nubus

The omnipresent personal computer

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Executive summary

The Nubus ecosystem is an omnipresent personal computing system that enables consumers to have seamless access to up-to-date processing power and data from anybody's endpoint from anywhere at any time as it is a product-service system. It solves outdatedness, incompatibility and device dependency problems for users, with a cheaper and more user-friendly system. The system is a successor concept for the current smart devices market, covering all possible smart devices and can be stated as perhaps the next generation of computing for consumers. The Nubus ecosystem consists of four parts, the Nubus, the Endpoints, the Ki and the user. The user is the centre of the ecosystem. The Nubus centralises the processing power and data storage of a user to enable access over any endpoint in a secure and seamless way. The Endpoints are simplified smart devices that act as gateways to the Nubi of users. The Ki is the only personal physical device a user needs to possess to access their Nubus from any(body's) endpoint at any time.

The user research confirmed the hypothesis of people actually wanting to have everything ready at their fingertips from any device at any time to be true. Users currently take precautionary measurements to enable them to have everything ready at their fingertips. They rely on specific devices to access specific data and processing power. This limits the users in their human geographic freedom, because the devices need to be present at all time to enable the hypothesis and clearly indicates the need for an overarching system that enables them to be materialistically independent.

The trend research provided insights for a detailed roadmap towards the Nubus ecosystem to enable the users to have everything ready at their fingertips at any time over any device. The roadmap indicated which variables need to align over time to enable the Nubus ecosystem. Due to current developments and prospects, the system, as indicated in the roadmap, will be feasible from 2022. Technical variables like Hybrid cloud, 5G network and dual connectivity are playing a major part in the development. The social trends and developments that are also shown in the roadmap, indicate the importance of a secure experience over ownership system. Both are resolved by the Nubus ecosystem, the Nubus creating experience over ownership and the Ki creating unobtrusive and seamless secure access for users.

The Nubus ecosystem, enables users to access their personalised Operating system over any endpoint. It includes the processing power, data storage and personal OS of users. The Nubus ecosystem is designed to be more user-centred, therefore differentiating from current computing solutions and penetrating a market gap. It will create an online ecosystem for users, by paying for a service over ownership, resolving all the current pain points of an offline ecosystem. This makes the user a subscriber to a product-service system, linking the personal computer to a person through an endpoint.

The system makes users custodian over endpoints, enabling the endpoint provider to refurbish and update models. This creates a longer lifespan for products, without incompatibility and outdatedness issues for the user, as endpoints merely function as gateways to anybody's Nubus. The Nubus ecosystem enables long-term relationships with users, by providing the users with always up-to-date and personalised services.

The Ki is the first step towards a complete dematerialised future computing system, enabling the user a seamless and unobtrusive omnipresent computing experience. The Ki is a personal dedicated hardware Key for the Nubus ecosystem, to provide access over any endpoint. Designed to be adjustable to the user's preference, it has endless modifications in ways of wearing. As the Ki is the personal Key to their Nubus system, the Ki is designed to be a precious device to highlight the importance of the device.

The Nubus ecosystem was well-received by potential users, clearly understanding the benefits of this system over the current system. All the potential users were really positive about the cost benefits and the prevention of outdatedness, incompatibility and device dependency. This indicates a major potential for change in the long-known linear smart devices market towards a product-service business model.

Terminology

Nubus -
Personal computer based service physically running elsewhere. The Nubus is linked to a specific user. People may refer to Nubus as the Cloud, however, the consumer cloud currently only contains a percentage of all our data, the Nubus contains all the combined processing power and data of current devices for a user.

Nubi -
More than one Nubus.

Endpoints -
Any type of device, ranging from personal computers (laptop, desktop, smart tv, etc.) to smart devices (Phone, tablet, smart watch, fitness tracker, smart glasses etc.) in a simplified form. these are unusable without a direct connection to a Nubus.

Ki -
The physical key that allows the user to access his/her Nubus. The Ki is linked to a person, but does not work without the direct presence of the owner.

Nubus ecosystem -
The combination of the Nubus with the Ki and endpoints and everything directly related to the service.

Human geographic freedom -
The geographic freedom people acquire through new technological developments. More human geographic freedom results in new/more geographically bound locations for people to operate technological functions which were before limited to a specific place(s).

Artificial gap -
The gap between understanding the technology and using it.

Introduction report

This report summarises the results of the Graduation project of Tom Kluijver for the faculty of Industrial Design and Engineering of the TU Delft. The project started with an vision for a user centred computing system for consumers. A computing system that would replace every current smart device. A system whereby users would have everything, data and processing, ready at their fingertips at any time over any device, by making the cloud responsible for the main computing power and devices merely enablers. To resolve the common problem of outdated and incompatible devices.
The feasibility research of the vision this report has a two fold. The first part of the two fold is presented as “The demand”, that identifies the problems users have with the current computing system. The second part of the research is focussed on the technical and social feasibility of the vision, presented in the report as the trend analysis. A roadmap in chapter three combines all the technical and social trend research, to indicate the development towards the vision. In the roadmap the timeframe for the feasible vision is shown.
In chapter four the feasible vision, named the Nubus ecosystem, is presented. The Nubus ecosystem service enables the user to access their Nubus from any(bodies) endpoint at any time. Disabling outdatedness and incompatibility from the users perspective. The Nubus ecosystem chapter describes the system, the potential of the seamless experience in combination with the Ki, the business aspect, the costs and the technical details of the service.
The Ki, the enabler of the seamless and secure experience for users, an essential part of the ecosystem is separately described in chapter five. The chapter explains how the users can seamlessly and securely have everything ready at their fingertips from an(bodies) endpoint at any time with a subscription to the Nubus ecosystem. The Ki enables the user to seamlessly and securely experience the Nubus ecosystem.

01

the project

The initial vision of the project defined the goal of the complete project. The vision is described in short, to indicate the scope of the initial research. Then there is elaborated upon the different phases the project went through. As the project had many different aspects in each phase, a flowchart is shown to enable a simple overview. This chapter provides some insights in the earliest stage of the vision and the process of the project.

1.1 The start of the project

Before the start of the project I, personally, experienced different cases of outdatedness/incompatibility and inflexibility over time as a bottleneck while using different devices. From these problems a vision for a more consumer friendly personal computer arose. A vision for perhaps the next generation of computing for consumers, whereby the cloud would function as the main personal computer on which local devices would rely. The cloud would enable functions for the users to be experienced via the local devices, see figure 1 for the vision as sketched before the start of the project.
The computing system as envisioned, would allow users to super easily switch devices and continue on the same point where they left of on the previous device. To enable this the processing power and data storage of your tablet, phone and laptop would be centralised, enabling the user to have access to the processing power and data from any device. Making the provider responsible for the processing power, and therefore eliminating the outdatedness/incompatibility and inflexibility problems from the users perspective.
The current computing system could be more user friendly or beneficial and therefore a user centred design approach was chosen before the start of the project. The aim of the project became: to create a long term vision for the development of a more user centred computing system, where the presumed problems would be resolved; the vision would be represented by a demonstrator, to showcase the user possibilities of the system.

Focus points

Before the project started, it was clear that my research would have a two fold. One part of the analysis phase would focus on the multiple possible pain points from users, to verify the problems to show the possible points of improvement. This part of the research was set up with questionnaires and interviews, creating a combination of qualitative and quantitative insights. The second part of the analysis phase would determine the technical and social feasibility of the vision.
The two fold was essential from the start to validate the problems from the users and to check the feasibility of such a service system.

Scope

For the project a lot of variables played a role. To eliminate various developments within different countries, the scope for the research was set to first world countries, specifically western countries. The research does not exclude the other countries, but it made the scope of research more achievable within the timeframe of the project.
Furthermore the vision is directed at the B2C market, however, the B2B computing market has been used as inspiration or functioned to test the feasibility.

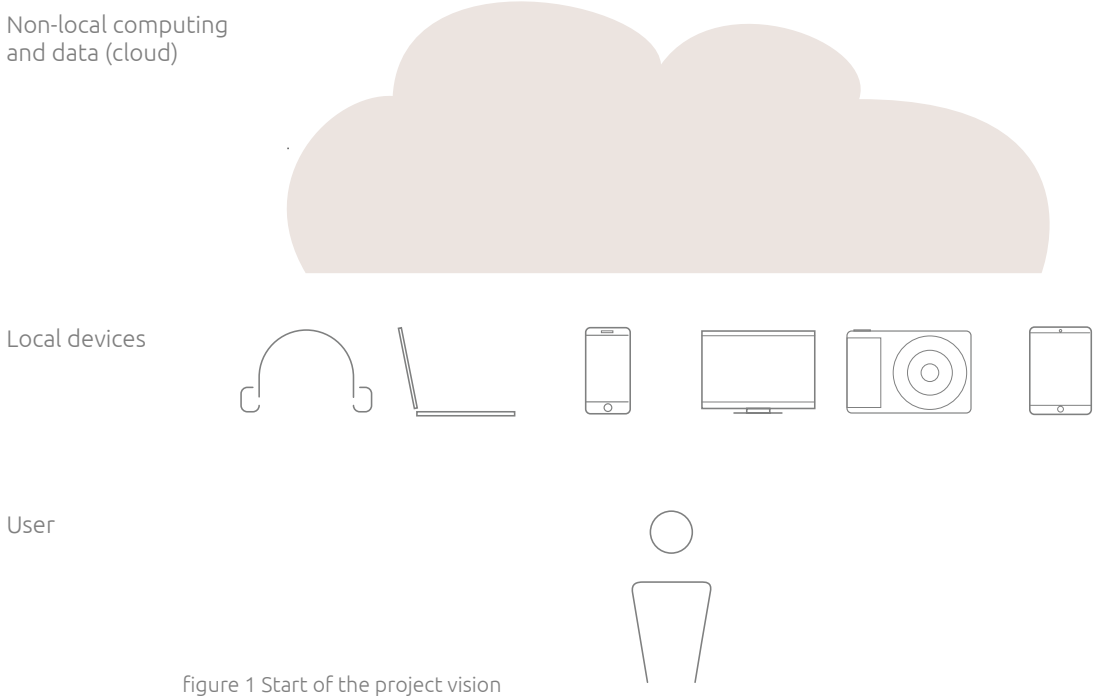
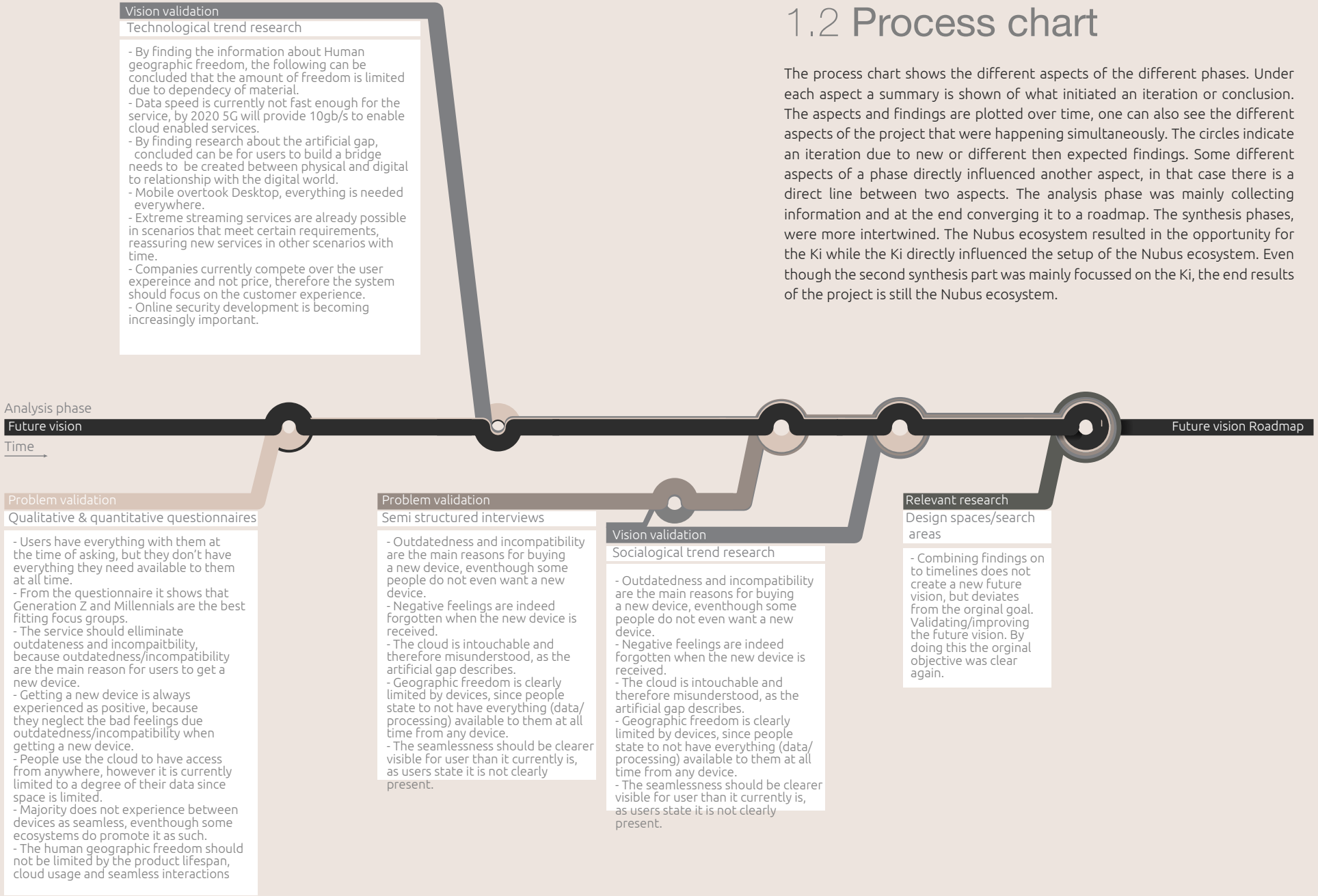
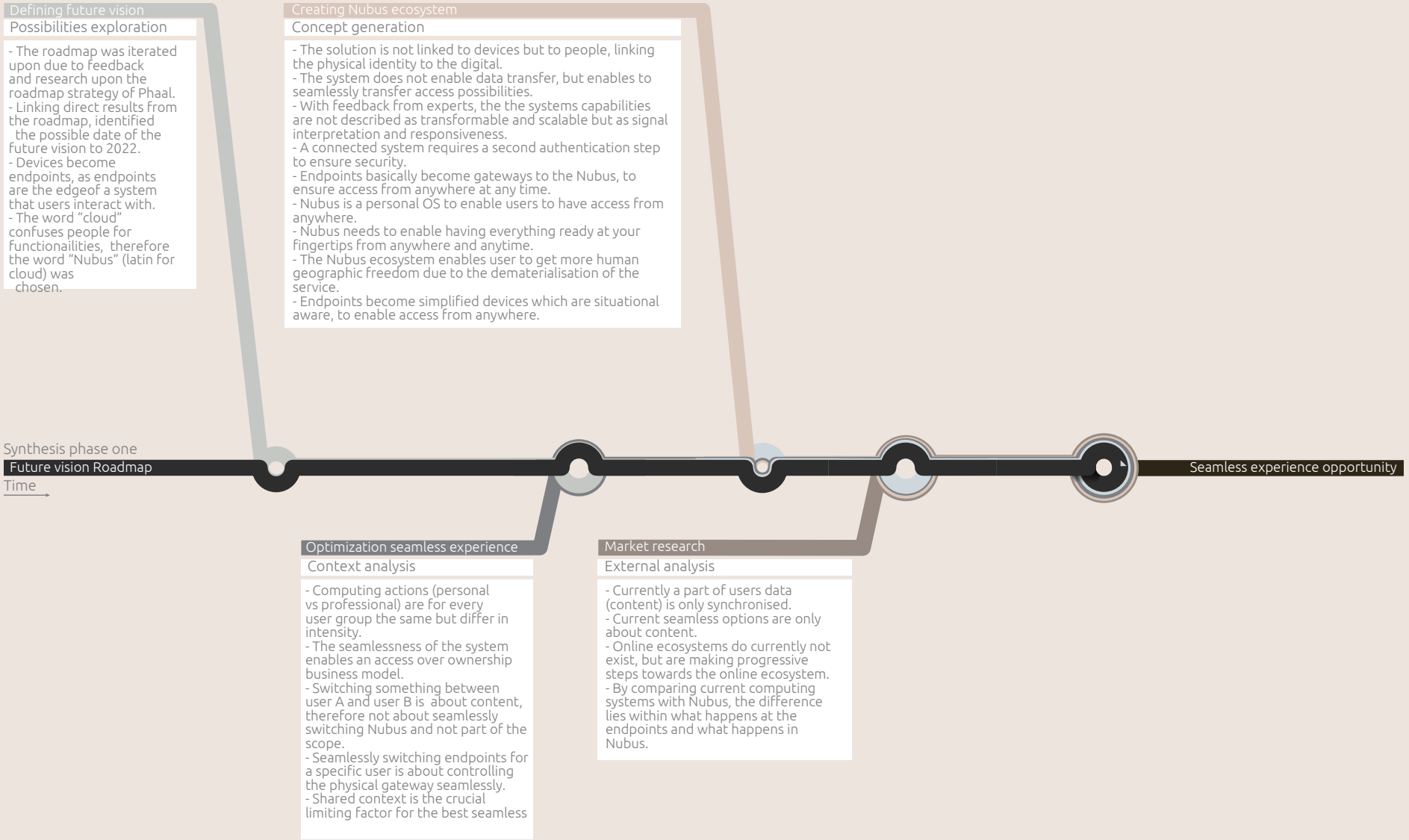


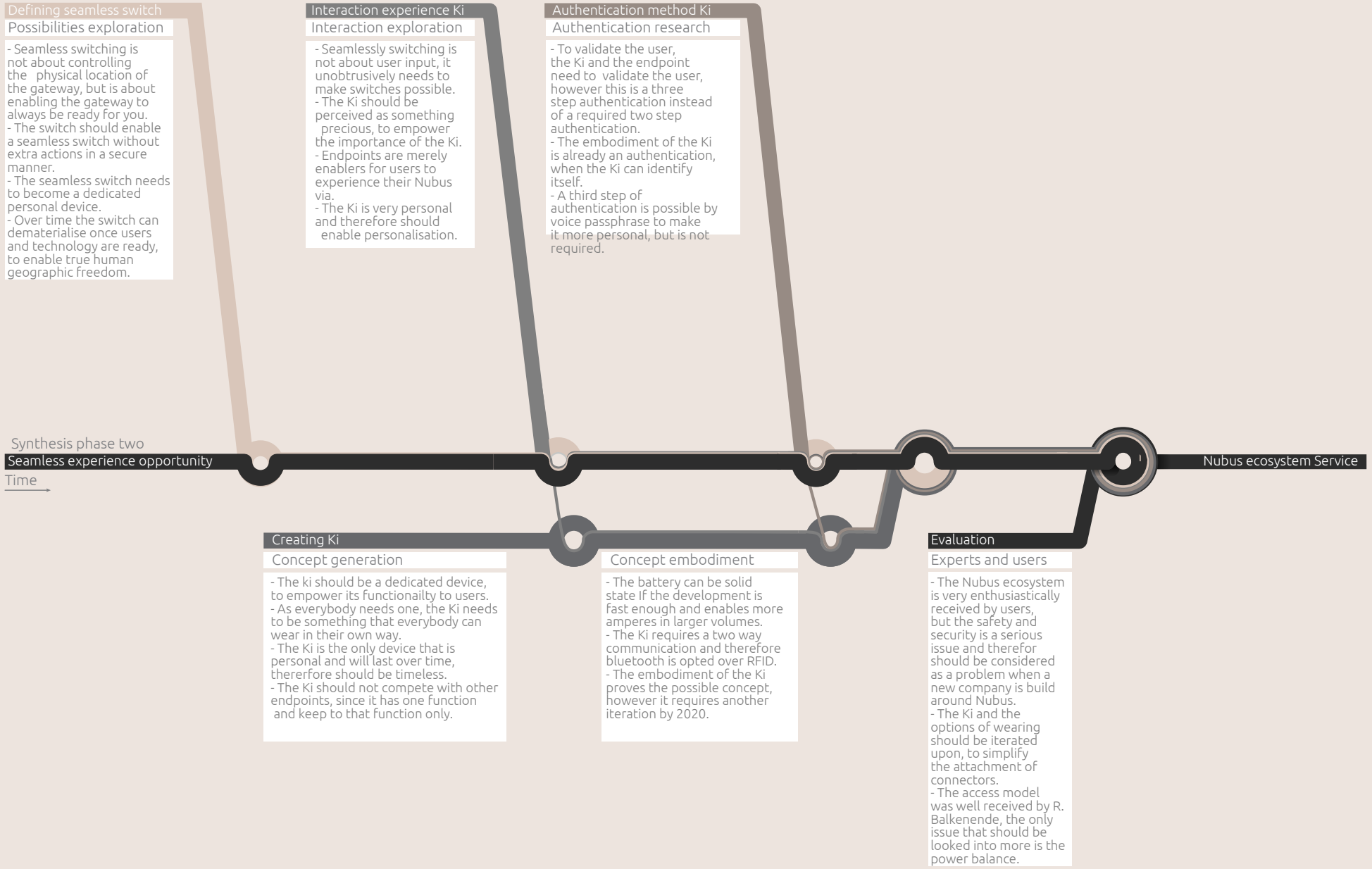
figure 1 Start of the project vision

1.2 Process chart

The process chart shows the different aspects of the different phases. Under each aspect a summary is shown of what initiated an iteration or conclusion. The aspects and findings are plotted over time, one can also see the different aspects of the project that were happening simultaneously. The circles indicate an iteration due to new or different then expected findings. Some different aspects of a phase directly influenced another aspect, in that case there is a direct line between two aspects. The analysis phase was mainly collecting information and at the end converging it to a roadmap. The synthesis phases, were more intertwined. The Nubus ecosystem resulted in the opportunity for the Ki while the Ki directly influenced the setup of the Nubus ecosystem. Even though the second synthesis part was mainly focussed on the Ki, the end results of the project is still the Nubus ecosystem.




Defining future vision
Possibilities exploration
- The roadmap was iterated upon due to feedback and research upon the roadmap strategy of Phaal.
- Linking direct results from the roadmap, identified the possible date of the future vision to 2022.
- Devices become endpoints, as endpoints are the edgeof a system that users interact with.
- The word “cloud” confuses people for functionailities, therefore the word “Nubus” (latin for cloud) was chosen.
Creating Nubus ecosystem
Concept generation
- The solution is not linked to devices but to people, linking the physical identity to the digital.
- The system does not enable data transfer, but enables to seamlessly transfer access possibilities.
- With feedback from experts, the the systems capabilities are not described as transformable and scalable but as signal interpretation and responsiveness.
- A connected system requires a second authentication step to ensure security.
- Endpoints basically become gateways to the Nubus, to ensure access from anywhere at any time.
- Nubus is a personal OS to enable users to have access from anywhere.
- Nubus needs to enable having everything ready at your fingertips from anywhere and anytime.
- The Nubus ecosystem enables user to get more human geographic freedom due to the dematerialisation of the service.
- Endpoints become simplified devices which are situational aware, to enable access from anywhere.
Synthesis phase one
Future vision Roadmap
Time
Seamless experience opportunity
Optimization seamless experience
Context analysis
- Computing actions (personal vs professional) are for every user group the same but differ in intensity.
- The seamlessness of the system enables an access over ownership business model.
- Switching something between user A and user B is about content, therefore not about seamlessly switching Nubus and not part of the scope.
- Seamlessly switching endpoints for a specific user is about controlling the physical gateway seamlessly.
- Shared context is the crucial limiting factor for the best seamless
Market research
External analysis
- Currently a part of users data (content) is only synchronised.
- Current seamless options are only about content.
- Online ecosystems do currently not exist, but are making progressive steps towards the online ecosystem.
- By comparing current computing systems with Nubus, the difference lies within what happens at the endpoints and what happens in Nubus.


Defining seamless switch
Possibilities exploration
- Seamless switching is not about controlling the physical location of the gateway, but is about enabling the gateway to always be ready for you.
- The switch should enable a seamless switch without extra actions in a secure manner.
- The seamless switch needs to become a dedicated personal device.
- Over time the switch can dematerialise once users and technology are ready, to enable true human geographic freedom.
Interaction experience Ki
Interaction exploration
- Seamlessly switching is not about user input, it unobtrusively needs to make switches possible.
- The Ki should be perceived as something precious, to empower the importance of the Ki.
- Endpoints are merely enablers for users to experience their Nubus via.
- The Ki is very personal and therefore should enable personalisation.
Authentication method Ki
Authentication research
- To validate the user, the Ki and the endpoint need to validate the user, however this is a three step authentication instead of a required two step authentication.
- The embodiment of the Ki is already an authentication, when the Ki can identify itself.
- A third step of authentication is possible by voice passphrase to make it more personal, but is not required.
Synthesis phase two
Seamless experience opportunity
Nubus ecosystem Service
Time
Creating Ki
Concept generation
- The ki should be a dedicated device, to empower its functionailty to users.
- As everybody needs one, the Ki needs to be something that everybody can wear in their own way.
- The Ki is the only device that is personal and will last over time, thererfore should be timeless.
- The Ki should not compete with other endpoints, since it has one function and keep to that function only.
Concept embodiment
- The battery can be solid state If the development is fast enough and enables more amperes in larger volumes.
- The Ki requires a two way communication and therefore bluetooth is opted over RFID.
- The embodiment of the Ki proves the possible concept, however it requires another iteration by 2020.
Evaluation
Experts and users
- The Nubus ecosystem is very enthusiastically received by users, but the safety and security is a serious issue and therefor should be considered as a problem when a new company is build around Nubus.
- The Ki and the options of wearing should be iterated upon, to simplify the attachment of connectors.
- The access model was well received by R. Balkenende, the only issue that should be looked into more is the power balance.

02

research

The following chapter consists out of six different subchapters. Every subchapter presents findings of the two folded research. Every conclusion in the following subchapters, has directly influenced the Nubus Ecosystem and the Ki.
The following seven subchapters are addressed in this chapter: The current computing situation, the artificial gap, the human geographic freedom, the demand validation, the Gen Z analysis with the complementary social trends and the tech trends.
The subchapter “current computing situation” will function as benchmark for the showcase of the Nubus ecosystem in the next chapter. The Artificial gap and human geographic freedom present findings that are reflected upon in the presentation of the Ki and the Nubus. The contradicting demand validation subchapter, will highlight the main problems with the current computing system defined by user research. These findings are used in the chapter of the Nubus ecosystem, to clarify how the ecosystem improves on the current problems. The Generation Z subchapter presents the focus group, and their characteristics. Directly after the subchapter presents social trends that return in the roadmap in chapter three. The final subchapter presents the technological trends that together with the social trends define the roadmap in the next chapter.

2.1 Current computing situation

The current situation of computing is described here to set a benchmark for the Nubus Ecosystem. The current computing situation, focusses on smart devices, like smartphones, tablets and laptops. All these products allow people to experience computing. The current computing devices are described in short, to enable the comparison between current devices and endpoints (explained in chapter 4.4). The current consumer cloud possibilities are shown to indicate the current focus of the cloud. Furthermore the market, with the current business mindset and competitors are discussed to indicate the gap on which the Nubus ecosystem will focus.

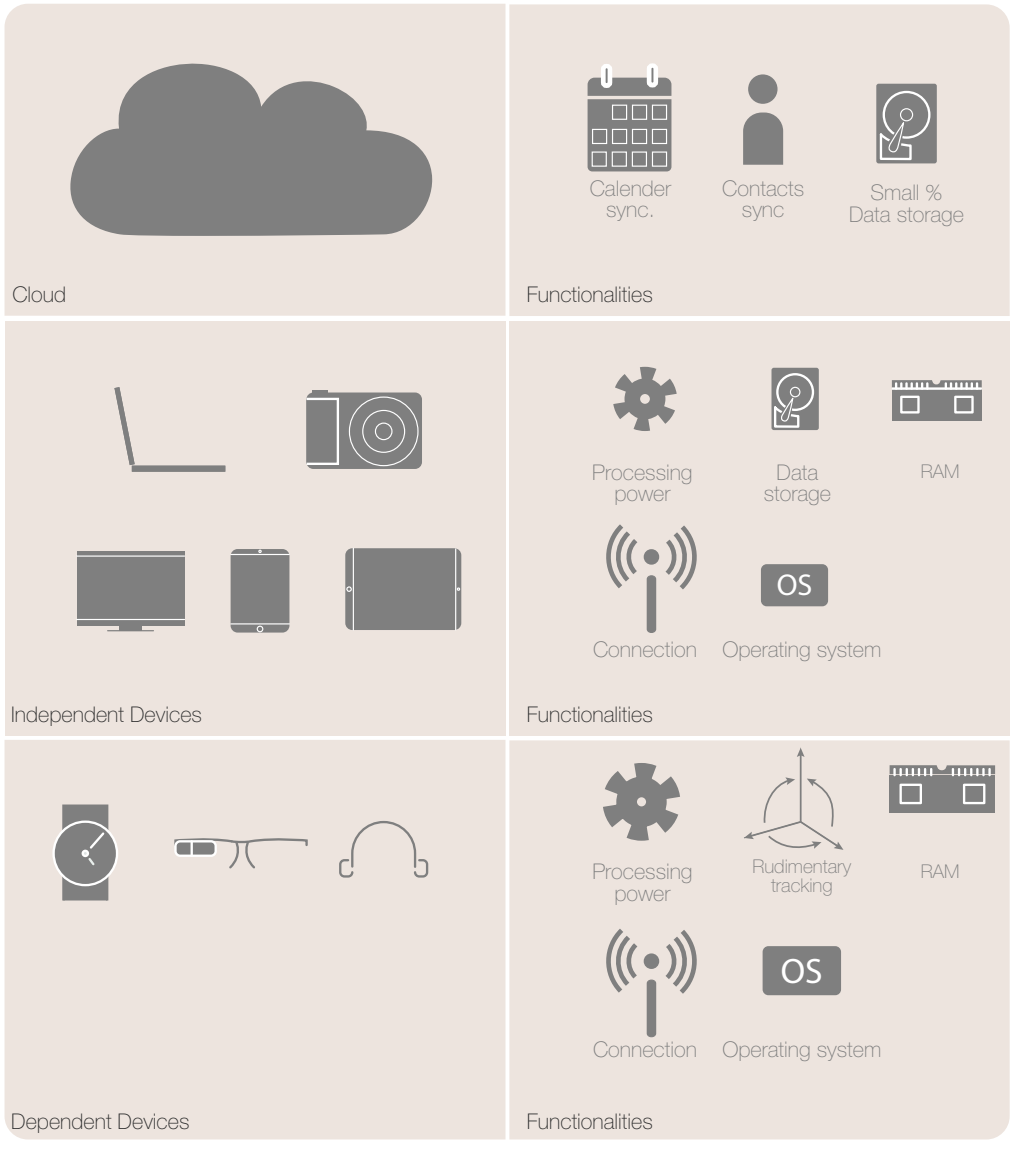
Devices

Currently there are many different devices on the market, ranging from desktop computers to small portable independent smartwatches. Every device has its own features. Every product fulfils specific needs of users. Depending on the amount of features, a clear separation between strong dedicated devices and weak dedicated devices is present (expert meeting E. Baha, 2017). A strong dedicated device is a device that is develop for one purpose and performs really well in that sector, like the professional DSLR. A weak dedicated devices is e.g. a smartphone, it is capable of everything in a normal manner.

Device categories

In figure 2 the current architecture of the different of devices is given, indicating if it is an independent or dependent device and its features. The development of the dependent device is interesting, because this makes device reliant on connections with other devices. This shift towards making one device the heart of other devices is an indication of the development of a web of interconnected devices. The different categories of devices make people dependent on specific devices, since they don't seamless exchange everything.

figure 2 Architecture (scheme) normal devices



Hardware
As can be seen in figure 2, the hardware does not differ a lot per device. The hardware components are not shown in detail, but a generalised image is created for all the components. Devices basically fall apart in memory/storage, processing and rudimentary hardware, like Wi-Fi, bluetooth and other sensors. The main difference per device lies within the power of the device, the amount of storage/memory and processing power. Moreover some devices differ in dedicated hardware solutions, often due to their specific product aim.

OS
Almost every device has a separate dedicated OS. Even though some device are reliant on other devices, these still have an independent OS. E.g. the Apple Watch is a product that is reliant on a connection with another apple device, however, it still has its own OS. These devices do not facilitate a continues workflow, except for content. See figure 3 for product specific possible synchronisation, mainly indicating the synchronisation of content. The current cloud synchronisation per device relies on the OS. The possibilities of cloud sync are directly linked to the heart of the machine and therefore the up to dateness of the hardware. If the hardware is limited, users are not enabled to have everything ready at their fingertips from any device at any time.

