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Streamlined Installation Process for Ericsson Enterprise Core

Master's Thesis in Learning and Leadership

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Gothenburg, Sweden 2020

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Cover: On the cover page is a picture of a person inspecting an *e-NodeB* radio unit on an antenna tower. This radio unit is utilized in the Enterprise Core solution, providing wireless radio connection between devices and the Packet Core (the software that runs and manages the network).

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John Henriksson, Johan Poddig

Abstract

Companies all over the world are now preparing the transition towards the next milestone of modern industrialization: Industry 4.0. One key factor in enabling this leap is the new fifth-generation (5G) mobile networking technology.

Ericsson Enterprise Core (EEC), is a private 5G mobile network solution; offering bigger industrial complexes a complete network infrastructural package – enabling them to utilize this the new technology.

The number of installations of EEC solutions is expected to increase in the oncoming years, as the number of sold units goes up. This installation can be quite complicated however and has so far only been conducted by experienced members of staff. To enable more personnel at the company to be able to conduct the installation, the process has to be simplified and shortened compared to today.

This faster and simplified installation process is referred to as the *'Streamlined Installation Process for Ericsson Enterprise Core'*, which also is the title and goal of this master's thesis – conducted at Ericsson Lindholmen, Gothenburg, during the spring of 2020.

A series of interviews were held with *EEC installation instruction creators* and *EEC installers* at Ericsson to reveal hurdles in the current installation process and why these had arisen.

The result indicated a necessity for installers to possess extensive telecommunication knowledge to be able to fully conduct the installation process. This included, for example, Packet Core structure, 3GPP standard, and orientation with server hardware. A discrepancy in the *instruction creators'* and the *installers'* opinion was noted, regarding whether the documentation structure was intuitive. Finally, the two groups agreed upon the difficulties an installer can have with installation completion verification, where the installed instance has to be connected to real-time traffic in order for its functionality to be fully verified.

The methodology *Design Thinking* was used to ideate, produce, and test new instructions that enabled a more effective installation of the EEC solution. Included in the thesis is the result – a conceptual prototype on how the EEC instructions could be further supported to reach the goal stated above.

Keywords: Instructions, Installation, Design Thinking, Ericsson, Packet Core, Enterprise Core, Industry 4.0, 5G

Abbreviations & Terminology

- **CEE** - Cloud Execution Environment
- **DHCP** - Dynamic Host Configuration Protocol
- **EEC** - Ericsson Enterprise Core
- **IIoT** - Industrial Internet of Things
- **MobaXterm** - A desktop application providing a toolbox for remote computing.
- **Packet Core** - An architecture, defining software components and VMs that runs and drives a mobile network. The term is also used interchangeably as a collective name when one wish to address all the software components within Packet Core.
- **UDM** - User Data Management
- **VLAN** - Virtual Local Area Network
- **VNF** - Virtual Network Function
- **Zoom** – IP-communication tool. It also has screen sharing and recording functionality.
- **3GPP** - 3rd Generation Partnership Project.

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1 Introduction

This chapter introduces the project. It begins with a background and situation analysis, followed by a short presentation of the Ericsson Enterprise Core solution – around which this whole project is conducted. It is concluded with project purpose, research questions and delimitations.

1.1 Background

In the emerging era of 5G, Industry 4.0 and Industrial Internet of Things (IIoT), wireless communication will play a key role and is predicted to generate new revenue streams for production companies over the next decade. With Industry 4.0 and IIoT *everything* will be connected: from big machinery to water taps – all collaborating and communicating via radio waves. (Gilchrist 2016). Closing up to this cyber-physical future, the demand for infrastructure able to manage this enormous payload of wireless data transfer is predicted to skyrocket. (Ericsson 2020).

As one of the world's leading suppliers of wireless communication solutions, Ericsson has joined the race to meet this growing demand. *Ericsson Enterprise Core* (hence called EEC), a private mobile network solution aimed for enterprises and industries, has already hit the market. (Ericsson 2020)

1.1.1 The Enterprise Core Solution

Enterprise Core is a highly complex network solution; a combination of many of Ericsson's core products such as *Packet Core* and *UDM*. In short, one can say it's a fully functioning mobile network in miniature with all the functionalities of a standard macro network – the networks that all world's mobile devices utilize for calls and internet connection.

