robust if the first extremely negative scenario is left out. The most critical design issue from KPN's perspective in this case is the selection and orchestration of their business partners depending on the direction of the surrounding driving forces.

5.2 Advice

The described business model of the service delivery platform has been made clear in the previous chapters. Furthermore, the last chapter has given an insight as to the most critical design issues, which are to be found in the organizational domain of the STOF model.

The most critical design issue has been identified as being;

- Partner Selection and orchestration

In the end it comes down to the value proposition, and the question if this holds up in the different scenarios. Not only the critical design issues noted as being the most crucial, but all other issues are taken into account when comparing the business models viability in the scenarios.

Since the robustness check has been performed per scenario, The advice for each scenario is taken directly from the analysis performed in 5.1.1.

5.2.1 Advice conclusion

Evaluation and advice question 2:

What are the critical design issues KPN needs to focus on for a viable business model?

- The main focus lies within the organizational aspect of the involved actors. The so called network issues. It is critical to manage the actors network complexity in order to make the platform a success.
    - Network governance for a sustainable network strategy is most important. KPN must see itself as the orchestrator since it has made the largest investments in the delivery platform. This however, does not mean it is a closed platform, and openness and transparency are crucial to making sure organizations are interested and willing to develop services for this platform.
    - Partner selection for the acceptable division of roles is also crucial. KPN must first select partners from different fields in order to deem the platform as a success. Large Dutch players such as Philips can play an important role, as do small innovative actors, and even the government which can offer many smart living solutions. Only though the selection of different types of partners will a broad range of services be possible.
    - All this is based on the network complexity which might increase once services from direct competitors are being delivered. In the meantime, KPN must orchestrate this complexity in order to maximize the amount of services. The chances for companies from different sectors to deliver more value to the customers by sharing information and ideas must become clear in the home environment.

6 Conclusion

This research has been conducted to answer the main research question, namely;

What is a robust smart home business model design for KPN in the future, and which sectors play an important role?

Currently homes are filled with technology such as broadband internet connections, in home networks, computers and LCD displays. The trend is that the technology to make the smart home a reality is becoming ever more available and many research facilities are still spending large amounts of resources in this area. Ubiquitous computing combined with ambient intelligence will deliver smarter, cheaper, and more capable computers with interfaces that are more user friendly and intuitive. It is only a matter of time before the standards on which these systems will depend are defined. Thus the technology does not form a barrier when looking at the smart home future.

KPN

From KPN's perspective the surrounding environment will form the largest uncertainties when it comes to the development of a smart home service. In order to be able to generate new revenue streams from new services, a need arises to deal with the uncertainties the future holds. Through future research it has become clear that customer demand and the way innovation takes place across different sectors will influence the environment in which KPN wants to offer its services. Since these factors are outside of KPN's influence sphere, they must prepare by pursuing a business model which is most robust in the different situations. Furthermore, it is important to know which variables KPN can influence, and in which direction, depending on the way the environment changes in order to increase the services viability.

To generate new revenue streams and stay profitable in the future KPN can deliver the customer the smart home as depicted in the future vision I have presented. The actual service components KPN needs to have in place in order to be able to offer this service is made up of three parts. The first being inline with current KPN strategy, and consists of connecting their customers with a high speed broadband connection in the form of "fiber to the home". Next, a group of specialists such as KPN is currently offering under the KPN "ServiceThuis" brand name need to be offered to the customers. The importance of this service is the fact that they make sure the complexity of the technology within the home is managed and devices are working to their full potential. This service currently helps people set up their in-home computer network and needs to be expanded in the future to incorporate such things as media servers, white goods, webcams and mesh networking technologies. The third part of the service is based on a virtual store that needs to be accessible on different devices within the home such as a persons television set and computer. It is in this virtual store, that customers can browse and purchase additional services to increase their living comfort or decrease costs, thus promoting 'smart living'. Together, these three aspects form the service delivery platform which can make the smart home concept a reality.

The services that are being offered in the virtual store, can be provided by KPN itself, but opening the store to third parties is crucial to the viability of this delivery platform. By being transparent and open about the criteria needed to provide services in the store, KPN can work together with third party developers in order to offer many different services to the customer. The methods used to

generate a viable business model led to a positive value proposition for the customer and the network of parties involved.

Customers

From the customer's perspective, the added value of this service delivery platform and the services it offers come in three major areas. Firstly the customer is offered a so called one-stop-shop. Here they can browse and purchase many different services, from different parties, which can be suited to their specific needs. Secondly, the customer will only be dealing with one party, namely KPN. Since the customer is already paying a monthly fee to KPN for the use of the broadband connection, KPN has all the customers billing information and is a trusted party. Thus if the consumer decides to purchase a service in the virtual store, this can automatically be charged to their monthly bill. In this case no identification or other information is needed. The third added value towards the customer comes in the form of a higher level of quality for the services. KPN is taking care of the delivery not only to the doorstep, but making sure the services work within the home. Through the additional service of offering experts to come by and fix local problems, customers do not need to contact different companies for different problems, this leads to an increased positive user experience.

Third party actors

From the perspective of the third party actors within the value network, there is also a positive value proposition. Again this can be broken down into three main aspects which should present positive value. The first of these being that KPN has a large customer base. Over 20% of current Dutch households are connected to broadband internet through KPN, and even more homes with television and a fixed telephone line. In the meantime KPN is gaining new customers as it rolls out ever more fiber connections to the homes. This offers a large customer base which can become potential customers to the service providers. Secondly, and closely linked to the fact that the user is already a KPN customer, is that KPN will be taking care of the billing procedures. Also mentioned as a benefit for the customer, the third party does not need to install and run billing services since this will be taken care of by KPN. The third and most valuable part of the service delivery platform for the service provider comes in the quality of service it offers. Within the delivery platform, KPN makes sure the customers devices are working optimally through the experts which visit people's homes. Next KPN is open and transparent as to the criteria it asks from the services before they are allowed in the virtual service store. Since KPN owns the fiber infrastructure over which the services are transported they can guarantee the bandwidth requirements of the service. Fiber will also be one of the first connection types to offer such extreme high upload and download transmission speeds, making previously unable services possible. These three aspects translate to a desirable service delivery platform where the service provider can reach a large amount of customers, with little extra effort in terms of customer contact and billing while making use of a high quality managed infrastructure.

General

In the end the business model needs to be viable from KPN's perspective. The way which KPN is to generate new revenue streams from offering the service delivery platform is a percentage of the profits which the service providers ask for their services. This creates an incentive for both KPN and the service provider to sell as many service contracts as possible. Since KPN is already rolling out fiber to the

home initiatives the service delivery platform can be seen as an extra possibility over this infrastructure. The same holds true for the 'KPN ServiceThuis' service providing experts for an hourly fee to fix in-home technology related problems. Thus the extra investment KPN needs to make, is in the actual virtual service store and in people to manage and recruit new partners. It can then gain the benefits of receiving a percentage of the services offered over its infrastructure.

Scenarios

From KPN's standpoint, the largest risk lies in the partner selection. Due to the partners being responsible for the types of services available in the virtual store, selecting the partner which can deliver what is in demand, is crucial. What futures research has shown, is which different organizations will be needed under different circumstances.

In the most negative scenario named slow and stagnant, where customer demand and transsector innovation are both low, the chances of a viable business case are slim to none. This position makes it hard to develop a positive value proposition for both customers and the network of involved parties. From here we move on to the next scenario, where consumer demand remains low while innovation takes off between companies.

In this second scenario, named perfect push, KPN needs to focus on increasing the customer's value proposition. Cost cutting services for its platform are needed due to the fact that the consumer is in a difficult situation regarding their economic situation. These can be found in energy saving services and can be provided by two types of organizations. The first being large energy producers such as Essent and Nuon which are working on smart meters. The second type of partner can be found in smaller firms offering new products such as Plugwise which offers a wireless energy management system. Once these services are being offered, a slow migration to more expensive services with a larger focus on improving living comfort can be instigated.

In the third scenario named practical pull we see customer demand for smart home services to be high, while the industry is lagging in providing new innovative solutions. This scenario is unlikely since the market is usually quick to follow demand. In case this situation does arise, KPN needs to be quick on its feet and improve the network value proposition. Partner selection in this case should focus on flexibility and innovation in order to find organizations which can be ushered into working together by KPN. The high consumer demand allows for risks to be taken with relatively new or unknown companies. Examples of firms which fit the bill are Ilse media for information delivery, Joost for digital media, and Hyves for social networking services.

In the last, overly positive scenario named hyper house, the focus on both customer and network value is important. Here KPN must try and deliver the broadest range of services in order to accompany all customers with services from as many providers as possible. In order to gain momentum and start strong, partnerships need to be made with influential players. In this case companies such as Philips should be approached to deliver quality services to enhance their products. Firms such as Google can use the high quality of service and penetration to implement their newest and most innovative services. The government can provide services which can benefit citizens while enforcing the platforms position.

In the end, the business model for the general infrastructure remains the same regardless of the surrounding circumstances. Thus this presents a robust business case to move forward and implement the necessities such as fiber to the home and the 'ServiceThuis' service. The virtual store development should be timed in order to be complete and working once the infrastructure is ready. The crucial element, which is dependent on surrounding factors on which KPN has no influence, is the selection of partners.

7 Reflection

Theory and outcomes

In the end the critical design issues line up with the uncertainties from the scenario analysis. This provides a useful way for the STOF method to be evaluated in the future where uncertainty plays a large role. I also found forecasting and the service concept design to work together nicely and had not previously thought these separate forms of analysis and methods would work together quite so well. Previous research cases regarding the STOF method have shown that scenario analysis can be used successfully as an evaluation step as I have done in my research. Scenarios can be used to reduce the uncertainties while checking for the robustness of a specified business model.

In the beginning I had anticipated thinking up novice and innovative new services for KPN to actually deliver in the future. This quickly turned out to be unrealistic due to KPN's limited influence and strategy in these markets. This then turned into the idea presented, where KPN delivers a platform to deliver new services. In this case, I also believe KPN might deliver some of the new services themselves, but think the majority will be based on third party providers. Having said this, I think my outcomes present advice which is already on track with KPN strategy being implemented today, such as FttH and the 'ServiceThuis' service. This brings back the timeframe of my research a couple of years from the intended smart home which was 10 tot 15 years into the future. On the other hand, once the platform actually exists, it will be the technology forecast in my future vision which will make the most exciting new services possible.

Another change which took place throughout my research was the focus on technology. My domain description was focused primarily on technology aspects of the smart home. Only later in my research did it become clear that the problem with the smart home would not be based on technology but more on partnerships across different sectors. This doesn't mean that the technology based description in invaluable, only that an extra focus on the organizations involved would have been helpful from the beginning.

Research shortcomings

Something that would give my research more power, but was not possible due to time limitations, would have been to run my business model past the people I had interviewed in the beginning. This would serve as an evaluation step. This same thing can be said for my scenario analysis. In this case it would have given more relevance if I had gathered the driving forces and key factors through brainstorm sessions with the same individuals I had spoken to in the first part of my research.

My research also has shortcomings in the financial part of the STOF model. In this case it would have been interesting to use real options theory and more common financial techniques in order to give more insight on the financial aspects of the platform. This in itself could form a research project, where different scenarios can be weighed on a financial model. This model would calculate the profitability of certain strategies, something that I cannot do with my research.

Considering my business model design, this research would gain validity if my delivery platform idea would have been run past individuals at some of the named outside firms. Since the service concept and business model where designed in the latter part of this research, a lack of time is the main reason this has not been done. The most important part in doing this would be to see if there is any interest what so ever from third parties in this model. Furthermore, it could be seen as the first steps in the direction of working together. By contacting third parties early on, they can help to specify criteria the platform must fulfill.