Cloud

The current cloud solutions are still limited, the cloud is not matured yet (Gartner Hype profile, 2015). Different companies provide limited storage, free of charge, this creates an independent synchronisation option for every device. It disables the user to have everything always up to date. Currently when looked at figure 3, one can conclude that synchronisation only works for content. Software is currently yet to be cloud based, however, the content of some software is synchronised over the cloud. In the diagram the type of universally available synchronisation over different devices is shown. Indicating that some content can be cloud synchronised and that some software relies on cloud synchronisation, but that actual storage and processing power is yet to be available via the cloud for consumers.
Other possibilities are cloud services, that enable more data synchronisation and data privacy, sometimes third party owned services and sometimes first party services. These extra services require a monthly fee next to the initial purchase fee of the device. This as well, is about synchronisation of content and not hardware that can prevent outdatedness or incompatibility. The current cloud only enables a little bit more human geographic freedom in data and not processing power, making people still dependent on specific devices.
On the next page in figure 4 the legend is shown for the symbols in figure 3.

figure 3 product specific possible synchronisation

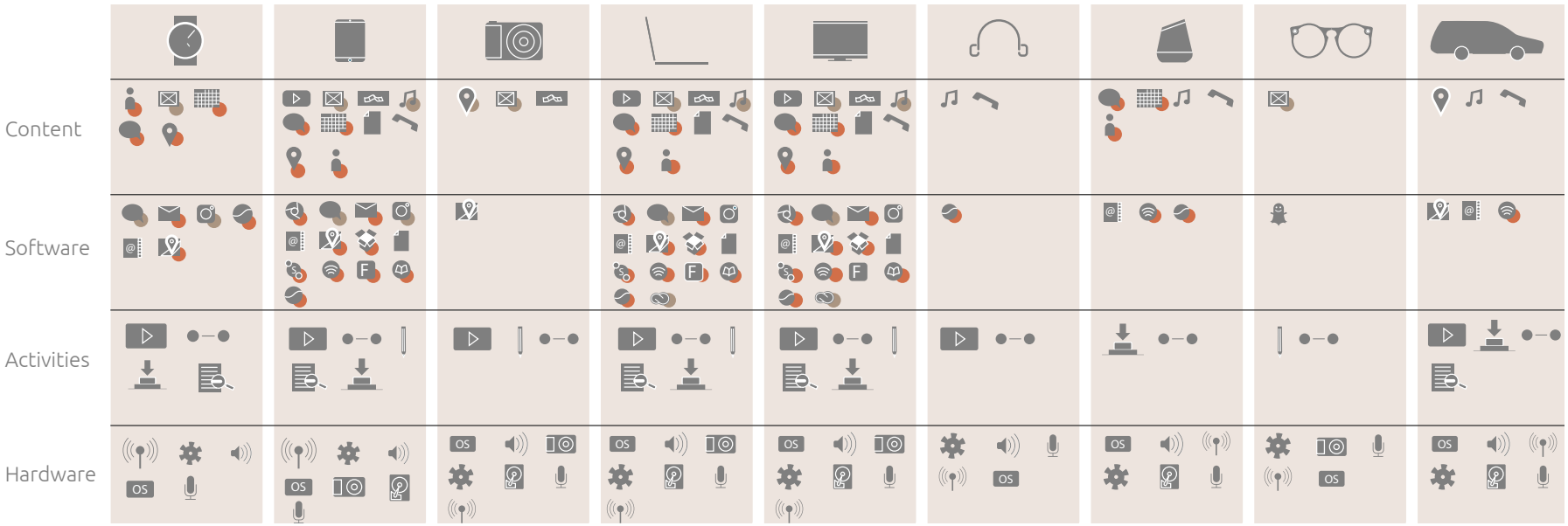
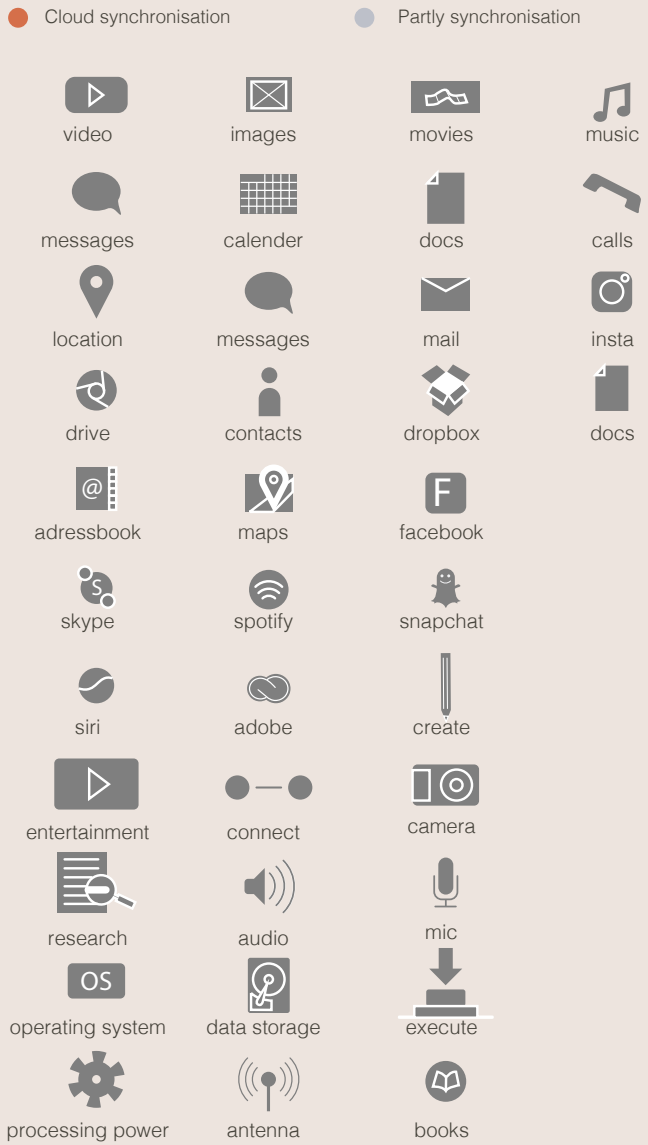


figure 4 legend product specific possible synchronisation



Business

Currently companies sell devices to consumers from a business perspective, one time purchase is a easy sell. In best case scenario this creates a single interaction moment between the company and the consumers. Other possible unpredictable moments are moments of repair, maintenance and/or exchange of information. The last one is often one-sided, without a physical interaction moment. The linear business model, requires little effort from the brand to keep consumers happy. From the point of purchase, consumers are on their own.
Therefore it is convenient from the brands perspective to push new products to the market to keep the cashflow going. Simultaneously it is in the brands best benefit to deliberately create outdatedness and incompatibility when pushing new products to the market.
The current linear business model puts the user in last place.

Competitor analysis

The competitors analysis was done to confirm the gap in the market, and indicate the possibility of the vision. The matrix analysis is based on the competitive value matrix. Multiple comparisons were made with different axis. In appendices 03 the other less relevant matrixes can be found.

Online ecosystem
The gap can be identified in the top of the matrix in figure 5. The online ecosystem market gap has not been filled yet. Important brands are slowly developing towards this space. When this is compared with the B2B market, one can clearly identify the importance of the online ecosystem. The Chrome book or the new devices that will come available with the new Windows 10 S, will provide businesses with a online ecosystem (see figure 6 for the B2B matrix comparison). Microsoft and Apple currently already fill the offline ecosystem market.

Competitors differentiation
Some competitors are focussing on different kinds of parts within the online ecosystem at the same time. Google for instance, is developing Chrome OS to enable a software online ecosystem. Chrome OS currently allows users to do parts of their work on their online ecosystem. At the same time other companies are developing hardware for the Chrome OS to run on, like Dell and Samsung. Apple is slowly making steps towards an online ecosystem, with every update both the hardware and the software move more towards an online ecosystem. All indicating that the online ecosystem is something every company is aiming for in the long term.

Products & software

The matrix in figure 5 only shows the respective position of the brands, however, as can be seen in figure 7 and figure 8 the brand themselves also differentiate in the types markets they focus on with certain products. Apple is big on offline ecosystem with their current OS X and iOS, but very little with their cloud development. Windows has many different software products ranging from offline ecosystems to online ecosystems, however, they are not well incorporated with each other and therefore is not combined to a great online ecosystem. Google is clearly focussing more on the online ecosystem, but is not there yet, because its application possibilities are still limited and their hardware is not completely online ecosystem orientated yet.

The size of the logo's show the impact the product/software/ brand currently has on the market, the location is respectively to each other and are not mathematically defined as it never is with competitive value matrix.

Conclusion

The market is indicating a shift towards the online ecosystem, however, the market also shows a gap of potential. All the potential competitors have a lot of power and own specialities. Huge companies move slowly, however have enough capital, touch points and reach to quickly take over a market.

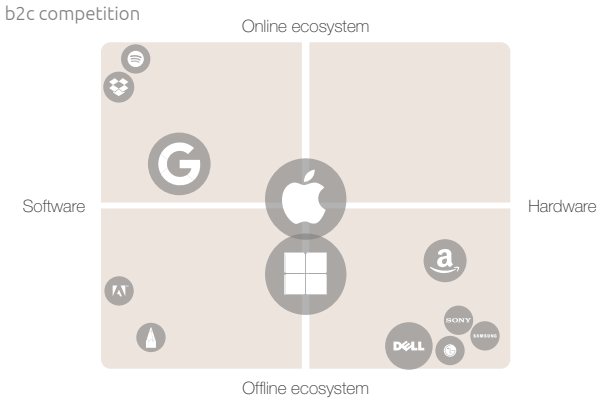


figure 5 B2C offline vs online competition

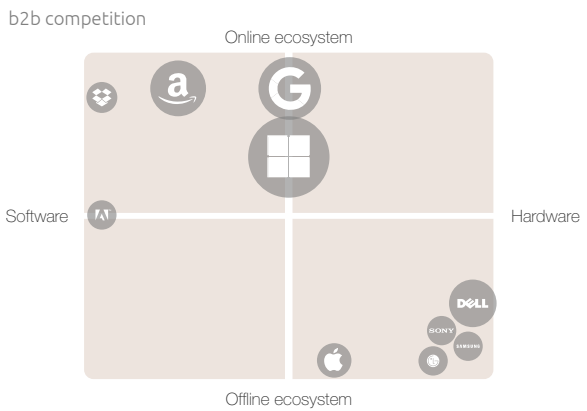


figure 6 B2B offline vs online competition

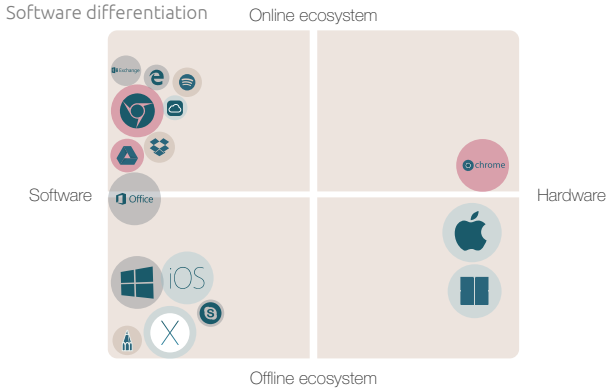


figure 7 Software differentiation ecosystems

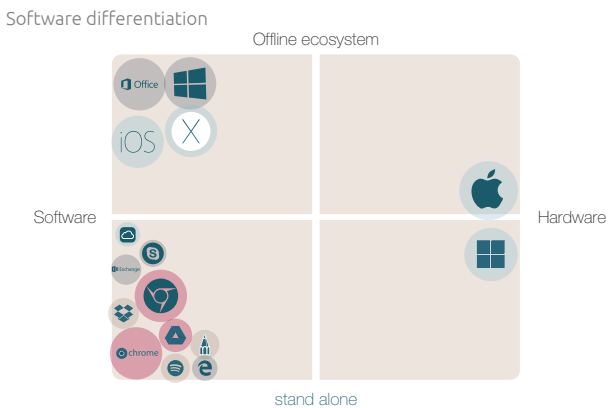


figure 8 Software differentiation hardware

2.2 Artificial gap

Since the outcome of digital services and digital products for the phone and PC, some kind of gap between the digital interface or product and the physical experience is present. Products that are only present in the digital world do not always have a direct relation with a physical product and thus its material. Practices are the foundation of a physical relationship with the digital product. The word “material” is not just to indicate of what the object is made of, but also the proportions, embodiments and arrangements through which they can be experienced and preformed (Giaccardi & Karana 2015).

The artificial gap as described by Prof. dr. Elisa Giaccardi (2014) in her inaugural lecture:
“The use of everyday objects and practices can make data, connections, and interactions relevant in ways proportionate and appropriate to the actions we preform in different physical environments and our broader social content. They can be used as both inspiration and ground to facilitate interactions that matter. Grounding flows in the practices of everyday life means creating intimate relationships between the materiality of objects and how practices are preformed around them. This requires bridging the artificial gap between online and offline practices, objects and devices.”

Practice theory

The artificial gap described by Giaccardi is a continuation on the practice theory of multiple psychologists, like Vygotsky and Latour. The practice theory is a social theory on the model behind practices. The definition of a practice by Reckwitz: practice theory, like other versions of social and cultural theory offers a system of interpretation, a conceptual framework that comprises a certain way of seeing and analysing social phenomena, which enables certain empirical statements, and excludes others (Reckwitz, 2002a : 257). It is defined by regularly performed activities, socially shared entities and a number of practitioners.

Wether materials/entities are included in a practice differs per psychologist.
For this report the adapted model of Shove and Pantzar by Kuijer is used to explain the framework as can be seen in figure 9. Vygotsky created a more elaborated model, however, due to the timeframe of the project the simplified model was used for this project.

Stuff
Tangible, material elements deployed in practices (Shove et all., 2012). Summarised as objects infrastructure, tools, hardware and the body itself. Stuff is socially shared, however, not equally available to all groups of people (Kuijer, 2014).

Skills
Skills are bodily and mentally learned routines, including know-how, levels of competence and ways of feeling and doing. Ways of feeling about and appreciating things and situations is seen as part of the practice, learned through doing.
Skills involve (inherently shared) knowledge about what is good, normal, acceptable and appropriate (also what is not) and learned. Body/mental competence to reach these standards more or lesser extends.

Images
Images are shared ideas or concepts associated with the practice. That give meaning to it. Reasons to engage in it, reason of being, the social and symbolic significance of participation at any moment.
Images bring concepts of association, relative positioning, norms, values and ideologies forward.

Cloud gap

The digital product, the cloud, is omnipresent and is marketed like its accessible from anywhere. However the cloud can currently only be experienced through 2D entities or devices. The cloud is a separate service within current devices and does not have a physical representation. Therefore creates a misunderstanding of the cloud among users (as can be seen in chapter 2.4 (Cloud usage). This prevents users to build an intimate practice with the cloud. Furthermore there are no skills required to enable an operation with the current cloud. The artificial gap should be bridged for users to have full understanding and control over the cloud, which should enable actions and practices that will help consumers to build a relationship with the cloud.

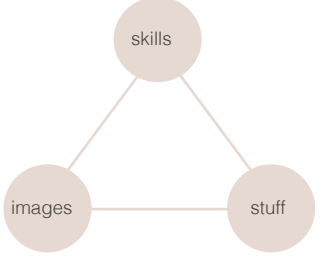


figure 9 Practice theory framework by Shove et all. 2012

2.3 Human geographic freedom

This chapter will explain some historical technological developments and how it influenced human geographic freedom. The Human Geographic freedom visual in figure figure 10 will show which products enabled which extra degrees of freedom for people. The development of the phone and the personal computer are shown in a graphic representation and is directly linked to the extra freedom the user acquired with the new products. In chapter 2.4 the demand, the current human geographic freedom is assessed.

Human geographic freedom is a dimensional development first described by Professor David Passig, and later elaborated upon by his student Michael Eisenberg. He describes that each new level of technology, also described as innovation, extends human geographic freedom (Eisenberg, 2016). A new level of freedom for users is created by innovation to enable them to do the same tasks in different or new locations.

Phone

The smartphone has brought human geographical freedom to a new level. The phone in the 19th century was a unique object to own. From the 1960's people were able to use phone booths on the street or own a household phone. From around the 1980s people were able to call with a private phone from any private home and sometimes even make multiple calls at the same time. From the twentieth century it became a common good to posses a mobile phone and walk and talk at the same time, now know as one of the many personal devices people have (British telecom, n.d.). See figure 10 for a more detailed explanation of the relationship between degrees of freedom and the development of the phone.

Personal computer

The personal computer origins from the 1930s, it was a very unique product which could do fast inhuman like calculations. The first PC was very unique and only privileged for special high end companies or governmental institutions. In the 1970s the first desktop PC was brought to the market. It enabled companies to own several at the same time, speeding up the process of work from employees. In 1985 the PC made its entry in households. Around 2000 it became a common good and the first consumer laptop started to show its potential. In 2012 the smartphone enabled consumers to do similar tasks to what a PC could do (Computer history museum, 2017). See figure 10 for the degrees of freedom acquired in relation to the development of the phone.

Conclusion

Both examples are meant to show what technology has done for human geographic freedom. Technology releases humans from being bound to a geographic location to preform tasks. At first PCs were privileged to companies and their employees, nowadays people carry a personal computer in their pocket enabling them to perform similar tasks to what they were able to on a desktop PC. The Phone and the PC are slowly merging and enables consumers to do any task on any location.

PCs are enablers for consumers to perform tasks, the tasks are often data sensitive. As people own multiple devices and their data is spread among these different devices, people are bound by the location of the devices as can be read in chapter 2.4 (the demand). In this instance people are limited in their human geographic freedom by material, that carries their personal data and processing power.

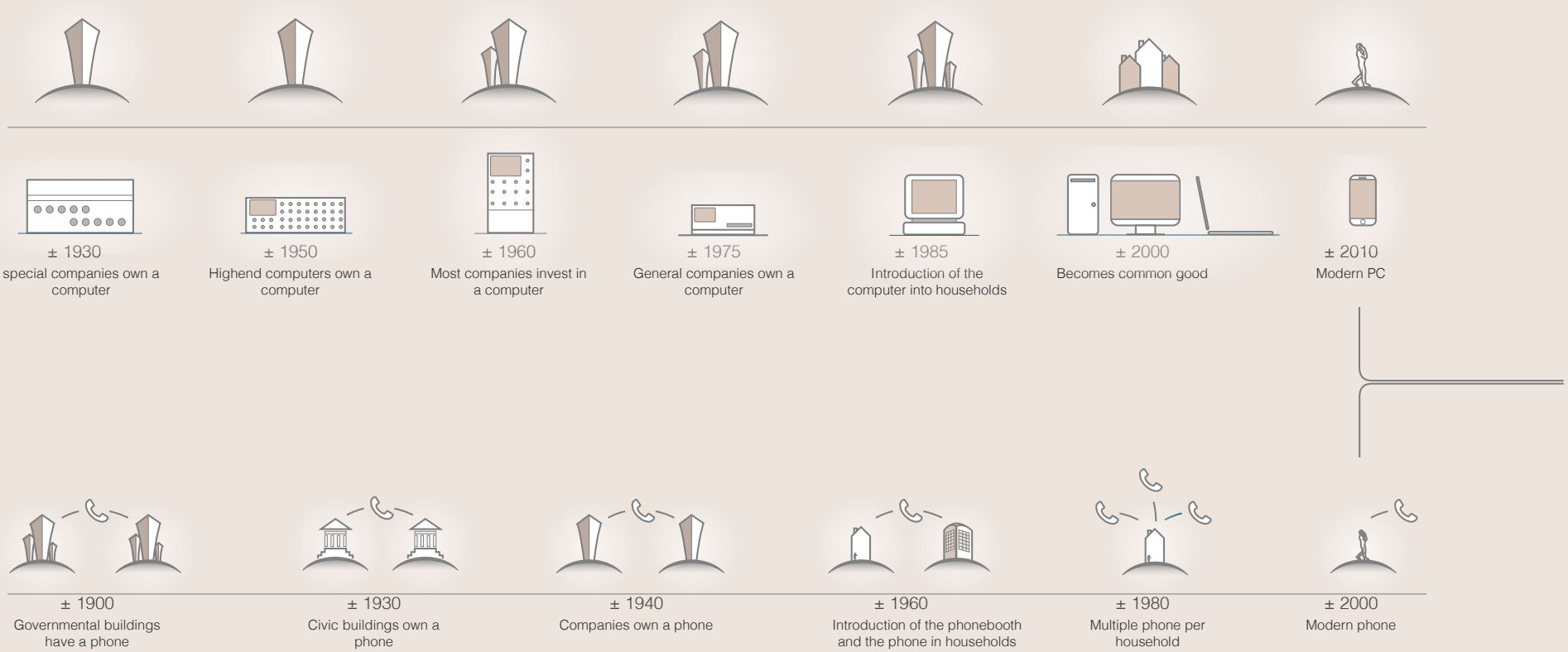


figure 10 Human geographic freedom

2.4 The demand

The following demand: “having everything ready at your fingertips at any time, to having everything ready at your fingertips from any device at any time”, was set as to be validated by a quantitative and qualitative research. The interviews were the continuation of the questionnaires. The questionnaires were used to get insights in the broad spectrum of the demand, and with the interviews specific in depth information was gained on the interesting findings from the questionnaires.
The following important findings will be discussed here: new device, feelings about a new device, data availability, seamless interaction and device dependency.
Other findings of the interviews and questionnaires can be found in appendices 01 and 02.

Approach
The approach to finding the actual demand of the users, a combination of quantitative and qualitative approach was used. The questionnaire was meant for everyone. To get insights in different age groups of computing, their computing usage and their understanding of the cloud. The questionnaire was intendedly set up broadly, to cover a wide range of aspects. Next to acquiring info on these topics the information was also used to get insights in potential early adopters of a cloud computing system. In the questionnaire, some qualitative questions were already asked to get more personal insights as every questionnaire participant was a potential interviewee.

The questionnaire was intended to diverge in insights, the interviews were intended to converge in insights. The second part of the user research was focussed on the qualitative aspect. The interviews were semi structured. Partially was focussed on the findings of the questionnaire and partly was focussed on open questions to get more insights on the spot.

Setup
In total 6 interviews were held, two brief (10min max) and two long (25+ min) interviews with Millennials, then two long interviews were held with two persons from Generation Z. The two brief interviews were held with working Millennials and the two long interviews were held with studying Millennials. Of the generation Z interviewees one person is currently studying and one person is working.
The most interesting answers in the questionnaire were all coming from people of Generation Z or Millennials, therefore the interviewees were selected within both of these groups.

New device

From the questionnaire it showed that 44% of the people were in need of a new model phone due to incompatibility or outdatedness. People also indicated that they are in definite need (83%) of a new laptop when purchasing one. Both numbers indicate that people are often postponing a new device purchase, and eventually are in need of a new one due to outdatedness and incompatibility. See figure 11.
With the interviews people noted the same reason, but in more detail. Ellen indicated that she replaced her most recent phone due to slow speeds and storage problems after owning her phone for 4 to 5 years. Solange stated that in general she gets a new phone, because of incompatibility, outdatedness or a damage.
When they were asked why they replace their laptop, Ellen stated to get a new laptop because she noticed a decrease in speed and because of incompatible programs. Kathrin, mentioned that she needed a new laptop, because she needed to use more power consuming programs and therefore had to replace her laptop.
In general from both researches it showed that new devices are bought due to outdatedness, low storage, incompatibility or damage or the combination of the previously mentioned. Incompatibility and outdatedness are the main factors to affect users to have everything ready at their fingertips at any time. Making them more dependent on specific devices, simultaneously limiting them in their geographic freedom.

Feelings about a new device

From the questionnaire it showed that people are generally positive when getting a new device, see figure 12 feelings about a new device. When asked why in the questionnaire, people mentioned the positive aspect of getting a new device. The results of the interviews indicated the same. Ellen stated, that she is very excited about the new features and possibilities of the new phone. When she was specifically asked about her old phone, she stated: “I don’t really know what to do with it. Actually I did not think about this yet until you asked.” Kathrin stated about getting a new phone: “Excited, I guess when just starting to see the new interface. I get excited about the responsiveness. The fast, the gesture control.”
With laptops they already indicated that they were in need of a new one. When questioned about how they felt about it. Kathrin: “It was really almost like nothing changed, I wasn’t really excited about the new laptop. It was an enabler, so I could work on multiple things at the same time easily.” Ellen: “Happy about the free new memory and fast speed. Pretty similar to what I felt with my old phone.”
The negative associations are most likely only present when the person is at that moment experiencing the negative outcomes, once the person owns a new device, the negative feelings appear to be forgotten. Currently the consumers are waiting so long with a product replacement that they are limiting themselves in the human geographic freedom they experience. Often limiting the seamless functionalities due to outdatedness or incompatibility.

Device dependency

As showed from the social trend analysis and from the questionnaire nowadays people have become device dependent, therefore the participants were asked whether they need all their data at all times, to check how device dependent they are. Two questions were asked in the questionnaire to get an indication of the demand. The first question: “How about today, did you use one of your devices and wanted to access or do something on that specific device that is only available to you on another device?” was meant to see if they had been in this specific situation today. The second question “Do you have all your own data you need, at all time available to you from any personally owned device?” was meant to see if it ever occurred to them at all.
Whether people needed data that they didn’t have available to them that day 68% stated to have all the data available to them that day, see figure 14. On the other hand, when asked if they have everything they need available to them from any personal device, 61% stated to not have everything available to them at any time (see figure 13). Showing a clear conflict between the answers, during the interviews more in depth questions were asked about the difference. The interviewees did not say they don’t have everything available to them at all time, but they did mention how they achieve having everything ready at all times. Ellen said when asked “do you have everything available to you at any time”: “No, certainly not. I have a lot of documents on my laptop, which are not available to me on my phone”. After asking how she manages to have everything available to her when she needs it, she responded with: “I almost always carry my laptop with me for that reason, otherwise I will send the documents to myself via email”. Kathrin responded in a similar way. Solange, responded with: “I don’t have all the data available to me at any time. I have a lot of documents on my laptop, which I don’t have on my phone.” When asked why, she explained: “On my laptop I don’t store a lot of documents, I mainly use it for school stuff, school stuff is stored on my laptop and not on my phone.
I explicitly use my laptop for things I want to see bigger.”
Javier, who is currently living in Shanghai (moved there 8 months ago) and had an empty phone battery explained his device dependency: “I did not know my address by heart. At that time I had no clue how to get home, and I could not access my information from any other device, because I only stored it on my phone, next to that I was on the street, not having access to any other device.”

Even though there was a slight difference between Millennials and Generation Z, they all had one thing in common: they are very dependent on their devices for a lot of data. This disables them from having everything ready at their fingertips at any moment from any device, but they are not aware of the hassle they currently have to go through to have everything ready at their fingertips at any time from any device.

Seamless interaction

The questionnaire showed, only 24 % said that current interactions between devices are seamless, 50% said maybe sometimes and 26% said no. See figure 15 for the results from the questionnaire about the seamless interactions.

During the interviews Ellen explained when asked about seamless interaction: “Because of owning only apple products, the interaction is smooth and easy. The layout between devices is the same, that is convenient when switching devices.” But then she added: “Airdrop is really convenient, at this moment I am not sure if we can also use it between a phone and laptop, but its really convenient that it is possible.” Kathrin mentioned: “The user has to initiate something instead of the devices already talking to each other. Sometimes ownership is a barrier, for example the iPad is always logged into the account of my boyfriend, it doesn’t know that I am using it.”
Jimte mentioned: “The iPhone and the iPad, I use them for total different applications.” indicating not needing seamless interaction. Solange said something similar: “For me the phone and the laptop are two completely different products.”

Everybody did understand that most products they own had some kind of seamless interaction with each other, however, they were not overly enthusiastic about it. The current functionalities of seamless switching devices, does not live up to its potential and makes people rely more on different devices.

Cloud usage

From the questionnaire it showed that 91% of the people were using the cloud (see appendices 01 for the figure), and more than half was mainly using it to have access to documents from anywhere (any location and any device). During the interviews it showed that people were really uncertain about what the cloud is when asked whether they use it and what it is. Ellen responded with: “Not that much no, I use dropbox and Drive, but I don’t really have any knowledge about the cloud.” Jimte responded with: “Yes that is.. a data storage on the internet, or something like that. It is a storage place for data… I do use it, but it is currently full.” Solange: “It is a place online, where you can store stuff, but its not stored on your own device its located somewhere else. Somewhere on the internet, sort of right?” and then continued with: “The cloud will always be a little bit vague for me.”
The vague answers about the definition of the cloud, indicate the presence of the artificial gap. The cloud is present and is used, but people are not really aware of how it works and how they can precisely benefit from it. People are not aware of what the cloud is and what it resembles.

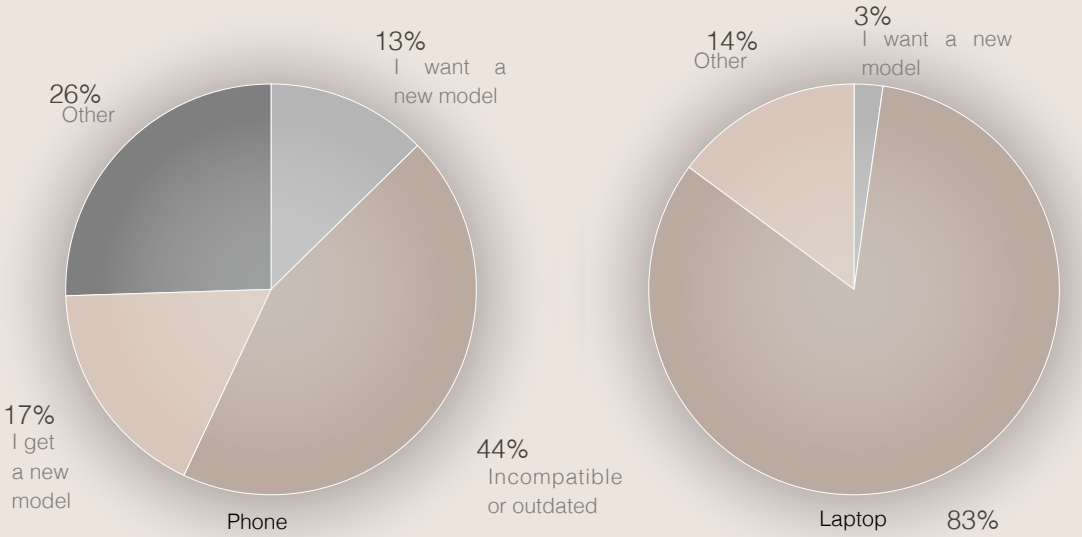


figure 11 Why people buy a new device

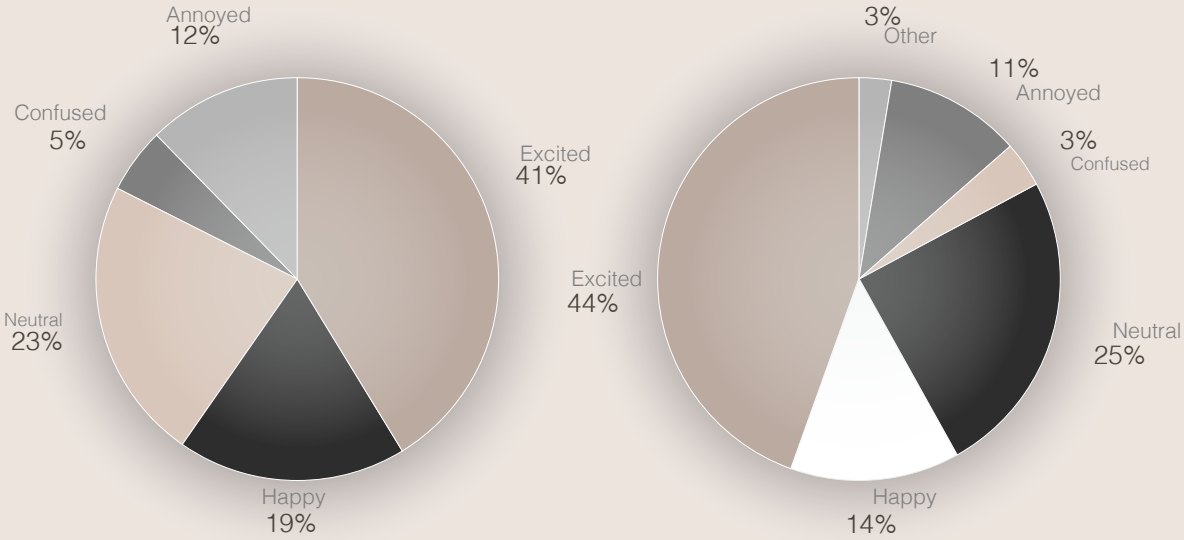


figure 12 Feelings about buying a new device

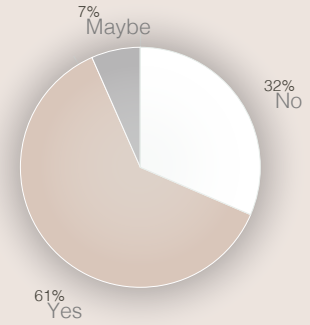


figure 13 All data available today

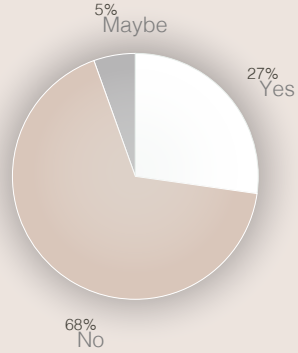


figure 14 All data always available

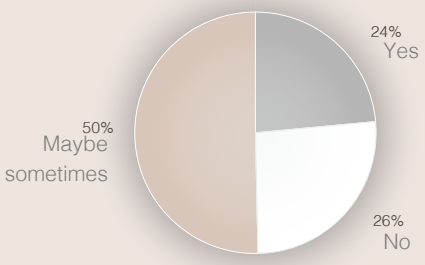


figure 15 Seamless interaction

Key pain points

Specific device data dependency
All interviewees had something in common, being highly dependent on their data. All their data is currently divided among several devices, disabling them from having everything ready at any time from any device.