The difference with a private network, is that all control- and user data is managed by the enterprises themselves instead of it going via a telecommunication operator such as Vodafone or Telia. This allows the enterprises full control over the network – making it more secure and enable them to make custom-made design choices for their particular, often unique needs (Ericsson 2020).

1.1.2 Problem Statement

The *private* mobile-networks market is new to all telecommunication-network developing companies, including Ericsson. Until now, only a handful of Packet Core (the software utilized by mobile networks) installations have had to be made in every country, due to there only being a few, operator-driven, nationwide macro networks; running on large, centralized data centers. These centers are maintained by a small number of trained telecommunication experts, who also carry out all needed Packet Core installations. With the introduction of *private* mobile networks, the conditions change quite significantly – Here, each

private network will have to carry its cost of operation including installation and maintenance (Fransson 2020).

The focus for developers at Ericsson has so far been on scalability, stability and functionality. This expansion into new domains put on new requirements for *installation simplicity*, since the few trained experts no longer can carry out all the installations needed. Without a simplified installation process, there may be a supply-demand-bottleneck where there are too few installers to meet this increasing number of installation requests.

This also puts on new pedagogical requirements. A wider group of people conducting the installation, constitute pedagogical challenges with increased demand for accessibility and meeting the installers on their unique level of competence.

The installation process also takes too long time to conduct. A time consuming installation process equals an expensive installation process for both customers and Ericsson. With a too long installation process, the Enterprise Core solution is not expected to be as competitive in the private mobile-network market.

Ericsson is addressing this simplicity issue from many fronts; one being this project. It is expected that with a simplified, faster and more pedagogic installation process– a *streamlined* installation process – the Enterprise Core would be a more competitive solution on the mobile-networks market (Fransson 2020).

1.2 Purpose

The purpose of this project is to *streamline* the installation process of the EEC solution, by *reducing installation time* and *decreasing installation complexity*. A streamlined installation process is predicted to allow more employees at Ericsson to conduct the EEC installation process and complete it in a smaller amount of time.

1.3 Research Questions

Research questions (RQ) one and two are exploratory, aiming to get a holistic picture of the current installation process and the installers. The third question handles how the knowledge from RQ one and two can be applied to the installation to further *streamline* the process.

1. What are the current hurdles in the EEC installation process?
2. How is the *EEC installation instruction creators'* [1] understanding of the

[1] 'EEC installation instruction creator' refers to the senior employees at several departments at Ericsson who either actively works with or have worked with writing, collocating or refreshing the EEC installation documentation.

solution installers' [2] needs?

3. How to support the EEC installation process for a more effective deployment?

1.4 Delimitations

The study was conducted at Ericsson R&D site in Gothenburg, from 2020-01-21 to 2020-06-15. The new and streamlined installation process was developed from, at the time of writing, existing instructions. Existing computer program code and scripts were not modified.

The EEC documentation refers to several independent documentation libraries; both external and Ericsson internal ones. Since these are not owned by the Ericsson department on which this study is conducted, they were not examined nor edited. This was mainly to avoid dependency conflicts.

Due to the outbreak of Covid-19 (Corona Virus Disease -19) during spring 2020, employees at Ericsson, including us, were requested to work from home. Therefore, was this project's second data gathering ('test session') conducted remotely to reduce the risk of spreading the virus. As a cause of this, only two persons in competence group 3 (employees at Ericsson) were able to conduct in test sessions, see section 3.5.

[2] *"Installer"* refers to both senior and junior Ericsson staff who either actively works or have worked with the EEC installation.

2 Theoretical Framework

This chapter constitutes the scientific basis for this project. The project's overall aim is to support the installation process of the EEC solution. This chapter explores different possibilities to achieve this support. It starts wide, describing human behavior and mind – allowing a clear picture of the human behind the installation. The chapter is then concluded with a walk-through of the science behind the Usage of Instructions– giving a historical, current and futuristic scientific perspective on instruction giving.

2.1 The Human Mind

When creating support functions for an installation process, it can be helpful to understand the mind and behavior of an installer conducting the installation. Transferring complex technical information about the EEC may be done using several methods. Analyzing the human mind might help gain an understanding of how this information is perceived by the person conducting the EEC installation.