Directions for further research and recommendations

As mentioned before, I have not done any interviews as to the willingness of other organizations to make use of the platform I have presented. It would be important to try and find out what aspects of the service these parties are most interested in, such as the quality guarantees KPN can make, or instead handling of billing and customer contacts. This contact can also be seen as the first steps into working together to make the platform a reality, and thus the general interest from these organizations.

In the domain description I came across the residential gateway as an enabler of many of the portrayed services to be provided. For this reason I believe KPN needs to do more research in the possibilities of these products and the developments taking place within them. I believe the residential gateway will play a large part in providing the actual online store interface to the end user and it is important to select the right manufacturer to make this product. Part of this research would include a stronger focus on the technology behind delivering such a platform. In my research I have seen the technology as something which is not the limiting factor, but by doing so does not mean it isn't important to look into which technology is selected.

Another area where more detail is needed is within the privacy issues such smart home services can create. Since large amounts of information are flowing to and from the home, security and privacy need to be closely guarded. The information that is received from the home contains a great deal of information with which it is possible to greatly improve customer experiences, while it is also very important this information is handled correctly and safely. For this reason I would advise research to be done into the security aspect of the smart home and where the customer information is stored and accessed. This would need to go paired with information from consumers in order to deliver privacy in a way the consumer is convinced and protected.

Another area that can have a large impact on the smart home delivery platform comes in the form of regulators in the Netherlands. Specifically the OPTA and the NMa. I would recommend research to be done into the possibilities that these regulators would not allow such a project to continue due to monopolies or unlevel playing fields being created.

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9 Appendix

9.1 Appendix 1: Domain research. Current smart home

1 **Current smart home research**

1.1 Broadband access technologies

In this first section I will give an overview of the broadband access technologies, such as ADSL, cable and fiber that can be found in homes today. The reason being that internet access is an important part of the smart home. Apart from internet access this connection to the outside world offers information to be gathered from outside the home and for information on the users in the home to be sent back to the device manufacturers. This critical link to the outside world allows the consumer to reach digital content such as video on demand services and once they are outside their homes, this connection allows for them to control their home while on the move. Thus the connection to the home can be seen as an integral part of the smart home.

1.1.1 Copper

Currently copper networks supply most data to households worldwide. In the past this has been done through ISDN (integrated services digital network) technology. ISDN is able to transfer data at up to 144 kbit/s. Currently only 2% of Dutch households still use ISDN to connect to the internet [29]. The next incremental step in copper technology came in the form of DSL (digital subscriber line) technology. Here a DSL modem converts the digital signal coming from a computer into a voltage signal so it can pass over the copper phone line. On the other end of the connection this conversion is undone thus transferring data over the network. Currently, the last version of DSL technology to be largely implemented in the Netherlands delivers 24 Mbit/s connections through ADSL (asynchronous digital subscriber line).

ADSL is currently very popular in the Netherlands with 48% of all households being connected to the internet through ADSL [29]. The future for cable based connections lies in VDSL (very high bit rate digital subscriber line) where transfer speeds well over 20 Mbit/s are theoretically possible.

1.1.2 Cable

The Netherlands has a special link with the coax cable since over 90% of households have a cable connection to the home. In the Netherlands 33% of all households connect to the internet using this coax cable [29]. In the current situation the maximum bandwidth that is offered by providers is up to 30 Mbit/s. In the near future this will be expanded to a theoretical 120 Mbit/s with the latest version of the DOCSIS (Data over cable service interface specification) standard, namely DOCSIS 3. In practice however the actual download speeds tend to be lower since households share the connection with a number of neighbors connected to the same distribution center.

1.1.3 Fiber

Currently FTTH (Fiber to the home) projects are being rolled out in a few areas around the world, including the Netherlands. Connecting homes with fiber is a costly endeavor since it requires actual digging, thus the uptake of FTTH is relatively slow. The bandwidth transfer rates on the other hand are relatively fast.

With fast Ethernet the current download speeds being offered to consumers with access to fiber are 100Mbit/s. In the future this will be even higher and the actual speeds reached by consumers at present with fiber are generally faster and closer to the advertised speeds than the alternatives.

1.1.4 Access technology conclusion

Thus we see that there are many different ways of connecting to the internet for homes in the Netherlands. Within each type of connection there are small differences such as fiber having a higher upload capacity than cable and both of these currently having faster download speeds then DSL alternatives. The fact of the matter is that the type of connection is not of importance to the smart home, as long as the connection is in place and allows for the bandwidth that is necessary for the services that are going to be supplied in the future.

1.2 Residential gateway

The residential gateway is where the connection point of the provider connects with the network of the consumer. With today's broadband standards, these gateways allow for the 'always on' connection. Thus the primary functionality of these gateways is as a modem, converting the computer signals into the different forms of access technologies offered by internet service providers. Next the gateway can often perform as a router, connecting computers, and other devices such as game consoles and networked storage devices within the home network. The new models include their own applications such as integrated storage for local backups, integrated print servers, and direct media playback capabilities. There are even vendors looking to integrate UMTS 3G connections into the gateways, turning them into femto cells. These can be seen as smaller mobile antennas which can take a load off of current mobile network. Thus we see a trend in residential gateways growing into a platform for delivering standardized services within the home network, and allowing specific tasks to be performed without the need of a full pc (personal computer) to run and manage the system. The new residential gateways offer more functionalities and easier integration while the standardization of standards and protocols allow for a more user friendly setup.

1.3 Home networking technologies

Within the home the residential gateway often provides the internal networking capabilities. This is either done by Ethernet over Cat5 twisted pair copper cables or Wi-Fi. Wi-Fi being the wireless alternative to wire twisted pair versions. These local area networks (LAN) provide high speed data transfer capabilities of up to 1Gbit/s, but most often 100Mbit/s. The LAN allows for multiple computers to share data, and when connected to a modem, allows for multiple computers and other devices such as Wi-Fi enabled mobile phones and game consoles to connect to the internet and share an internet connection. In the Netherlands 31% of homes with a broadband connection have access to their network over Wi-Fi [29]. These in home Wi-Fi networks do not only allow devices to share a single internet connection, but also to share information within the network in order to share a single printer, or stream digital content such as music around the home.

1.3.1 Wireless mesh networks and sensors

According to some, mesh networks play an important role in the home of the future [30] [31]. A mesh network, unlike wireless Wi-Fi networks, is very robust. This means that if a node in the network is removed, the network stays intact and a different way of routing is automatically found. In most cases, these wireless mesh networks allow for the nodes to use very little energy allowing them to be very small and easily integrated. This also means that they can be produced at very low costs and can run up to 5 years on a small battery. In this case, unlike previous wireless networks, each sensor doesn't have to transmit directly to the base station, but can pass data onto 3 to 4 other nodes. Thus, if one node stops functioning, redundancy in the system fixes the problem automatically. A driver behind wireless mesh networks is that they do not require rewiring an existing building. This makes the installation cheap and effective. An old house could be set up with many wireless sensors that cooperate in a mesh network to give a clear indication of the temperature in different rooms, but even the temperature differences within a room.

One of the leading standards in this area is called ZigBee. This open technology standard has been developed and is being promoted by companies such as Huawei, Philips, Samsung, Texas Instruments and Motorola. Products using the ZigBee standard such as Plugwise are on sale today and can do things like remotely control lights and other electronic equipment without having to install new wires, with very little interference. The ZigBee standard thus offers wireless mesh networking technology on sale today for a reasonable price allowing customers to start the integration of different appliances within their home and the remote controlling thereof. In an article published by the San Francisco chronicle, the estimated market value of mesh networking technology was around 100 million dollars in 2005, and is estimated to grow to over a billion within a couple of years [32].

1.4 Middleware and standards

Consumers are bringing ever more electronic devices into the home [33]. Not only new thin LCD and plasma displays, but washing machines and refrigerators are becoming ever more capable of communicating through new standards and innovations. Companies like GE (General Electric), one of the world's largest appliance manufacturers are testing what they call energy management-enabled appliances which can communicate in order to use the electricity supplied as efficiently as possible. The problem with such devices at the moment is the lack of standards. Of course there are a couple of standards, but each has a different specialty and it is a matter of time until the standards mature into their final role. Hereafter some of the largest standards will be explained such as UPnP, DLNA, and OSGi.

1.4.1 UPnP

UPnP (Universal Plug and Play) is a standard that has been developed by a large number of consumer electronics companies like Canon, Dell, Sony, Samsung and 861 others. It is an open architecture that is based on standards such as TCP/IP, HTTP, and XML. The goal is to allow devices from different manufacturers to join a network and interoperate automatically. By having the device join the network, name its capabilities, obtain an IP address, and learn the capabilities and presence of other devices in the network, the architecture supports zero configuration and

automatic discovery for the end user. This is a basis for intelligent devices to be able to communicate information that is of importance to the devices operation. The end goals for these devices is to be able to seamlessly transfer user content such as audio and video files, remotely control different devices, share information with the world wide web, and support electronic commerce. Currently UPnP devices are separated into a number of categories, these are, audio/video devices, basic devices, home automation devices, networking devices, printer devices, remote devices, and scanners. In this way UPnP devices can communicate with all types of devices on a network that is often already established in many residential homes.

1.4.2 DLNA

Apart from UPnP, the other largest system is DLNA, or the Digital Living Network Alliance. The main members in this alliance are Philips, Sony, Samsung, Cisco, IBM, Microsoft, Nokia, Intel, and Panasonic to name a few. Here, again, the goal is based on allowing for different consumer products to interconnect and interoperate creating a better end user experience. By doing so it should become possible to get more out of existing consumer devices and networks installed in most homes. DLNA devices are already being sold today, and the alliance names OSGi (explained in the next paragraph) as being complementary to the vision of DLNA. In both DLNA and UPnP examples the focus lies with sharing digital content, and allowing for new services such as video on demand and shopping online without having to sit behind your computer. Thus these are both architectures that focus largely on in home digital entertainment.



9-1 DLNA logo and benefits[4]

1.4.3 OSGi

The OSGi (Open Source Gateway initiative) is an open standard to make sure that residential gateways can be managed and run interoperable software. This is a specification to promote the easy delivery of services into the home network and local devices. OSGi is a framework that allows services such as UPnP and DLNA to

[4] www.sonystyle.ca

be installed and operate in order to provide a common running environment for these applications. In the future, such an open standard can make it possible for other developers to add more functionality to the gateway device in order to deliver even more services. OSGi has been developed by companies in many different areas such as service providers, device manufacturers and network operators. Specific companies in this initiative include IBM, Alcatel Lucent, Cisco, Siemens, Texas instruments, Nokia and Sun Microsystems to name a few. The main benefits of the OSGi platform include security functionalities, platform independence, multiple service capabilities and the support for multiple home networking technologies as explained previously [34] [35] [15].

1.5 Home Automation

Apart from digital content being accessible throughout the home, the smart home today also incorporates many other aspects such as lighting, heating, and security controls. The following section will go into more detail about what is currently available and possible in these areas. This will range from automatic lighting controls to single purpose robots that are slowly taking over small chores in the home.