Outdatedness/incompatibility
Currently limited human geographic freedom is a result of incompatibility and outdatedness and device dependency. People own devices until they are incompatible or outdated, limiting themselves in possibilities enabled by new devices. This disables users to have data and processing ready at their fingertips at any time from any device.

Interactions are not seamless
Even though some products have the possibility to communicate seamlessly with other devices, in the owners benefit. These are not perceived as seamlessly. Some third party apps enable the seamless synchronisation as well, however, these have sync time that create latency. Disabling users to have data ready at their fingertips.

Cloud creditability
The cloud is not resembled by anything, indicating the artificial of the current service. Disabling users to use it to its full potential.

Insights

Every pain point, disables users to have next step in human geographic freedom. Currently people are being limited by outdatedness/incompatibility and device dependency. To enable users to have the next step in human geographic freedom users should not depend on devices as much to have everything ready at their fingertips from any device at any time. With “everything” is referred to processing power and data according to the outcomes of the interviews.

2.5 Generation Z

This subchapter will in short elaborate on the focus group for the vision, the focus group is described in this report as Generation Z. This chapter explains how the generation is defined and sums up some basic characteristics of this particular group. Generation Z is still very young and their personality is still developing and thus changing. The social trends and developments were taking into account to indicate that the vision is not only technically feasible but also fits the social developments of this group of people. Technological developments often go faster than the development of social acceptance or social preference, therefore the social trends are consciously part of this project. The social trends specifically addressing Generation Z and their digital world perception and how it will influence their personality is explained hereafter.

Introduction Generation Z

The focus group for this project is Generation Z. The name focus group is specifically chosen, which should not be confused with target group. This focus group enabled boundaries to create a more specific focus for this project.

Generation Z is the youngest generation of the current society. They are intelligent and self-reliant. People often confuse them with Generation Y, or known as Millennials. Generation Z is for simplicity categorised in the age range of 0-20 years, normally generations are not categorised by age but should be categorised on behaviour predicted by scenario (Dorsey, 2015).

Focus group

Since the project is focussing on Gen Z, this does not exclude other groups, however, it creates boundaries for the project and enables a more specific approach. The specific group has been chosen for the following reasons.

-Generation Z is stated as the Cloud natives, indicating cloud knowledge and cloud acceptance.
-Generation Z will be entering the labor market within 5 years and will then have a strong buying power.
-Generation Z is less constricted by previous device related purchases.

Other groups are not taken into account, the main focus is creating the best product for Generation Z. As Jason Dorsey describes, it starts in the youngest generation and over time the effect will also ripple through to influences other generations (Dorsey, 2015).

Who are they

Generation Z, now ranging from 0-20 years old (The center of generational kinetics, & Dorsey, 2016). This generation is the young group that knows glass as something interactive. Depending on the date of birth - ranging from 1996 until now, depending on the source - some are becoming a major part of the working forces soon (within 5 years). The generation is divided in three parts, a part is in elementary school, a part is in high school and a part might already be working or studying. The generation almost embodies 4 million people in the Netherlands alone (CBS, 2016), in the United States the group is growing larger than 23 million (The center of generational kinetics, & Dorsey, 2016). Millennials are known as the digital natives, generation Z is one step ahead and more commonly known as cloud natives. Generation Z still has multiple names, like iGen, Founders or post-Millennials, in this report they will be described as Gen Z or Generation Z.

Generation Z is still a young generation and as children of most likely generation X, they are influenced by their parents. As generation X has been most likely influenced by the economic global crisis, terrorism attacks and natural disasters, they will influence their children with these experiences. However children are known as to be highly influenceable and will most likely still change some behaviours over time.

Groups within Generation Z

Generation Z can be divided into three different groups of computing users, as was found from the questionnaire, see appendices 01. The following three groups were found: light, normal, power. When looked at gaming, similar groups appear. In 2015, Mills & Mills state the following user groups among gamers: casual, avid, extreme. The users were not categorised on devices owned but by processing power demands, the most extreme activities determine the type of user. These groups were used to define different user subscription models, as explained in chapter 4.6, furthermore user trademarks were used to define groups for the user evaluation.

Light user

The light user is defined by using programs that require basic actions from devices. Light users are defined by activities like: writing, web surfing, interacting on social media, making appointments, taking photos or videos and navigating. Basic activities that do not require a lot of processing power from devices.

Normal user

The normal user is defined by using programs that occasionally require the devices to deliver higher than average processing power. Normal users are defined by activities like: occasional games or simple games, some simple photoshop, occasional moviemaker etc. and the previously mentioned underneath Light.

Power user

The power user is defined by using programs that require the device(s) to deliver extremes. Power users can be defined by doing one of the following activities often: 3D modelling, Gaming, Photoshop, Editing music, Editing video, simulations, VR etc.. Every activity requires a powerful processor, even though some activities are only possible on some of the current devices. The power user does also do similar activities as mentioned underneath Normal and Light users, however the more extreme activities stress the possessed processing power. From the questionnaire showed that the Power user, was the biggest group, however this mostly related to the participants which are for a big part from the TU Delft.

Gen Z summary

Age group
Generation Z is here defined by the age 0-20, therefore the group spans over different “age” groups. Currently, they are in elementary school, high school or just became students. However, a generation is not defined by age but should be categorised on behaviour predicted by scenario.

Cloud natives
People from Generation Z are the first generation that grew up with the cloud being present as something interactive. Therefore Generation Z is often called cloud Natives.

Five years to labour market
Some people from Generation Z are already in the labour market, some might still be studying. Within five years, they will have a significant presence within the labor market.

Long term orientated
Generation Z has been influenced by their parent Generation X, who are sceptical of short term goals. This has influenced Gen Z to orientate themselves for the long term.

Identity aware
Generation Z is very aware of the digital world. They are not aware of a world without it, however, they are aware of the power the digital world. Generation Z is very identity aware, and therefore prefers peer-to-peer messaging over open social media.

Complex world
Generation Z is at a young age influenced by events that changed their economy and society, making them more cautious, creating clearer future goals than the previous generation.

Connected society
Everyday, more people enjoy the connected world. Currently we live in a connected society. Gen Z is leading the society in the importance of being connected.

Relationships
The boundaries between physical and digital start to vanish. People become friends over the Internet with whom they have never met before. Generation Z is connected to enjoy the experiences one can have over the digital world and merges this with the physical world. Devices are merely present to enable digital experiences.

2.6 Social trends

This subchapter is focusing on social trends and developments. The social trends discussed in this sub chapter are all social cultural trends and developments related to the society of specifically Generation Z. The trends are clustered in seventeen categories, however, the trends that mostly affect the development of Gen Z and computing, are summarised here. The other societal trends are elaborated upon in the appendices 05. These trends will also influence other generations, as Dorsey states: "it will ripple from the youngest generation to the oldest generation". It does not exclude that it will not directly influence other generations. However, for this report the trends are only reflected upon Gen Z.

The following clusters are discussed here: complex world, connected society, goal orientated, individualism, privacy, care for the world, relationships, financial view, flexibility, device usage and sharing.

The following clusters are discussed in the appendices: visual culture, health to happiness, Power of play, heterogeneous society, urbanisation, and customisation.

The results all influenced vision and are presented on the roadmap in chapter 03, to indicate the relation between the trend and the vision in its timeframe.

Complex world

Global warming, overpopulation, terrorism, natural disasters are all affecting people's choices and make people perceive the world as complex. This complex world creates a social psychological impact that may change consumer behaviour completely. The social psychological effect of the complex world can last for five more years and even longer depending on future events (Trendsactive, n.d.). Even though Gen Z does not really know what happened during the terrorist attacks (e.g. 9/11) or the economic breakdown, they know it heavily influenced family members. People of Generation X, often the parents of Gen Z, were heavily influenced by previously named events, who reflect this on their children and influencing their discussion making (The center of generational kinetics, & Dorsey, 2016).

At a young age, Generation Z is influenced by events that changed their economy and society, making them more cautious, creating clearer future goals than the previous generation.

Connected society

Since the outcome of the public internet, people became increasingly connected. Nowadays, people are exchanging everything we have over the internet, we have become a connected society. As a result people are afraid of missing out, also known as FOMO. Being connected has changed human behaviour, but also the way people interact with others (Trendsactive, n.d.). People connect online but also exchange everything via a connection. Gen Z is not aware of the time without online social media (The center for generational kinetics, n.d.), making them more dependent on their connected life than other generations.

Gen Z has become so interwoven with the connected life, that they are physically influenced by online personalities (Rohampton, 2017) and reviews and services (The center of generational kinetics, & Dorsey, 2016). Gen Z lives by being connected (Wharton University of Pennsylvania, 2015).

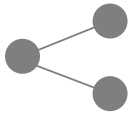
Generation Z is very dependent on the connected society and fear of missing out if they are not connected. This shows the importance of always having access to a personal digital world.

Privacy

Even though Generation Z is so reliant on being connected and having a merged online and offline social life, they are very aware of their online identity. Due to the amount of cyber security issues, security and privacy will be in the top criteria for consumers in 2017 when selecting online services (Sparks & honey, 2016). More than half of Gen Z is worried about their identity when using online open apps, while only 42% of the Millennials is concerned about their identity when using similar apps (The center of generational kinetics, & Dorsey, 2016). In general, Gen Z is more concerned about their identity than Millennials. 63% even fears about identity risks in retail stores, this is 6% more than Millennials (The center of generational kinetics, & Dorsey, 2016).

Identity security is of high priority for Generation Z.

Sharing



As the connected society grows and people become increasingly identity aware, people start to prefer peer-to-peer messaging platforms. These messaging platforms are expected to grow from 2.5 billion to 3.6 billion users by 2018, which is already a 25% larger audience than for social media. Facebook sharing has decreased with 20% in 2016 (Pineiro, 2016). A recent study showed that nearly 25% of 13-to 17-year-olds left Facebook this year, indicating that they prefer peer-to-peer messaging like Instagram and Snapchat. As Generation Z is becoming more identity sensitive, digital products that use less personal information and are more visually appealing to the eye are growing quickly (The center of generational kinetics, & Dorsey, 2016).

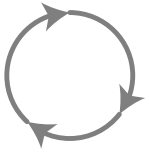
42% of Gen Z said that social media shares affect how people perceive you. This is 5% higher than Millennials. Even more, 42% states that social media influences how Gen Z feels about themselves, compared to 32% of Millennials (The center of generational kinetics, & Dorsey, 2016).

Gen Z is relating more to what is shared digitally, as it is becoming a bigger part of society.

Goal- orientated

Generation Z is very goal-orientated and is not afraid of failure. They know what they want and how to achieve this (The center of generational kinetics, & Dorsey, 2016). They state that significant failure is the way to success. 40% say they see failure as a mean to start over. 71% expect to experience such a significant failure before success (Deep Focus, 2015). Products are used to support their goal orientated mindset.
Making it important for products to empower self-development of Generation Z and adjust to their entrepreneurial mindset.

Care for the world



Due to the industrial revolution, mass production and the internet, we are currently living in the era of abundance. The more the merrier does not fulfil Gen Z's needs anymore. They prefer to have filters to avoid being overwhelmed by products and choices one does not even want to consider. 76% of Gen Z states to care about the environmental impact (Carmichael Lynch, 2016), they are eco-conscious and are concerned about humanities impact on the environment (The center of generational kinetics, & Dorsey, 2016).
Generation Z is very eco-conscious in every product category, they also pay attention to food and its quality (Spark & Honey, 2016), 40% stated to prefer sustainable food ingredients (Bridges, 2015).
Generation Z wants products that do good for the world. They are aware of what products do to the waste.

Relationships

Physical relationships are merging with digital relationships. New and different mediums change relationships between people and materials. Generation Z still prefers face-to-face communication, but they use online channels to facilitate their face-to-face communication like Skype, FaceTime, Google Hangouts, Snapchat or any channel that can facilitate this (Patel, 2016). Social media, like Instagram or Vine, enables them to meet people online based on similar interest. They create visual asynchronous relationships with new people, whom they might have never seen before (Patel, 2016). People become dependent on online statuses, as relationships become more dependent on experiences shared online (Arthur, 2016). Generation Z is merging relationships between online and offline practices, materials/ products are merely mediums to facilitate these streams of communication that determine the relationship.

Financial view

Financially the world is improving; the middle class is expanding significantly enabling more parents to improve Generation Z's buying power. Money that is often spent wisely by this generation. Therefore, more companies are pushing products for a reasonable price to the market (Singh, 2014). Children in households determine some part of what will be purchased of the parents of Gen Z (often Generation X) 93% states that Gen Z has some say in what will be purchased (Deep focus, 2015).
Of Gen Z, 60% thinks that with money comes success, making them very aware of financial choices (Goldman Sachs, 2015). Generation Z spends its money wisely making quality of products important.

Individualism

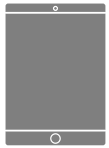
Early indications show that people from Generation Z are increasingly self-aware and self-reliant. They are very self-reliant in education, making them more influenced by education than the Millennials. The channels of education differ slightly, both Pinterest and Youtube are used for self-development (The center of generational kinetics, & Dorsey, 2016).

The amount of self-employed teens in Gen Z is very high. They are fully aware of turning skillsets into business. 89% state to prefer to work on improving their skillsets over just hanging out (Deep Focus, 2015). 70% of the teens of Gen-Z is self employed (Goldman Sachs, 2015). 62% state to prefer to work for their own company instead of an established company (Deep Focus, 2015), making it important for products to empower self-development of Generation Z and adjust to their entrepreneurial mindset.

Flexible

With the current developments of video on demand, online shopping etc., people have gotten used to having access to something whenever they want. This results in a daily schedule that is very flexible for Gen Z, directly influencing schedules for work and social life. They state that working and social life has become intertwined. Generation Z'er's rank flexible working hours at their top of employee benefits to enable them to freely organise their days (Patel, 2016). The 9-5 work day is quickly becoming a thing of the past when Generation Z has taken over a large part of the working forces (Bridges, 2015). As Generation Z lives are becoming more intertwined life of work and social life, products should support the flexible requirements.

Device Usage



Nowadays, people are becoming more reliant on their devices, resulting in more device usage. The usage of mobile phones has become more socially accepted in any given scenario.
Research shows that Gen Z states that the usage of a phone is acceptable during activities like: riding a bike, during a religious service, while eating dinner with your family or during your own wedding ceremony and many more situations (The center of generational kinetics, & Dorsey, 2016). Due to their usage of the device in almost any situation, their connected device usage time variates between six hours a day to more than ten hours a day (Statista, 2015). Generation Z has become very reliant on their devices as they use it in almost any given scenario.

Key insights

- Generation Z is at a young aged influenced by events, that changed their perspective on the economy and society, making them more cautious, creating clearer future goals than the Millennials have.

- Generation Z is very dependent upon the connected society and fear of missing out if they are not connected. It shows the importance of always having access to their personal digital world.

- Identity security is of high priority for Generation Z when it comes to services.

- Generation Z prefers experiences over the product, the current devices are merely enablers for them to have digital experiences.

- Generation Z wants products that do good for the world. They are aware of what products do to the world, and prefer not to contribute to the waste.

- Generation Z is very flexible in time schedules and life in general and needs products that support this lifestyle.

2.7 Technological trends and developments

The following trends and developments are part of the foundation for the conclusion of the Analysis phase. Technical trends were researched to verify the vision, as described in chapter one. The trends and developments led to specific insights that influenced the possible outcome and its timeframe significantly. The combination of multiple trends enabled the Nubus ecosystem as outcome as described in chapter [x[conclusion. Other trends that were used, but were less relevant for the main conclusion are described in appendices 04.

Internet everywhere

The world is making a transition to a world where everyone has access to internet. In 2020 some first world countries will have the 5G network available to them, enabling an even bigger range of access and higher speeds.
Some first world countries are still struggling to create stable connection in every area. The UK has a 2G coverage in 90% of the country by 2017 and 3G and 4G will cover 85% of the country (A British Infrastructure group report, 2016). Public internet is currently the weakest link in public cloud offering. Cloud service providers must invest in more secure and stable circuits if they want to make the move to cloud enabled services (Davis, 2016). With the development of 5G, internet will become more secure and reliable, 5G will create multi-hop to extend network range and connect unconnected devices to create internet everywhere (Qualcomm, 2015).
Every network provider and company in first world countries is working on providing a network that will create edgeless connectivity to their services from 2020, providing everybody with high speed internet to enable cloud applications.

Cloud computing

The term cloud is very broad and the applications are very diverse. Therefore a few developments and trends are discussed here that can have an impact on future seamless cloud possibilities. Currently, Cloud solutions are mainly private or hybrid solutions, a private cloud is fully integrated in a company and a hybrid, is based on a combination of a public and a private connection for companies. Yet, still a lot needs to be done to remove fear, uncertainty and doubt from the cloud for consumers (Clearly et all, 2015).
Connectivity to cloud possibilities is the key part of the solution, creating low latency applications and/or creating secure connections. The possible customer engagement issues over security and consistency will vastly disappear as their users will no longer be able to tell the difference between cloud and hardware (Davis, 2016).
The development of Mesh apps and service architecture will enable a digital mesh life, enabling users to interact with every application at any endpoint. It will enable information, apps, devices, services and micro services to function over all different endpoints by using a flexible architecture (Clearly et all., 2015).
Android is currently working on a cloud platform, called web apps. This enables users to work with apps without requiring to directly install the app on their device. This seamless integration of the cloud for the user is an ideal way to work around the boundaries of apps users are currently still facing (Android, n.d.).
These developments will create more secure cloud solutions that fully integrate apps in a seamless mesh, enabling users to access more over other devices.

Mobile computing era

The start of the mobile era is disputable. That we are currently in it is certain, because two billion people have a mobile computing device. Some state the mobile era has come to an end, because of the saturated market (Evans, 2016).
Highlighting the momentous shift from desktop to mobile, for the first time ever, mobile internet usage has overtaken its competitor, the desktop computer. Mobile has accounted for 51.3% of the internet usage worldwide compared to 48.7% by desktop in October 2016 (Daws, 2016). This has positively affected mobile shopping (Perez, 2016). Also, the mobile era resulted in a growth of physical mobile payments. In some contradicting countries like China, the US and Africa, in store mobile payments are possible (Bonnington, 2015).
Adobe found that the shift towards mobile has to be taken more seriously by companies (Abramovich, 2016). Current consumers own in general 3,64 digitally connected devices (Buckle, 2016). Generation Z's own five devices with a screen (Glum, 2015). Every development contributes to the momentous shift towards a mobile first society. Due to the exponential growth of mobile usage and ownership, the data traffic will almost eightfold between 2015 and 2020 (Cisco, 2016).
The mobile computing era created a whole new trading market, worth over 17 billion dollar in 2016. The trading market in used mobile computing devices, has a YoY increase of 50% (Deloitte, 2016).

The mobile computing market is still expanding and developing. Mobile devices are more often being used as tools, providing unlimited access to data and information, enabling new paying methods and providing new cooperative interaction opportunities.

Wearables

The wearable market is still very young, even though it has reached its peak of inflated expectations according to the Gartner hype curve. Gartner noticed that the smartwatches are not really doing well, but the dedicated smart wearables are thriving. IDTechEx predicts the wearable market to be worth around 55 billion dollar by 2020, however, they also take wearables like headphones, hearing aids, basic electronic watches into account (Hayward, Chansin, & Zervos, 2016).
The wearable market can be subdivided in many different segments and some segments are predicted to do better than others. Market research firm Gartner predicts the global unit sales of head-mounted wearable display devices to more than quadruple by 2017 (Daws, 2017). They think the wearable displays are the future and will slowly win ground from the smartphones (Gartner, 2016). AR and VR, which can be part of the wearable market, will both grow in sales as well. Expected is that by 2020, 96 million VR headsets will be shipped (Lamkin, 2016). Wearables are a large part of the current mobile era ecosystem and will continue to expand in different segments over time.

Network Developments

With the development of new apps, cloud applications and the expanding range of users, the network development determines its success. Multiple countries (EMEA) show growth numbers of at least 22% YoY increase for mobile website visits (Ruddick, 2016). Deloitte stated that next to more website visits, the amount of web-based calls is also growing, accompanying a decrease in normal calls, resulting in more data usage (Deloitte, 2016). To enable real high speed data transmission, networks are being prepared to enable the 5G network. Cisco states that the first deployment will be around 2020 and it will roll out from that point on (Cisco, 2016). The 5G network will enable up to 10 Gb/s speeds (to support mobile cloud services) and 1 Gb/s (to enable ultra-high definition visual communications) (Qualcomm, 2015). Simultaneously the 5G network will be supporting independent cloud gateways to access cloud services. This allows the user to separate their connectivity provider from its cloud provider (Davis, 2016). Big companies like IBM, Microsoft, Amazon and Dell are therefore becoming providers instead of resellers of computing devices in the consumer market (Columbus, 2015).
In the 5G network, where connectivity is user-centric, the user is no longer the end point of the network. Devices will connect with one another directly, for both discovery and communication (Qualcomm, 2015).
To enable enough offload points for the data from cellular, more Wi-Fi hotspots will be created. The amount of hotspots will sevenfold by 2020 (Cisco, 2016). Dual connectivity, connecting with 4G/5G and Wi-Fi, enables seamless transitions from one network to another, to optimise user experience (Qualcomm, 2015).
By 2020, 5G will become available and in the meantime 4G will continue to develop, bringing new capabilities to expand far beyond what is possible today (Qualcomm, 2015). The new 4G will enable wearables to connect to the network independently and will enable separate data transfer (Cisco, 2016).
Seefigure 16 for the difference in data speed capabilities.
The 5G network will be developed for extreme use cases and current networks will enable separation of different types of communication to enable the best data speeds. The development of 5G will enable new kinds of reliable and high speed services.

Streaming

On demand streaming is happening across different markets, providing the user with everything on demand. TVE, Television everywhere, is a development of a cloud offering that had a year-over-year increase of 282% in 2015. It provides customers with on demand video streaming (Abramovich, 2015). 40% of Generation Z indicates to drop linear TV for on demand TV (Nielsen, 2016). On demand music has tripled between 2012 and 2015 in revenue (Richter, 2016). Playstation Now was the first to enable game streaming. Recently Nvidia announced their own game streaming platform, called GeForce NOW. This will allow high speed and quality gaming as a service (Burnes, 2017).
Streaming with low latency has been troublesome, however, due to recent developments highly responsive and low latency products are becoming less scarce.

User experience

UX

As products mature, the user experience becomes more important. Nowadays, new tech is being used to increase the user experience. Customers prefer loyal customer experiences over the best price. 89% of companies compete on customer experience and not the channel itself (Hinshaw, 2016).
Gartner states in their User experience report of 2015, that companies should not rely on UX alone anymore, but on the complete customer experience. Hall was quoted, in Coopers report of the WSGN Futures 2016, “Sell your store as a product” (Cooper, 2016). Amazon is enabling no-line stores and thus no physical checkout interactions. Amazon Go registers whatever you pick up by using Computer vision sensor fusion and deep learning to enable this store. Making customers free to walk in by only checking in and shop anything they want and freely walk out without standing in line (Silver, 2016). The user centred customer journey should be the focus of product services nowadays.

Heavy clouds

As the cloud is becoming increasingly easy to use and more widely accepted, the potential of the cloud is becoming clearer. Companies are developing more unique cloud solutions.
Microsoft Azure, is a service that enables high speed data storage with high security standards, AWS has the biggest market share. Apple, Dropbox, Drive (part of Google) and Amazon AWS are already providing more direct cloud possibilities to the consumers. Online cloud applications will continue to grow. Gartner predicts a growth in cloud applications and services until at least 2026 (Columbus, 2016). The cloud has a lot of potential and very little consumer based solutions that are available on the market currently. It has the potential to grow extensively in possible applications for consumers.

AI & deep learning

AI

AI (artificial intelligence) is very much on trend, and is used in some manner by most companies. Currently 80 of the 100 biggest companies will have incorporated cognitive systems in their consumer products by 2020, Deloitte expects that 95 of the biggest 100 companies will have integrated cognitive systems in their products. In 2016 companies will likely already have the following aspects integrated in their products: speech recognition, computer vision, machine learning, natural language processing, optimisation, planning & scheduling, robotics and rules based systems (Deloitte, 2016). Microsoft, google and Amazon are currently already entering homes with machine learning enabled products, like Amazon Echo and Google Home, enabling them to help you through machine learning (Metz, 2016). Machine learning can help by customising to the liking of the user to enable better interactions.

Data privacy

To prevent data losses or data breaches, cyber security is of high priority in this digital era. Different types of data require different types of security.
Cyber security has become increasingly important, because cyber crime has become gigantic. In 2015 alone, 50% of the US population was very concerned about their online privacy and 46% was somewhat concerned (KPCB, 2016). New security systems are emerging that enable self-testing, self-diagnostics and self-protection (Clearly et all, 2015). Signal currently encrypts asynchronous channels, like Whatsapp (Open Whisper systems, 2016). Blockchain encrypts value exchange, by decentralising its system. This enables a socially controlled system. IP addresses were setup in a similar way, to enable security measurements (Breemaiah, 2015).
The best way to create secure encryption, as stated by the brain behind Open Whisper systems, is by having a two to three factor authentication. It requires a system with one public key and one private key (Greenberg, 2016). Data is privacy sensitive and must be secured in the best way possible, by applying different security methods.

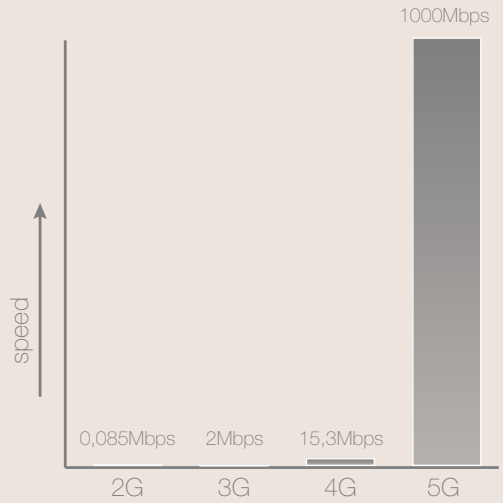
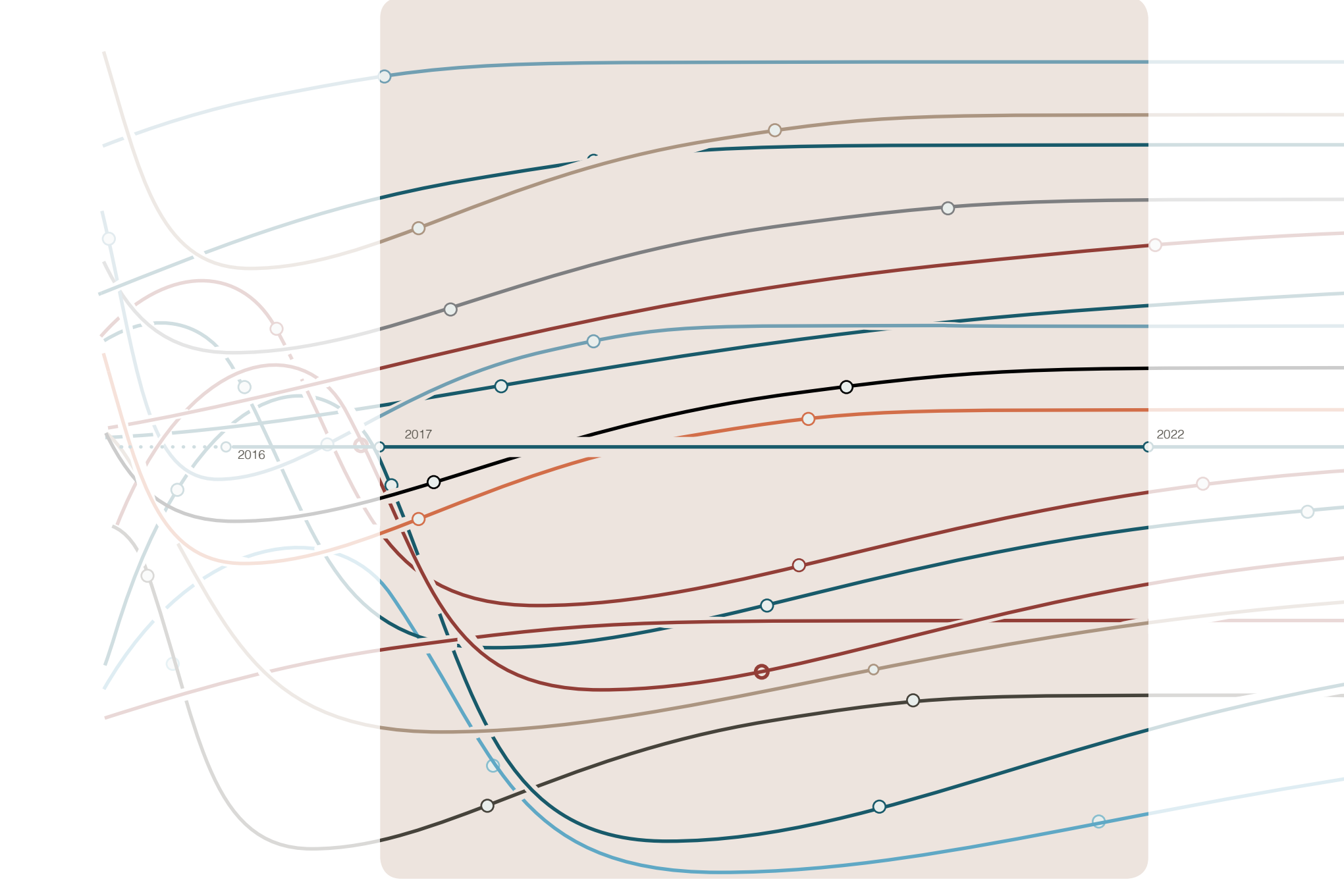
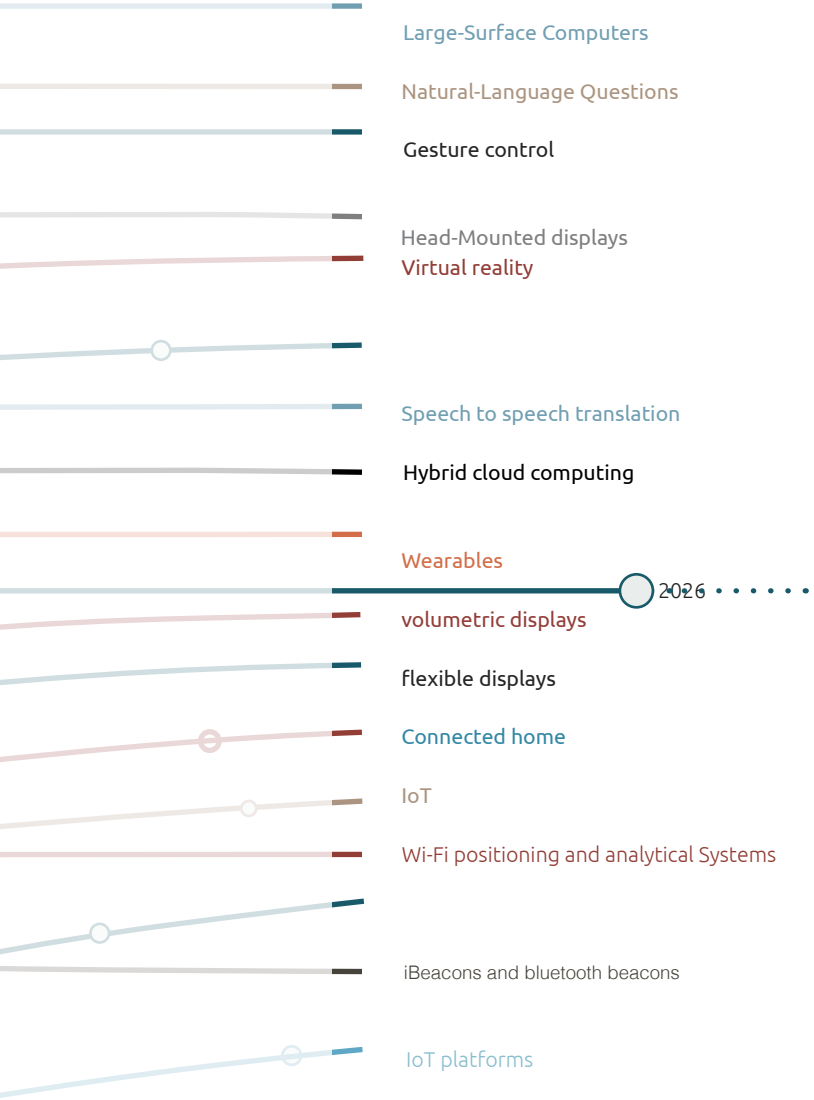


figure 16 Data transmission speeds


2016
2017
2022



Tech developments

Technical developments are influences that we have to accept over time. These developments were researched to shed light on possibilities in technology that can enable new products or product features. The technological developments are based on the hype curve of Gartner. The hype curve is translated into the visual shown in figure figure 17 to understand the state of being over time per development. The vertical axis is the same as with the normal hype curve.