This section describes some functions in the human mind, involved in the learning of a new subject: cognitive structures, analogies and association and the human memory.

2.1.1 Cognitive Structures

Phillips and Soltis (2014) describes the forming of *cognitive structures* in the human brain when a person is learning a new subject. When learning something new, the person constructs a mental map over the subject matter with the help of a learning tool and forms a mental structure, a map of all parts in the subject and how they link together. This internal representation is made by the person's brain to simplify information retrieval and to associate it with earlier, entrenched knowledge.

Phillips and Soltis (2014) describe cognitive structures and mental maps, using an analogy to a city road map. The *knowledge* is thought of as attractions or places within the city, and the streets connecting them are the brain's connections – linking the knowledge together. If a person misunderstands some knowledge in a new subject matter, the in-brain constructed road map becomes faulty and would not direct the user to the place/attraction searched for. If the learning person creates a defective mental map of a subject, it would be difficult to understand new information given and associate it with already entrenched knowledge in the brain. Conclusively, the authors say that teaching and other conveying of information, need to follow a structure and help the learner connect entrenched and new information.

2.1.2 Analogies and Association

One common learning mechanism is *learning by analogies*. Gerlee and Lundh (2012) describes the analog model as a tool to represent a phenomenon. Analog models are characterized by using other systems to explain themselves. The authors exemplify: models of atoms and their electrons circulating the core *are analog* to how the planets in our solar system circle around the sun. Winston (1980) provides a further example of when analogies are used. When teaching about electrical resistance, water pipes can be used. The smaller the pipe, the less water can flow through. The water is an analogy to the electric current and the small pipe to the electrical resistance. What is to be understood is that analogies are used when learning and reasoning about specific topics. Learning happens when a description of a subject is explained by analyzing a description of another subject. Hence it is possible to learn about Ohm's law by analyzing water pipes.

The usage of analogies is based on the assumption that if one aspect is equal between a certain subject and the analogical system, other aspects have to be equal as well. The choice of picking a relevant analogy is based on analyzing different properties of the subject and finding an analogy which has similar characteristics for these properties. However, the chosen analogy can not be too similar to the specific situation – it would not provide any new information (Winston 1980).

Hon and Goldstein (2013) says that scientific analogies frequently are misunderstood when explaining a theory. While an analog model might illustrate and simplify a certain phenomenon, this simplification may also imprint faulty assumptions of the phenomena.

The analog 'plum-pudding model' was an attempt to explain the physicist J.J Thompson's atomic model from 1904. The positively charged atomic core was symbolized by the cake, with negatively charged ions (raisins) circling inside the core. Together, the positively charged core and the negatively charged ions created a neutral atom (cake) in balance. Though, Thompson's model was based on the assumption that the atom had some form of inner structure, where the electrons were circling inside the positive atomic core – something that is not analogized in the plum pudding model. Thompson further describes the dynamic between negative and positive charges; neither this is the case with the plum-pudding. The plum pudding model has *some* similarities with Thompson's model, but is far from comprehensive enough. This is an example of a *misleading* analogy, that may imprint a skewed understanding of Thompson's atomic model if used. (Hon and Goldstein 2013).

Another learning method similar to the analog models is *learning by association*. OECD (2010) discusses that learning something new involves recognition-, strategy- and affective networks in the brain. When information is received, the brain identifies it, categories the information, and connects the information to emotions; for example joy or stress. Optimal learning happens when new knowl-

edge is connected with earlier known information or experiences. To comprehend information, people tend to link- and associate it with prior knowledge. Randolph (2018) develops this further and explains that if emotions are connected to memories, a powerful learning and teaching tool is created. Examples of subject material that could be learned by this technique are, for example, words and phrases. To learn and remember the word 'blissful', it could be associated with another word such as 'peaceful'. It could also be associated with a color or a feeling connected to it. Since the associations are personal to the learner, a unique bond to the subject matter learned is created and a tangibility in the learner's mind is set.

2.1.3 The Human Memory

The human memory apparatus is an immensely complex structure. Many scientists have made different models of the brain's memory function, trying to understand how memories are formed and what it means to forget something.

One such scientist is Bjork (2012), who has conducted research in *Applying Cognitive Psychology to Enhance Educational Practice*. This research divides the concept of *remembering* into two different sub concepts: *Retrieval Strength* and *Storage Strength*. With these two sub concepts, the author aim to explain *what is means to remember something*.