1.5.1 Lighting

Current homes do not often include automatic lighting facilities. Only in more expensive homes do we see lights being integrated with other equipment to form different mood light settings. Thus it becomes possible that the lights automatically switch to a special movie watching mode once a movie is started on the home cinema set. Another option is for the lights to dim to an acceptable level for a dinner party through a remote control so that there is no need to walk over to each light separately to get the required light setting. Current offerings also include lights that are turned on according to a motion sensor in the room. These closed circuit solutions are often used in security questions where a large light on the outside of a building will turn on when movement is sensed. This is something that works in this instance but would create unwanted circumstances when installed in a bedroom where the light would turn on every time the person in question turns in their sleep. Thus these systems need to become cheaper and smarter in order to become useful to the average homeowner. Once this is the case the possibility of saving energy by turning off lights in rooms where there are no occupants and being able to turn lights on right before coming home on a dark night will most likely be a driver for consumers to install such devices. This will be offered in the form of adaptive lighting. Such systems are not yet for sale on the consumer market, but are being tested and researched at institutes such as the University of Colorado which will be reviewed later in this report.

1.5.2 Heating and Energy

Heating a home is an area where different solutions are in place, but a large gap still appears as to what is usually installed and the current possibilities. Today, most homes have a thermostat in the living room from where the heating in the whole home is controlled. It is up to the user to set the desired temperature and the heater will react accordingly. This is very inefficient since the temperature is only recorded in one room. Most of these thermostats allow for scheduled programming in order to allow the central heating to come on and off at pre set times. Even with this being the case, most users do not use this function and

manually set the temperature each night and morning [36]. This also means that the user is being very inefficient with the heat, since each room has a slightly different temperature and rooms that are not being used are also heated. Some people go so far as to spend time 'tuning' the heater in each room so that the ambient temperature is more or less the same in each room when the single thermostat is set to a specific temperature.

New systems on the market allow for thermostats to record the temperature in different rooms simultaneously and direct heat accordingly. When this is incorporated with new energy saving technologies and better isolated homes, large energy savings can be accomplished [4]. With the current rise in energy prices this should be a driver for consumers to take up this technology once prices start to drop and the system becomes easy or maybe even automatic to use. The market is starting to offer smarter and eco friendlier thermostats all the time. Honeywell, famous for its thermostats, is offering temperature zoning thermostats where, after having placed ducts in your heating system, different rooms can be set for different temperatures. Another innovation is the Ecobee smart thermostat, which provides a thermostat that can manage products that support the ZigBee standard to be integrated into a larger network. The new thermostat also supports Wi-Fi so that it can connect to a local utilities supplier and give up to date, price and weather information. Ecobee states you can save up to 350 dollars every year just by using their smart thermostat.



9-2 ecobee smart thermostat[5]

1.5.3 Smart Meter

Due to the regulations that have enforced the use of smart meters, a smart energy grid allows for a future in which energy is used more efficiently [37]. A smart meter is a device that replaces the current electricity meters with a device that does not only register the amount of energy being used, but also allows for this information to be sent back to the supplier through a myriad of different technologies. In the case of KPN, they have partnered with Oxxio, a Dutch electricity supplier to support a smart meter that send the data over an integrated

[5] www.ecobee.com

GPRS module, eliminating truck rolls for Oxxio when getting exact data from its consumers. Another named benefit is that smart meters allow for users to get real time consumption information thus making them aware of their consumption and lowering their usage [38]. Smart meters should also make it easier for households that are generating their own energy to deliver this back to the grid if they are generating more then they are using at that moment. The next step in smart metering is to support a smart grid. In this case, the energy consumption in a local area can be evened out by having energy flow from low usage areas to where it is needed.

Once appliances can start to cooperate with smart meters, through such systems as Plugwise, by planning their high electricity needs the meter can control the usage of the home in such a way that peak demand is stabilized putting less stress on the network as a whole. In a European research paper by the European commission, ICT is named as being critical since it will not only provide the communication behind the smart grid, but also the intelligence and capable of providing many new services that will increase the demand for such systems [39].

1.5.4 Entertainment

Audio video solutions to stream and play music and videos throughout the home are abundant. One well known solution to the problem of playing your digital audio database in separate rooms of your house is provided by a company called Sonos. Using SonosNet, a mesh networking technology, the system wirelessly transfers music to any room in your house where a Sonos receiver is present. All you need is an electrical socket, 2 speakers and the system allows you to use a remote from any room to play audio files from your computer over the ether. There are many comparable systems, some from high end brands like Bang & Olufsen and Apple, and others are third party options that require the user to set up the system themselves using normal Wi-Fi or wired solutions.

Video streaming has been harder due to the increased bandwidth needed to send video signal. Currently products that allow high definition video being sent over Ethernet through a conversion from HDMI to Ethernet can be bought. This allows users that have a wired home network in place to connect a television in any room where they have an Ethernet port and watch a signal coming from another room. Other options such as the Sling Box allow consumers to plug the system in at home to their local television cable and internet connection. The user can then log into a website worldwide to watch their own home television channels over the internet. Although most of these named products are relatively expensive, cheap solutions such as KPN's Digitenne which sends digital video over DVB-T (Digital Video Broadcasting Terrestrial) also exist.

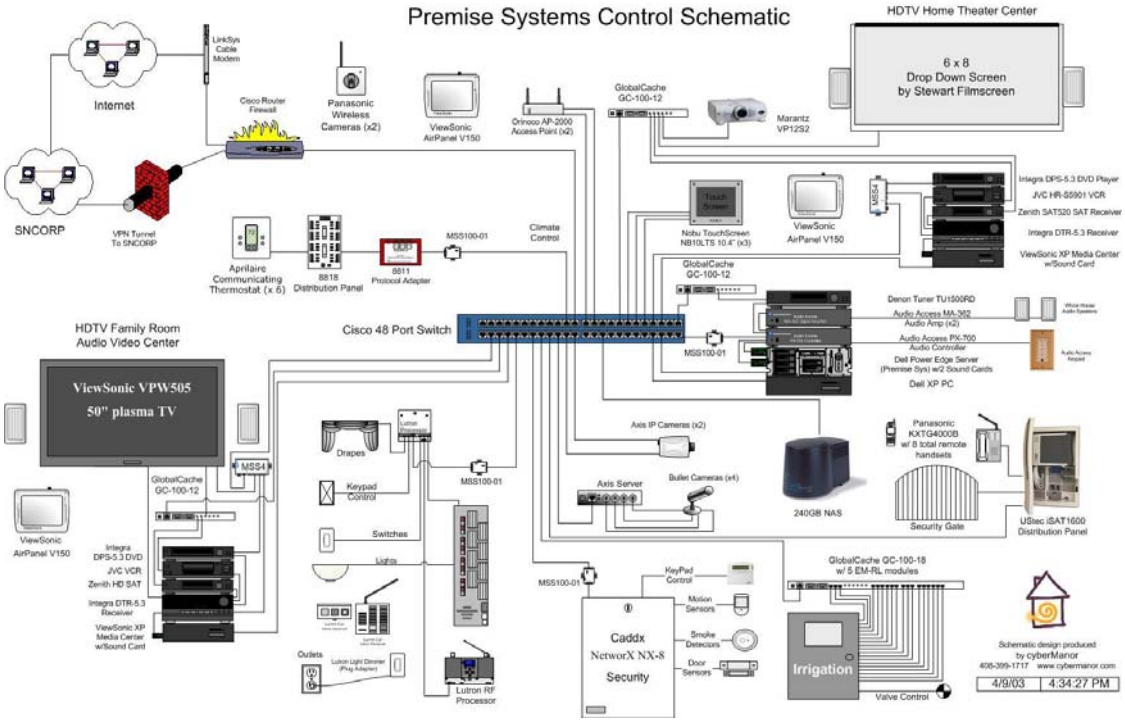
The trend in this area seems to be video on demand services, eliminating the movie rental store commute. Companies like Sony with their Playstation 3, Apple with their Apple TV and Netflix allow customers to download and watch movies almost instantly. With these services it becomes the customer who decides where they watch the movie depending on the location of the device they download it to. This can be a computer connected to a large screen display, but also a handheld device such as a Playstation portable or a mobile phone.

With all the audio and video streaming solutions out there, a lot of problems can be overcome. The main problem however is interoperation and integration.

Manufacturers are trying to lock in consumers and the integration of other smart home solutions are left out of the picture. These systems usually have a pure entertainment focus. Alliances like DLNA do support new devices from different vendors working together, but here we still see that it is only the digital content for entertainment purposes that can be shared. Instead we would want these systems to be integrated with other smart home systems like energy conservation systems, kitchen appliances and context aware sensor networks.

1.5.5 Integration and Control

Home control devices are becoming more capable and available every year. The main problem is that these systems are usually custom built from modular components. A typical newly built home where the owner wants control over their lights, temperature, security and digital media can easily cost over $25,000 for the system alone. This then is a place to look at what the possibilities are, but a large step still needs to be made in order to make this conceivable for the ordinary household. Furthermore, these homes or not as smart as they seem to be. In most cases there are a myriad of separate objects with the capability to be controlled remotely. This is a step in the right direction, but is not a fully integrated adaptive solution. In this case it might be possible to dim the lights and shut the curtains automatically once a movie is started on the home cinema set, but this functionality is all pre programmed. The system does not make a judgment on say the time of day or amount of sunlight entering the room in order to decide to close the curtains or dim the lights. What is needed is true interoperability, in which the system allows for newly added devices to use their full functionality without the user having to intervene. This then would be automatic integration and complete interoperability.



9-3 Schematic of home network to control the home[6]

1.5.6 Home integration companies

In this section I will go on to discuss some of the companies that currently offer home automation solutions as they are usually called, signifying their goal of making certain actions automatic and remotely controlled.

Embedded automation, Savant Systems, HAI, Crestron, and AMX all offer custom built home automation solutions. Their services differ in small areas such as Embedded Automation integrating irrigation solutions for the garden into the system, while Savant systems is more specified around the actual control panels that can be built into the walls to control lights, curtains, and even the fireplace.

Crestron and AMX are two of the biggest companies in this field, with a background in supplying upscale offices with presentation screens folding out of the ceiling and allowing for different light settings in large boardrooms. AMX goes so far as to allow for security services such as watching your homes webcams on your mobile device while on the move, and being able to lock the doors of your home. A company called Control4 offers similar solutions, but has put a stronger focus on the green aspects of automatic systems saying their system can help lower your energy bill by letting you manage your lights and temperature in a more efficient way. With current Crestron and AMX systems this is not the case since these installations require massive servers and other energy hungry hardware.

[6] www.cisco.com



9-4 Integrated home control system by AMX[7]

BestBuy, one of the largest US electronics stores offers a 15,000 dollar system that included wireless webcams, a game console in the form of an XBOX 360, light switches and a media PC as a do it yourself starter kit to the automated home.

Most of these systems work with a variety of controllers in the form of wall mounted and mobile (within the home) 7 to 12 inch touch screens from which to control the settings. In most cases the companies design and program their own controllers so that the system that manages the separate devices is proprietary and locks in the user. The devices themselves such as the TV, audio equipment and security cameras can be from any vendor. For this reason the system needs pre programming in order to make it all work, however changing the setup is a difficult procedure.

1.5.7 Security

Security is an area often incorporated into smart home visions today. The idea of being able to receive an sms message from your house with the option of starting a direct live video feed is often named as an example. By integrating wired or wireless cameras that are linked to the home network, this is technologically a relatively easy service. The main problem today is making sure the mobile phone has a fast internet connection to carry the streams and the home network to upload sufficient data towards the internet. Apart from securing the home from unwelcome visitors, securing the smart home technology itself is of great importance. If the network can be accessed by anybody, being able to lock your doors remotely is of no use if the third party can do so as well. In this area a number of solutions are offered, and as is the case today with Wi-Fi networks, comes down to getting authorization systems in place. In my research I will not

[7] www.amx.com

focus further on the security of the smart home service itself, but only on the security the smart home can offer its residents in the form of alarming, preventive action and automation.