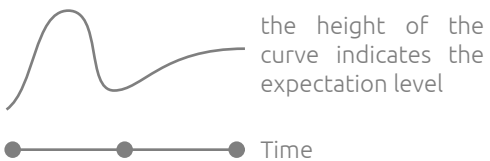
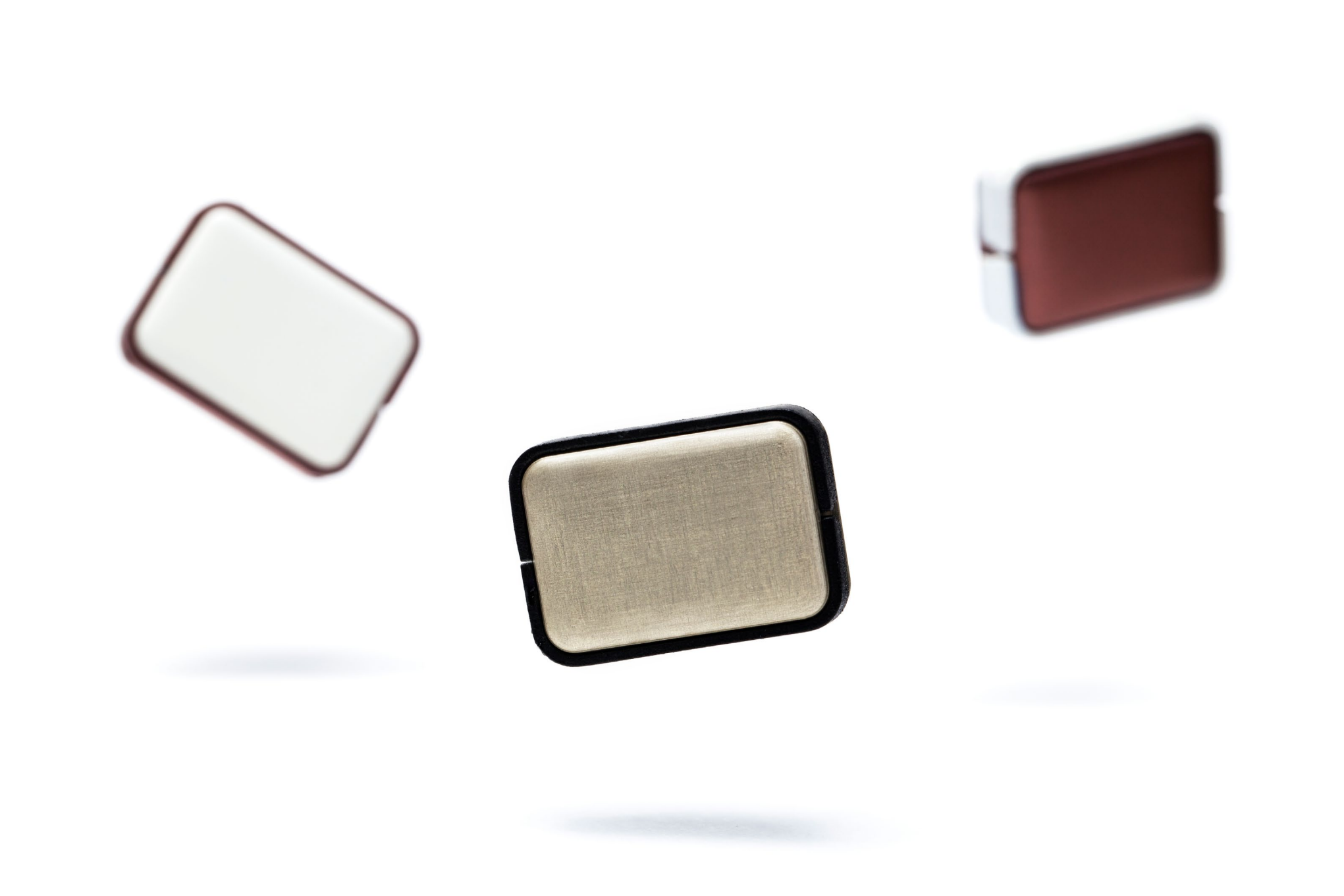


figure 17 Translated Hype Curves Gartner (Gartner, 2015)

03

vision

The following chapter will show how the information explained in the previous chapter is converged into a roadmap to indicated the feasibility of the vision. The roadmap is an official approach by Phaal to create future visions. The roadmap elaborates on the vision as described in chapter 01 with possible outcomes based on the findings from the previous chapter. The roadmap are the conclusions from the previous chapter translated into the foundation for the next chapter Nubus. In short the possible outcomes of the roadmap are discussed and then the value proposition for the next chapter is shown.



3.1 Roadmap

The roadmap is a summary of all the findings of social trends and developments and technical trends and developments. The roadmap is shown in figure 19. The roadmap is based on the factor analysis of the VIP Method and on the roadmap approach by R. Phaal. The possible outcomes in the roadmap are the conclusions based on the trends and developments combined. In the roadmap all the trends and developments that directly affected the vision are linked with colors in the roadmap, to provide a quick overview of the relation between different key findings and the outcome. In appendices 16 the complete roadmap is shown, including more trivial trends and developments that did influence the outcome. The Nubus ecosystem, described in detail in the next chapter, is a direct outcome of the roadmap by 2022.
In the roadmap the social trends are combined with the technical trends and developments. The social trends are taken into account because these are trends that can heavily influence the social behaviour of people. Social behaviour can make technical trends and developments obsolete. Therefore the combination of both types of trends and developments are shown in the roadmap.

At the bottom of the roadmap the possible outcomes are indicated. From 2020 the Nubus ecosystem can start developing, however, due to some unreliable factors like the recent release of the 5G network and the development of wi-fi hotspots, 2022 will be a more feasible goal for a good functioning system. Before 2022, the first steps can be made to test its potential. From this roadmap is then assumed that the system will be fully operational from around 2022.
The possible outcomes after 2022, are still based on trend findings, however, these are becoming increasingly unreliable as possible outcomes due to the timespan from now and the sequence of findings. Therefore the timeframe chosen for this project is 2022. This timeframe enables a complete new computing system for consumers, hereafter called the Nubs ecosystem.
In the legend of the roadmap in figure 18 is the relation to the previously discussed findings shown.

Explanation of the possible outcomes

Third party synchronisation
The possible outcomes also include the past, to indicate the direct relationship between the outcome and to steps technology has previously undergone. One of the first cloud based services consumers experienced in the past was third party data synchronisation. For example Dropbox enabled file synchronisation, photo synchronisation and files sharing.

Cloud synchronisation for data, limited amount.
Original hardware product and software providers for devices, released cloud synchronisation as a service. Apple originally launched the 5Gb cloud synchronisation in mid 2011 (Apple, 2011) and it still stands today in 2016-2017. The data is limited and does not offer a lot of opportunities for consumers, because it is very limited as a service currently.

Unlimited cloud data synchronisation as service for consumers
As indicated on the roadmap with the orange dots connected with an orange line, companies will move towards cloud more cloud offered services. They will start offering consumers a service that enables users to have all their data synchronised with the cloud. This will happen in 2018-2019, because the cloud solution development will kickstart for consumers in 2018. Furthermore a bigger part of Gen Z will be have an increased buying power and therefor more products will be adjusted to their flexible living schedules.

Computing & data as service for consumers (cloud as a service tryout)
From 2020, 5G network will become available in limited areas of the Netherlands and therefore the first trials of computing & data as service will be initiated. These trials will focus on computing & data storage for consumers allocated somewhere else as a service. Dual connectivity and hybrid cloud computing for consumers will be an essential part of enabling the trials.

Cloud computing for consumers as service
In the year 2022, the first steps of the vision as described in chapter 01, can be initiated. A service for consumers, that enables simple seamless user experiences.
As the roadmap shows, it is after the initial launch of some essential services, this is done to take the optimisation of the 5G network in combination with dual connectivity and hybrid cloud computing into account. Furthermore many developments and service often have delays or setbacks. The service, cloud computing for consumers, is very dependent on these factors and can affect the service significantly. Therefore it is essential that these factors are reliable and stable.
With the launch of the service the first implementation options will be taken into account, connecting basic devices to the service to fill the gap as described in chapter 2.4.
The following chapter 04 Nubus ecosystem, will elaborate on how this service functions.

Cloud computing for consumers as service enabled on "every pc" like device
With time the service will expand, enabling new possibilities for the users. As the service proves itself, more endpoint providers will develop new products for the service. With time this will enable every pc like device to be directly connected to the service, this is explained in chapter 4.4 (the endpoints). This enables the users to fully control everything, over every device. Enabling a full device integration in the service. This will happen over a longer timespan.

Cloud computing for consumers full life integration
The service will centralise everything a user digitally owns, with the development of sensors to track people, full life integration will become easier. This system will enable smart learning of activities, spendings etc. Enabling the service to expand to a platform for everything they own, being integral part of their lives, by first party or third party help.

Omnipresent cloud computing without devices
The far future vision enables full human geographic freedom. As full life integration means that the service is omnipresent and omni-tracking, the service will be experienceable without direct devices. Creating the ultimate human geographic freedom as described in chapter 2.3. This creates a world where humans can interact with the service without having to own a device.

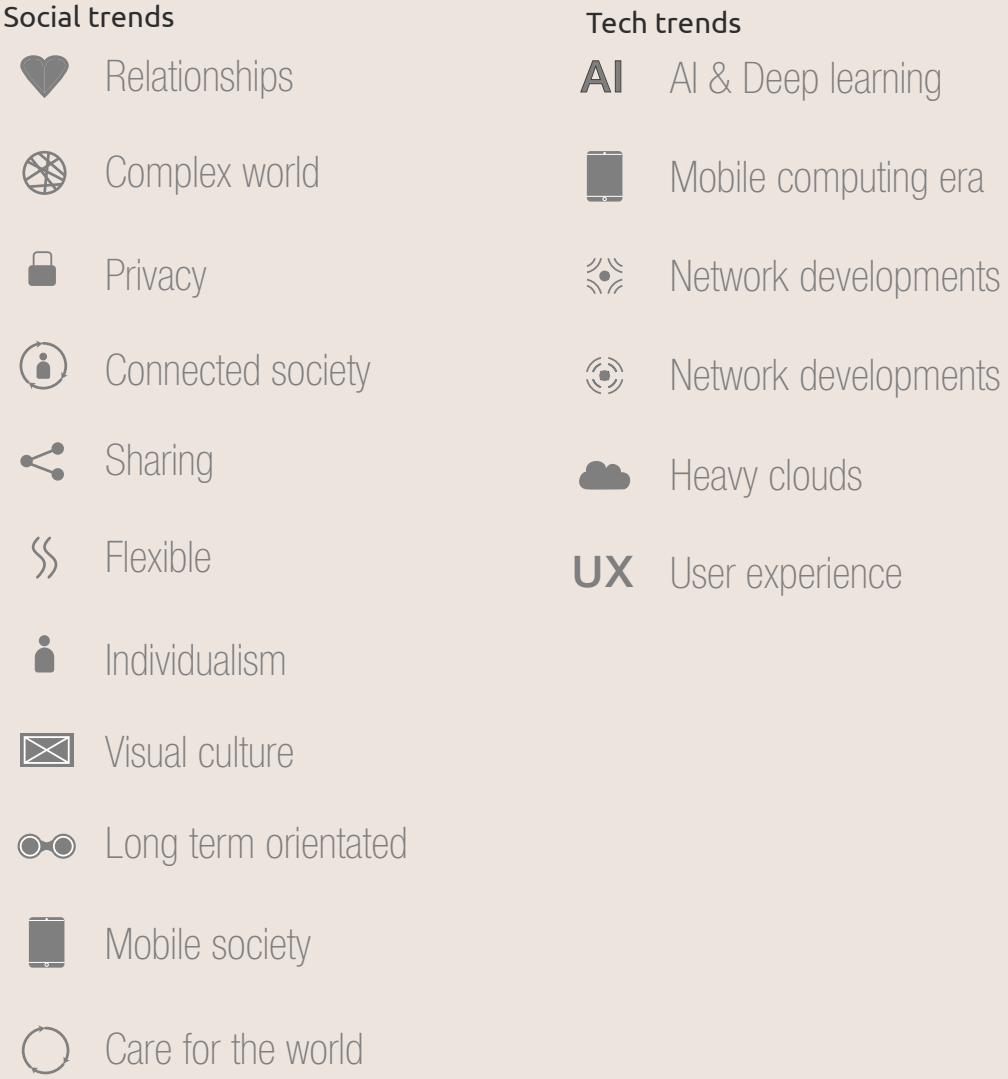


figure 18 Legend roadmap

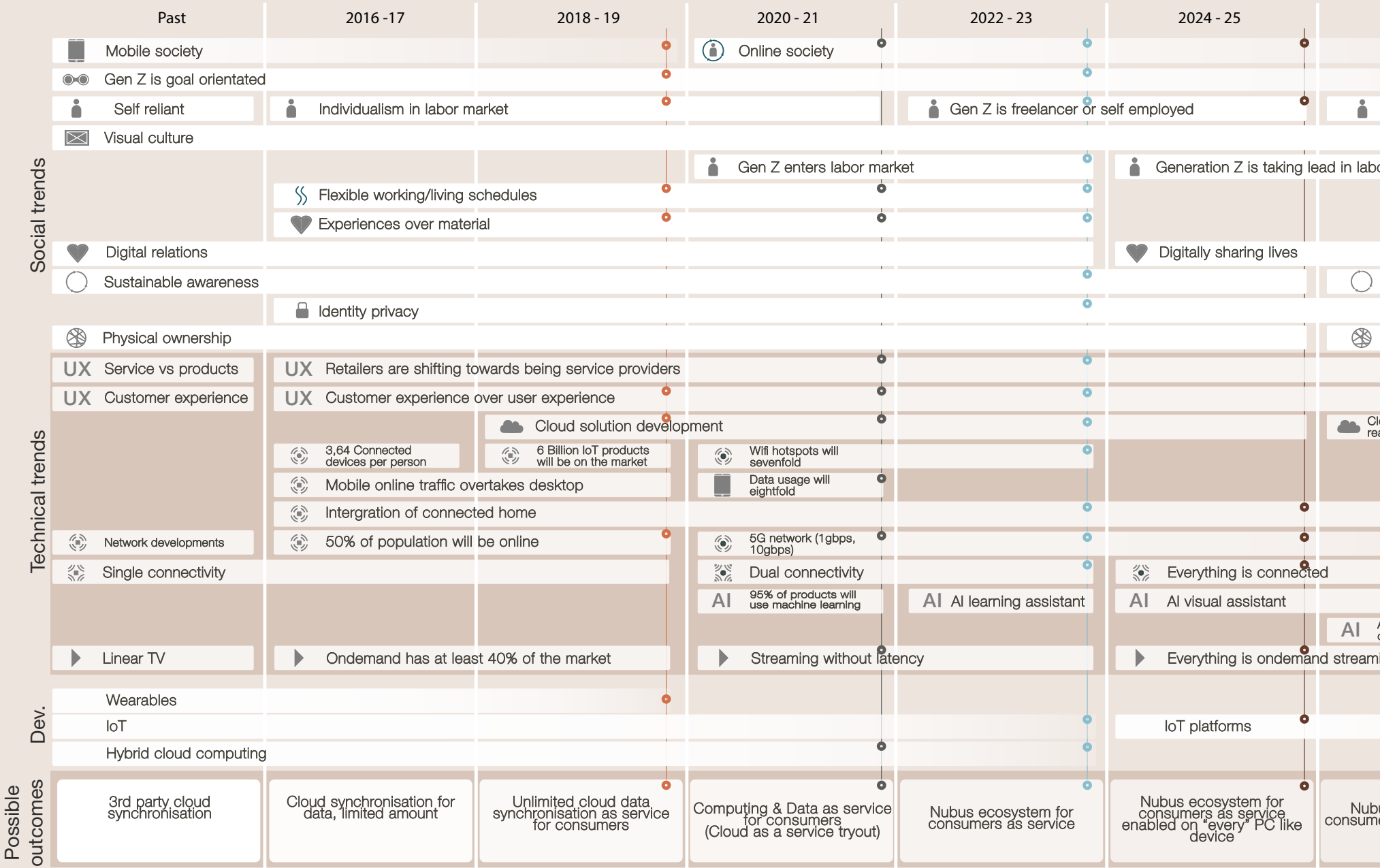
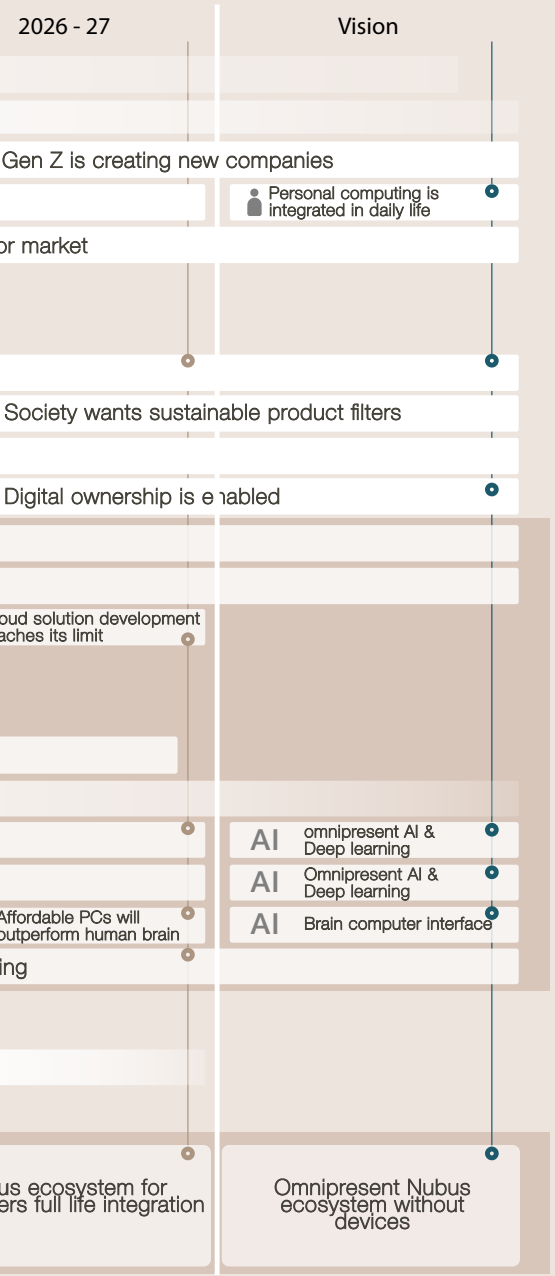


figure 19 Roadmap



3.2 Value proposition

From the findings presented to you the following value proposition was formulated for the Nubus ecosystem. The value proposition is created by using the methodology of the value proposition canvas, by A. Osterwalder. The process towards this value proposition is shown in the appendices 06.

Creating a personal digital experience by effortlessly having your up-to-date processing power and data ready at your fingertips at any time from anybodies endpoint at any location in a secure environment.

04

nubus ecosystem

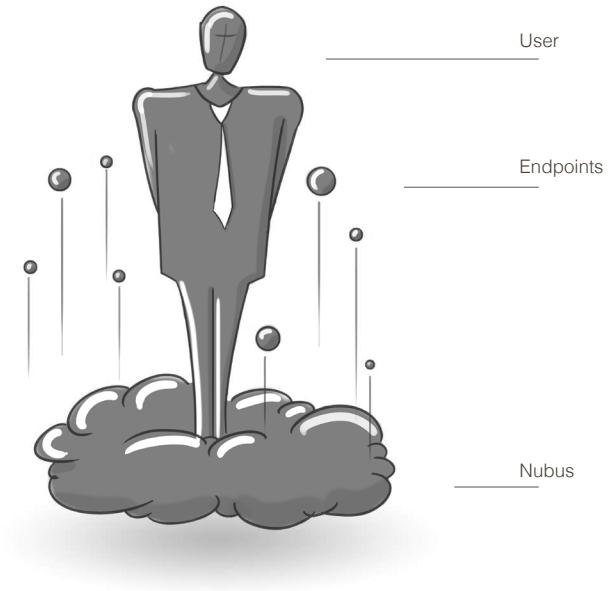
In the following chapter the Nubus Ecosystem will be explained, that enables users to have seamlessly access to up-to-date processing power and data from anybodies endpoint from anywhere at any time as a product service system. The Nubus ecosystem is a subscription based omnipresent service that enables consumers to have digitally everything ready at their fingertips from any endpoint at any time. The Nubus ecosystem consists out of four parts, the Nubus, the Endpoints, the Ki and the user. The user pays for all the parts together to the Nubus provider. The Nubus is the omnipresent personal computer service for the user. Endpoints are gateways through which the user can access their Nubus. Endpoints are simplified smart devices, that purely function as gateways to anybodies Nubus. Endpoints therefore enable users to access their Nubus over anybodies endpoint at any time. To enable this seamless experience the endpoints are therefore not owned by the user, but the users are custodian over their endpoints.

The Ki enables the user to have a seamless and secure experience while switching endpoints to enable the users to have everything ready at their fingertips from any device at any time. In chapter 06 will explained in more depth how the Ki makes the system more seamless and secure.

The user is central in this system, Nubus is linked to a user. Creating an omnipresent personal computer without personally owned hardware.

The Nubus ecosystem is a concept for the next generation of computing based on the outcome of the roadmap in 2022 as the Nubus ecosystem will prevent outdatedness/incompatibility and ends device dependency for users. It enables user to have everything ready at their fingertips, it is the next step in human geographic freedom. By 2022 the social, technical trends are aligned to make the Nubus ecosystem the outcome for the next generation of the PC.

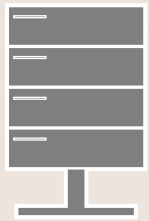
Nubus ecosystem



Nubus summary

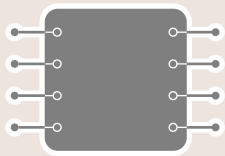
Nubus is a personal computer running as a virtual machine in a server at a provider of the Nubus. The Nubus is specifically linked to a person. Every user has his/her own Nubus. The Nubus contains the processing power and data storage of normal devices, this provides the user to access a personalised operating system via every endpoint.

Nubus is linked to a subscriber. A user pays for accessing Nubus, which includes an OS, processing power and data storage. With the subscription the user has his own personalised digital environment or Operating System that can be accessed via endpoints, see the explanation about endpoints on the next page.



This Nubus is run by a virtualised machine that can power multiple endpoints, the Nubus will eliminate device outdatedness/incompatibility and dependency from the users perspective by placing the responsibility of the newness of the system at the provider.

The endpoints are the physical gateways of the Nubus, representing the service. Endpoints determine the types of interactions the user can have with the Nubus.



The Nubus has universal signal interpretation. Nubus can interpret different inputs, but will also be capable of different output signals, expanding the possibilities with endpoints.

Endpoints summary

The endpoints can be very diverse. Current devices can become endpoints. Cameras, phones, laptops, headphones and many more devices can become endpoints, by simply linking them to a network, directly connecting users to their Nubus.

The endpoints are simplified versions of normal devices. The endpoints are still capable of fulfilling rudimentary hardware related functions. Location tracking, orientation tracking and connecting are functions endpoints keep fulfilling. The hardcore processing power and main data storage will be removed from the endpoints and will be relocated to the Nubus.

The endpoints are gateways to the Nubus. Every user can use any endpoint to get access to their Nubus. Users become custodians over endpoints and not owners. This makes the endpoints universal gateways to anybodies Nubus with the right authorisation.

The endpoints are situational aware. The endpoints can detect the amount of users around the endpoint. This is possible due to the Ki users carry (see chapter 06). By being situational aware, the endpoints are enabled to seamlessly and unobtrusive do the first step of authentication. Access via endpoints to their Nubus requires a two factor authentication.

Since the endpoints are merely universal gateways, the endpoints are person independent. The endpoints are provided to a specific user, who will be the custodian. The endpoint will be in their protection, but they will not be the owner. The endpoints are merely present to enable access to their Nubus.

4.1 **Analogy Nubus ecosystem**

The analogy is based on the Monsters Inc movie. Where doors function as gateways to a room of a child.

The Nubus is like your digital living room, a trusted and well known place which you can enter from anywhere, via any door.

Your living room that is very familiar to you, you know what it means to you, you know what it can do for you, specifically adjusted to your liking.
The Nubus can be accessed through doors, with the right “keys”. The doors are the endpoints, without a specified exit.

Every endpoint has its own characteristics. Some doors are visual and others are audible orientated. Through each door one can enter only their own Nubus, because of their unique keys.

4.2 System architecture

The Nubus ecosystem service can be subdivided into the Nubus, the Endpoints and the user. Each subdivision can be divided into several levels of abstraction. These levels of abstraction indicate the different aspects of the service and how they hierarchically relate to one another. This description is meant to clarify the different aspects within the same system and the hierarchical order. See figure 20 for the system architecture.
The Ki is an essential part of the architecture, therefore the next chapter is dedicated to explaining its functions and it meaning.

Nubus

The Nubus is the personal computer, which is the digital service the user pays for. The following levels of abstraction exists within the Nubus.

Level one of abstraction:

The subscription based Nubus service is on the first level a personal computer. The personal computer is run on a virtual machine on a server from the Nubus provider. For this service the user pays, enabling the user to access the Nubus from every endpoint. The service is therefore linked to a person and not to an endpoint. The service consists out of a personal Operating System and processing and data storage, which are the second and third level of abstraction.

Level two of abstraction:

The second level of abstraction of the service Nubus, is personalised OS. The personalised OS is the operating system that users interact with and know by heart. This personal operating system will be present, in some form, on any endpoint.

The third level of abstraction:

To enable a fluent interaction with the operating system, the third level of abstraction is the processing power and the data. As explained earlier this PC runs entirely on the Nubus, which is only represented via an endpoint for the user. The processing power and data that the user uses is allocated in the server to run on the virtual machine. It is not physically present in the endpoint(s).

Endpoints

The endpoints architecture can also be split in three levels of abstraction. These levels of abstraction are for ease of understanding directly linked to the levels of abstraction of the Nubus. as can be seen in figure 20.

Level one of abstraction:

The endpoints are physical gateways of different sizes to the Nubus. The endpoints are the physical carriers of the Nubus, but are dependent on the connection with the Nubus. Without endpoints one can not access the Nubus and without a direct connection to a personal Nubus via an endpoint, one can not interact with the Nubus.

Level two of abstraction:

One level deeper, the endpoints are a gateway to the personalised OS. Via the endpoints users can interact with the OS. The OS representation can variate in form per endpoint, because every endpoint has its own product characteristics.
As new endpoints develop, new possibilities arise, to which the OS can then adapt.

The third level of abstraction:

The third level of abstraction of the endpoints is accessing software and data. The endpoints are gateways to programs and data. With endpoints users can create/edit/erase data and interact with programs.

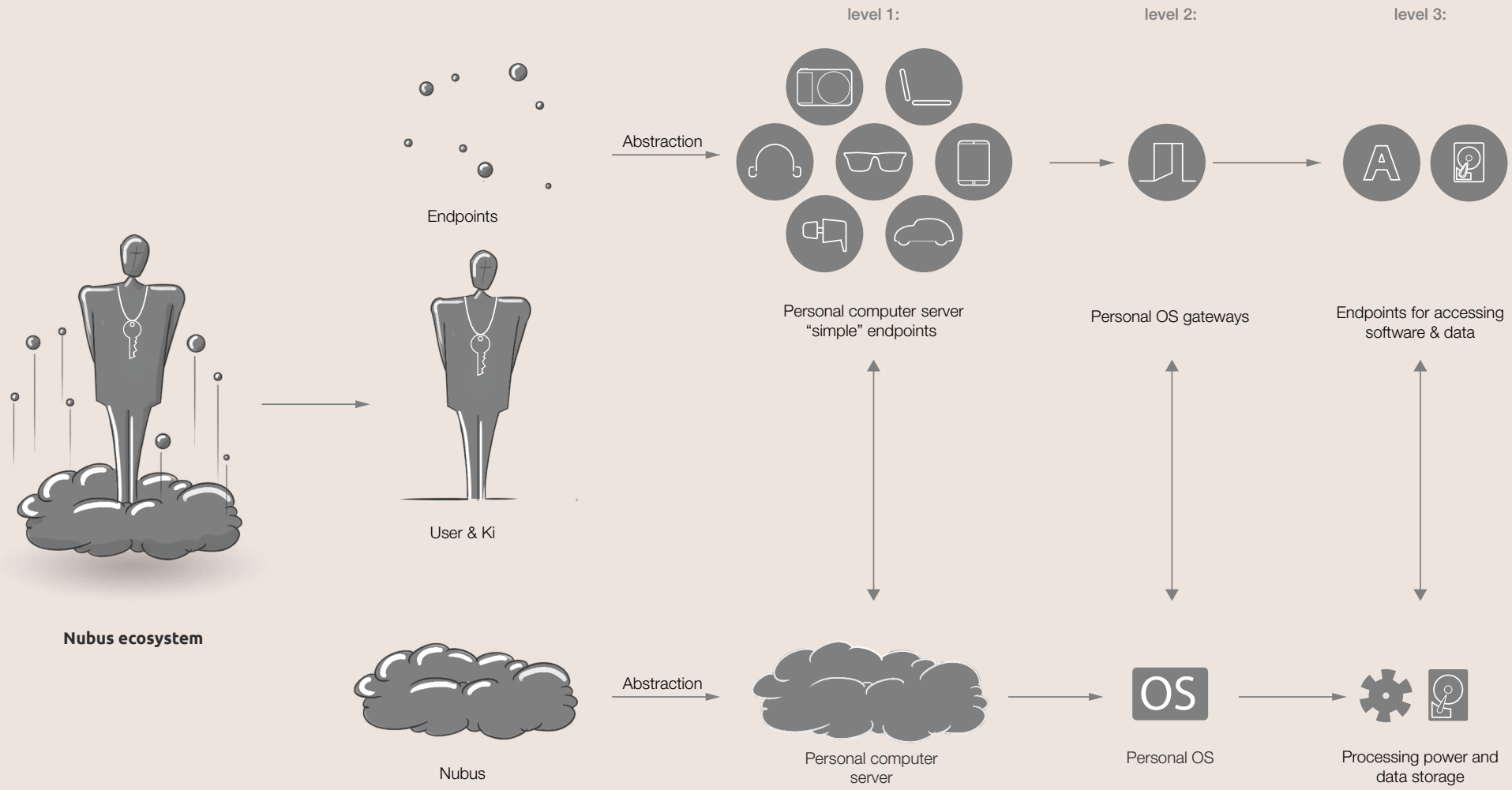


figure 20 Nubus ecosystem architecture

4.3 Nubus in detail

Nubus

The Nubus ecosystem exists out of four parts, the Nubus, the endpoints, the Ki and the user is integral part of it. First the Nubus will be explained. The Nubus is the heart of the ecosystem, without the Nubus the endpoints would not function.

The Nubus is a omnipresent digital personal computer provided to users as a service. It has the same digital characteristics as a normal PC without the physical characteristics. With the word PC in the previous sentence includes all the devices that are smart and independently used by consumers.

The actual Nubus is a virtual machine running on the servers physically present at the provider of the Nubus, which can be accessed via any endpoint with a connection. For the user the Nubus service can interpreted as an omnipresent personal computer, since the Nubus becomes accessible via the signals we are surrounded with.

The Nubus is a user specific environment in the digital realm and is attached to a persons identity and not an endpoint and is therefor accessible via any(bodies) endpoint.

The personalised Nubus OS

On the service Nubus, the personalised Nubus OS is situated. This is the personal environment users experience via any endpoint. Similar to current OS's sprung among different devices, which are almost always adjusted by users to their preference. The personal Nubus Operating System is a system that runs in the data center of the provider. This is the actual digital environment, as explained in the analogy, that the user will be familiar with. Every users has his own Nubus and therefore will also have his own digital environment. As every endpoint is different, as explained in chapter 4.4, the OS is responsive to the endpoints it is accessed through. This is explained in depth in the chapter 4.3, signal interpretations. The Nubus OS capabilities are beyond the current OS capabilities, processing different input signals and providing different types of output signals. The output to the user differs per endpoint and therefore the OS becomes responsive see figure 22. Every endpoint from every endpoint provider can be connected to the Nubus, and therefore the Nubus can respond to the endpoint. Users can personalise their Nubus experience, by choosing specific endpoints from specific brands (see chapter 4.6 User groups & costs)

Since the OS operates from the Nubus, the personal OS can be compared with a web based operating system. The Nubus OS is provided to the user via a connection, which can be 5G, Wi-Fi, data hopping and other similar possible connections as described in chapter 2.7.