The reason for this exemption is that even though security is an integral and important part of home automation, it is something that is inevitable in such systems. Security in such systems will always form a challenge, but one that cannot be excluded in the building of such systems. For this reason it can be seen as a given that the companies supplying such services and devices will integrate this into their services in the best ways they see fit, and security in this sense is more of a necessary functionality then a core capability of the systems.

1.5.8 Telemedicine

Telemedicine is an area that has a lot of potential with the increase in elderly people, especially in the Netherlands. Telemedicine is often used to describe a number of different medical or health related subjects in which information is transferred over a distance. Such things as telephone consults can be seen as telemedicine, with the other extreme being robots performing operations through a doctor that can be across the globe controlling the robot. In this case, telemedicine will be used to describe services that elderly people can use from within their own home such as video calling with their doctors. Another area of telemedicine that will be looked into in this research is the area where the home keeps an eye on the patient through a network of sensors. In this case it is possible for the home itself to alarm caretakers, loved ones and doctors in case of an emergency. Examples of this include carpets that track the users movements through the house and can phone a loved one if it senses a person lying on the ground for an extended period of time. Such a system would then be able to allow the patients family or doctor to get a live video feed of a webcam on their mobile device to see what is going on in the patient's home. In this field a number of other technologies can be implemented in order to allow elderly people to continue living in their own home for a longer period of time. Living Tomorrow, a concept future home near Brussels, has included mirrors in the bathroom that can show a persons vital statistics and remind them to take their medicine when the person enters the bathroom. Other features turn on the lights automatically in the middle of the night once pressure is felt on the carpet next to the bed. This is a safety precaution in order for people getting up at night to go to the bathroom to be able to see where they are going.

In this research, the use of telemedicine will focus around the products and services that prolong the time elderly can continue living in their own home and which could be provided by KPN.

1.5.9 Robots

Some smart home scenarios include robots in the future vision [40]. Today there are a number of single purpose robots available for purchase. The two main chores in which consumer robots are active are in lawn mowing and vacuuming. Both work in relatively the same way, in that they have a charging station where they replenish their batteries. In both cases the robots use a similar tactic of tracking along the edge of the lawn or room in order to return to the base station. The most popular vacuuming robot is built by a firm called iRobot and is called the Roomba. The largest producer of robotic lawn mowers is a company called

Friendly Robotics. Both these robots show the trend for relatively cheap and single purpose robots starting to take over tasks in and around the home. From this perspective, the view of a multi purpose robot is still far off, even if it is only due to the extreme cost of such robots. The most famous in this case is most likely Honda's Asimo. Asimo is a human like robot that walks upright and is packed with computer power, providing it with so called intelligence, and a multitude of sensors. With a price of over 600,000 Euros it is a long way off before this kind of robot finds its way into the modern home, and even then its usefulness is questionable. Thus the future of robots in the home seems to be one where single purpose robots take over simple yet time consuming chores.



9-5 iRobot's Roomba, vacuuming robot[8]

[8] www.irobot.com

9.2 Appendix 2: Domain research. Research projects

1. **Research projects and developments**

1.1 Philips ExperienceLab

Philips has its largest research facility based in Eindhoven the Netherlands. In 2002 they opened HomeLab as an experience and application research facility. Later they renamed this into ExperienceLab with the incorporation of ShopLab and CareLab where innovations in the retail and medical sector are researched. HomeLab is based around the vision of Ambient Intelligence. As Philips puts it, the definition of Ambient Intelligence is "The vision which anticipates a world in which electronic systems will become miniaturized, intelligent, and integrated in people's environment, thus moving electronics into the background and people into the foreground. The vision of Ambient Intelligence is aimed at improving people's lives by supporting their productivity, well-being and lifestyle". Their vision goes on to describe a future where entertainment, information and communication services will be provided through a distributed network of intelligent devices. These devices will adapt and even predict our needs in order to provide ideal living circumstances.

This vision shows how Philips, an electronics giant, thinks about the future and that interoperability and integration is an essential requirement for the smart home of the future. Researchers in their HomeLab are spending a great deal of time trying to find the solution to the question of how to make it as easy as possible for the consumer to control their electronic devices. They want to control large flat screen LCD TV's and simple lights through a single, simple and intuitive control system. Products that have made it into the consumer shelves so far stemming from this research project are their Ambilight television set and the LivingColors mood light. These immerse the viewer with multicolor lights in the color of the picture being shown on the TV and the remote controllable mood light that allows the user to set the color of the lights in a room.

More interesting are the products currently being tested and researched in the HomeLab environment. One such example is the DreamScreen, a virtual window that allows the user to select the virtual background that mimics what can be seen through a window. With sophisticated sensors measuring the users distance and angle in contrast to the screen these screens allow for a virtual representation of the outside world. Thus when moving closer, a person sees more of the virtual outside world, and by moving from side to side they can see behind objects creating a 3d effect. This is not possible with a typical 2 dimensional picture. Other systems that allow the user to simply tell their living room what mood they are in could then provide the setting by playing the corresponding music, setting the right thermostat level and changing the view from your virtual windows.

Thus the trends that Philips names which will guide their research are that of society becoming ever more connected, technology following Moore's law and becoming more capable of producing technological breakthroughs and mass customization leading to new business opportunities and thus changing the economy [17].

1.2 MIT Project Oxygen

Massachusetts Institute of Technology (MIT) runs a project called Oxygen in which Philips is actively involved. This project is based around the idea that computers will be omnipresent in our future. Instead of one person being served by a single computer as we are today, the future will be made up of hundreds of computers serving each individual. To make this possible computer interfaces must become easier and more intuitive to use. For this reason project Oxygen is looking into ways to control the computers of the future with voice and hand gestures. The concept should make it possible to simply talk and have computers embedded in objects all around us respond to all our wishes. In this way it should become easy to access information, work together, and automate repetitive tasks.

In this test site the students at MIT have installed an "intelligent room" that is equipped with many microphones and webcams recording and observing peoples actions. This makes it possible for the users to record their sketches and record their words in order to share this or have specialized software take action accordingly. Other sensors in this room, named crickets, allow for indoor positioning so that users can be followed around and actions such as directing the cameras and microphones can be adjusted accordingly.

Together with the 5 other main sponsors, namely Nokia, Acer, Delta Electronics, Hewlet-Packard and Nippon Telegraph and Telephone Inc., this initiative is set to support highly dynamic and varied human activities. The future of this system means we will be able to simply talk and gesture to our home in the way we currently do with other humans in order to control the networked systems in our home.

1.3 MIT House_n

Another research project at MIT is the House_n Project. This project, initiated by the architecture department, sees the current home not keeping up with changes taking place all around us. As their introduction states, "The widespread adoption of digital technologies is leading to profound changes in how we communicate with others, shop for goods and services, receive news, manage our finances, learn about the world, participate in politics, deliver and receive medical care, conduct business, manage resources, find entertainment, and maintain autonomy as we age. Increasingly, these activities will take place directly in the home. As our notion of banks, bookstores, universities, communities, and cities change in response to new technologies, the home will take on extraordinary new importance."

The project goes on to say that the current homes cannot meet these demands and that new technologies create chances that currently are not taken advantage of.

Projects within the House_n project include sensors that can sense context awareness, making it possible to automatically recognize everyday activities, and taking action accordingly. The proactive health display project within House_n is testing to see which health data the house can collect from the person's behavior. The House_n project is made up of a multidisciplinary team that are looking to deliver innovative products and services that can be used in and around the home. These type of projects offer a great chance to see how the home can be changed from many different perspectives in order to catch up with the rapid changes taking place in other areas. This project also shows that world class

research institutes such as MIT believe that changes are taking place in this direction and we can expect our homes to become a lot more capable then simply supplying a roof over our heads in the coming years.

1.4 Aware home research initiative

At Georgia Institute of Technology they have started a project called the Aware home research initiative. This project names its focus as seeing if it is possible to build a house that is aware of its inhabitants. The main reason for wanting such a home, according to their vision, is to be able to enjoy the modern technology we bring into the home today. Peoples homes are becoming ever more digitized and technologically advanced. In order to keep this under control, it is imperative that the control systems for the technical infrastructure become easier and simplified for the users. For this reason the Aware home research initiative sees opportunities to support the communication and coordination through new technology in order to make living in the 21st century home more enjoyable.

Again, as in the MIT and Philips research projects we see a great deal of time and effort being put into the way we control the technology currently installed in our homes. The researchers believe that we have conformed to be able to control modern appliances, but this should be turned around. With computers becoming more powerful, adaptive and aware we can start to control them intuitively instead of on their terms. This research initiative is split up into three main sections; these are chronic care management, future tools for the home and digital entertainment and media. Systems that are being developed include a system for closing blinds and curtains automatically throughout the day in order to conserve heat and maintain optimal lighting conditions, and new infrastructures of wireless sensors and low cost location detection devices. Within digital media the researchers are working on simplifying the way in which digital content is shared within the home, and digital media sharing between different homes [41].

1.5 The Adaptive house

The University of Colorado has spent a great deal of time developing a home that has adaptive lights. This means that the system intends to learn from the person living within the home in order to have lights turned on in the right room at the right time. This project had the intention of having the home program itself. By installing over 75 sensors in an actual residence they hoped that the system would be able to learn from a combination of the person's behavior and measurements picked up from the environment.

By installing this system it became possible that the home could predict the time the homeowner would arrive home and make sure the right temperature has been reached by this time. Lights could be turned on in the areas the person first visits when returning home such as the kitchen and the living room while the rest stays turned off. Since the home found hot water was only used early in the morning and a couple of times in the afternoon the boiler could be shut off during the rest of the day. If the user would move around in the middle of the night, the house predicted this was for a bathroom visit and could turn on the lights in the bathroom only, and could predict the owner coming home later on Fridays then on regular work days. The intelligent system even realized that the user would

return slightly later on days rain was sensed due to traffic congestion, thus turning on lights a little later then normal.

This system kept the user in charge by keeping all the normal light switches we are used to intact and learning from situations where the user walked into a room and found the lights to be off and turned them on manually, thus also defining habitual movements in the home from the living room to the kitchen around dinner time for example.

This example of the adaptive home shows how simple sensors plugged into the right computer software can learn a great deal from our daily routines and thus create a more comfortable living environment while saving on electricity costs. After living in the adaptive home for over 6 months the user even experienced loneliness once the system was turned off, having generated a bond with the adaptive home system [42].

1.6 Living Tomorrow

Near Brussels a group of companies have joined resources and knowledge to set up a house based on their vision on what the future brings. This showcase home is called Living Tomorrow and is open to the public as a demonstration of what is possible with current technology. This high-tech home features an outside shell with blinds that allow in light and heat automatically in order to keep a comfortable temperature with as little use of energy as possible. Inside we find state of the art equipment in the kitchen such as a digital notice board where the family can leave each other messages from their mobile phones, or add things to the shopping list while on the move. Other features are a large home cinema set, which allow the user to shop online and even watch videos of holiday destinations before booking a flight and paying for it from the comfort of their living room couch. One technology that was integrated into the house were mirrors that could double as screens. These can provide up to date news while shaving in the morning, or show a 2 minute cartoon so that kids spend the minimum amount of time brushing their teeth. This home is not placed far into the future, but more a showcase of what is possible today .

1.7 Hobbyists

In the smart home arena it would seem that large research facilities with large amounts of resources would be at the forefront of creating the homes of the future. In practice, it seems that there is a large community of people dedicating large amounts of their own time and resources into turning their own homes into smart homes. A prime example of this is the so called Bwired home in the Netherlands. www.bwired.nl , and similar websites such as www.hekkers.net, are websites that show how people who devote a lot of time and resources can come a long way in building their own smart home concept. These websites show a legion of different graphs portraying information from a multitude of sensors installed within the home. At closer inspection it becomes clear that this home is laced with sensors, including every window, light fixture, door, electrical appliance and even the amount of times the toilet is flushed is recorded and displayed in a graph online. Most of the sensors allow the information from these sensors to be depicted online, but many of them can also be controlled online. Thus the home owner can go online before leaving work and create the right settings for when they arrive home.