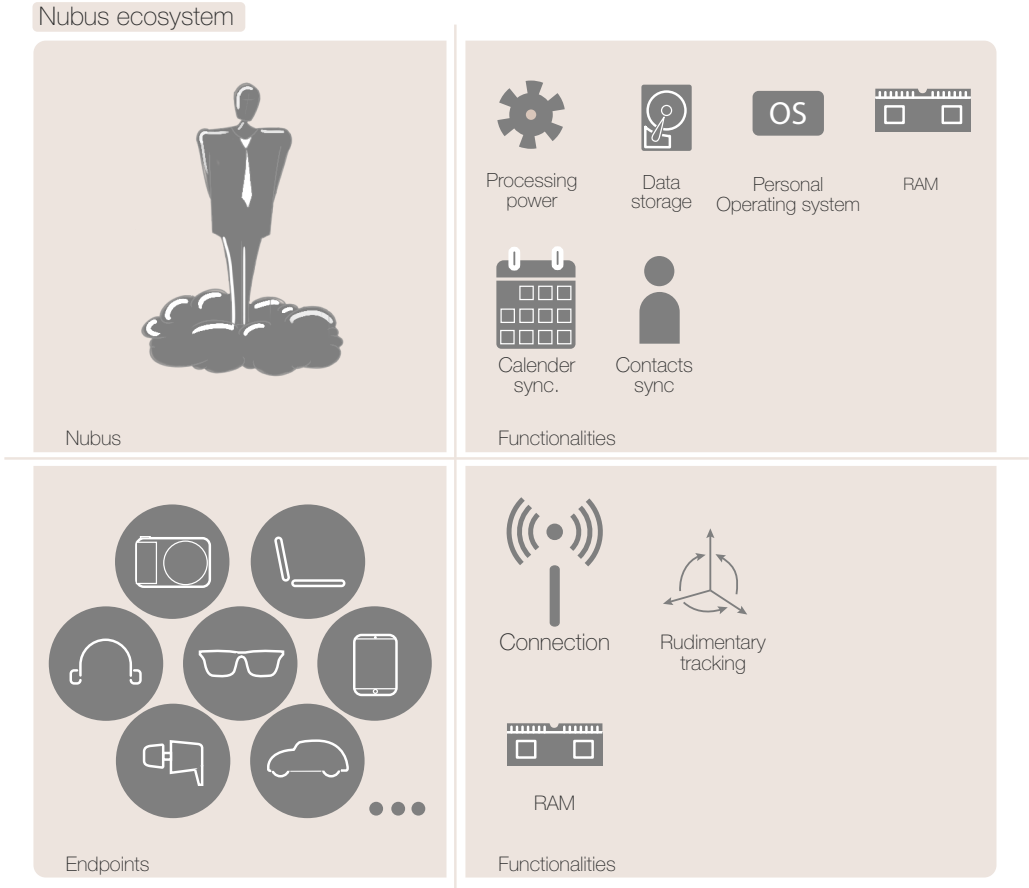


figure 21 characteristics of the Nubus and the endpoints

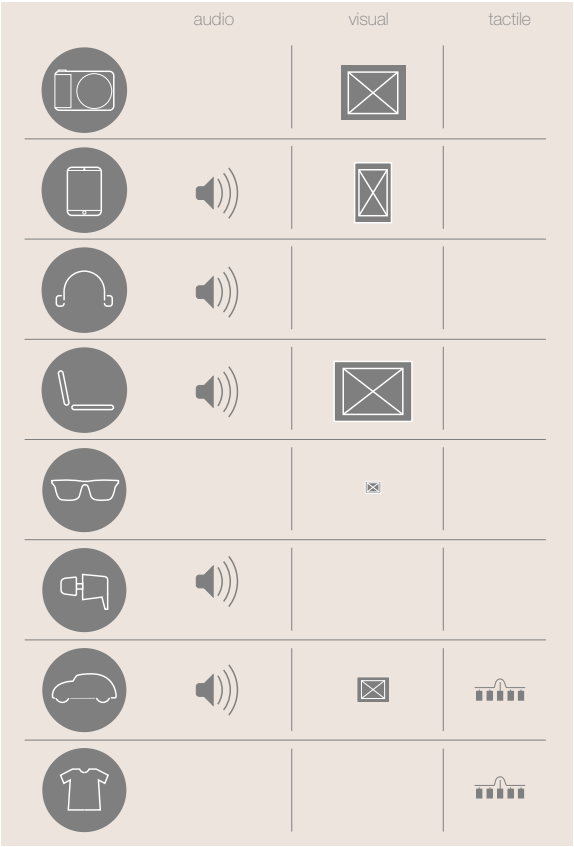


figure 22 OS responsiveness

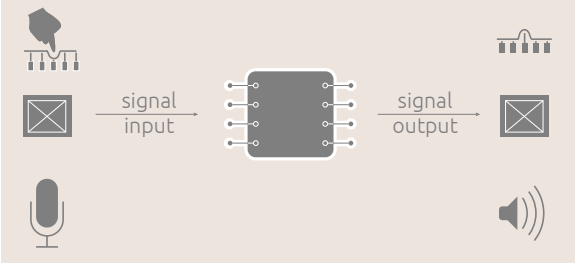


figure 23 Signal interpretation

Signal interpretation

The Nubus OS needs to be responsive if it is accessible over every endpoint. The request send by the endpoint to the Nubus (see chapter5.5), needs to contain the information about the type of endpoint is trying to get access. This will enable the Nubus to respond accordingly. In order for the user to control the OS over every endpoint, the input possibilities of the OS need to adapt to the Endpoint.

For example an audio endpoint is activated by a user, the Nubus provider knows the type of endpoint and who the user is that wants access via the endpoint through an peer-to-peer BEEP session. Once the Nubus knows its an audio endpoint, it sends over information to enable an interaction with the user. This will simultaneously enable the user to then interact with the OS via voice only.

The Nubus OS will be capable of interpreting different types of user generated signals to understand every command executed by the user. The Nubus can then provide the endpoint with the right input and output data to enable the right type of input via the endpoint. Some endpoints will be capable of sending and receiving multiple types of signals. Coherently sending and receiving different types of signals is called universal signal interpretation, as discussed with M. Dankoor and H. Sheombar, (personal communication experts, 2017). Input is a signal and output is a signal, in both input and output the OS will be able to receive and send all types of signals. As can be seen in figure 23, the channels of input and output will be currently be tactile, audible and visual. Over time the possibilities with endpoints will be expanding and thus the possibilities of types of signals.

The processing power and storage

To run an operating system and applications, the server needs to have the processing power and data storage for the user. Even though it is a virtual machine for the user, the server is required to have processing power and data storage. By placing the processing power and data storage in the hands of the provider the problems of outdatedness and incompatibility are shifted out of the hands of the user and towards the provider. Indefinitely eliminating outdatedness and incompatibility from the users perspective. Making the Nubus a centralised computing system for all their endpoints, allocated somewhere else, reachable via the endpoints as gateways. Eliminating the need of having processing power and storage in every endpoint as can be read in chapter 4.4.

As the endpoints function as gateways, the users experience the same processing power and data storage via every endpoint. See figure figure 21, to see the shift of hardware from the user to the Nubus service provider when compared to the current state of computing architecture (figure 2 on page 16).

Centralised computing

The centralisation of the processing power and data storage, is new in the consumer computing market. Nubus will become a centralised computing system for consumers. A centralisation of computing, means that the personal PC's of users are virtual machines. They do not exist physically, but are part of a server system. The servers are the centralised form of all data and processing power, but more efficiently than the current devices. By relocating the main necessities of a PC to the server centre of the provider, it minimises the required processing power and data storage distributed over all endpoints. The edge of the digital realm, the endpoints, will only contain its necessities for input and output. The endpoints will process user input and send it to the Nubus. Simultaneously will receive and translate output from the Nubus. Current examples of similar sort centralised computing systems in B2B markets are, Citrix, virtual machine, Dropbox etc.. These B2B solutions are currently possible, due to, among others, the hybrid cloud in the B2B market and a direct line with fast internet. This hybrid cloud is available in the business to business markets, and will most likely come available to the consumers market around 2019, enabling an essential part of Nubus from then on.

Applications

Next to running the Nubus OS, the Nubus is will also be the heart for applications. The Nubus OS will enable to run all the applications user access via the endpoints. A new type of responsive applications needs to be developed, to enable the user to access every application over every endpoint. Responsive applications enable users to have everything ready at your fingertips at any time from any(bodies) endpoint. The technical standard COLLADA (as described in the next paragraph) will enable the applications to be responsive by code. The software developers can then decide to not let users access some applications over some endpoints due to limitations in signal interpretation.

Since the Nubus is a centralised system, the safety of the system is extremely important. To enable a secure environment Nubus will do a safety check of the applications before they are available for download from the app store. To prevent security leaks or hidden cracks. This is similar to what Apple does with their app store, they check every app before it may be sold via the app store. The app market place will be created for the users, to download secure, Nubus suitable apps. Any type of app will become available over time, Apps like Photoshop, illustrator, Battlefield and programs like Word. How to ensure the availability of enough apps will need further research and detailing.

Technical standards

Here in short are some technical standards that are essential for the Nubus system to operate, ensure safety and data structure. More technical standards will become clear, when the system is continues into its developing phase.

- Blocks Extensible Exchange Protocol (BEEP): The BEEP protocol enables peer-to-peer messaging (Raj, 2008), whereby the Ki will function as the initiating peer and the Nubus provider as the listening peer. This protocol also enables signal encryption (see chapter 2.7 data privacy).
- Filesystem Hierarchy Standard (FHS) developed by Linux: enables a distributed file system like the Google file system (Redhat, n.d.), it enables a great distributed size of data over multiple storage points to easily retrieve and access it. This will enable the Nubus to efficiently distribute all files over multiple data storages to increase data safety.
- Collaborative design activity (COLLADA) developed by Sony computer entertainment: Defines the location in space for assets of tools, therefore being an important technical standard to enable responsiveness of the OS (Collada, n.d.).
- Transport layer security (TLS): Enables a secure private connection between the two communicating computer applications providing a secure data connection. This is essential for the endpoint and the Nubus. A temporary TLS key is exchanged to encrypt the information exchange (Nationaal cyber security centrum, 2014).
- Single UNIX Specification (SUS): Is a computing operations system standardisation, to enable programs to run easily over different systems (The open group, n.d.). It is a recommended technical standard for Nubus OS, however since a new type of OS will be build for Nubus, the SUS could not be important anymore and should consider other or new technical standards.

4.4 The endpoints

As shown with the Analogy the endpoints are basically doors with no specific exit, until a user authenticates himself, the exit leads to his Nubus. The endpoints are the second part of the Nubus ecosystem, through which the user interacts with the Nubus.
The definition of an endpoint is being capable of receiving input from the user and giving output from the Nubus, at the moment of interaction the digital signals are translated into something physically experienceable for the user. Therefore the name endpoint, as it is the endpoint of the digital Nubus.
The Endpoints are merely gateways to the Nubus, however, without the endpoints the user will not be capable of reaching the Nubus. The Endpoints are part of the service and are selected by the user to be added to the service see chapter 4.6. The user becomes custodian over the selected endpoints. This lets users have access to everything from anybodies device at any time. Enabling them to have all the digital experiences they want, from anywhere without being dependent on a specific device.
The complete incompatibility and outdatedness problem will then be shifted towards the provider.
The possibilities with endpoints are endless, in figure 24 some examples of endpoints are given. Every endpoint has specific features and unique user interaction possibilities. The endpoints are simplified versions of current products, provide a secure connection and are seen as gateways to your personal living room as described in the analogy of the Nubus.

Simple endpoints

Endpoints heavily rely on the capabilities of the Nubus to function. The endpoints are basically simplified devices that rely on a connection and are capable of preforming rudimentary functions. In a sense the endpoints are simplified versions of smart devices we currently posses, however, current devices are capable of functioning independently while the endpoints depend on the Nubus. By eliminating the independent devices, the problem of device dependency by users is eliminated as well. See figure 21 for the product features of general endpoints vs Nubus.
Each endpoint is a gateway (as explained in the system architecture) to the users Nubus, providing the user with unique interaction possibilities due to the product features.
To enable a constant connection from any endpoint to anybodies Nubus, the endpoints heavily rely on connection capabilities. Therefore all the endpoints are capable to directly connect to the 5G or a Wi-fi network.
To enable a two factor authentication connection with a Nubus the endpoints are situational aware. Situational awareness means that the endpoints are capable of sensing the Ki's of the users that are within a certain proximity radius. This requires simple bluetooth, as Ki sends encrypted messages to endpoints via bluetooth, see chapter 5.8. In the chapter 5.5 situational awareness is explained in combination with the Ki.

figure 24 possible endpoints

Authentication on endpoints

As described in the Analogy of the endpoints, the endpoints are basically doors without a specific exit, and depending on who uses the door, the user gets access to their living room. To get access to the Nubus the user needs to do a two step authentication, from which one happens on the endpoint, see figure 25.
The first step of authentication happens when the users Ki is recognised by the endpoint, this happens by situational awareness of the endpoint. See chapter 05 Ki for a more in depth explanation of how the first step of authentication specifically works.

Gateways to Nubus OS

As the endpoints are basically doors without a specific exit, the endpoints only provide a gateway to the users Nubus and therefore their personalised OS after the right authentication. Endpoints become universal gateways. The gateway leads the user to the personal living room like described in the analogy. Enabling users to have everything ready at their fingertips from any(bodies) endpoint at any time. After logging into their Nubus, the user will work with their personalised OS. The endpoints are the doors through which the user can interact with his personal OS, connecting the digital service with the physical world.
The gateways to the Nubus OS contain rudimentary functions to enable interactions via the endpoint with the OS. This means that the gateway will posses a GPS, gyroscope, an accelerometer etc. to provide the OS with input of the context of the user.
As described in chapter 4.3 (The personal OS), the OS is responsive to the endpoint it is accessed via. Users can therefore enjoy different capabilities via every endpoint.

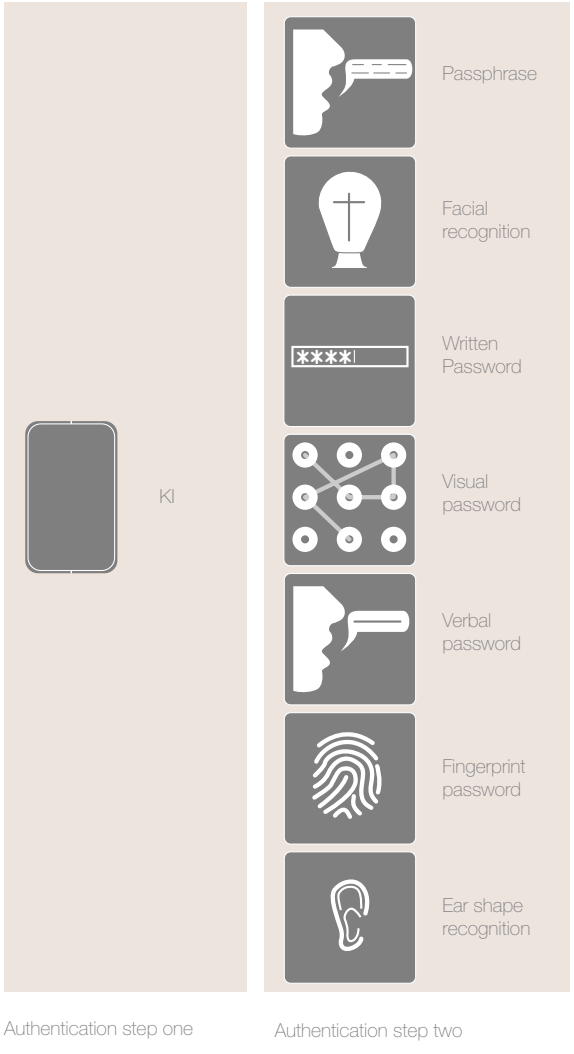


figure 25 two step authentication

Gateways to processing power and data storage

The Nubus service provides the processing power and data storage to allow the OS to run on their premises. Therefore endpoints provide universally accessible processing power and data storage by being a gateway for user. This enables users to have access to everything at any time from any where. Requiring one type of processing power and one centralised data storage per user, for every endpoint. Endpoints enable users to create, erase and order data in their Nubus. Any software (first party and third party) can run on their Nubus, that will then be accessible via any endpoint. The centralisation of processing and data enables users to create, erase and order data over any endpoint. With the variety of possible endpoints users are able to create different kinds of data, by using different endpoints with the same processing experience.Enabling users to play the same game on their tablet endpoint as on their laptop endpoint.

Due to shifting most of the hardware towards the Nubus provider, while simultaneously simplifying the hardware from the endpoints, the costs will drop significantly per endpoint. Decreasing the amount of costs per endpoint, enabling a cheap subscription costs plan per endpoint. See chapter 4.6 for the subscription plans

4.5 The future of devices towards endpoints

The Nubus service can perhaps feel as a major change from the current devices, however, the shift towards the Nubus ecosystem will not require drastical changes over night. The shift will be a more gradual shift towards the ecosystem. In this subchapter the gradual shift will be explained, to provide insights for the gradual appraoch. Current devices are over engineered for the Nubus ecosystem, but this does not mean that they can not be optimised via software to enable a gradual shift. This will enable companies to gradually prepare for the shift, and user to simply grow towards the system.

Development towards the endpoints

To enable device to become part of the Nubus ecosystem, and change to become an endpoint, no drastic actions have to be taken. Current devices are very independent and can almost always operate stand alone. Very little has to be done to enable current devices to work within the Nubus ecosystem. The capabilities of the endpoints are described in chapter 4.4.

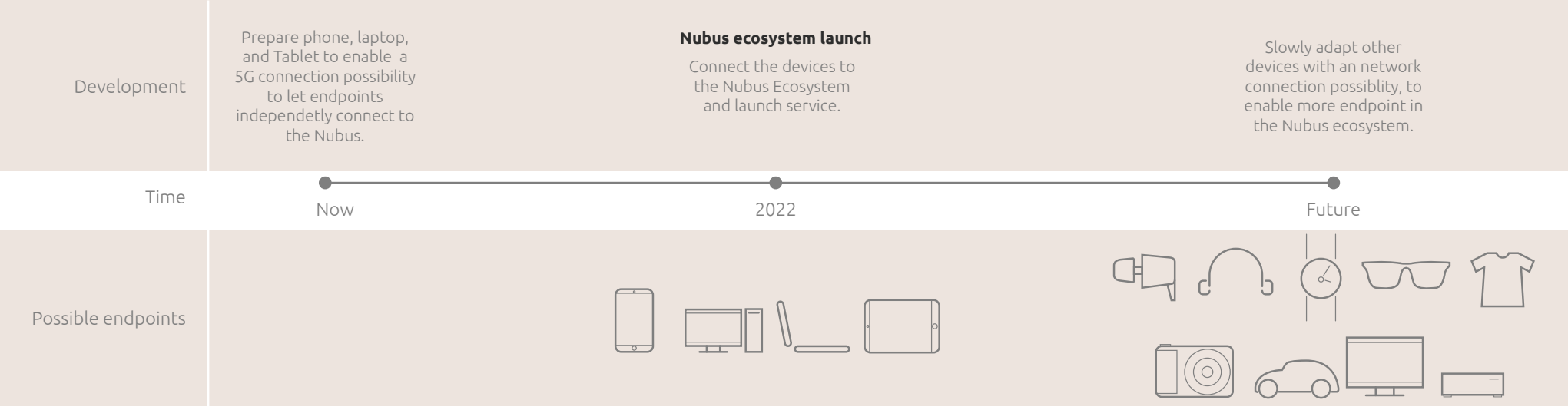
Current devices can at first be connected as they are to the Nubus ecosystem, if this is done some hardware options become trivial since almost everything will happen within Nubus. With the first deployment of Nubus, the network will not be super reliable in any given context and therefore the current state of devices will come in handy. If the network fails, the device will be able to operate independently. When the network is available again, the data and processing power of the Nubus will kick back in and everything will be directly synced.

Over time the network will become very reliable, that the actual hardware within the endpoints will stay unused, just before that tipping point the hardware can be stripped from endpoints. Enabling manufactures of endpoints to safe costs. The devices can firstly be stripped of the huge hard drive, later this will shift towards a simpler RAM memory and later on will simplify the processor and battery. See figure 26 for a schematic representation of the development towards and after deployment.

Endpoints possibilities

As already described in figure 24, the variety of endpoints are endless. However to prevent a broad focus including every possible endpoint from the launch, a recommendation is made for the approach for endpoints towards the Nubus ecosystem. The phone is the most commonly used device currently, second and third place are laptop/desktop devices and tablets. The benefits of the Nubus ecosystem become clearer when multiple devices are used within the ecosystem, therefore the system should at least support at the moment of deployment the top three used devices. Since the top three devices is currently shifting towards even more mobile, the top three devices can differ in 5 years to now. Therefore the assumption is made that the top three will not differ a lot to the current situation, however, the tablet is more commonly used device than the desktop.

figure 26 Development towards endpoints &deployment of possible endpoints



Endpoints hardware

Eventually endpoints can be simplified to a hardshell containing absolute necessary hardware to enable all functions of the Nubus ecosystem. The essential difference is the “power” of the required hardware. Some hardware can be neglected, since it has been repositioned to the servers of the provider. In figure figure 27 on page 58 a schematic representation of an endpoint can be seen, to indicate the required hardware per endpoint. The black objects with a grey box represent the change of component to the currently used components.

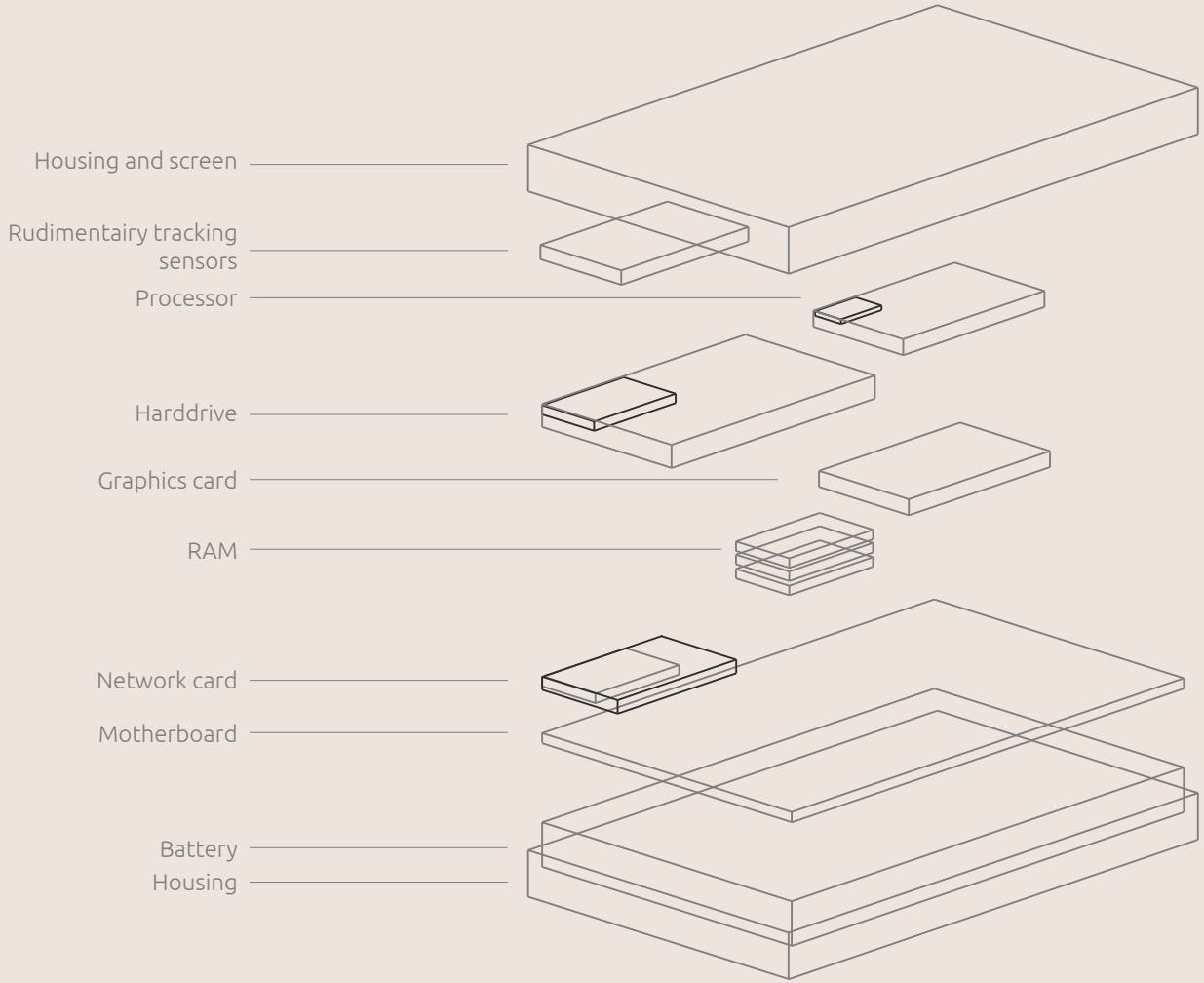


figure 27 Schematic representation of an endpoint

4.6 Business model & position

The success of the Nubus ecosystem for users highly depends on the quality of the service and the costs as can be concluded from the user evaluation, see chapter 6.1. Moreover the success factor of the problems that Nubus solves highly depend on the access model to be successful. Therefore in this sub chapter will be elaborated upon the business model for the service Nubus, the costs per subscription, and personalisation of the subscription. This will shed some light onto the service and how it will function from both the users and the business perspective.

Nubus ecosystem service

The Nubus service, is subscription based and will provide the user with a Nubus, Ki, endpoints and a data plan. After considering different types of business models, the access model as described in the book products that lasts (Bakker & den hollander, 2014) is the business model that fits the service the most. This enables a proposition that will benefit the user most and makes the current issues, as described in the analysis phase, shift towards the provider. The device dependency and outdatedness/incompatibility will be a problem of the past for users. As Balkenende described during the feedback session, this will enable every provider to maintain their current roll within the business model, creating an interesting power balance via an access business plan (Feedback meeting Balkenende, 2017).
The payment for the usage of the Nubus ecosystem includes processing power, data storage, data plan, endpoint(s) and a Ki (this will be explained in the next paragraph). In figure 28 is shown what the user will get for a payment. The payment per month is based on the prognosed amount of processing power required per type of user and the according data plan. The current assumed relationship between intensity and required data plan, are explained in the following paragraph (User groups).

User centred costs model

As stated before in figure 28, is stated what the user will get for a payment. The payment system is user centred and based on the access model, therefore the user will only pay “x” (depending on the subscription) amount to the Nubus provider, whom in turn pays the data plan provider and the endpoint provider. The provider of the Nubus, the heart of the system, will play an intermediary role for the subscription. The payment will be split by the Nubus provider, this can still be part of the access model according to Balkenende (feedback meeting Balkenende, 2017). Depending on the type of user the payments vary per user for the data plan provider and endpoint provider(s). Per endpoint a predetermined fee will be paid, depending on the amount of endpoints and the precise endpoints a user has, the amount for several endpoints varies per user (see chapter 4.8). The data plan is based on speed and not data package. The service is very dependent on the connection, and therefore the user pays for speed. This makes sure the service fits the users computing needs and is usable over a whole month without unexpected exceeding costs. This is similar to what current household have, households pay for unlimited data in combination with a certain data speed.

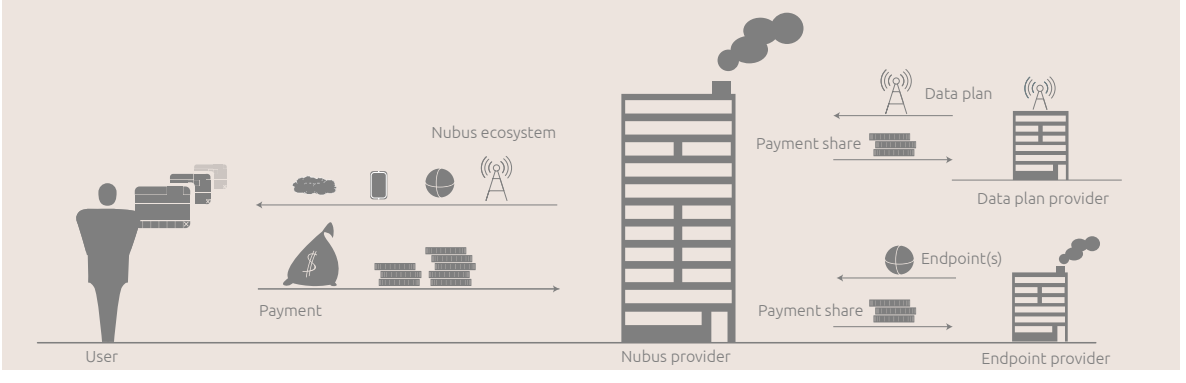


figure 28 Payment flow diagram Nubus ecosystem

Access model

As indicated with figure figure 28 (flow diagram Nubus), the service model for the Nubus ecosystem results in no initial costs (except for a deposit) and a monthly fee over a longer period of time. This makes the service less of a hurdle and a good intrinsic motivation for the consumers to switch from the current linear system towards the Nubus ecosystem.
With no investment costs, a monthly subscription, the service stays up to date. The hardware related aspects of the service will stay in the hands of the provider. Therefore the user becomes custodian over the endpoints that are selected with the service.
In figure figure 29 (service costs) the costs are displayed over time, in comparison with costs of the current linear model. For the comparison a persona was created, A power user with a laptop and a phone with internet both at home and on their phone is used for comparison.

In the same figure the costs for the current linear system is translated into a periodical payment, and as can be perceived the Nubus is significantly cheaper, see appendices 08 for the translation of the linear payment system and the costs calculation of the Nubus or the upcoming description figure 30 for the elaboration on the subscription costs. In both cases, either linear or circular, the provider wants to renew services to be ahead of competition, but with the Nubus ecosystem it benefits the user.

Normally the translation of a linear business model into an access model significantly increases the subscription fee, results in higher overall costs than the original product would be if purchased. This is due to risk on the side of the provider. The risks are significantly lower with this system (feedback meeting Balkenende, 2017), because the providers can remotely control the access to Nubus and the usability of an endpoint. Enabling a lower risk policy and therefore lower subscription fee.

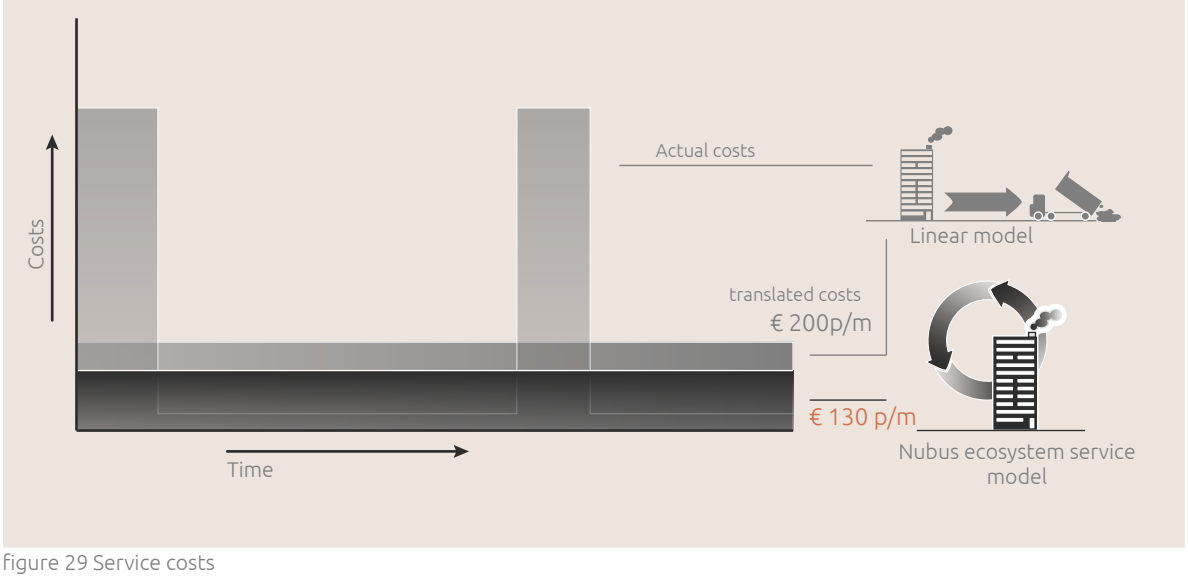


figure 29 Service costs

User groups & costs

As described in chapter 2.5 (Generation Z, user groups) three different groups of users are present in the current computing market. The groups are categorised on the amount of required computing power.

Every user will have specific requirements for the service and therefore the following generic tiers were created to enable categorisation on type of users. Every tier has tailor-made specifications, to optimise the user experience. It also highlights the differences in users, and what they can require from the system. The costs per tier are visualised in figure 30, to create an understanding of the approach and the variables. The costs for a complete system are compared with different currently available options, to indicate the feasibility of the outcomes. The detailed costs calculation can be seen in appendices 08 (costs calculation), all the specific details for the costs calculation are specified there.
To determine the costs of the service, two extremes are taken, the maximum possible costs and the minimum possible costs. This creates a range for the costs per subscription model and can be results in a spectrum for the true costs. In figure figure 30 the costs that are shown are on the high end of the spectrum and can not be interpreted as the true eventual costs, but are an indication of an comprehensive calculation as can be seen in appendices 08 (costs calculation).
An assumption is made for the lifespan of the endpoints, which are essential for calculating the costs for the subscription models. With an access model, products should last longer, because of the refurbishment and shorter loop for repair. Even though this is the case, no direct conclusion can be made over how much longer the product will last. Therefore the assumption is made that endpoints will last as long as the current products, a phone endpoint will last 2 years and a laptop endpoint will last 4 years. This is shorter than the findings from the questionnaire, this is due to taking in some room for error.

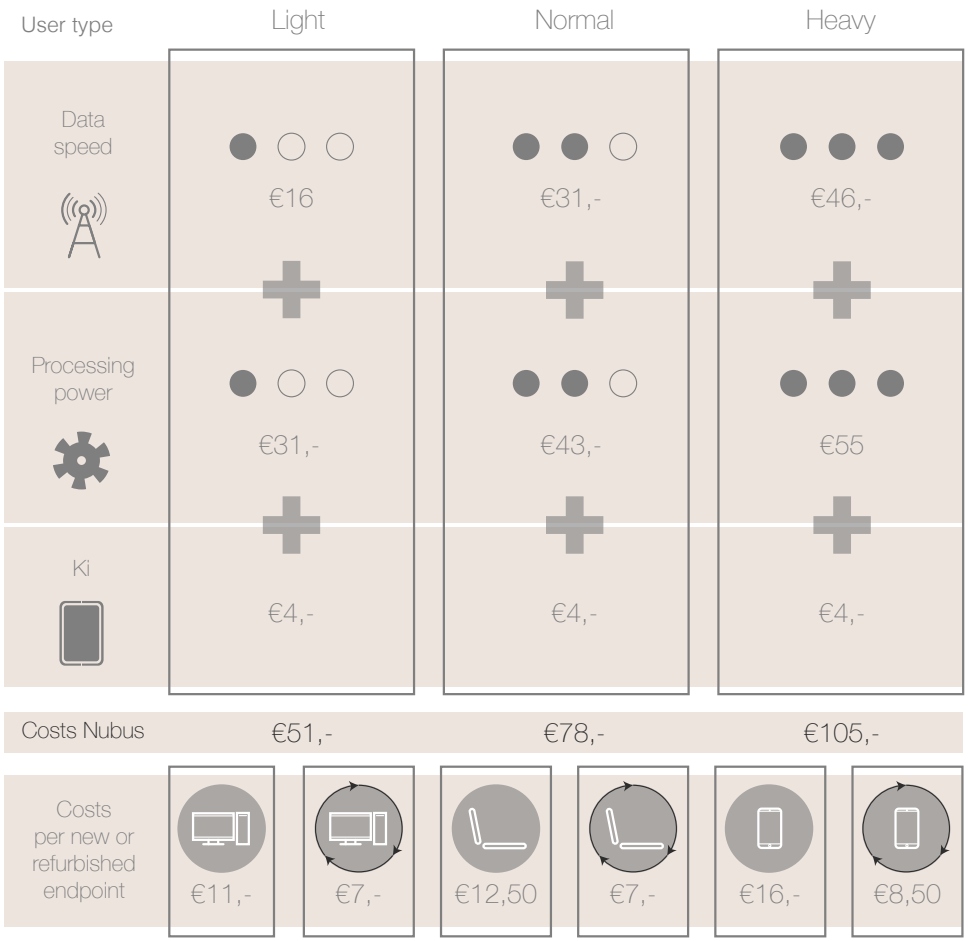


figure 30 The costs overview per user group and per endpoint

Brand relationship

As described underneath “User centred costs model”, the intermediary roll of the Nubus provider is essential for users to enable a relationship with brands that produce Endpoints. The user will create a two loyal relationships, one with the Nubus provider and one with the endpoint provider(s). This also encourages providers of endpoints to compete with each other, over the best hardware for the system. E.g. currently Dell computers that run Windows compete versus Lenovo computers with the same Windows OS. By letting brands exists in their own branch a healthy competition for the Nubus market and for the endpoint market will exist.
Users will always have a preference for certain endpoint brands, and this will continue to exist to create a healthy competitive market in benefit of the user. Furthermore by letting endpoint providers commercialise for themselves, a more equal power balance between the endpoint provider and the Nubus provider will exist, which is very essential for the access model according to Balkenende (Feedback meeting Balkenende, 2017).

Service personalisation

The Nubus service is very flexible and can easily be personalised to users preferences. Users can pick from different branded endpoints and also choose from older model endpoints (see chapter 4.7 the circle of service). The hereafter is an example to indicated the possibilities with the Nubus ecosystem, please keep in mind that every device in the example is an endpoint within the Nubus service.

As example:
A gamer always wants the best gaming experience and therefore always wants the newest TV. He chooses to get the best 1080P TV for gaming available at that moment. When a 4K TV is released, it is in the best interest of the endpoint provider to offer this user a 4K TV, because of his gaming behaviour and the previous indication to always wanting the best TV. The 4K TV will provide him with the best user experience. The user can then decide to trade in his old one for a new one, and most likely does so. At the same time the gamer does not care about phones at all, and therefore chooses the oldest refurbished Samsung phone at the start of his subscription. Making the phone option very cheap for him. With the release of a new phone by samsung, he will most likely be offered a newer refurbished phone in the same price and specs category if the timeframe indicates it most beneficial for all parties (see chapter 4.7) for the definition of a timeframe) Enabling the user to always have a personalised service experience.

In the case of the gamer, he will subscribe as a power user due to his gaming needs, but will save costs on the phone because he does not mind a older refurbished model. The 1080P TV he trades for a new one will become available through refurbishment to the next user, who always prefers the second to newest TV. See the chapter 4.7 for the explanation of the refurbishment. Concluding, the general setup of a subscription is for every user the same, three option, the biggest variables for costs are the type of endpoints a user includes and can therefor have an personalised subscription experience.

Business model canvas

The access model is highly dependent on the complete business model to enable a feasible and profitable business approach. Three different business model canvasses were made, based on the Business Model Generation book by A. Osterwalder and Y. Pigneur, to see which business approach has the most potential. One canvas was made for a Nubus startup, whereby other companies will become endpoint providers. The second canvas was created for Google as Nubus provider, the third canvas was created for Apple. The Apple canvas is an outlier in the scope of the canvasses, because Apple prefers to do everything themselves. Making the canvas focussed on creating the Nubus and endpoints. Each canvas can be seen in appendices 12 (business model canvas). One insight from making the canvasses is that the business approach with Apple has the most potential, because Apple is really well known among users for its privacy standards and security measures. This is very important for users as can be read in chapter 6.1 (user evaluation). This will also enable Apple to create an online ecosystem with hardware, which they currently lack as can be read in chapter 2.1. Resulting in higher investment costs for Apple, while for Google lower. The canvasses mainly provided insights in the needed aspects for a feasible business approach, but a definite conclusion which business approach is most profitable and feasible can not be drawn yet without further research.

Competitive position

The Service of Nubus relies on having a competitive advantage over competition. Next to another way of offering service it also targets an interesting gap in the current market. The competitive advantage of Nubus can be shown by two different methods. The first comparison is made with the competitive value matrix. As was shown in chapter 2.1, with the current competition. The second comparison is made with the four levels of competition, to indicate the other possibilities users will have versus the Nubus.

The matrix position
The matrix competitive comparison of the current computing situation functions here as reference point. In figure 31 is the same competitive matrix shown with Nubus added as competition and infiltrates in the gap of online ecosystem. In this instance the Nubus provider is both a software and hardware developer. This gap can be filled by 2020 with Nubus as a service for consumers.

four levels of competition
The four levels of competition based on Lehmann et al.,

2005 provides insight on the current competing products on 4 different levels. See figure 32. The fourth level of competition was adapted to make it fit this research, instead of indicating different products for the same prices, other relevant products from similar categories were selected as fourth category.
In both instances the Nubus and the Ki are unique in its kind and don't have direct competitors. The Nubus is solely focussed on the market gap "the online ecosystem for consumer computing devices" and therefore the Ki is unique in its kind. The competitive position of the Ki is indicated in appendices 09, because the Ki currently does not really have direct competitors and is dependent on the market create by the Nubus and is therefore left out of the main report.

The Nubus competition

The second level of competition for Nubus are other operating systems and the related hardware. The combination of both makes an ecosystem possible, but that does not offer as many possibilities for the consumer as the Nubus does. Android makes instant apps possible, enabling more devices to effortlessly open and load new/unused apps. Chrome OS, enables a degree of exchangeable data and offers some online apps, accessible from anywhere. OS X makes communication between different devices of the same owner very simple.
The third level of completion enables users to exchange some info, like dropbox and Spotify. Both exchange data, enabling users to simply continue somewhere else, because the data is in more places than only on the device itself. Third party competition show examples of other ecosystems that seamless exchange data between different users or consoles, however still require a application on the device.
All levels of competition indicate that Nubus is possible when combined correctly.

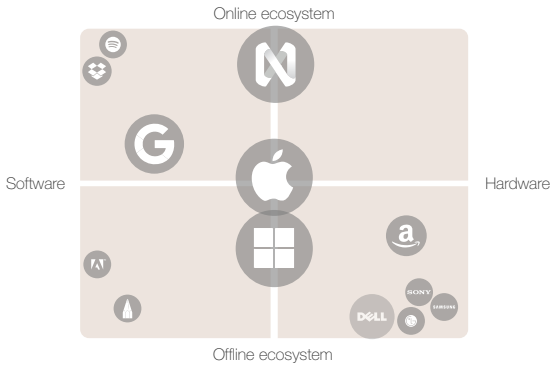


figure 31 Competitor value matrix comparison

1st level of competition Product form	On- and offline ecosystems Nubus	Secure seamless switch Ki
2nd level of competition Product category	Ecosystems Android Remix Windows 10 windows 10 S OS X Google Chrome OS	Digtal data secure switch enablers Drive AWS One Drive Chrome OS Web app Dropbox Continuity Continium
3rd level of competition Generic	3rd Party solutions Dropbox Drive Microsoft One drive Spotify Amazon AWS	Physical data secure switch enablers Usb stick Remix OS NAS Server HDMI Portable harddrive Physical identity card Identifier
4th level of competition Budget competition	Other ecosystems Sony playstation Microsoft Xbox Nintendo Switch	Other PC options Augmented reality Business PC Virtual assisitant Phone Virtual reality Smart watch

figure 32 four levels of competition

4.7 The circle of service

The business model as described in the previous subchapter, explains the access model. The access model is part of the products that last book by C. Bakker and M. den Hollander, indicating a more sustainable service. The following subchapter in short elaborates on how the Nubus ecosystem will create a more circular business model, enabling a more sustainable product outcome. Since 89% of phones and many more other devices end up on landfill, the sustainable side will also be a benefit (green alliance, 2015). The circular approach of the complete system will first be explained, then the essential parts of making the access model more sustainable and profitable are in detail discussed.

Circular

The Nubus ecosystem is a product service system, which is completely different from the current smart device product category. Current products are often sold as one time purchase products. Once the product is purchased, it is out of the hands of the company. The Nubus ecosystem deviates from the current linear product sales.

Since Nubus customers pay for its service, there is a constant quality check by the customer over the service and not the endpoint. The endpoint is only an enabler to experience the service. This is in contrast to the current products services, where the customer only comes into contact with the product itself. Therefore, the complete lifecycle of the product service needs to be taken into account by the Nubus provider and the endpoint provider(s). The service can be perceived as a circular service model, because the provider wants to enable the best quality service in each product stage and simultaneously reduce costs to a maximise their profit. Furthermore, an access business model is part of circular business strategies.

Nubus

The quality of the service experience is in the hands of the Nubus provider. The provider needs to make sure the digital product remains up to date to create the best quality service. This is in best interest of both the user and the provider. From the user's perspective, this prevents incompatibility and outdatedness if the service is kept up to date. For the Nubus provider, the profit is the highest when efficiency is kept high by keeping the hardware of the servers up to date. Furthermore, the customer experience is the main priority for a service provider, to keep ahead of competition. The service will be a long term commitment for users. At all times, the service needs to be premium, requiring the provider to keep the service and its hardware-related solutions up to date. A circular business strategy like the access business model is very important for high efficiency and return rate.

Efficiency and return rate

Due to competition the Nubus provider wants to keep their service up-to-date and simultaneously wants to keep the return rate high. The rate of return depends on the efficiency of the servers, electricity consumption, amount of possible users per server etc. From the providers perspective the facilitation costs need to be kept low to enable a high return rate, therefore the provider will be pushing for the best quality products to enable high efficiency for their servers. This will make Nubus providers take the end of lifecycle of their system into account as well. If they can reuse or refurbish parts to keep the costs low, it will be in their benefit.

Centralised processing power

The current user owns multiple computers, all equally powerful, however interchanging the processing power is not possible. With Nubus, one virtual machine will power every endpoint of the user, enabling a significant decrease in processing power required per person. Simultaneously enabling a high efficiency of processing power per user, making the system more sustainable. Since the processing power is part of the Nubus, it is easier to update, because it is situated at the core of the provider and out of the hands of the user.

Endpoints

The quality of the Nubus service will be experienced over endpoints, as endpoints are the gateways of the service, they are partially reliable for the experience of the service. As the endpoints are also provided via the access business model, the user will always look for the most personally suiting and best quality endpoints. Due to competition this will push endpoint providers to create the best endpoints and replace them when the return rate will be the highest (feedback meeting Balkenende, 2017). To keep the power in balance between the endpoint provider(s) and the Nubus provider, the push for better user experience goes both ways, as this is what both companies will compete over in their own market. The provider of the Nubus service will push endpoint providers for endpoint updates, to prevent outdatedness and incompatibility and vice versa will endpoint providers push the Nubus provider to update Nubus services as they release new hardware functionalities. This will keep the relationship between the Nubus provider and the Endpoint provider in balance (Feedback meeting Balkenende, 2017).

Refurbishing or reusing

The endpoint providers can offer users a new endpoint and retrieve the old one in their own benefit at some point, to enable a new hardware update push, prevent upcoming incompatibility issues with the Nubus, to coop with a change in the user subscription plan or for the highest return rate. The circle of a service forces endpoint providers to look into minimising the costs without sacrificing the quality of the product, to enable a high rate of return and maximise profit. It makes the endpoint providers take end of life of endpoints into account, to have a high return rate by refurbishing, reusing or recycling parts. When the parts did decrease in value, but are still worth enough for the next user, the

endpoint provider will opt for refurbishing or reusing. See figure 33 for the lifecycle of a product.

Timeframe and value of an endpoint

Every time the product is due for a refurbishment the overall value of the product drops, by refurbishing the Endpoint provider will increase the value a little bit for the next user, but will never be as high as the original new value. This means the price also drops per month for a refurbished endpoint, as can be seen in figure 29 the refurbished endpoints are cheaper for users. In figure 34 the value over time is shown for an endpoint.

The Timeframe of a product lifecycle for one user depends on multiple factors, the time until a significant upgrade for the user becomes available, the best return rate for the company, outdated hardware functions like the battery fatigueness and the will of the user for a new endpoint.

This could mean that the timeframe differs per user, endpoint and category of endpoints. As can be seen in figure 34, how an endpoint decreases in value when it has finished a timeframe. The amount of timeframes per endpoint before the endpoint will be recycled varies per type of endpoint. As people are more likely to go for refurbished devices nowadays, the overall likelihood that companies will try to minimise costs and increase profit by refurbishing endpoints increases (NOS, 2017).

Sustainable step

The Nubus ecosystem service will be a step towards a more sustainable personal computer system. The processing power of current devices will be centralised and more efficiently used. Per user less actual processing power and data storage is needed. The provider will try to keep the costs as low as possible, making it an financial motivation to keep efficiency high.

The Endpoints will merely be tools for the user to access their Nubus. These tools should be up to date, to enable the best user experience. As the endpoints are merely tools it is in the best interest of the endpoint provider to keep costs low, enable refurbishment, updatability and make reuse in-house possible. Taking the end of life cycle into account will become more important for endpoint providers. Making it more sustainable than the current devices market.

As discussed with R. Balkenende in the feedback meeting, the power balance between the endpoint provider and the Nubus provider still needs further research, because this could heavily affect the market attractiveness for both endpoint and data plan providers.

figure 33 Endpoints life cycle

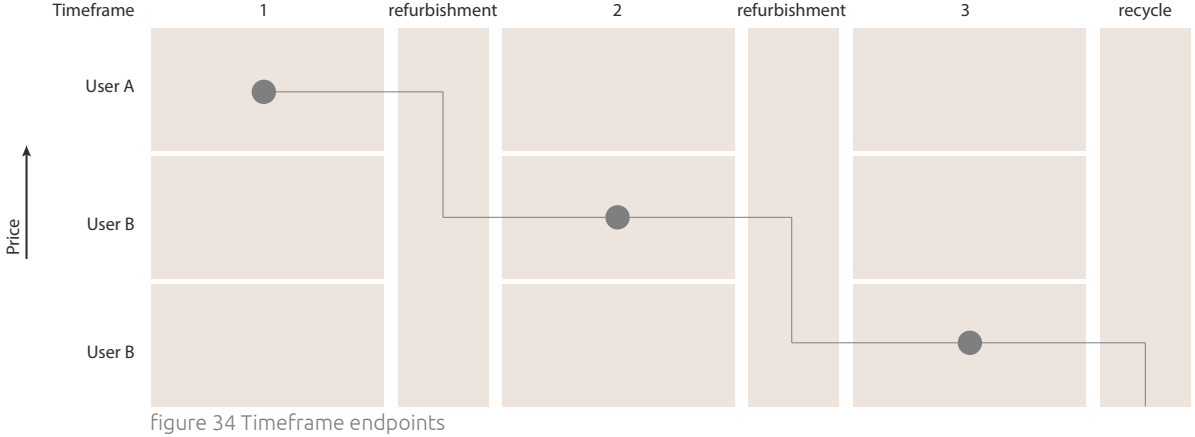
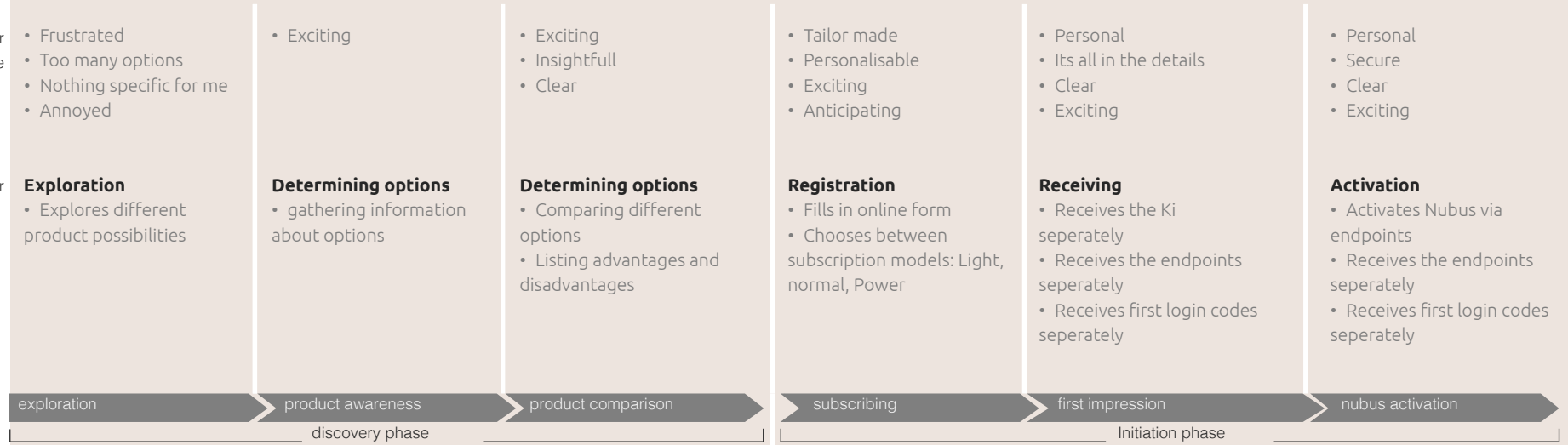


figure 34 Timeframe endpoints

4.8 User Journey map

The user journey map on the following three pages gives a detailed explanation of initiation phase and different timeframes of the user journey. The actions required by the providers are also stated, to elaborately explain what is required from which party within the ecosystem.


Desired user experience
• Frustrated
• Too many options
• Nothing specific for me
• Annoyed
• Exciting
• Exciting
• Insightfull
• Clear
• Tailor made
• Personalisable
• Exciting
• Anticipating
• Personal
• Its all in the details
• Clear
• Exciting
• Personal
• Secure
• Clear
• Exciting
User
Exploration
• Explores different product possibilities
Determining options
• gathering information about options
Determining options
• Comparing different options
• Listing advantages and disadvantages
Registration
• Fills in online form
• Chooses between subscription models: Light, normal, Power
Receiving
• Receives the Ki seperately
• Receives the endpoints seperately
• Receives first login codes seperately
Activation
• Activates Nubus via endpoints
• Receives the endpoints seperately
• Receives first login codes seperately
exploration
product awareness
product comparison
subscribing
first impression
nubus activation
discovery phase
Initiation phase
Nubus provider
Promotion
• Promotes Nubus possiblities online
Promotion
• Exploiting the possiblities of Nubus by promoting it everywhere
• Emphasizes on the advantages of the system
Detailed info
• Shows the costs benefits
• Shows long term benefits
• Shows versatility
Registering
• Detailed info
• Receives subscription
• Prepares a nubus for user
• Prepares a Ki, by linking it to user
• Forwards the order for endpoints
• Forwards order for data
• Prepares Ki accessoires
• Sends Ki and activation information separately
Initiation
• waits for activation of user
Initiation
• Links Nubus to biometric identification options
• Registers passwords for Nubus
• Guides the user through the system
Endpoint provider(s)
Promotion
• Promotes endpoints with specific UX possibilities
Promotion
• Promotes endpoints with specific UX possibilities
• Emphasizes on the advantages of the endpoints with Nubus
Detailed info
• Promotes endpoints with specific UX possibilities
Processes order
• Receives endpoint(s) order
• Sends endpoint(s)
• Activates endpoints
Initiation
• Waits for the user to activate the endpoints
Initiation
• Registers activation of endpoints
• Checks all functionalities

- Effortless
- Seamless
- Secure
- Easy

Usage
- User accesses Nubus via laptop
- User calls friends via every endpoint
- user games on every endpoint

Maintenance
- Nubus provider keeps servers up to date, to enable high efficiency and to stay ahead of competition

Maintenance
- Periodically checks functions of endpoint(s)

- Surprised
- Anticipating
- Tailored offer
- Personal
- Clear

Update offer
- User receives an digital message offering an endpoint upgrade.
- Accepts

Update
- Pushes through Nubus a possible endpoint update to user
- Registers the acceptance of the offer
- Nubus provider updates Nubus to support/ enable new endpoint functionalities

Hardware push
- Pushes update offer to user, because of new endpoint possibility
- Prepares endpoint
- Sends out endpoint to user
- Sends return package

- Exciting
- Easy
- User friendly

Receives update
- User receives a package containing the endpoint upgrade
- User receives package for sending back old endpoint
- User directly uses new endpoint.

Maintenance
- Constantly updates system to enable new hardware and software features.

Initiation
- Registers activation of new endpoint
- Recieves old endpoint
- Reuses, refurbishes or recycles old endpoint

product usage → upgrade offer → endpoint upgrade

Timeframe

- Effortless
- Seamless
- Secure
- Easy

Usage
- User experiences the best UX due to the new endpoint.

Maintenance
- Nubus provider keeps servers up to date, to enable high efficiency and to stay ahead of competition
- Updates software to enable new endpoint hardware

Maintenance
- Periodically checks functions of endpoint(s)
- Samsung develops new hardware, the AR endpoint

- User friendly
- Clear
- Insightful
- Personalisable
- Anticipating

Order
- User is super enthusiastic about the new AR endpoint from Samsung
- User adds new endpoint to subscription

Registers
- Receives new order from user
- Communicates the new order with Samsung
- Adds endpoint to his subscription

Processes order
- Samsung receives endpoint order
- Sends out order to user

- Personal
- Secure
- Clear
- Exciting

Activation
- Activates Nubus via endpoints
- Receives the endpoints seperately
- Receives first login codes seperately

Maintenance
- Constantly updates sytem to remove bugs for the new endpoint category
- Updates Nubus to seamless product usage among all endpoints

Initiation
- Registers activation of new endpoint
- Checks all functionalities

product usage → order new endpoint → new endpoint

Timeframe

- Effortless
- Seamless
- Secure
- Easy

Usage
- Experiences the benefits of the new endpoint

- Simple
- Clear
- Effortless

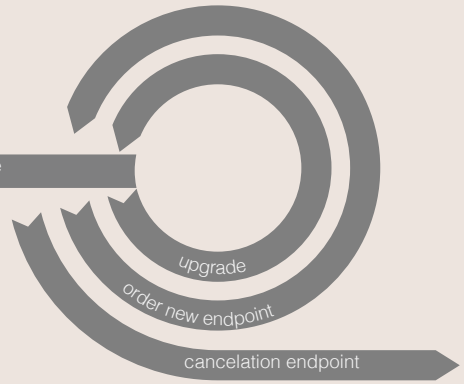
Cancel endpoint
- User does not use endpoint anymore
- user cancels endpoint from subscription

- Simple
- Clear
- Effortless

Sending
- User receives package to send endpoint back
- User sends endpoint in package back to provider

product usage → cancelation endpoint → endpoint shipping → product usage

Timeframe



Maintenance
- Nubus provider keeps Nubus up to date to smooth out the new endpoint usage

Cancelation
- Receives cancelation of an endpoint
- Forwards message to endpoint provider
- Adjusts subscription fee for user

Maintenance
- Constantly updates system to enable new hardware and software features.

Maintenance
- Periodically checks the correctness of operations of the new endpoint

Cancelation
- Receives cancelation of an endpoint from subscription.
- Cancels
- Sends return package

Refurbishes
- Provider receives endpoint
- Provider checks functionality and reuses, refurbishes or recycles endpoint

4.9 The seamless switch

The Nubus ecosystem enables users to access their Nubus from any endpoint, creating the opportunity for users to seamlessly switch endpoints. This would provide the user to have everything ready at their fingertips at any time from any device, as was described in the vision in chapter 01 and the conclusion of chapter 2.4 (the The demand). To enable the seamless switch different kinds of contexts were analysed, to pinpoint the most preeminent context. For this specific context the seamless switch needs to be enabled, to enable it in every context. Hereafter the most preeminent context is described. The preeminent context has led to the value proposition of the Ki, the next chapter will elaborate on the Ki.

Shared context

The Nubus ecosystem enables users to have everything ready at their fingertips at any time from any device. To enable seamlessly switching between different endpoints initiated by the user, different use scenarios were observed, sketched and analysed. First the comparison between personal and professional usage was made, however, these only differ in intensity and not in types of scenarios (see appendices 07, professional vs personal). Then the scenarios were categorised on personal and shared scenarios. This categorisation pinpoints a security issue, when enabling seamlessly switching endpoints in a shared context. The definition of seamlessly switching here means: no direct action required to activate and continue on an endpoint.

A personal context is defined by, being alone in any given environment. In personal contexts, the user can activate any endpoint by being in its proximity. There are no other people around that can access your Nubus via an endpoint. This enables a secure access window.

A shared scenario is defined by, being present in an environment within a certain radius of other familiar or unfamiliar people. In the shared scenarios, proximity to an endpoint could create security problems if it is completely seamless.

This could jeopardise data privacy. For the shared scenario, the most preeminent scenario, the following value proposition was created, to enable user to enjoy the seamlessness of the Nubus ecosystem in any given scenario. In the next chapter the Ki will be explained and how it achieves this value proposition.

Value proposition for the Ki

Enables seamless switching between endpoints in any given scenario, that ensures a secure and private access gateway to Nubus.

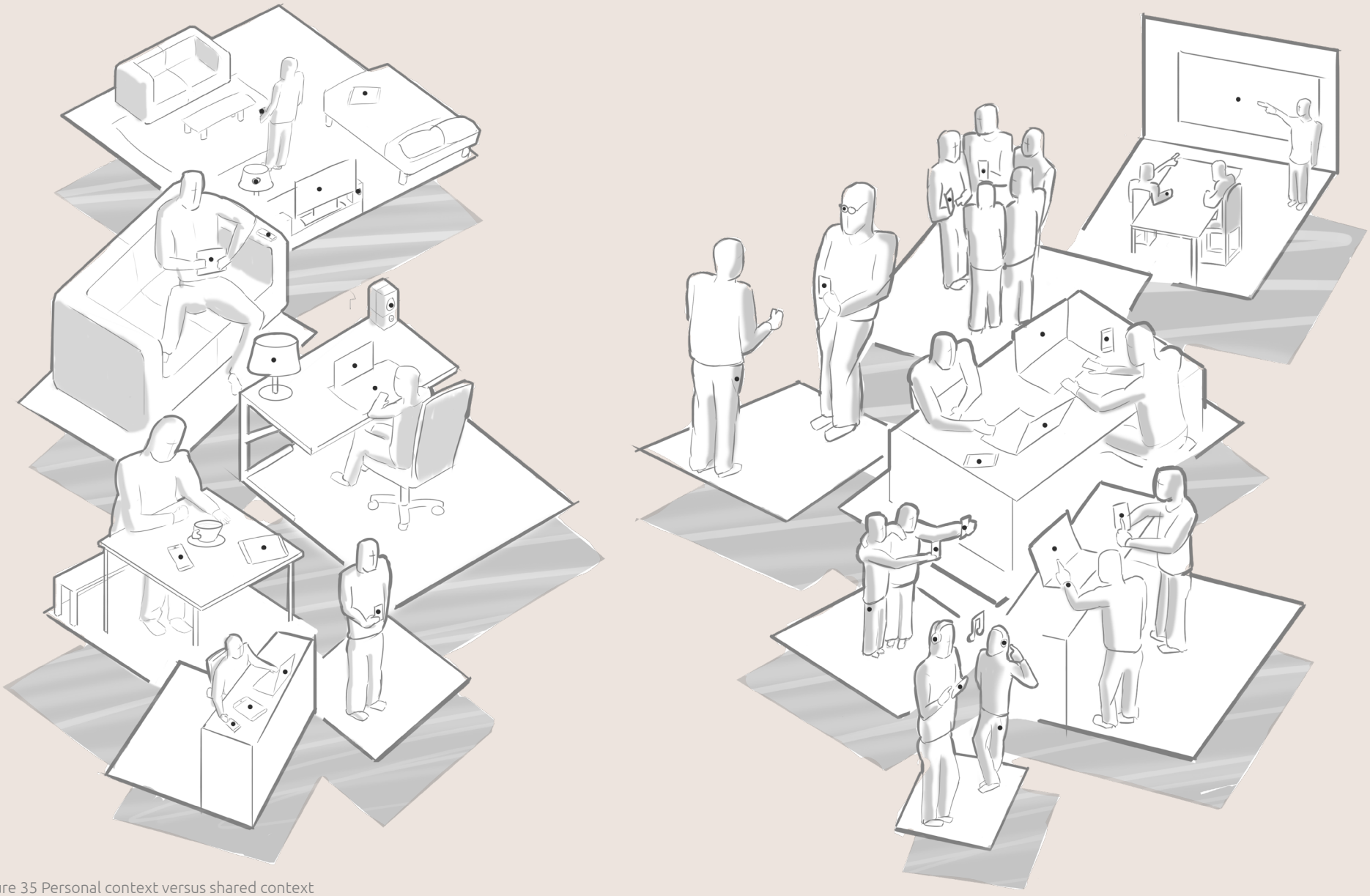


figure 35 Personal context versus shared context

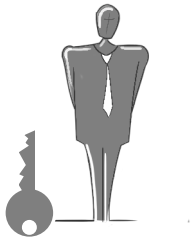
05

The word “Ki” in Japanese stands for energy and aura. It is pronounced as Key and the Kanji “き” (Japanese original characters) is original based on a Key shape. The device Ki beams a personal energy, representing a kind of aura enabling other devices to feel the users presence. Therefore the device is named Ki.

The Nubus ecosystem will enable a seamless switch between endpoints to have everything ready at your fingertips at any time. The Ki is required to enable the seamless switch or as in the vision was stated in chapter 01 an “easy switch”. With an omnipresent Nubus, accessible via any endpoint, high security measurements to access the Nubus are a necessity. Moreover with the growing awareness and demand in data security and privacy, a two step authentication becomes a necessity. The Ki is developed to enable a secure and unobtrusive two step authentication, by radiating an encrypted message constantly. That enables endpoints to pick up an users presence and prepares a login, which for the user is perceived as seamless.

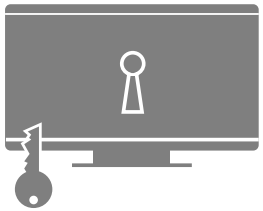
The Ki is a physical representation of a digital key. The two factor authentication is done to provide a more seamless experience in some contexts and similar to the current authentication steps on devices in the most preeminent context. The Ki is designed to be perceived as customisable jewellery, to emphasise the personal value and importance of the Ki. The Ki can be customised to ones preference, to further improve intrinsic value. The Ki is a personal possession, linked to a person, and does not require any more input after receiving the Ki. The Ki is designed to be unobtrusive, to empower the seamlessness of the Nubus.

ki summary



Personal key
The Ki is a personal key to the digital world, the Nubus of the user. Every user has his own personal dedicated Ki.

Two step authentication
The two step authentication is done by having the Ki sending an identification message to the nearby the actual endpoint(s). By making a second physical authentication step, the security is improved because it differentiates from the current possible authentication possibilities.



Physical key for digital world
The Ki is an embodiment of a digital key. Since the physical world is merging with the digital world, the Ki is a product that is a physically embodied for the digital realm.

unobtrusive interaction with endpoints
The Ki is carried by users on their body. The Ki communicates with the endpoints before the user interacts with the endpoint and therefore creates an unobtrusive interaction with endpoint for the user.

Customisable
Every user is unique, to adapt to every user the way of wearing and part of the Ki's appearance is customisable.