9-6 Screenshot: Bwired home showing live water, gas and electricity usage[9]

What is interesting in these homes is the fact that water, energy, and gas usage can be followed and acted upon in real time. Speaking to one of these homebuilders, it became evident that just by creating awareness in their hourly usage of gas, water and electricity they became more interested in trying to lower

[9] www.bwired.nl

their usage. This phenomenon is also visible in cars where the addition of a fuel consumption meter made drivers more aware and in turn gave them an incentive to drive more economically [43].

The main problem with the incredible amount of sensors and electronic devices that are found in these wired homes come from the interoperability they are trying to create. A large amount of programming knowledge is necessary to be able to control all the equipment from a single device. As an example, Robert Hekkers, the owner of the home depicted on the website www.hekkers.net, explained how he has connected the living room lights through powerline technology so that they can be turned on and off through a wireless transceiver. To be able to control these fixtures with the same remote that he uses to control his television set however, he had to connect a similar wireless transceiver to his home server, which receives the input from the remote through the in home Wi-Fi network. What is evident from these examples is that the programming on the home server and the main control unit for the whole home, need a lot of specific programming and understanding in order to get the separate functions such as home cinema sets, lighting controls and thermostat settings to work together. Thus the limitations of these systems currently staying within the realm of technologically savvy individuals, is the simple integration of home automation equipment that is readily available. Once this hurdle is overcome, these hobbyists believe the home filled with sensors and remote controllable appliances will become much more mainstream then their homes currently are.

1.8 Smart Home Literature

Smart home research is dispersed over the many separate research areas that are encompassed by the total smart home. As my domain description above shows, the smart home is not a stand alone product or service, but a combination of many available technologies to form a complete concept. As Francis Aldrich states in the book 'Inside the smart home: ideas, possibilities and methods' "To date, the limited amount of research into smart home that has been carried out has been primarily focused on the technical possibilities." [8].

One research area that I came across, which is also explained in the adaptive home research project above, has to do with having intelligent systems program themselves according to our behavior. An example of this would be a thermostat that programs its own dynamic schedule instead of having the homeowner program in a static weekly schedule. The paper named 'Inhabited intelligent environments' describes embedded agents such as temperature sensors to program the intelligence instead of having the user pre-program this, the solution is seen as working relatively well. This research states that this allows for increased agent autonomy and thus making embedded computers more practical to implement [44].

In 'Pervasive home environments' the author sees the truly intelligent home still some time away. In this paper the technological barriers that still need to be overcome are explained but the integration of in home networks, broadband access and faster cheaper and smaller computers shows us how close we already are. The main focus of this paper is that the future is one where we will focus more on what we want to achieve, then on the technology that is needed to achieve it. The increased complexity will be fixed by having sensors and devices

self-configure and work autonomously. These steps in the technology will then bring the chance for a wide variety of new products and services for the consumer. The main technological challenges according to the author are configuration, user identity, resource reservation and the user interfaces. Once these barriers are overcome, being a question of time, many commercial opportunities will arise [5].

Further research goes on to say that we are close to computers being ubiquitous and our interaction with them will be almost subconsciously. Intelligent devices will interact autonomously for our benefit with minimal human intervention [45]. In the same journal, namely the BT technology journal, another article reviews the status of hardware technology developments. The main challenge concluded from this paper is "its seamless integration into the pervasive environment but significant progress is being made in making the devices cheap and small enough to begin the construction of the vision" [14].

Interestingly enough, 4 years down the road, literature has started appearing with solutions to the named problems. The first of which describes a proof of concept of an "automatic communications architecture to solve the self-configuration problem". In this paper a self-configuration functionality has been designed and implemented into a residential gateway supporting the OSGi framework. As stated in the conclusion of this article this has a large benefit for the consumer. "When a customer buys and installs a new device in his home network, the automatic element is able to automatically offer services suitable for such a new device." This then means that customers will not need to worry about which services are suitable for their setup, since only supported services will be offered [46].

9.3 Appendix 3: interviews, brainstorms and visits

In this appendix an overview is given of the experts I interviewed during my research. Furthermore, experts I spoke to for brainstorm sessions and visits I made regarding my thesis are also included to give an overview where I gathered my data.

Interviews

The following section provides the names of the experts I interviewed. Followed by their name, is the company they work for, and the function they perform within this company.

These interviews were performed in an open manner, meaning no fixed questions had been specifically prepared before hand. Each interview was started with an introduction on my thesis and the main research question. This always led the interviewee to immediately ask me a couple of questions before going on to give me their ideas on the subject matter. Lasting on average an hour, each interview was not recorded, instead notes where taken on the most important ideas. Below each name I have summarized the main conclusions gathered from the interview.

Peter Maarten Westerhout: Strategist at KPN
Business Markets: marketing strategy and innovation
In this general brainstorm the complexity within the smart home domain was the focal point. The main complexities are to be found within technology are the connectivity, the applications and the sensors needed to run these applications. One of the large uncertainties in this instance is seen to be standardization. Without this, there is no feasible way to deliver services to each home since each will need a custom built platform. Furthermore, the idea that many companies are already heavily integrated into their market was looked into, and the question as to what KPN can offer these companies was raised. What can KPN offer security and healthcare companies for example?

Jan Kroon: Strategic innovation manager at KPN
Business Markets: marketing strategy and innovation
The interview with Jan Kroon focused on the realization of the smart home. His advice was to find people whom had tried to realize a smart home concept and ask them why it had failed. It was also of importance to better define the smart home. Through showing me examples of specific services KPN had started such as ‘inbeeld’ a webcam based security service, problems of such services where made clear. The clear point that the specificity of each different sector is hard to integrate into one service was made. Other examples came in the form of ‘ipt’ a telemedicine firm KPN had recently acquired. These examples show how there are different ways of going about doing business in each of these sectors based on the standards within these sectors.

Rob Visser: Architect at KPN
Wholesale & operations: network & service innovations
This interview started with the idea that the smart home is mostly based around ‘domotics’. The services this smart home should deliver, is mostly based on the operators. It was in this interview that the idea was presented of the services needing to be modular. Meaning, the complete smart home should be something that can be pieced together over time, instead of trying to fit it all in at once. These

services can then only be possible with the right connection infrastructure in place. Within the home, high bandwidth services will still benefit from being wired instead of wireless. The main conclusion was that there is a connection between the type of services on offer and the infrastructure it runs on.

Remco Helwerda: Consultant at KPN
Consumer Markets: Glass innovation management
During this interview we discussed the possibilities of the home or residential gateway. In house solutions based around these components are much easier if an expert comes by to install them instead of having a large helpdesk and having consumer do it themselves. The problem here is that KPN does not have the image of being able to help people within the home. The expert stated that people most often visit the 'Dynabite' or similar electronic stores to get their advice on problems occurring within the home. With the new residential gateway which is currently being tested more should become possible for the consumer. KPN is also going to focus on becoming a partner which to turn to in case of in home networking problems. A problem, which currently is often faced by KPN mechanics, is the fact that old Dutch houses have the main entrance point for the voice communication infrastructure in strange, and often hard to find places.

Harm Mulder: Architect at KPN
Wholesale & operations: Network and services innovation
The first concept of this interview was based on the idea that KPN will start to deliver services not only to the end consumer, but also the other way by providing information and update services to the provider of these services. This business model allows for the consumer to pay less for its services while the provider pays KPN for the delivery services. The reason being that these services often not only make things easier for the consumer, but also for the provider of the services. The second main concept was that within 5 to 10 years intelligence in the network will allow for truly easy plug and play installation of devices. Until this time the service to offer KPN experts and mechanics to the customers in order to install and solve their networking problems should be realized.

Theo Mol: Device manager at KPN
Wholesale & operations: Network and services innovation
The standards within home networking technologies will not form to big of a problem although they are an uncertainty. Currently WiFi and Zigbee are industry standards and capable of the requirements, with improvements on the way. The biggest problem is that technology is entering the home through a technology push. Once technology pull from the consumers is perceived the truly smart home can become a reality. In this interview the view that network intelligence is on its way was also agreed upon and the exact technology is not an issue.

Joost-Willem van der Veer: Marketeer at KPN
Consumer Markets: Mobile Development
And
Harmen Witkamp: Strategic innovation manager at KPN
Consumer Markets: Mobile
In this interview I spoke to two people simultaneously. Here they came up with the idea that services which are currently being provided to the business market such as external logging, webcam security, and interconnected locations will

become available to the consumer in the future. Furthermore, services such as online backup, cloud computing and femto cells will all increase in popularity once the consumer has gained confidence. It is this confidence that KPN needs to instigate in the consumer, not only in relation to the data handling capacity of KPN, but in the technology itself. The consumer should not be aware of the technological difficulties behind the services. This will increase their demand for such services.

Anke Hagemijer & Marcel Eijgelaar: Innovators at Essent
Through my meeting with Anke and Marcel at Essent I was quickly brought up to pace with the current situation in the electricity market. In this open interview I asked questions regarding the smart grid and the options which can change the way electricity is currently being produced and supplied to homes. The main conclusions are that the peak loads which need to be generated have the largest focus,. These loads are hard to predict and thus require specific power plants which can be turned on or off relatively quickly. This is an expensive requirement which could be controlled by having decentralized energy production in the form of solar power of even using the car battery which is connected to the home as a buffer. The main challenge still lies within the flow of information, knowing where electricity is being produced and where it is needed at any given time is far from realization. Thus it is in this realm that KPN can provide its services to such companies in order to provide the information to make a smart grid possible.

Robert Hekkers: Smart home Hobbyist, owner of www.hekkers.net
My visit to Robert Hekkers home gave me an idea of what is currently possible with some passion, free time and programming knowledge. Furthermore, the discussion provided information regarding the role KPN should play within the home. Mr. Hekkers gave an insight as to what he sees possible in the near future and which possibilities are most beneficial in our daily lives.

Brainstorms:

These brainstorms were held with people I spoke to more often. Sometimes they focused on a specific part of my research, while other times they were about the smart home in general.

John Hoffmans: Architect at KPN
Wholesale & operations: Service technology office, technology & innovation
Over the top players and the smart home infrastructure.
The idea of companies being able to use the internet connection consumers are paying for to deliver their services can be seen as a threat to KPN. Over the top suppliers such as Sony and Apple can deliver video on demand services over internet making use of the infrastructure KPN owns. KPN gains little if any benefit from such players. A solution would be to be able to deliver a certain quality of service to these firms once bandwidth demand becomes even larger and the strain on the network bigger. Currently it is not possible to detect the type of data the consumer is enjoying over their internet connection. Thus the difference between illegally downloading a movie, using Skype video conferencing software, or listening to an internet radio station is all handled in the same way. In the future these services can be improved by working together with KPN to deliver the bandwidth, latency or speed different services require.

Nico van Belleghem: Architect at KPN
Wholesale & operations: Service technology office, technology & innovation
And
Edgar van Boven: Architect at KPN
Wholesale & operations: Service technology office, technology & innovation
Scenario analysis, key factors and uncertainties
In a brainstorm session with these experts we identified the key factors in the local environment as input for the scenario analysis. These led to the driving forces which were also discussed in order to develop the scenario matrix in the futures research chapter of my thesis. The plotting of the key factors within the uncertainty matrix led to the matrix used in my research. In the end, the matrix axis based on consumer demand and transsector innovation was found to be ideal in order to generate scenarios for the smart home environment.

Separately, with Edgar van Boven, brainstorm sessions were held in order to create the service concept ideas presented in chapter 4.2.3. The presented ideas where chosen from a long list generated in separate brainstorm sessions. These sessions where set up by picking a sector at random and trying to combine this with telecom to form a service. Some of the ideas are based on ideas proposes by students whom follow Edgars university course.

Nico Baken: Senior strategist at KPN
Corporate strategy: Management
The first conceptual ideas of the smart home and the smart living concept were formulated during the preliminary meetings with Nico Baken. In these meetings, much in the form of a brainstorm session, ideas on smart grids, consumers becoming prosumer, transsector innovation and KPN's role herein where formulated. These led to the generation of the research proposal for this thesis.

In following meetings with Nico Baken the scenario framework was presented in order to receive feedback on the choices made as an evaluation step. This was the case for the key factors plotted in the matrix and the scenario logic matrix.

9.4 Appendix 4: Service design research. Service concept

1. Service concept design steps

1.1 Goals

The first hunch design step is to define a set of goals the service or product should fulfill. These goals are split up into the general KPN wide goals and the goals specifically for the smart home service:

- General KPN goals: These goals have been taken from internal KPN memos, documents and presentations.
  - Create new revenue streams
  - Bind current and attract new customers
  - Provide new, market leading services
- Smart Home service specific goals: These goals are in relation to the smart home service. Speaking to experts within KPN, these goals are what was distilled from the interviews and discussions.
  - Manage in house technology complexity
    - In the domain research it became clear that many different technologies and systems are currently found in the house. In order to get consumers to take up the smart home, the current and especially future complexity of all this technology needs to be managed for the customer.
    - This goal was presented by the ideas from the interviews with Harm Mulder, Peter Maarten Westerhout and Remco Helwerda. As they proposed, this is in line with the findings in chapter two.
  - Supply necessary bandwidth to run future services
    - As seen in the smart home domain research the smart home will be abundant with information streams, within the home, and with the outside world. This asks for high bandwidth access to the home.
    - This goal became apparent by the topics discussed with Rob Visser and John Hoffmans in their interviews. This same goal is apparent when looking at the future vision and trend forecast in chapter 3.2.
  - Either improve living comfort or decrease costs for consumers
    - In order for consumers to take up new services there has to be a demand for them. Currently the services that KPN offers increase comfort for their customers. In the future these services might also save them money. It is important that the new smart home services KPN is going to offer continue to add value from the customer perspective in order to create a viable business case.
    - This specific goal was taken from the ideas presented by Jan Kroon and Theo Moll in their interviews. This goal is in line with KPN's general goals to create demand from the consumer side for new and innovative services.

1.2 Requirements and assumptions

The next step is to find the requirements and the assumptions that fit these goals.

- Functional requirements
  - Deliver the services into the home
    - The service needs to be delivered to the homes. People need to be able to not access them but also buy them from the comfort of their own home.
  - Manage in house technology complexity
    - Functionally this needs to be managed by a person who can come by and fix the problem when the customer wishes.
  - Cut costs
    - The service needs to allow customers to enter the value network by either cutting their costs or allowing them to produce and sell things such as content or electricity.
- User requirements
  - The service needs to be user friendly and intuitive to use for different age groups.
  - The consumer needs to be able to buy the service at any time. This needs to be an automated process which can take place so that the user can start using the specified service instantaneously.
- Contextual requirements
  - The services in the service bundle need to build towards the future vision of the smart home.
  - The services need to be based around technology, specifically information communication technology for which KPN can use its assets and expertise to add value.
  - The services need to be interoperable with non telecom in home technology.
  - The services need to work together with the utilities already found within the home such as electricity, gas and water.

Assumptions of the quality of the service

- The quality of the services need to be as high as current digital television, internet and voice services KPN offers in order to maintain their name as a high quality service provider.

1.3 Structural specifications

The structural specifications of the previously made requirements and assumptions can be categorized by their characteristics, aspects and parts.

The structural specification of the smart home service is that it is based on services which need access to certain information which is provided by a physical connection. This comes in the form of broadband internet access, either through ADSL technology today, or higher bandwidth connections such as fiber in the future. This specification allows for the service delivery. This is to satisfy the second goal.

The services then need to either contribute to the improvement of living comfort, or in cutting costs. The services need to do this by combining physical devices with intangible services these devices can deliver. Real added value can be created when devices the customer already owns can be used together to deliver

services they previously didn't have. This makes it clear that managing the devices, which the consumer already has, and the ones they are going to add to the technology within the home need to be managed in order to create new chances for service concepts. These services need to then be provided in such a way that consumers can easily see the benefits. Only by providing services that are in demand by the consumers will the service be profitable. This specification can fulfill the second goal of increasing living comfort or lowering costs through the services on offer.

Once this is the case the service needs to be made deliverable through the customer connection KPN offers. The parts of the structural specifications can be seen as the access part, the in home complexity management part and the actual service part. The technicians KPN has, need to be used to help their customer manage the complexity of the technology within the home. By doing so it will become easier for consumers to experience the benefits of having new services and their devices. This satisfies the first named goal of managing in house technology.

9.5 Appendix 5: Service design research. First Hunch STOF

1. First hunch STOF method steps

1.1 Service design

Customer and end-users

- Who is the customer? Who will pay for service?
  - The customer is the same as the person paying for the service. This is the homeowner, such as people currently buying triple play services from KPN. In the beginning these might be technology savvy individuals. Later on, as with internet adoption, these services will become mainstream. The same user as internet today. 5.6 million
  - internet connected homes from the total of 6,5 million. 3.1 million with digital television (CBS, 2008). Smart home services are to be delivered to the same customers so basically all households within the Netherlands.
- Who is the end-user? Who will be using the services?
  - The end users are the people living in the household which is paying for the services, again these are the same people currently buying triple play services from KPN.

Context of use

- In what specific situations would people want to buy or use the service, e.g. when and where?
  - The user will purchase these services from their home. Usually in time currently being spent watching TV or surfing the internet. It can also occur that the person runs into a specific problem for which they want to know if there is a solution (home security as an example) and they use the KPN service in order to look for a solution.
- What does the daily life of the intended customer or end-user look like and how does the service fit in?
  - It is crucial to make this service applicable to as many users as possible. If KPN is able to deliver many different types of smart home services over their delivery platform, the user group can encompass all the demographic groups which are connected. This also makes the delivery platform interesting for the service provider since there is a larger potential market.
- Within which social context does the service fit?
  - All sorts of homes, from single home dwellers to large families whom are looking for ways to increase their living comfort through brand new smart living services. Some services, specifically within the energy management of the home will also be cost saving measures which fit within almost all household contexts.
- Does the service match the behavior of the customers and end-users?
  - As their currently are very few users of smart home services this question is hard to answer. If buying and using smart home services can be compared to current services such as internet, and TV then the service seems to match the behavior as most households in the Netherlands have both.

- Does the service offer a benefit to the customers or end-users, in terms of user-friendliness, fun, efficiency, etc.?
    - The main user benefits as mentioned before are in the increased living comfort these types of services can offer. On the other hand, services related to home energy management will decrease costs making the use of energy more efficient as an example. Thus the main benefits come in living comfort and home efficiency.

Intended value, delivered value and value proposition

- What does the service do for the customer or end-user?
    - The service allows the user to access brand new services through a platform which not only delivers the service, but makes sure it will work as intended.
- Why would people want to buy and use the service?
    - Many smart home services are intended to increase living comfort within the home. Thus if the user decides to take up the smart home delivery platform from KPN they can pick and chose from services they find will increase their living comfort in the best way. This might mean they have more free time or are a better entertainment experience.
- What is new/innovative about the service?
    - Is the service an improved version of an existing service?
        - In a sense it is. The delivery over high bandwidth internet connection make it comparable with the internet itself through which people can already watch videos on demand and many other free services are provided. What is improved upon is the fact that the service does not end at the connection point with the home, but is extended into the home. Thus making sure that the technology which is there can actually implement the service is new. It is also new to give the context and service providers a fixed platform where they can reach a large amount of customers. For the customers it is made transparent by giving them a so called one-stop-shop and a single firm sending them bills with an overview.
    - If so, is the technology a new one?
        - The technology that supplies the service is not new. The technology is, since most households do not yet have a fiber optic connection. The in home technology itself will be new, but based on current trends such as intuitive remotes, and mesh networks.
    - Is the type of cooperation between the partners involved a new one?
        - Yes. It is critical that KPN adds value which the service providers want to take advantage of to offer their service through their delivery platform. For the user this means they have access to many different services from different providers, but all accessible through one medium.
    - Is the business model a new one?
        - The business model is a new one when it comes to supplying smart home services. The business model can be compared to the application store model Apple, and now most other

mobile phone manufacturers have developed for their devices. This means that their devices, in this case the phone can access and buy services which will work and fulfill a specific service the customer is willing to spend money on. In the case of the smart home the device should be seen as the whole home and thus the management of the technology and its complexity is a very important part. As long as there are many different standards and options, KPN can supply this functionality by supplying a service in the form of a person which will literally come over and make sure the technology is functioning.

    - Is the marketing approach a new one?
        - Since the smart home delivery service does not yet exist the marketing will be new in its content, but most likely supplied in currently used forms such as TV and internet advertisements.
    - Or is the service entirely new to this market?
        - Yes. Fiber to the home is not a new service, nor is the service which fixes in home technology problems. The combination of these to form a smart home service platform and thus supplying a place for services to be bought and used is entirely new.
- What are the unique and distinguishing benefits of the service?
    - For the customer it is ease of use and amount of different services. For the provider it is the amount of potential customers and the fact that they are not responsible for making the service actually work.
- What is the essence of the service?
    - A smart home service delivery platform.

Previous experience, expected value and perceived value

- Are there alternative products or services? Think of products or services that allow customers or end-users to carry out approximately the same tasks.
    - Alternatives come in the form of companies which do the whole installation themselves. Current smart homes exist but are hugely expensive and based on proprietary specifications which make them locked into the single supplier of the devices, protocols and user interface. These products and services need a complete home overhaul and are only available for wealthy individuals. This product allows the consumer to mix and match. On the other hand there are the companies supplying these services free over the internet. These firms however cannot guarantee a specific quality and do not have any control over the devices on which the customer is going to use these services. In other words, they deliver up to the endpoint of the internet connection and from here the consumer must figure it out themselves.
- What experience do people have with comparable services offered by competitors?
    - The service is incomparable since there are nu such service providers in the market. In the future there might be, thus KPN should take this chance to be the first with a large install base.
- What aspects of these services do people like and dislike?

    - The fact that they can shop for a specific service which they see as beneficial. The ease of use is a positive effect. That KPN does its best to help manage the in-house complexity. Since many different services will become available over the delivery platform, there should be something for everyone.
- What do people expect from these services in general?
    - Increased living comfort and usability.
- What are the benefits that are perceived by the user or customers of this service compared to existing alternatives?
    - Smart home technology that actually works, since KPN also offers a service to fix local technology hardware related problems. A lot cheaper than current domotica systems since it is based on open platforms.

Market Segment

- What is the target group of the service?
    - The target group is all current Dutch households. This includes all house types and demographics of citizens.
- What is the size of the target group of the service?
    - There are over 7 million households in the Netherlands.
- What is the size of the installed base of the service?
    - Depending on the specific smart home service being delivered this can vary. For the delivery platform itself, this can be delivered to current KPN customers.
- How big is the potential market?
    - The potential market is no bigger than the 7 million Dutch households.