5.1 Analogy

The Ki enables the Endpoint to prepare for your entry.
The Ki enables an experience like the Tesla now does for its owners.
The car recognises the presence of the owner, by proximity of the Key fob, and automatically prepares the door handles for the owner to enable entry. It is still up to the owner to physically open the door. The car will only execute request if the owner wth the key fob opens the door en operates the car.
The Ki does the same with endpoints, the endpoint recognises the user by proximity of the Ki and will prepare for entry of the user. An endpoint will only enable the owner of the Ki to operate the endpoints after a second step of authentication on the endpoint. The second step of authentication will be done with a similar authentication as now when physically activating the endpoint.

5.2 User scenario

Infigure 36, two typical actions for users are displayed. First the action of putting the Ki on and then the action of accessing the Nubus. Both actions will be very common for Nubus users. The first action has to do with enabling the first step of authentication, the second action is actually accessing the Nubus via an endpoint. The user scenario is meant to indicate the seamless two factor authentication steps with the Ki. Both steps are explained here.

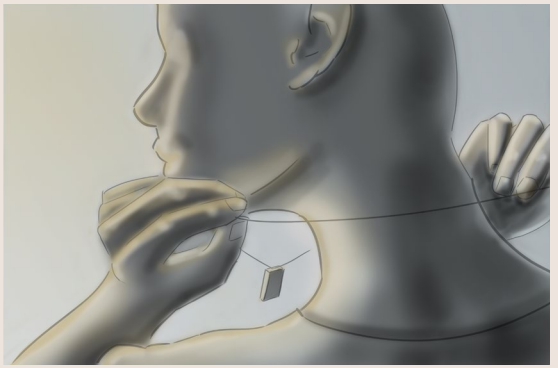
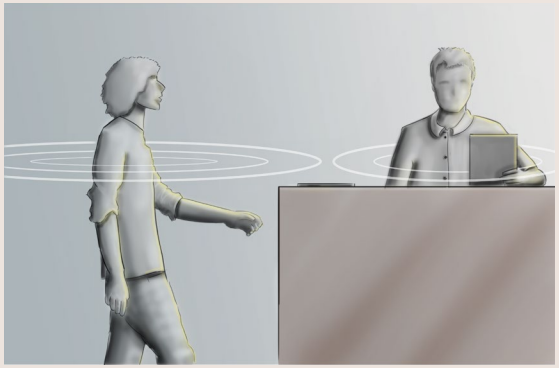
User authentication
In the morning a user will take the Ki from a wireless charging platform and will start wearing the Ki to his preference, to enable a seamless and secure experience throughout the day (see the top three images of figure 36 user scenario). By wearing the Ki around the neck the first authentication step will be constantly beamed to endpoints nearby the user. Enabling the user to authenticate himself unobtrusively to any endpoint in its proximity. This enables the unobtrusive and seamless experience, the Ki is designed for. The Ki is always activated, to authenticate the user at any time in any given scenario.

Seamlessness

Preeminent scenario - shared context
The seamlessness is experienced by the user as projected in figure 36. The visualised scenario is for a shared context, as described in chapter 4.9, as the most preeminent scenario. At that scenario the user is required to physically execute the second step of authentication.
Due to proximity the endpoint recognises the Ki's present and therefore the connected Nubi. The endpoint does not respond, because the second step authentication is not performed yet. When the user picks up the endpoint, it will activate the endpoint by clicking a button, at which point the endpoint preforms the second step of authentication (fingerprint scan). From which access is granted to his Nubus, the user can then freely use the endpoint to his liking.
Afterwards the user will lock the endpoint and walk away, by leaving its proximity the first authentication step (the Ki) will not unobtrusively requests access anymore via the endpoint, as can is depicted in chapter 5.5.

Personal context
Within a personal context a user can have a more seamless experience. A personal context is defined by an environment that is a secure premise. Meaning the user is at home or another context that is declared as secure by the user. This will then function as the second authentication step, and will enable the user to get access via endpoints by being in their presence without requiring a physically authentication action.



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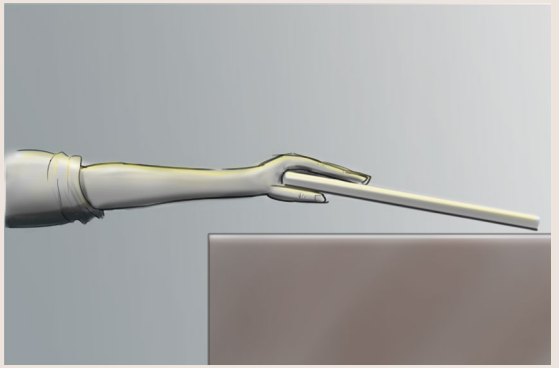
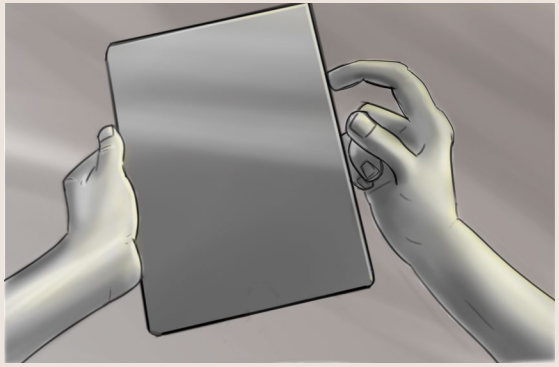
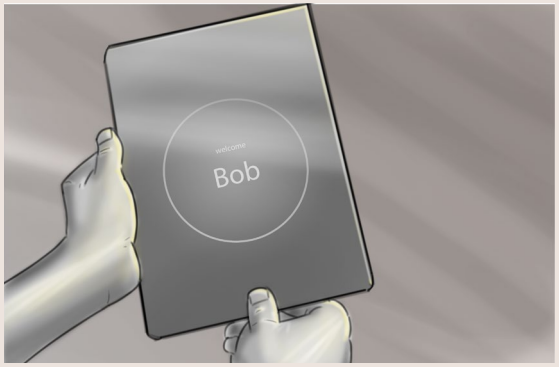
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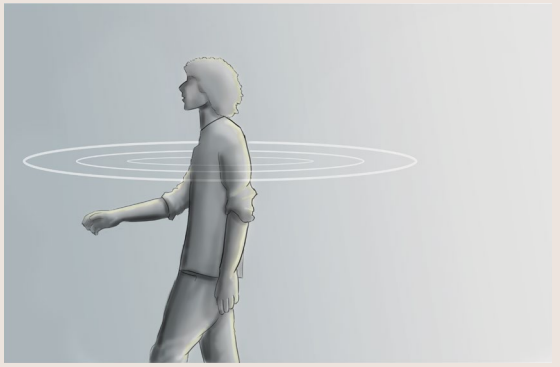


5.3 Ki, an independent device

The dematerialised omnipresent ecosystem, still requires one dedicated personal device, the Ki. The current embodiment of the Ki is a result of the current pace of technological developments and social acceptance, and is a step towards a completely dematerialised future. The Ki enables a seamless user experience, a secure connection and a physical possession enabling a practice and representing the current meaning of personal computing.

Seamless user experience

Firstly, the Ki enables endpoints to unobtrusively prepare for users to facilitate a seamless user experience. The Ki provides the first step of authentication and in some situations, like at home, endpoints can recognise the presence of the user due to the Ki and automatically login (see chapter 5.2 user scenario). This is possible because the second step of authentication is then the secure premises where the endpoints are located. This will provide the ultimate seamless experience.
By possessing the Ki the user is not required to take extra physical actions to login to Nubus, making the authentication as simple as currently but more secure.

Secure connection

Secondly, the first step of authentication for a the secure connection is facilitated by the Ki (of two). The second step is described in chapter 4.4. Personal data is currently not very secure, and with future possibilities in technology it will require a second step of authentication as identity and privacy become increasingly important. As discussed during the expert meeting, “we underestimate the importance of our personal data security and should take steps to improve online security” (personal communication experts, 2017).
Furthermore technology is not advanced enough to determine a persons location at any time in public context (which could function as the first authentication step), without the required dedicated hardware. Therefore users are currently required to have an extra device to do a two step authentication. Moreover, as described in social trends, people are very identity/privacy aware, making at all time person tracking not possible yet.

Physical possession

Finally, the most advanced yet acceptable for users, is a step towards complete dematerialisation. By dematerialising the complete computing experience from the start of the Nubus service, users can become sceptical about the service, due to losing the meaning of the physical possession of hardware and all data (Baha et al., 2012). Therefore the Ki represents the step towards a complete dematerialised future. Moving from multiple personally owned devices to one that represents their Nubus or their possession over personal data and processing power. As described in chapter 2.2 (artificial gap), from a practice theory perspective it is most convenient for the user to have an entity representing the Nubus, to enable a practice. The Ki is a tangible element which can be deployed in the practice with the Nubus, since the Nubus is omnipresent it requires a physical tool (or key in this instance) to gain access to it. Therefor the Ki is designed to create a bodily routine by daily wearing it on their body.
Currently we associate computing with personal devices. With Nubus when every device is not personally owned anymore and can be used by everyone to access their Nubus, the Ki is the only personal device people own within the system. This combined with the other factors of the practice theory, makes the user associate the Ki as the representation of their Nubus, making the shared endpoints comprehensible for users. The reason of being for the Ki is providing seamless secure access to the Nubus, bridging the artificial gap.

The Ki is not the final solution within the Nubus ecosystem to enable a secure and seamless experience. It is the first step towards a dematerialised and therefore more human geographic freedom acquiring future.

5.4 The product functions

Seamless recognition

The Ki enables Endpoints to seamlessly recognise the presence of a user and their personal Nubus. This makes sure the user can easily log into their Nubus via anybodies endpoint with a two step authentication. The Ki contains a simple bluetooth module, that constantly pushes a signal to endpoints, to prepare a login by the user. The Ki pushes a notification via bluetooth towards every surrounding endpoint to prepare the login, similar to what an active beacon is capable off. They Ki does this constantly, to make sure that every endpoint in any given situation is prepared for a login to their Nubus by the user.
How the login is prepared for the user is shown in the subchapter 5.2 (user scenario) and how the secure exchange works is explained in depth in subchapter 5.5.

Two step authentication

The two step authentication is already important in the current days of technology, but by 2022 it is essential (personal communication experts, 2017). Two factor authentications are currently used in consumer online and offline bank payments and DigiD login. A lot of Business services already use it. The Ki is a physical embodiment of a digital key for a user, enabling users to have physical ownership over their unique key to the digital world. Creating a secure and private way of authentication. The two step authentication enables endpoints to be used by anybody seamlessly.
The unique physical presence of the Ki, functions as the first step of authentication. The second step of authentication is similar to what we currently do to identify ourselves to devices. Per endpoint the type of authentication can differ, as input possibilities differ per endpoint. E.g. a headphone endpoint requires a verbal password. Enabling a very strong two factor authentication with one physical proximity method and a unique personal biometric authentication (Skau, 2017). See appendices 13 for the in depth comparison of identification possibilities.

With this first authentication, the beholder of the Ki is not capable of anything in any given context. To enter the Nubus via an endpoint, the user needs to authenticate himself, comparable with a debit card. The card itself is precious, however, without the pincode you are not capable of anything. See chapter 5.5 (secure authentication) for a more in depth explanation of the backend of the two step authentication.

Physical key for the digital world

The two step authentication is already important in the current days of technology, but by 2022 it is essential. The Ki is therefore an embodiment of a digital key, enabling users to have physical ownership of a unique personalised key. It makes the two factor authentication unique in its kind. This enables users to have physical control over a digital product that has no further physical embodiment. This is the first step of embodiment, towards a complete dematerialised future. See chapter 5.7 for how the future vision by time can be embodied.

Knock to activate

Since the Ki will be such a very precious device for users, It is designed to be customisable and to be timeless. To create the most timeless, secure and waterproof design, it was opted to remove all interactive buttons. Furthermore the Ki also requires very little actions from the user, only when battery feedback is wanted. Therefore to request feedback from the Ki and its battery, the user needs to knock twice on the Ki. Then the Ki will indicate the battery status by emitting light. Which is cleverly sealed underneath the casing, to make it invisible upon passive state.

Waterproof

The Ki will be a very personal product, something people are willingly to keep close to themselves. The user attachment to the Ki should be comparable to the attachment to jewellery, the Ki needs to be precious to the user. By making it precious for the user they are not willingly let it easily linger around. Therefore the design of the product will motivate to wear it in their own unique way. Since the Ki will be perceived as precious and people will not easily let it out of their sight it should be functioning in any given scenario, therefore the product is designed to withstand all weather types and is even waterproof. This enables people to wear it while swimming as well.

Feedback battery

The Ki does not need to give feedback often, because the battery will last up to 10 days see chapter 5.8. The moment of feedback can be narrowed down to the moment the user wants feedback about the battery life. A drained battery of the Ki will result in a heavily locked Nubus see chapter 5.6. To prevent a heavily locked Nubus, the user can request feedback about the battery status, via a simple single interaction as described in the knock to activate. For this instance the Ki will indicate the battery status with an unobtrusive light as indicated in figure 37.

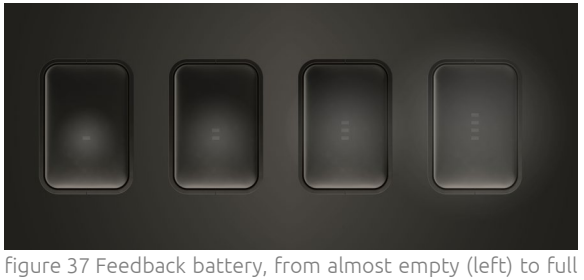


figure 37 Feedback battery, from almost empty (left) to full (right)

Customisable Ki

Because the Ki is a unique personal key, it becomes an important personal item. To enable the success of a precious product, it is designed to adapt to any users preference. The Ki, that enables the identification step is just one part of the design, enabling the users to adapt the two other parts (connectors) to their preference. Some users prefer to wear the Ki on their hip with a clip, some users might prefer to wear it as a necklace, enabling the users to only replace the connectors with different ones to create a necklace. The Ki, the actual module, containing the electronics is therefore offered in different colors. The connectors, are interchangeable and available in many different options and colors, providing many different wearing types for users.

The connectors that enable the customisation can be interchanged for any other accessory, creating a market for third parties. This will provide users diverse accessories to chosen from for the Ki. Creating the freedom for user to adjust the form in any sense, but especially in the way of wearing it.

The two easily removable connectors provide the user the opportunity to connect the module to other connectors enabling them to wear it in any way they want with any colour combination. In the report the following four prototyped connectors are shown in combination with different coloured modules: bracelet, necklace, keychain and clip.


Press this button to unlock the connectors


Hanger
Clip
Bracelet
Necklace
Make the Ki a clip

5.5 Secure authentication

To establish a secure connection with Nubus, the following steps are taken as shown in figure 38. These steps are partly the steps a user undergoes to establish a secure connection, but most of it happens automatically between the Ki and the Nubus. The authentication method is discussed during the expert meeting (personal communication experts, 2017). The secure connection is based on a combination of authentication steps, to enable to most secure and effortless seamless experience. The following step by step description shows the technical side of the story of the two step authentication.

Step 1.1:
The user receives a personal Ki separately by mail.

Step 1.2:
The user receives one time use login codes separately by mail.

Step 1.3:
The user connects to the Nubus with the Ki via an endpoint for the first time and authenticates with the single use login codes. And then sets new personal identification methods. See step 2.2 for the explanation of how the Ki enables the first step of authentication.

Step 2.1:
The Ki constantly sends an encrypted message to Endpoints. The Nubus stays two factor locked, because the Ki is not in proximity of endpoints.

Step 2.2:
The Ki will constantly push a message towards endpoints, to make the first step of authentication possible. Once the user, who wears his Ki, comes close to an endpoint, the encrypted message is received by the endpoint. The Endpoint in its turn will forward this message towards the provider of the Nubus. The provider will be able to read the encryption and will confirm the first step of authentication.

Step 2.3:
Because the first step of Authentication is done, the second step of authentication request will be pushed to the endpoint by the Nubus. The Nubus will push a login screen to the endpoint, which can not be perceived by the user. This second step of authentication requires the user to identify himself via fingerprint or with another authentication method.

Step 2.4:
The login screen is prepared on the endpoint. The user authenticates himself via fingerprint, to gain access to the Nubus. Other possible user authentication steps are described in chapter 4.4.

Step 2.5:
The user interacts with the endpoint, which is possible because the Ki will keep authenticating the user, because of its proximity. At the same time the Nubus will keep communicating with the endpoint, to enable the input and output requests from the user.

Step 2.6:
The user locks the endpoint, and therefore locks the second authentication step of the Nubus.

Step 2.7:
The user leaves the proximity radius of the endpoint and therefore the first lock of the Nubus closes as well.

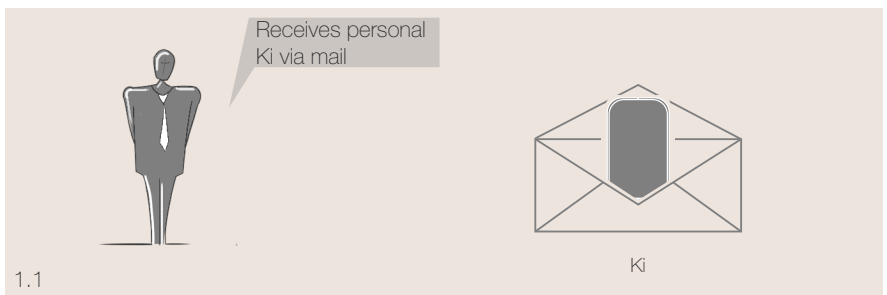
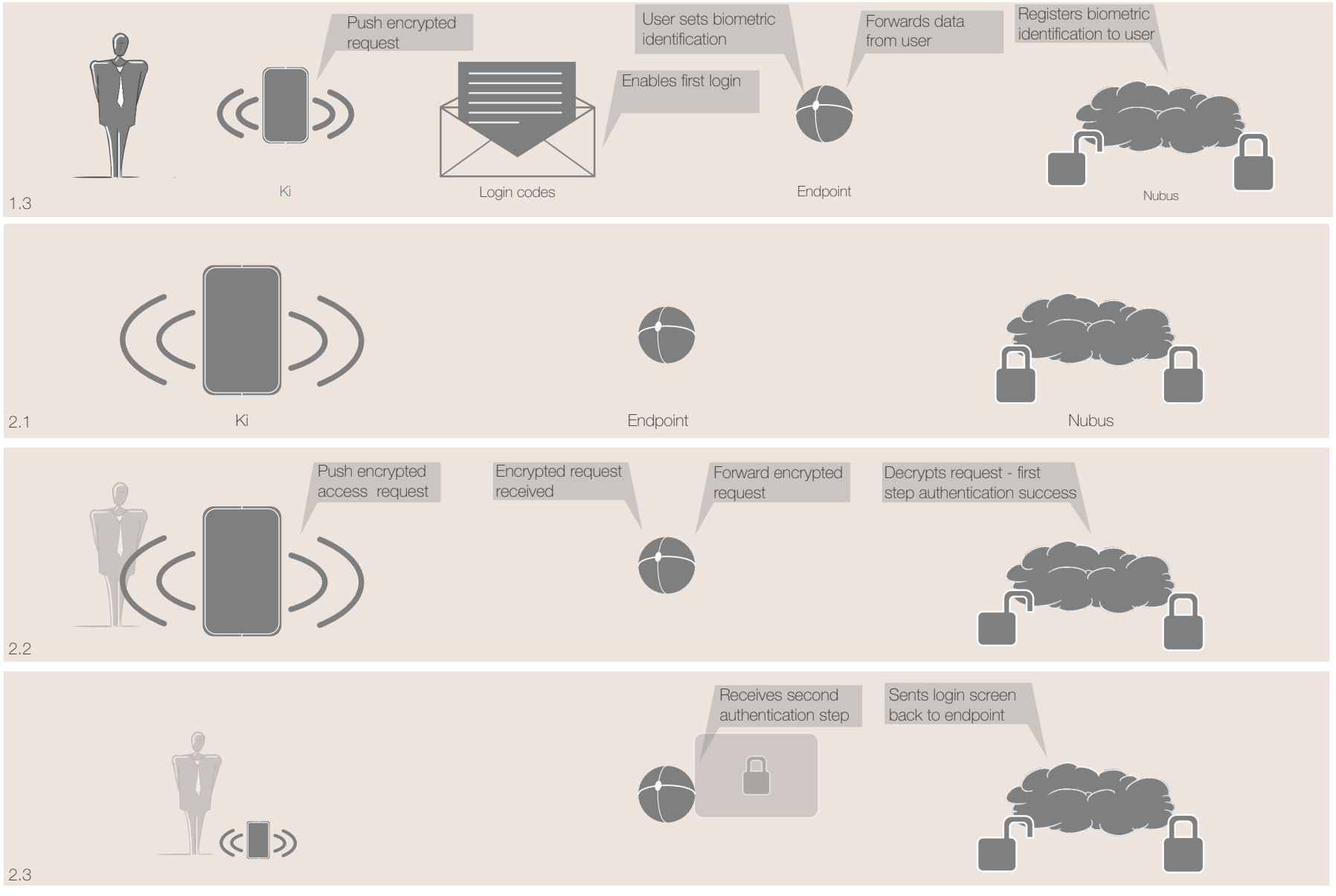
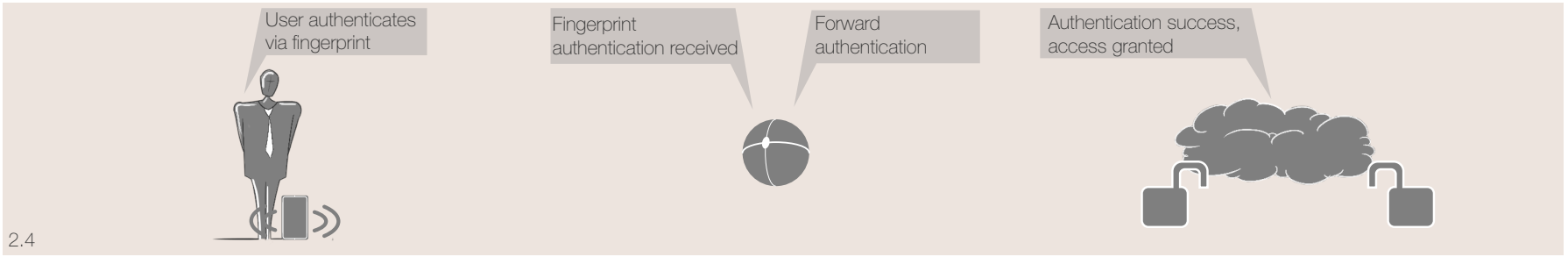
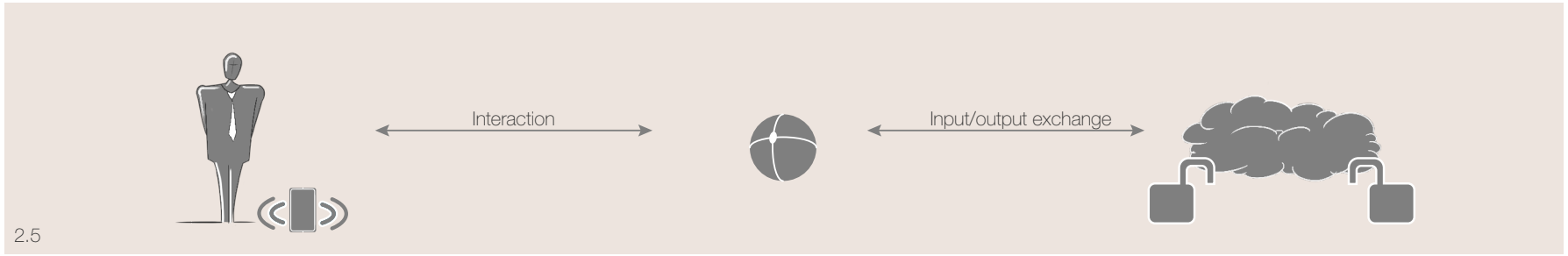


figure 38 secure authentications steps

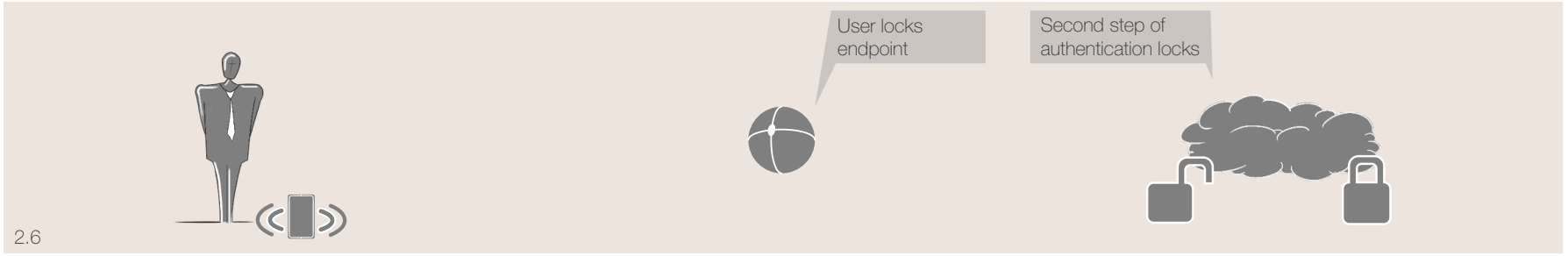

Push encrypted request
User sets biometric identification
Forwards data from user
Registers biometric identification to user
Enables first login
Ki
Login codes
Endpoint
Nubus
1.3
Ki
Endpoint
Nubus
2.1
Push encrypted access request
Encrypted request received
Forward encrypted request
Decrypts request - first step authentication success
2.2
Receives second authentication step
Sents login screen back to endpoint
2.3


User authenticates via fingerprint
Fingerprint authentication received
Forward authentication
Authentication success, access granted

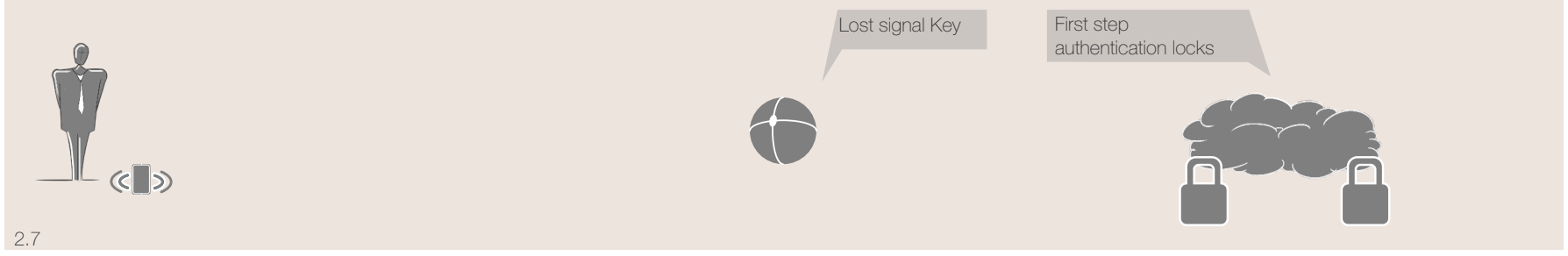
2.4


Interaction
Input/output exchange

2.5


User locks endpoint
Second step of authentication locks

2.6


Lost signal Key
First step authentication locks

2.7

5.6 Lost, stolen or hurt

When the Ki gets accidentally lost or stolen, the user will still be able to access their Nubus, however this will take more authentication steps. To ensure a watertight system. The user will need to authenticate themselves via an endpoint with multiple authentication steps without physically needing the Ki and therefore will not be experienced as seamless. When the Ki is lost three or more steps of authentication need to be taken, requiring a lot of effort from the users to ensure high security measurements. As can be seen in Appendices 13, the quality of an identification steps and some possible authentication combinations are indicated for when a user has lost his Ki or got his Ki stolen. For now is assumed, to enable access without the Ki, that the user will be required to insert their system number, their account number, authentication one, authentication two and authentication three. Every password needs to differentiate in type. E.g. requiring the user to authenticate by fingerprint, a written password and a facial recognition authentication to gain access. The specific amount of authentication steps when the Ki is lost or stolen, can not be determined yet, and requires further research.

After the user is logged in to his Nubus, by going through the multiple steps of authentication via an endpoint, he can deactivate his old Ki and request a new one.

If the Ki is unusable due to an accident. The user can authenticate himself with the same steps of authentication as described above, to access his Nubus and request a new Ki.

5.7 Ki future implementation steps

As with new systems, new potentials arise over time for improvement or further development. Ki is currently limited due to technical possibilities and social acceptance, as described in “Ki, an independent device”. Due to those reasons Ki is developed as a separate physical device specifically linked to a user. Over time Ki can be transformed into a different form. In this subchapter the future implementation steps of the Ki are explained, to show the possibilities of this system and how it can affect the user experience. See figure 39 for abstract explanation.

Dematerialisation steps

Step one:
The Ki can, with time, be dematerialised to a form that is not noticeable by the user. The Ki can become materialised in a sort band aid form. The user can stick it on their skin, without the band aid being directly visible. This will make the form of materialisation of the Ki be unnoticeable over time by the user. The band aid will enable the same seamless secure functions as the current design of the Ki, but with a more dematerialised feeling. Moving towards more human geographic freedom future by dematerialising the Ki.

Step two:
The final step of dematerialisation, will result in a user being the physical Key to the Nubus. No further hardware solutions are required to gain access to the Nubus and creating a seamless interaction. To make this step possible, the Nubus needs to privately and unobtrusively track the users location and needs to be aware of endpoints surrounding the user at all time. The present endpoints need to be activated by the Nubus upon the moment the user wants to gain access. To enable this step strict regulations about privacy and identity need to be in action, to avoid an identity theft or privacy sensitive service. Stricter regulations will enable users to socially accept person tracking at all time, if their identity and privacy is secured.

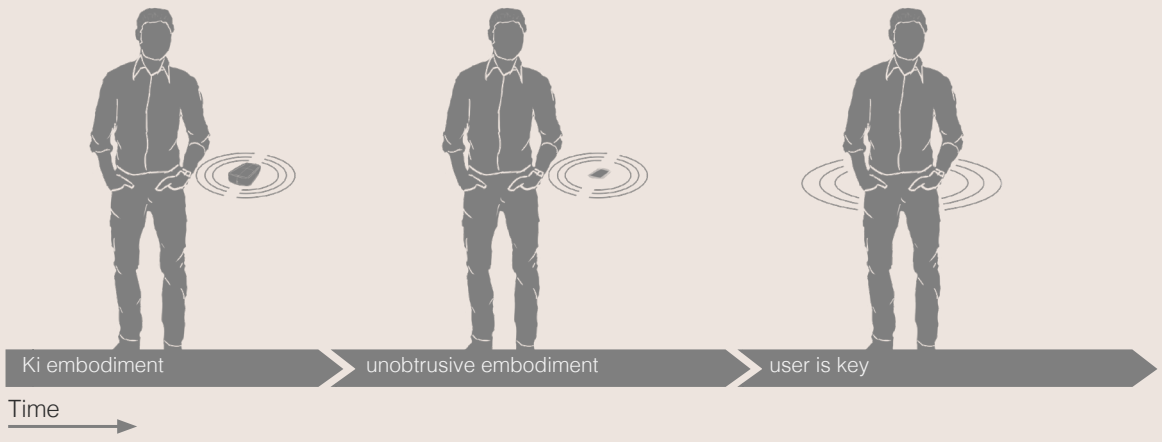


figure 39 Future implementation steps

5.8 Technical components Ki

The Ki is currently designed with off the shelf components, to show the feasibility of the design. The technical components addressed here will suffice for a working Ki, however function as an example of components that can make the Ki work. By defining the technical components, the minimum size of the Ki could be determined. The hereafter described components are recommended for an fully functioning Ki. Infigure 40 an exploded view indicates the components and the positions in an overview.

Body and connectors

The Ki is a module, enabling users to exchange the connectors for other connectors providing the opportunity the change the way of wearing easily (see chapter 5.4 customisable). As viewable in the exploded view, the connectors are interchangeable, by releasing the locking mechanism. The locking mechanism can be released by pressing a small button on the outside of the Ki. The top and bottom part of the module enclose all the electronics and the closing mechanism, creating a watertight module. The LED's are visible through the top part of module, by laser cut holes. The module is designed to be fabricated out of aluminium, to enable a robust and more precious feeling product.

Semiconductor

The following semiconductor has been chosen: Dialog semiconductor smart bond DA14581 (Dialog Semiconductor, 2015). The DA14581 was developed with A4WP wireless power and host controller interface (HCI) applications in mind and to enable low energy bluetooth communication with endpoints. This semiconductor also enables wireless charging with A4WP. It creates a very small package that enables a bluetooth connection and a wireless connection, making it ideal for the Ki. Tushar Rath, principal field application engineer with Dialog Semiconductor, stated why this combination of this semiconductor with BLE is preferred over normal BLE, "the DA14581 still provides the lowest power consumption -- 4.9 mA peak at transmission and reception and extended sleep currents of less than 2 µA -- resulting in longest battery life" (Mannion 2016).
The DA14581 allows to connect extra memory and additional sensors to the semiconductor and can therefor fit the wireless charging kit and additional memory.

Bluetooth upgrade

The semiconductor is designed to for the low power consuming Bluetooth module. Because the Ki requires a two way communication for secure encryption protocols, Bluetooth is preferred over RFID. Bluetooth is a radio transmitter, it transmits data through low power radio waves. Requiring very low power. RFID only allows one way communication (Smiley, 2016). NFC is only capable of two way close proximity communication, within at least 20cm. Therefore not capable of informing endpoints beforehand.
The semiconductor is currently designed for bluetooth 4.2, however, Bluetooth 5 provides more possibilities. Bluetooth 5 is developed especially for products related for IoT, creating high range possibilities with low power consumption (Bluetooth, 2017). Furthermore Bluetooth 5 enables high end security measures complying to security regulations. Making encryption updates over Bluetooth possible.
Furthermore Bluetooth is commonly used in devices and therefore simply fits in the current development of products. Preventing major changes in endpoint to enable a connection with the Ki.

Wireless charging

The Ki, is designed to be waterproof and to be unobtrusive in its required actions. To enable a secure waterproof housing, the charging of the Ki is wireless. The semiconductor is specifically developed for wireless charging if its used in combination with the NX2A4WP (NXP semiconductors, 2015). This module enables wireless charging on the front end. This will require a back end charging station, however, this is left out of the design scope, since wireless charging stations are already in full development of which the Ki can then take advantage by 2022. The NX2A4WP can withstand voltages up to 20V, and is capable of converting this voltage into useable voltage for charging the battery, enabling it to recharge the battery from a variety of wireless charging stations. Furthermore wireless charging also enables the user to charge the Ki while not having to think about it. This enables the user to just place the Ki on a cabinet after removing it off their body, at the end of the day, that enables wireless charging. Enabling a a no effort way of charging the Ki.

MCU

The comparison between a micro controller and a MCU was made, both capable of being the brain of the Ki. MCU is more convenient for the Ki, because it has an internal storage. While the micro controller requires another separate storage. The micro controller physically requires more space inside the Ki, while the space is very limited. Therefore the MCU was opted over the micro controller.
The Ki's main computer will be the Ambiq Apollo MCU with 512 Kbytes of flash, this enables the Ki to run encryption software directly on the Ki. The Flash memory, is required because it needs to contain the software permanently and will enable updates via bluetooth 5. The software running on the MCU will control the complete Ki.

PCB

To enable all the components to work together, they will require a direct connection with the MCU. The PCB will enable that. The PCB is merely a board with a circuit. The components will be soldered to the PCB, it enables all the components to transfer data from one component to another.

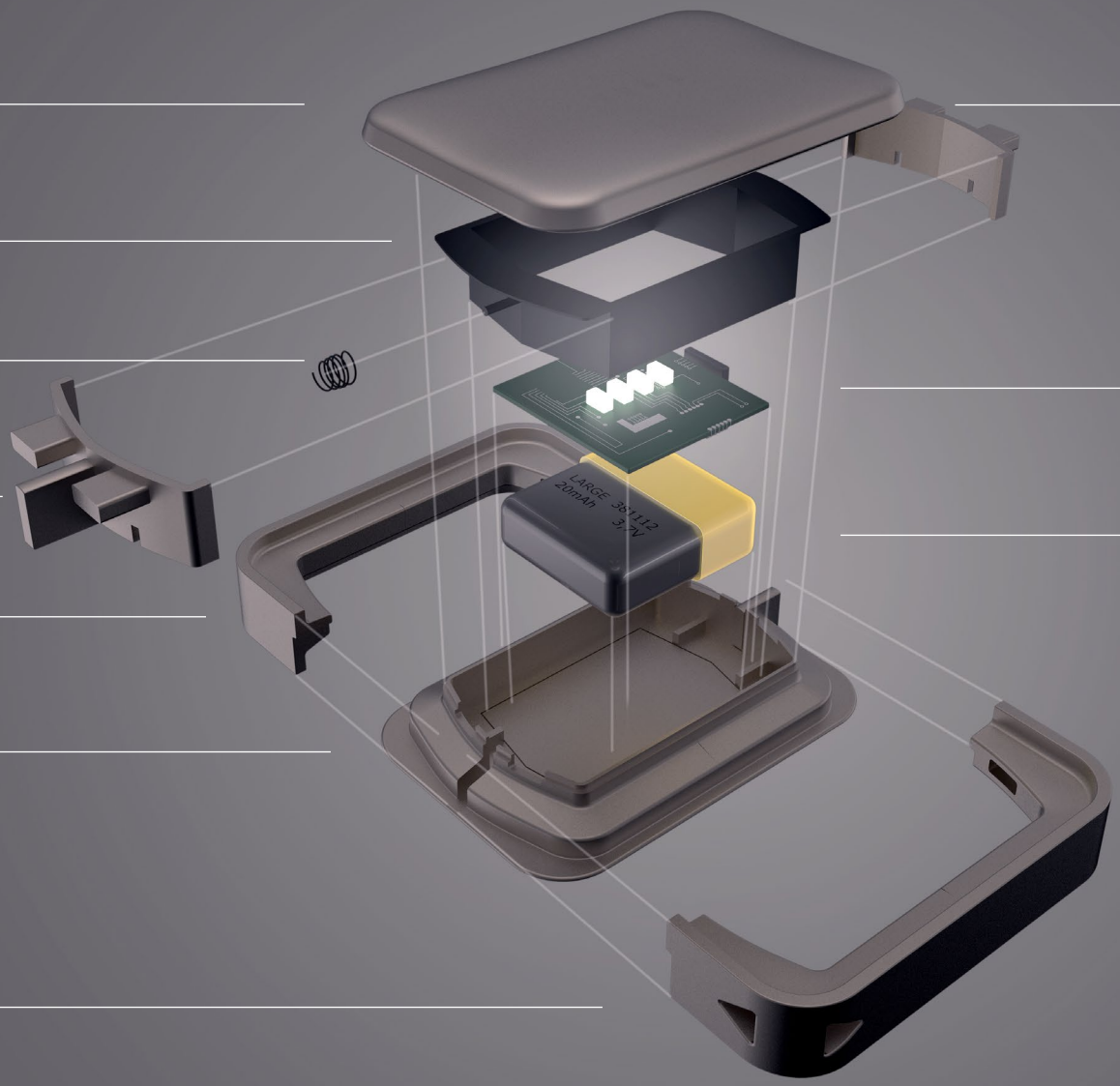


figure 40 exploded view Ki

3-axis accelerometer

The user will be able to request the status of the battery at any moment. This will be enabled via knocking on the Ki. To enable the Ki from interpreting the knocking from the user, the device will have a 3-axis accelerometer sense the the knock delivered by the user to request the battery status. A one axis would have sufficed, however, a 1 axis accelerometer is less common than a three axis, making it more cheap to go for the 3 axis.
An accelerometer that fits the requirements is the cheap MMA8653FC (NXP, 2015). This accelerometer is specifically designed for detecting shock and vibration and motion detection for portable power saving devices. The accelerometer is designed to be very low in power consumption.

LED

The LED's are used to inform the user about the battery status. Four LED's are used simultaneously, because otherwise the status of the battery is difficult to bring across. Therefore was opted for four LED's, every LED representing 25% of the battery charge. Different LED's were compared. The LED's need to be very small, to fit within the Ki. This was one of the main requirements. The Lumex 696-SMLLXFP0603SYCTR, is small enough, has very little power consumption and are very cheap (Mouser electronics, 2017).

Battery

The type of battery and it's capacity is determined by a power consumption calculation of all the parts. The actual consumption is based on data from the data sheets of the parts, however, time a part consumes electricity is based on assumptions. Appendices 14 shows the details of the calculation. This calculation revealed that the power consumption would be around 1,85mAh a day, to verify the power consumption it was compared to the power consumption a day of the Misfit Ray (similar tech and setup). The Misfit Ray only consumes 0,65mAh power a day, however, the Ray does not require a continues push notification via bluetooth, but does track movement continuously. Since bluetooth is more power consuming, the power consumption of the Ki is higher.
Furthermore, due to the limited size of the Ki, the battery was restrained by size as well. The battery with right specs is the 381112 lipo batterij 20 mAh (Hangzhou Future Power Technology Co., Ltd., n.d.). This battery will enable the Ki to last on one charge for 10 days more or less. Providing enough battery power to make the product last for a long time, while in the meantime the Ki will most likely be recharged by wireless charging. Enabling the user to always have a functioning Ki and not being dependent on a charging point for the Ki every day.

06

user evaluation, conclusion

6.1 User evaluation

The Nubus ecosystem service was evaluated with a feedback session with four different groups of people. The groups were categorised by their computing usage. The first group, of normal users, consisted of two people. The second group, users in between normal and power, consisted of three people. The third group, was a single power user. The fourth group, consisted of two power users. With each group, a short presentation was given, like Nubus was ready to be brought to the market, to introduce them to the service. During the presentation they could ask questions. After the presentation there was a moment for them to ask more questions. For the evaluation, some questions were prepared to get user insights about specific aspects of the system, to enable feedback for each essential part of the system.
The goal was to get insights in the value of the service and determine the value of specific aspects of the concept. The approach, setup and feedback can be found in appendices15.

General remarks

All the users thought it was a very "cool" system and for example a power user said: "I hope that this will be launched soon, because then I will be one of the first to adapt." In general, they were all very positive about the system, and that this system would add value a lot of value over the current system. By filling in some flaws and gaps of the current system (as discussed in chapter 2.4). A response from a normal users was: "I think its a really cool idea, especially since the endpoints will be really simple, everything will be in the Nubus."

Subscription based devices

The subscription-based devices were perceived as something positive. Next to access over ownership, people were happy about spreading costs over months instead of paying large amounts of money at once. "That makes it really clear, I know what my costs are per month." The only remark was, that it needs to be cheaper or the same price, otherwise it would not make them change from the current linear business model. "You really need to show that it is cheaper. Only then I will switch."

Access over ownership endpoints

The users mentioned that they often use devices from other people to access secure items over the internet. When asked: "How will accessing your Nubus via the endpoint of a friends feel?" One responded: "It will feel secure. Recently I logged into my bank account on a friend's phone. And if I am already doing that, then why wouldn't I do it with a computing system."
And one person responded to the question: "What do you think about using endpoints that are not in your possession?" with "That seems to me like, what you said, that you can update them when a new and better one appears, is really better than now." The access over ownership became really clear when one of the users mentioned: "Personally, I don't see a problem. In the end, it is only a device that you use to have access to a service. It is about the experience that is provided through the device, but I do not have to own it. I use it for what it is capable of and not for having it." The access over ownership was fully accepted by the users, because they understood it was in their benefit.

Processing and data allocated somewhere else

Six out of eight users did not have any problems with allocating their data and software somewhere else. They all understood the advantages of having everything ready at their fingertips at any time from any device, they compared it to an advanced version of Google drive and Dropbox. About processing and data allocated somewhere else a normal user said "I would not have much trouble with that. Not because I do not think about it, but because I know Google drive or Dropbox, can protect it ten times better than I could."
Even though the advantages were really clear, there was one thing that worried them about having access from any where: privacy and safety.

Privacy and safety

The evaluation showed that they trust the security and safety from the user's side, however, they had some difficulties in knowing whether they could trust the Nubus provider. Even though they mentioned the trust in some companies, they were unsure if Nubus could offer them full data safety and privacy. As stated in the analysis phase, identity privacy is really important for Generation Z, and this became even clearer during the evaluation. The extra safety the Ki could offer was explained very briefly during the evaluation, because it was not the main focus. They understood the Ki, however, they were mainly concerned about it being centralised to one service. Which would result in a hotspot for hackers. "A really big company or an authority, won't use it if its is not safe, if it doesn't offer the best protection. If you can hack through, you would have to be a really good hacker. They don't just place their data somewhere. They trust that, that place safeguards their data and therefore I would trust it as well." They wanted to know who would safeguard their data before they would trust the system. "There will always be risks, certainly with such a system, the risk is significantly higher. Everybody that is connected to Nubus can lose their data if someone breaks into Nubus."
The trust in such a system lies within the credibility of the Nubus provider and is then picked up by power users, who know what to trust and then the other users will follow.

Normal users vs power users

The power users really stated to see the benefits of this system. Power users clearly stated "what you just said is something that I have been waiting for for a hundred years." While normal users understood the benefits, and would take a subscription once they were convinced. One of the triggers to directly convince them would be experts using it. One normal user mentioned: "Not being an IT specialist, I have no clue how safe this is. I would totally rely on the opinion of people with knowledge. That is something I am already doing currently." This indicates that they preferably follow people who have expertise.

6.2 Conclusion

The vision as stated in chapter 01, whereby a small hint was given towards perhaps the next generation of computing for consumers, is feasible. By user research in the analysis phase the demand of wanting to “have everything ready at their fingertips from any(bodies) endpoint at any time from anywhere” was proven to be true, user are currently taking precautionary measurements to enable this. They depend on specific devices for specific data and processing power. The devices are limiting them in their human geographic freedom, because the devices are then required to be present at all times. Even if they are present at all times, which requires preparation, due to incompatibility and outdatedness issues they limit their possibilities with the devices.

With the demand in place, the technological and social trends and developments proved the vision to be feasible from around 2020 to 2022. Hybrid cloud, 5G network, dual connectivity and a generation movement towards the labor market enables Nubus from then. The social trends and developments confirmed the need of a secure system, also to prevent access by thieves from any where at any time. The long term vision is proposed with the Nubus and the Ki for a more user centred computing system. The Ki being the demonstrator of the system, that shows the possibilities of the system in a safe, seamless and private manner.

The system was designed to be more user centred and therefore provides new benefits for users that are currently not present in the current market. The market indicated a gap to penetrate, the Nubus ecosystem is precisely aiming for that market. It will create a online ecosystem with software and hardware, by deviating the current standard.

The Nubus system makes companies more reliable for the system and its e-waste, it centralises the problem users currently have and provides the opportunity to move towards a more sustainable future by providing a better product service while being more sustainable. Clearing the user from e-waste.

The centralised computing system of Nubus as a service will overcome most of the shortcomings of current devices (outdatedness/incompatibility and device dependency). Over time the amount and type of endpoints will expand and will enable all the users to have everything ready at their fingertips from any(bodies) endpoint at any time from anywhere. The system enables a seamless experience in combination with the Ki. The Ki ensures safety and privacy and an unobtrusive first authentication step to enable the seamless experience. Providing the consumer with a system that enables better quality, for a cheaper price.

Discussion

The final service in combination with the Ki has proven to have more potential than the current system. The idea to move the responsibilities from the user towards the providers, seems to be easily accepted by the users. Certainly when they consider the shortcomings and costs of the current system.

Several different developments during the project proved the interest in different aspects of the system by companies. Indicating clearly that there is market ready for this type of consumer product service. The current question of which company will provide such a system or will be best suitable for such a system is still unclear. The intel from projects within companies was missing, to clearly get an indication of the potential of such a project within a company.

The market gap is really clear, however a concern is the size of the potential of the market. The scope for this project was the Netherlands and therefore did not take into account other less developed countries. Therefore the potential can only be judged upon the market size of the Netherlands.

6.2 Recommendations

The exploration of the business approach needs further research. The three business model canvasses provided insights, however a definite conclusion can not be drawn yet about the best option. Before a conclusion can be made, canvasses for Amazon, Microsoft and perhaps Uber can be made.

To create a attractive market, for both the Nubus provider and the endpoint provider(s) the power balance needs to be correct. Therefore some further research needs to be put in the business model canvas, to indicate the power balance between the different parties.

A successful business relies on growth and since this project only focussed on the Netherlands, a more in depth research needs to be done to check the potential of an international service in the long run.

The success of the Nubus ecosystem relies on the usability of the system, therefore new applications need to be developed. App stores need time to develop. The question is how to ensure a sufficient amount of applications for this new system? The answer to this question needs more research.

The technical standards, are very important for software and hardware to easily work together. Some technical standards are already defined in this report, however to ensure quality software, applications and endpoints more technical standards will need to be defined. This could be already defined standards or new standards.

When the Ki is lost, a part of the system becomes vulnerable, and the user will have difficulties access his Nubus easily. The amount of authentication steps the user needs to go through to enable a secure yet accessible Nubus, will require further research. Perhaps inspiration can be taken from DigiD or debit cards.

The Ki is currently designed with off the shelf components, to indicate the feasibility of the device. By the 2020, new and better of the shelf components will be available for most likely a cheaper price. By that time the components of the Ki need to be reconsidered and most likely changed for something better. The technical embodiment of the Ki is a first draft, and as components will still change, the technical aspect of the Ki will require some iterations.

With the user evaluation the Ki was not evaluated, because it was not the most important aspect to evaluate. The advantages of the Ki are clear, but these need to be verified with users. Before this can be done the system needs to be usable or needs to appear usable to make the benefits experienceable and clear for users.

A few Ki customisations are shown in this report to trigger the imagination, however many more are possible. To make a customisation for everyone, to enable everyone to wear it in their own manner, some more time needs to be put into designing more options.

The encryption for the Ki is really important to enable a secure first authentication step. Before the Ki can be launched with the service, an encryption expert needs to look at the system and develop a new kind of encryption for the Ki.

References

A British infrastructure group report. (2016, October). Mobile coverage: A good call for Britain? Retrieved from http://britishinfrastructuregroup.uk/wp-content/uploads/2016/10/Mobile-Coverage.pdf

Abramovich, G. (2016, November 27). Study: Smartphone Traffic Grows Fast, But Revenue Still Lags Desktop. Retrieved from http://www.cmo.com/adobe-digital-insights/articles/2016/10/7/adi-mobile-retail-benchmark-2016.html#gs.zAsIYvg

Android. (n.d.). Android instant apps [Blog post]. Retrieved from https://developer.android.com/topic/instant-apps/index.html

Apple. (2011, June 05). Free Cloud Services Beyond Anything Offered to Date. Retrieved from https://www.apple.com/pr/library/2011/06/06Apple-Introduces-iCloud.html

Arthur, R. (2016, March 16). Generation Z: 10 Stats From SXSW You Need To Know. Retrieved from http://www.forbes.com/sites/rachelarthur/2016/03/16/generation-z/#666ec0684ba4

Atmel. (2013). Microprocessor (MPU) or Microcontroller (MCU)? Retrieved from http://ww1.microchip.com/downloads/en/DeviceDoc/MCU_vs_MPU_Article.pdf

Baha, E., Lu, Y., Brombacher, A., & Mensvoort, K. (2012, August 22). Most Advanced Yet Acceptable, but don't forget. Retrieved from https://www.designsociety.org/publication/38525/most_advanced_yet_acceptable_but_dont_forget

Bakker, C., den Hollander, M., van Hinte, E., & Zijlstra, Y. (2014). Products that Last: Product Design for Circular Business Models.

Bluetooth. (2017). Bluetooth 5. Retrieved from https://www.bluetooth.com/specifications/bluetooth-core-specification/bluetooth5

Bonnington, C. (2015, October 02). In Less Than Two Years, a Smartphone Could Be Your Only Computer. Retrieved from https://www.wired.com/2015/02/smartphone-only-computer/

Breemaiah, K. (2015). Block Chain 2.0: The Renaissance of Money. Retrieved from https://www.wired.com/insights/2015/01/block-chain-2-0/

Bridges, T. (2015, August 19). 5 ways the workplace needs to change to get the most out of generation Z. Retrieved from https://www.fastcoexist.com/3049848/5-ways-the-workplace-needs-to-change-to-get-the-most-out-of-generation-z

British telecom. (n.d.). UK telephone history. Retrieved from http://www.britishtelephones.com/histuk.htm

Buckle, C. (2016, February 18). Digital consumers own 3.64 connected devices. Retrieved from http://www.globalwebindex.net/blog/digital-consumers-own-3.64-connected-devices

Burnes, A. (2017, January 04). NVIDIA Unveils GeForce NOW For Mac and PC At CES 2017. Retrieved from http://www.geforce.com/whats-new/articles/geforce-now-for-mac-and-pc-announced-at-ces-2017

Carmichael Lynch. (2016, March 14). Millennials are so 2015. Retrieved from http://carmichaellynch.com/fomo-gen-z

CBS. (2016, October 13). Population: key figures [Dataset]. Retrieved from http://statline.cbs.nl/Statweb/publication/?DM=SLEN&PA=37296eng&D1=0-7,9,14-68&D2=0,10,20,30,40,50,60,65-66&LA=EN&HDR=G1&STB=T&VW=

Cisco. (2016). Cisco Visual Networking Index: Global Mobile Data Traffic Forecast Update, 2015–2020. Retrieved from http://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.pdf

Clearly, D., Walker, M., & Burke, B. (2015). Top 10 Strategic Technology Trends for 2016: At a Glance. Stamford, USA: Gartner inc..

Columbus, L. (2015, April 5). Predicting The Future Of Cloud Service Providers. Retrieved from http://www.forbes.com/sites/louiscolumbus/2015/04/05/predicting-the-future-of-cloud-service-providers/#107b4169639f

Computer history museum. (2017). Timeline of computer history. Retrieved from http://www.computerhistory.org/timeline/1934/

Cooper, R. (2016, November 15). 5 retailers creating amazing instore experiences. Retrieved from http://retailbiz.com.au/topics/marketing/5-retailers-creating-amazing-instore-experiences/

Davis, S. (2016, November 10). How to clear the final hurdle to public cloud adoption. Retrieved from http://www.cloudcomputing-news.net/news/2016/nov/10/how-clear-final-hurdle-public-cloud-adoption/

Daws, R. (2016, October 13). This company has just been named the enterprise wearable device of the year. Retrieved from http://www.wearabletechnology-news.com/news/2016/oct/13/company-has-just-been-named-enterprise-wearable-device-year/

Daws, R. (2016, November 02). Global mobile internet usage overtakes desktop for the first time. Retrieved from http://www.telecomstechnews.com/news/2016/nov/02/global-mobile-internet-usage-overtakes-desktop-first-time/

Deep focus. (2015, March 30). Deep Focus' Cassandra Report: Gen Z Uncovers Massive Attitude Shifts Toward Money, Work and Communication Preferences. Retrieved from http://www.marketwired.com/press-release/deep-focus-cassandra-report-gen-z-uncovers-massive-attitude-shifts-toward-money-work-2004889.htm

Deloitte. (2016). Technology, media & telecommunications predictions, 2016. London, Britian: Deloitte.

Dialog semiconductor. (2015). DA14581 Bluetooth Low Energy 4.2 SoC with Optimized Boot Time. Retrieved from https://www.dialog-semiconductor.com/sites/default/files/da14581_ds_3v1.pdf

Dorsey, J. (2015, 03 maart). #1 Millennials & Gen Z Speaker Jason Dorsey Receives 1,000+ Standing Ovations - No PowerPoint [Video]. Retrieved from https://www.youtube.com/watch?v=RcZieFwXZio

Dunn, R. (2015, March 11). RFID versus NFC: The big difference you should know about. Retrieved from https://www.linkedin.com/pulse/rfid-versus-nfc-big-difference-you-should-know-rob-dunn

Eisenberg, M. (2016, November 26). Ears, hands or eyes. Retrieved from https://techcrunch.com/2016/11/26/ears-hands-or-eyes/

Eisenberg, M. (2016, November 26). Ears, hands or eyes. Retrieved from https://techcrunch.com/2016/11/26/ears-hands-or-eyes/

Evans, B. (2016, April 29). The end of a mobile wave; the Dell of mobile. Retrieved from http://ben-evans.com/benedictevans/2016/4/29/the-end-of-a-mobile-wave

Expert meeting, E. Baha, 2017-02-26

Feedback meeting, prof. R. Balkenende, circular product design, 12-05-2017

Gartner. (2016, June 19). Five Personal Technologies That Will Disrupt Your Business. Retrieved from http://www.gartner.com/newsroom/id/3352017

Glum, J. (2015, January 13). Marketing To Generation Z: Millennials Move Aside As Brands Shift Focus To Under-18 Customers. Retrieved from http://www.ibtimes.com/marketing-generation-z-millennials-move-aside-brands-shift-focus-under-18-customers-1782220

Goldman sachs. (2015, December 02). What if I told you. Retrieved from http://www.goldmansachs.com/our-thinking/pages/macroeconomic-insights-folder/what-if-i-told-you/report.pdf

Google. (2016, September). How people use their devices: What Marketers Need to Know. Retrieved from https://storage.googleapis.com/think/docs/twg-how-people-use-their-devices-2016.pdfhttps://storage.googleapis.com/think/docs/twg-how-people-use-their-devices-2016.pdf

Greenberg, A. (2016, July 31). Meet Moxie Marlinspike, the anarchist bringing encryption to all of us. Retrieved from https://www.wired.com/2016/07/meet-moxie-marlinspike-anarchist-bringing-encryption-us/

Green alliance. (2015, January). A circular economy for smart devices. Retrieved from http://www.green-alliance.org.uk/resources/A%20circular%20economy%20for%20smart%20devices.pdf

Hangzhou Future Power Technology Co., Ltd.. (n.d.). 381112 lipo batterij 20 mah. Retrieved from https://dutch.alibaba.com/product-detail/381112-lipo-battery-20mah-for-card-reader-60126168595.html?s=p

Hayward, J., Chansin, G., & Zervos, H. (2016, July). Wearable technology 2016-2026. Retrieved from http://www.idtechex.com/research/reports/wearable-technology-2016-2026-000483.asp

Hinshaw, M. (2016, April 26). The Real Value In Voice Of The Customer: The Customer Experience. Retrieved from http://www.cmo.com/opinion/articles/2016/3/29/the-real-value-in-voice-of-the-customer-the-customer-experience.html#gs.AIOIZnA

Jain, A., Bolle, R., & Pankanti, S. (2006). Biometrics, Personal identification in networked society. New York, United states of America: Springer.

Ilika. (2016). StereaxTM M250 Rechargeable Solid State Battery. Retrieved from http://www.ilika.com/images/uploads/general/Stereax_M250_Spec_Sheet_V1.01.pdf

KPCB. (2016). PPCB internet trends. Retrieved from http://www.kpcb.com/internet-trends

Khronos group. (n.d.). Collada. Retrieved from https://www.khronos.org/collada/

Lamkin, P. (2016, February 17). Wearable Tech Market To Be Worth $34 Billion By 2020. Retrieved from http://www.forbes.com/sites/paullamkin/2016/02/17/wearable-tech-market-to-be-worth-34-billion-by-2020/#1c9321383fe3

Lehmann, D and Winer, R. (2005). Product Man- agement. 4th International edition. New York, NY; McGraw-Hill

Mannion, P. (2016, January 26). Teardown: Misfit Shine 2 and the art of power management. Retrieved from http://www.edn.com/design/sensors/4441289/Teardown--Misfit-Shine-2-and-the-art-of-power-management

Metz, C. (2016, October 12). Tech's Biggest Showdown Is Unfolding in Your Living Room. Retrieved from https://www.wired.com/2016/12/microsofts-project-evo-way-living-room/

Mouser electronics. (2017). Lumex SML-LXFP0603SYC-TR. Retrieved from http://eu.mouser.com/ProductDetail/Lumex/SML-LXFP0603SYC-TR/?qs=sGAEpiMZZMseGfSY3csMkQQrRvliDGXll4LsAYaq%252bQY%3d

Mills, N., & Mills, E. (2015, June 20). Taming the energy use of gaming computers. Retrieved from http://evanmills.lbl.gov/pubs/pdf/Taming-the-Energy-Use-of-Gaming-Computers.pdf

Nationaal cyber security centrum. (2014). ICT-beveiligingsrichtlijnen voor Transport Layer Security (TLS). Retrieved from https://www.ncsc.nl/actueel/whitepapers/ict-beveiligingsrichtlijnen-voor-transport-layer-security-tls.html

Nielsen. (2016, March). Video on demand. Retrieved from http://www.nielsen.com/content/dam/nielsenglobal/eu/docs/pdf/Nielsen-global-video-on-demand.pdf

NOS. (2017, May 17). Opgelapte smartphones en laptops steeds populairder. Retrieved from http://nos.nl/artikel/2173563-opgelapte-smartphones-en-laptops-steeds-populairder.html

NXP Semiconductors. (2015). NX2A4WP, A4WP compliant high frequency wireless charging receiver front end. Retrieved from http://www.nxp.com/documents/short_data_sheet/NX2A4WP_SDS.pdf

NXP. (2015). Freescale Semiconductor. Retrieved from http://cache.nxp.com/assets/documents/data/en/data-sheets/MMA8653FC.pdf?pspll=1

Open whisper systems. (2016, April 05). WhatsApp's Signal Protocol integration is now complete [Blog post]. Retrieved from https://whispersystems.org/blog/whatsapp-complete/

Patel, D. (2016, September 14). 5 Trends That Will Inspire and Engage Both Millennials and Gen Z. Retrieved from https://www.entrepreneur.com/article/281551

Patel, D. (2016, December 28). 10 Ways to Appeal to the Next Wave of Workers: Generation Z. Retrieved from https://www.entrepreneur.com/article/286583

Perez, S. (2016, November 25). Mobile shopping hits record numbers over Thanksgiving and Black Friday. Retrieved from https://techcrunch.com/2016/11/25/mobile-shopping-hits-record-numbers-over-thanksgiving-and-black-friday/

Personal communication, M. Dankoor, Data warehouse analyst ASR; H. Sheombar, Digital Age research + consulting Kankan*Tree, 19-03-2017

Pineiro, V. (2015, December 16). Five social trends marketers won't be able to ignore in 2016. Retrieved from http://adage.com/article/digitalnext/social-trends-marketers-ignore/301725/

Qualcomm (Ed.). (2015). 5G - Vision for the next generation of connectivity. San diego, USA: Qualcomm Technologies Inc..

Reckwitz, A. 2002a. The status of the "material" in theories of culture: From "social structure" to "artefacts". Journal for the theory of social behaviour, 32, 195-217.

Raj, V. (2008, August). BEEP. Retrieved from http://dspace.cusat.ac.in/jspui/bitstream/123456789/2618/1/Block%20Extensible%20exchange%20protocol.pdf

Redhat. (n.d.). nterprise Linux 3: Reference Guide. Retrieved from https://access.redhat.com/documentation/en-US/Red_Hat_Enterprise_Linux/3/html/Reference_Guide/s1-filesystem-fhs.html

Richter, F. (2016, August 29). Music Streaming – Subscriptions Win. Retrieved from https://www.statista.com/chart/5636/music-streaming-revenue/

Rohampton, J. (2017, January 03). 5 Social Media Trends That Will Dominate 2017. Retrieved from http://carmichaellynch.com/fomo-gen-z

Ruddick, G. (2016, February 23). ADI: Who Needs To Browse On A Tablet? That's What A Phablet's For. Retrieved from http://www.cmo.com/adobe-digital-insights/articles/2016/2/19/adi-who-needs-to-browse-on-a-tablet--thats-what-a-phablets-for.html#gs.JqXl9cQ

Shove, E., Pantzar, M. & Watson, M. 2012. The Dynamics of Social Practice: Everyday Life
and How it Changes, London, Sage.

Silver, C. (2016, December 05). Amazon Announces No-Line Retail Shopping Experience With Amazon Go. Retrieved from http://www.forbes.com/sites/curtissilver/2016/12/05/amazon-announces-no-line-retail-shopping-experience-with-amazon-go/#722411fd4f94

Singh, S. (2014, May 12). The 10 Social And Tech Trends That Could Shape The Next Decade. Retrieved from http://www.forbes.com/sites/sarwantsingh/2014/05/12/the-top-10-mega-trends-of-the-decade/#548fa3b1570a

Sparks & Honey. (2016). A-Z culture glossary 2017. Retrieved from https://sparkshoney.app.box.com/s/3r3b5o1z6cuajtgjb9vm2uizc2ucmilk

Skau, D. (2017, March 16). Biometrics Provide Convenience at the Expense of Security & Privacy. Retrieved from https://blog.pivotusventures.com/biometrics-provide-convenience-at-the-expense-of-security-privacy-1b061f8e8ed#.by24au2at

Smiley, S. (2016, March 4). Active RFID vs. Passive RFID: What's the Difference? Retrieved from http://blog.atlasrfidstore.com/active-rfid-vs-passive-rfid

Statista. (2015). Average hours per day spent on mobile devices by Generation Z in the United States in 2015 [Dataset]. Retrieved from https://www.statista.com/statistics/530785/gen-z-daily-hours-spent-on-mobile-device-us/

Sutter, M. (2016, October 28). Post-Z: Meet Generation Alpha. Retrieved from http://www.cmo.com/features/articles/2016/10/25/postz-meet-generation-alpha.html#gs.wzCAFgY

The center for generational kinetics. (n.d.). Top 10 Gen Z and iGen questions answered [Dataset]. Retrieved from http://genhq.com/igen-gen-z-generation-z-centennials-info/

The center of generational kinetics, & Dorsey, J. (2016). iGen Tech disruption. Retrieved from http://genhq.wpengine.com/wp-content/uploads/2016/01/iGen-Gen-Z-Tech-Disruption-Research-White-Paper-c-2016-Center-for-Generational-Kinetics.pdf

Trendsactive. (n.d.). Societal trends. Retrieved from http://www.trendsactive.com/#!/our-trends/societal-trends/

Wharton University of Pennsylvania. (2015, September 28). Millennials on Steroids': Is Your Brand Ready for Generation Z? Retrieved from http://knowledge.wharton.upenn.edu/article/millennials-on-steroids-is-your-brand-ready-for-generation-z/