Rates

- What are tariffs of alternative or competitive products or services?
    - There are currently no alternative competitive products.
- How much would consumers or end-users be willing to pay?
    - The delivery platform itself would be free of charge. The service to have a person come and fix hardware problems within the home would be on an hourly basis of around 20 Euros per hour with a minimal charge of 50. The consumer would then pay for the specified services they use from the offerings.
- What and how high are the one off costs for the customer? Specifically
    - Connection costs
        - Comparable to current broadband internet connection costs.
    - Entry fee
        - A one time fee, including the price for the hardware in the form of a residential gateway.
    - Costs involved in purchasing the devices or equipment
        - A one time fee for a residential gateway. The other costs are dependent on the user. If they wish to purchase more devices, the amount of service which can be offered increases. But this is entirely up to the user and the devices will not be marketed by KPN.
- What and how high are the fixed, periodical costs for the customer? Specifically
    - Subscription per month

        - A data subscription fee similar to the one which users pay for broadband services today. In addition they will see monthly fees for the services which they decide to buy and use from the services which are provided from the platform.
    - Flat-fee
        - The access fee will most likely be a flat fee.
    - Service costs
        - The in home hardware servicing service will be based on service costs per visit made by the specialist.
- What and how high are the variable, recurring costs for the customer? Specifically
    - As with the other costs data, it is very hard to know what the price point will be for a kilobyte in the future.
- Are there obligatory conditions that involve certain costs? Such as a subscription to another service?
    - To be able to purchase and use all the smart home services deliverable through the platform a high bandwidth data connection from KPN is needed. The next important feature is that the devices which the consumer has in their home depict which services are available to them.

Effort

- What effort do customers have to make to purchase the service?
    - Since most households already have a broadband connection this effort is minimal.
- List all the actions that are required, and compare them to any available alternatives
    - There are no exact alternatives. The customer has to have a KPN broadband account, and have the residential gateway installed through which the services can be offered.
- What effort do end-users have to make to use the service?
    - Same answer as for the previous question.
- List all the actions that are required, and compare them to any available alternatives.
    - There are no comparable alternatives.

1.2 Technological design: Functions and architecture

The technology section looks into the necessary technology which will be needed in order to deliver the named service. Through answering the following questions in the named areas, the aspects of the service idea based around the technology will be covered.

Applications

- What kind of application is it, e.g. communication, content, interaction?
    - It is a content providing application. The complete smart home service provides the user with a delivery platform over which to access and use smart home services.
- Does the service include sending text, video or images?
    - The service platform itself does do this, but marginally compared to the services which are offered through the platform.
- Is settlement of transaction necessary? How are the transactions organized?

    - When services are purchased, a transaction occurs and this needs settlement. KPN will be in charge of settling these transactions as it is the contact towards the user. The service provider for the specific service bought by the customer will be paid accordingly.
- Does the service always have to be on or not?
    - The service delivery platform does not always have to be on, the smart home services it delivers might.
- Is the service tailor made or one size fit all?
    - The service delivery platform shows the services which are available to the customer depending on the hardware in their homes. Thus the customer receives one size fits all services for their specific situation.
- How is the security of the application organized?
    - The service delivery platform is a closed system used only within the home. As with current broadband connections, the security is organized in the same way.
- Which functions are supported by the application?
    - A number of different options have been given in this thesis paper. The amount of services which can be provided over the delivery platform is huge. It depends on the creativity and usefulness of the services which will be for sale over the delivery platform.
- How much data (kilobytes) will be transported?
    - This is completely dependent on the services which the user decides to use. A normal future household will most likely have multiple HD video streams coming in, a lot of machine to machine communication, live information streams of utilities, data backup services etc. Thus it seems reasonable that fiber to the home connections will be necessary.
- What data-transmission speed is required?
    - See previous answer.

Devices

- Which types of devices are needed?
    - The device needed to support the delivery platform is a capable residential gateway. Furthermore a television set is needed to browse and search through the services database. Specific services might then require specific hardware. Imagine a security service to watch live streams on your mobile phone, this would require cameras in your home.
- What functions does the device have to perform? What are the required specifications?
    - The main function, apart from providing services such as TV, and internet connectivity is to make the services available for the customer. They must be able to search, browse and buy services that could be of interest to them. The services need to be placed on a central KPN server in order to deliver them to the user.
- Can the device only be used for this service or for other services as well?
    - The device through which the platform operates and interacts with the customer will most likely be their television set which is used for many other services within the home.

- Is the intelligence located in the network or in the device? Is it an active part of the device or is it the network and is the device "stupid".
    - The intelligence is located in the network.
- Can software be adapted to user requirements or is that not possible?
    - The software is closed. The user has no influence on the interface through which the services are browsable.

Service platforms

Describe the set-up of the system (the entire infrastructure, both the hardware and software needed for the service) on the basis of the following questions

- Can the system be adapted to meet user requirements?
    - Yes, if users want to look for services with their computer, netbook or mobile phone, this is possible.
- Can the user carry out these modifications?
    - No these things need to be arranged by KPN whom decides how the services are showcased for sale.
- In which way is the security of the system safeguarded?
    - The security will be managed in the same way as current KPN services are secured. This is not such a large issue as with mobile services since it is provided within the home.
- Can the new service be used on existing systems, hardware, and software?
    - The service to deliver smart home services to the home will need a high bandwidth broadband connection. The most likely case is that the user will also need a connection specific residential gateway. From this point on the users existing system defines the services they are offered.
- Does the customer or end-user need new systems, hardware, software?
    - See previous answer.
- Is the system a centralized or distributed one?
    - The system is centralized, where the services which can be provided are centrally stored and managed on KPN servers.
- Is the system closed or open to new modifications?
    - The system is open to updates and new services added to the store. The actual interface is not meant to be open for user generated changes and thus is a closed system.
- Does the system use location based information?
    - The delivery platform itself would use information based on the user in order to offer them the most interesting services, this can also be based on location information.
- How is the accuracy of the location-based information organized?
    - Since the service is for the home, the user could simply type in their location. It would also be possible to use the persons billing information in order to know their location.

Access network

- Does the access network use a fixed line, or is there a wireless or a mobile connection?
    - Fixed line.
- Does the access network use broadband technology?
    - Yes, preferably Fiber to the Home.
- Does the access network have to be available at a national or at an international level?

    - Since KPN is mainly national player when it comes to internet access, the access technology would be at a national level.
- Is the service scalable? Is it easy to transpose it from a small scale access area to a larger one?
    - Yes, once broadband access through fiber is country wide, the delivery of the service platform in the form of a service store is easily scalable.

Backbone infrastructure

- What is the bandwidth that is used by the core network?
    - Current backbone technologies are sufficient for the desired services.
- Is the core network future proof or not?
    - The core net in terms of technology is future proof. In terms of capacity the core network is continually being upgraded according to the demand. Thus the core network is future proof.
- Does the service depend on the network infrastructure that is being used?
    - No, it can run over any type of access network.

Additional functionalities

- Does the platform include billing?
    - Yes, this is a big part of the service. By providing the billing within the platform KPN connects the customer with the service provider and can generate revenue from this service. This is done in order to make it as simple as possible for the customer when receiving an overview of their services.
- Does the user data management take place within the platform?
    - Yes, this is connected to the user data management systems KPN currently already has in place.
- Does the platform use location-based data?
    - Yes, as specified before, the system uses static location based information to deliver the most interesting services for the customer in their geographical area.
- Does the platform include the possibility of speech?
    - This is not relevant to the delivery platform of the services. Specific services might use speech functionality.

1.3 Organizational design: Roles and cooperation

This section will look into the organizations which are necessary in order to develop the smart home service.

Roles

- Functional roles
    - Service providers: KPN provides the service to the customer
    - Access network operator: KPN provides the network
    - Core network operator: KPN operates the Core network
    - Platform provider: KPN provides the software to run the service
    - Application provider: KPN provides the application to run the service
    - System integrator: KPN makes sure the system works within the home by providing specialist that come by your home.
    - Web hosting/presence provider: KPN does the webhosting.

- Content value chain
    - Raw data provider: This can be any content, from video, audio and games, or user generated data such as water usage information. This can come from 3rd parties or from the customer themselves.
    - Content developer: The raw data is converted into usable data by the specific party developing the service being offered in the service store. Thus an energy saving solution service takes the users energy data and their lifestyle and delivers the service to maximize their efficiency.
    - Content provider: The group of content providers is anybody willing to develop content that can be sold as a service through the smart home delivery platform
    - Content aggregator: The role of content aggregator can be held by a number of different organizations or even single persons. This all depends on the specific smart home service. This can be a party like Sony in order to maximize the potential of their in home devices.
- Hardware
    - Equipment provider: The main hardware used is the residential gateway and this can be provided by KPN's current residential gateway provider Thomson. The other hardware needed for specific services depends on the service in question.
- Customer relations
    - Billing: KPN will do the billing in order to give the customer a simple service overview.
    - Marketer: KPN provides the marketing for the service store and the people who come and fix your in home network. The services which are sold through the platform do their own marketing.
    - Customer support: Customer support is available to all customers regarding the delivery platform. Services in the store need to be of sufficient quality and transparent that KPN can also fix the problems within a specific service.
    - Content quality manager: KPN controls which services are offered and if they are on par with the quality conditions.
- Enabling technologies
    - Security: Security is handled by KPN as it handles security for its internet, telephony and television customers today. They will have access to the customers data, third party service providers do not.
    - Authorization: KPN provides the technical solution behind authentication. This is also not a huge issue since it is an in home service.
    - User profile management: KPN manages and coordinates the user profiles. It is based on this information which services are deemed most interesting for the customer.
    - Payment: KPN provides the payment solutions as they do for their services today.
- Location based services: There are no specific LBS actors involved.
- Environment
    - Financer: As KPN funds all its projects, with its own and borrowed capital.
    - Regulator: There is currently no issue to be seen relating to regulation.

    - Interest groups: Interest groups can help in developing services which can be delivered to the home over the delivery platform. This might be done in the healthcare sector where smart home services can offer large benefits.
- Customer or end-user
    - Customer: The customer pays for the services they decide to buy from the platform.
    - End-user: The end-user is the same as the customer.

Actors, resources and capabilities, and value network

- Which actors might be willing to be involved in the value network?
    - The actors, which are going to be developing and selling the smart home services, will be involved in the value network. If these are not the same as the device manufacturers, these will also be involved in order to make the most of their devices.
- What are the capabilities and resources that these actors can provide? Also consider financial resources?
    - The organizations, which are only providing the software for the services, are usually creative and relatively small. This means they can work fast and specialize in a single area for which they are developing niche services. The larger actors, such as device manufacturers like Philips, have large amounts of resources such as money and man-hours in order to develop services which can make more use of the devices their customers already own through the KPN network. The companies have in depth knowledge about their products and the way they can make them work together to generate extra functionality.
- Which resources and capabilities are critical? Hence which actors are preferable?
    - The critical factor are the services which are supplied over the platform. These can also be made by KPN but will most likely need in depth knowledge of the devices in the home. Thus the device manufacturers, or companies able and willing to find this information are critical. It must be profitable for companies to spend time and resources on developing and selling services.
- Which actors should be structural partners, i.e. providing essential and non-substitutional tangible and/or intangible assets?
    - Large device manufacturers, which can benefit by providing extra, previously non existent services to their customers. These larger players will pave the way for smaller players to deliver new services.
- Which are contributing actors, i.e. providing specific goods and/or services but play no direct role in decision making?
    - There are no other actors playing a role in decision making. They decide for themselves if they are willing to sell their services and/or products through the smart home platform.
- Which are supporting actors, i.e. providing generic goods and/or services that alternatively could be obtained from another supplier?
    - Basically all actors are supporting actors, unless the service is tied to specific hardware. Even if this is the case, third parties might still be able to sell services which make use of these devices.

Partner selection

- What capabilities and resources are required for a given role in the project?
  - The service providers need to come with innovative services. This needs creativity, and insight. Resources such as man hours and financial backing are also needed in order to fully develop a service. Mostly this is dependent on the service being made since these can vary drastically.
- What companies/organizations can deliver these capabilities and resources?
  - All types, from government organizations, large device manufacturers, huge internet players such as Google, and small, start-up companies.
- Can the envisioned partner show is has/can acquire access to the capabilities and resources that are needed?
  - Yes, they already do so in many ways.
- What is the level of capability of key personnel?
  - Computer programmers are a must. Technical architects and industrial designers are also needed to develop a solid service.
- What is the willingness to learn?
  - Once a service proves profitable, learning can make the next development that much easier and quicker.
- What is the track record and reputation of the potential partner?
  - Depends on the partner. For this reason partner selection is important.
- Is there a personal click with the potential partner?
  - Depends on the partner, not really an issue yet.
- Does the collaboration fit with the long-term strategic objectives of partners?
  - Depends on the partner, not really an issue yet.
- Is there a match with regard to the organizational cultures of the organizations involved?
  - Depends on the partner, not really an issue yet.
- What is the added value brought in by the actor compared to alternative actors?
  - This again depends on the specified partner. This shows the importance of the selection of the partner towards making the platform a success.
- In what way do the partners guarantee the quality of the offered services?
  - Service level agreements will be in place to make sure quality is up to par. It is also important to test services before supplying them to the customer, in this way KPN can see if it wants its name associated with the service.

Organizational arrangements

- What are the reasons behind the collaboration?
  - Profits for both organizations
- What is the added value brought in by various partners?
  - The delivery of a specific service, making the platform more useful.

- What are the long-term objectives of the collaboration?
    - Generating more revenue through a successful platform which can keep on developing.
- What are the objectives and deadlines?
    - Delivering smart home services. There is no actual deadline in this instance.
- What are the expected obstacles?
    - Finding the right partners and having them believe the platform adds value for them and the customers.
- When will the collaboration be terminated
    - Once the services are no longer needed or can be supplied by a different party.
- What are the possible problems and how could they affect the time plan?
    - Not being bale to find sufficient partners to deliver enough interesting services.
- Who is doing what?
    - KPN is doing al of the orchestration and customer contact. Only the actual service provisioning is done by the service provider. KPN does the rest.
- Who is responsible for what?
    - KPN is responsible for quality guarantees. They also bill the customer and provide for a place where the customer can browse new services.
- How will disputes be resolved?
    - Through contracts and legal parties as is the case today with KPN and its partners.
- What resources are allocated to the collaboration project?
    - KPN needs to allocate a specialized team in order to contact and keep business partners for the smart home services. They also need to share information in order to make the best possible services available.
- What does the communication structure look like?
    - This depends on the organization which is providing the service. Within KPN this is done by the team responsible for the delivery platform.
- Who is paying whom for what?
    - The end user is paying for the service, KPN take a small percentage of this income for providing the platform and the rest goes to the service provider themselves.
- How are the rewards, investments and risks divided among the various partners?
    - KPN holds the largest risks since they invested the largest amount. This risk however is not based purely on the delivery platform since these investments are already on the agenda to be made. Thus the delivery platform infrastructure will be in place, yet the idea as to how the services will be delivered is not. For the Service provider to KPN there are relatively small risks involved, thus stimulating them to join the platform.
- What are the expected rewards and risks?

    - A large installed base of customers which is easily accessible to the customers. The largest risk is if not service providers decide to share services and try to sell their wares over the internet without the quality KPN can offer.
- What investments are needed for the collaboration?
    - Contracts need to be made, infrastructure in order to update and deliver the services by the providers, and a team specialized in contacting third party organizations to join the platform.

1.4 Finance design: Costs and revenues

As mentioned previously, the financial aspects fall outside the scope of my thesis project.

9.6 Appendix 6: Service design research. Critical success factors STOF

1. STOF method step 2: Critical success factors

1.1 Customer value

The STOF model names the following critical success factors for customer value.

- Compelling value proposition
    - The future household will have the availability of a fast data connection for their digital television, internet and voice services. Aside from this their home has filled up with a myriad of hardware which is communicating amongst each other and with the outside world. All sensors in the home share information which can be used accordingly. By offering the user a channel through which they can buy additional services, they can increase their living comfort to their own desire. A person with the latest technology in house can browse and buy services specifically based around the devices already in their home from the comfort of their couch. These smart home services should increase their living comfort by giving them more free time from tiresome chores, or increase there entertainment spending allowance by increasing the efficiency of their current electricity use. These examples are just two of many types of smart home services the platform can deliver to the customer.
    - To make sure the user actually has the chance to use and benefit from these services, KPN is supplying specialists to come over and make sure hardware, from any particular manufacturer is working to their full potential. This means that the services KPN provides extend into the home, helping to manage the increased complexity that technology brings along.
- Clearly defined target group
    - The actual service delivery platform has all the households in the Netherlands as its target group. Since the platform allows for all types of services, they can be specified and chosen by the user themselves. This means that a family with kids can buy the newest entertainment services while a senior citizen can purchase a service allowing her to communicate easily, through video conferences, with her doctor or grandchildren. Thus the target group of the delivery platform is extremely large, while the services which are offered by KPN itself and 3rd party developers can be as generic or specific as they want to be.
- Unobtrusive customer retention
    - Since the services offered through the platform are in some form connected through the platform (billing through KPN, availability of certain in home technology information, etc,.) the user will loose all its smart home services if it decides to change its access channel to another provider. Thus KPN has limited customer retention since they are offering what some would call a commodity. Access will be seen as a utility necessary in every household.
- Acceptable quality of service
    - The quality of the service is based around the technology. For this reason it is important to offer specialists to physically visit the

home in order to guarantee quality. By doing so, people will be more willing to buy new devices since they are more assured that they will function properly and can increase the amount of functionality within their homes. By having large amounts of specialists and an information sharing application for these problem solvers, most devices should be able to be installed by these technicians for the customers. Since they are paid for by the consumers, their costs should at least be covered.

1.2 Network value

The following are critical success factors for network value

- Acceptable profitability
  - The actors supplying the actual services must be willing to pay a fee (in the form of a share in their profits) in order to make use of the KPN network. This does not only include the physical infrastructure, which they can often access for free over the users internet connection, but more the customer and information KPN has. This means that KPN must take a small share of the profits in order to deliver the high quality network, billing and problem solving services. This leaves a smaller profit margin for the companies delivering the services. In return they have fewer risks since the distribution, and platform is arranged and serviced by KPN.
- Acceptable risks
  - The risks seem very acceptable from the service providers point of view, since KPN has taken the risk to deliver the platform. The service companies take risk in developing new, innovative services, with minimal distribution, implementation, and marketing headaches.
- Sustainable network strategy
  - KPN is the key initiative taker in this process. By making it possible for other service providers to take advantage of their expensive network, they are offering a huge benefit to players whom chose to deliver over KPN's platform. KPN needs to make sure its processes are transparent in order to maximize the service being provided by third parties. This will show returns in their customer satisfaction since each customer has access to a large amount of services.
- Acceptable division of roles
  - It should be clear that KPN is the owner of the network. Therefore they can set the standard for the services that are provided. Within the third parties, the roles are hard to define since service providers can range from monolith companies such as Microsoft to small single person start ups delivering specified services. KPN should make its role clear, and the relationship with each participant.

2. Evaluation of critical success factors

- Is the value proposition sufficiently attractive to the target group?

    - The target group, in this case homeowners, receive a free delivery platform with new, innovative services. They do not need to buy any of these services if they do not want to, thus for them this is an attractive proposition.
- Is the service offering competitive compared to similar offerings?
    - The only other offerings in this category will be future companies trying to offer an all in one solution. This won't allow customers to have all their devices working together and create lock in effects. In other words, so far there is no other competitor, and when they do come, the quality, and simplicity KPN can offer should be greater.
- Is the target group sufficiently clear?
    - Yes, all homeowners. Since the services on offer over the smart home platform can supply many different types of people with smart living opportunities, the target group includes almost all Dutch households that are connected through a high bandwidth connection.
- Do we know enough about the customer in terms of his or her needs, preferences, capabilities, available resources and sensitivities?
    - This is not the main question for KPN since it is the service providers whom will be marketing to a specific group to sell their services. Thus single, retired people will receive healthcare service offerings, while a young couple might find entertainment services on offer.
- What customer retention mechanisms are included in the business model?
    - For KPN, the high bandwidth connection which delivers the smart home services, also delivers KPN's own services such as internet. This product (the physical connection) has basically, and will increasingly become a utility in every household. For this reason customer retention isn't really an issue.
- Do they reward customer loyalty and are they sufficiently unobtrusive?
- Is the outcome of the service of an acceptable quality?
    - Quality can be an issue with brand new technologically based services. It is for this reason that KPN will also offer a special service in order control and fix problems customers have.
- Is the process of delivering the service of an acceptable quality
    - This process will take place over the KPN network. There is also a role to be player by a in home device such a s a residential gateway in order to supply the in home network and deliver the service to separate locations.
- Are there clear revenue sources and are they sufficient to sustain the business model?
    - The separate parts of the business model have their won revenue streams, like flat fees for the FttH connection, and par per use fees attached to in home problem solving by specialists. The extra revenues come in the form of the shared profits with companies that supply their services over the platform KPN has created. This is a highly profitable business since the basics are already in place and self-sufficient. It is critical for KPN to make sure the platform allows for highly innovative services that actually work. This provides a win-win situation for all parties involved.

- Are the actors in the value networks satisfied with the division of the investments, costs, benefits and revenues?
    - Large companies such as Sony, Microsoft, and Google will most likely not be extremely interested at first. It is the small, fast moving companies supplying software based services which allow the consumer to make more use of their products and have them work together to provide extra comfort that benefit. They now have a transparent platform and a large customer base. To be able to sell their services over this platform they are asked to share in their profit margin.
- Are the financial and technological risks facing the business model and partners involved clear and acceptable in terms of the likelihood of their occurrence and of their subsequent consequences?
    - The largest risk is that service providers find a way to supply the same services over the internet. This means the idea behind the service platform is useless. The risks however are rather small since the customer must in this case still pay for their connection. They can in this case also still make use of the service to help with their ICT problems in the home. Thus the risks are relatively small. It is critical that larger device manufacturers such as Philips decide to work together r since they can have the greatest impact on the services to be provided to benefit smart living. With such partners, quality of service can be maximized.
- Have the interests and strategic objectives of the parties involved been sufficiently coordinated and aligned with the dominant business logic of the service?
    - Yes, it should be obvious that delivering a platform that is taken care of in terms of quality control and user friendliness can make the adoption much higher amongst consumers. This benefits all firms supplying smart home ideas since they can share information and benefit from new possibilities that are created.
- Do the partners involved in the network have the necessary networking capabilities?
    - KPN certainly has the market power in the Netherlands to contact large business in order to generate support for their platform. Current Dutch firms such as Philips are working hard on smart living ideas and have large networking capabilities.
- Are al the necessary business roles fulfilled?
    - Yes, KPN supplies most of these themselves.
- Are the actors satisfied with and capable of fulfilling the business roles?
    - For actors it should be seen as a market place to sell their services where most other aspects such as distribution, billing and customer contact are taken care of for a share in the profits.
- Is there a focal actor willing and capable to lead the value network?
    - Yes, this is KPN itself.

9.7 Appendix 7: Article: Evaluating a business models robustness using scenario analysis

9.8 Appendix 8: Article: The Smart Home, present or future?