Storage Strength [SS] is how well the memory is "engraved" within the brain. Bjork (2012) describes it as an *"accumulation process"*. All known about a certain topic is stacked within the brain; just like pallets in a storage area.

Test data also indicates that once a piece of information stored in the brain, it remains there forever: *"Any SS you build up from your past remains. It's a pretty strong assumption, but so far – in terms of fit this framework to different findings – that idea has been supported."*

Bjork further states:

"No matter how well learned something gets. Some street address you had growing up for the first 18 years of your life, some combination number or phone number that was automatic and you've used hundreds of times – no matter how well learned it becomes, in the SS sense, it will become inaccessible with a long enough period of disuse. You won't be able to recall this thing 15-20 years later if it hasn't been any use or access. But you can easily see that it remains in memory any number of ways, e.g:

You've forgotten this high school friend's name, you can't recall it. But if you were shown a list of four names you pick it out immediately."

Retrieval Strength [RS] is the subject's capacity to access something from memory. This implies in how retrievable a certain memory is. When we are forgetting something, it is the inability to access a certain memory in the brain Bjork (2012). An example of high retrieval strength may be the remembrance

of a friend's phone number which was learned a few hours earlier. The memory has low storage strength though, since it was not very well learned. This means that the person with a memory like this probably will not remember the phone number after a week.

Conclusively. Retrieval strength and storage strength usually interact; they are explained as cooperating when accessing information in the memory. Certain memories have high storage strength but low retrieval strength, such as a childhood memory of a best friend's street address. In other cases, such as the recently described example with a newly learned phone number has high retrieval strength but low storage strength. Conclusively, the brain's use of retrieval- versus storage strength is a matter of the situation, depending on from where the information was retrieved.

2.2 The Usage of Instructions - Historical Perspective

Peikola, Skaffari, and Tanskanen (2009) describes the need of instructions in a historical perspective. In the latter part of the sixth century, with the introduction of Christianity in the Anglo-Saxon world – the need rose for instructional texts, spreading the word of the church. This continued in the centuries followed, where instructional literature is believed to have constituted the lion's share of the published texts:

"A boost to the provision of religious instruction in (Middle) English was given by the Lateran Council of 1215, which promoted the production of vernacular texts to educate the laity in matters of faith, with particular reference to confession" (Peikola, Skaffari, and Tanskanen 2009)

In closer historical proximity – during the eighteenth century – other forms of instructional literature began to emerge; such as medical advice and behavioral guides for women (Peikola, Skaffari, and Tanskanen 2009).

Closing up to present time, almost no written instructions are religious. There has been increasing commercialization of instructional writings, with publishing companies trying to make a profit on textbooks and self-helping guides. Non-profit instruction text still exists however, mostly in the form of "information to the public", issued by public authorities (Peikola, Skaffari, and Tanskanen 2009).

The Second World War had a major impact on the instructional development. The need for instructing soldiers, following written order for survival. Mediated learning material was created, such as thousands instructional movies, with and without sound – but also text manuals. Also audio recordings and photographs were used for solider-training purposes and simulations (Sharon 1995).

One example of instructions created in the last century is the manual for the world's first electronic computer, ENIAC, launched in 1946. The text instructions comprise around 50 pages, including complicated illustrations and hand-

written text. First on page 28 in the instruction are the installer told what happens if the start switch is flipped. The first 27 pages mainly describes troubleshooting and pictures of different racks and wiring. One example of troubleshooting written in the instruction: "avoid stirring up dust in the ENIAC room to avoid relay malfunctions" (Cassel 2020).

2.3 The Usage of Instructions - Current Perspective

This chapter takes a closer look at the research on how one can develop and design effective instructions using different instructional strategies. This is followed by a comparison of commonly used instructional media and what types of instructions that are used in society today.

2.3.1 Instructional Strategies

When planning an instructional teaching session, the instructor has a few *instructional options* to choose from:

- **Active learning**
  Instead of just listening and get fed with information, the learner is actively participating in an activity, such as writing, talking or experimenting. The advantage of this instructional method is the high level of engagement the instructed individual reach, compared to passive listening only. Disadvantages are the increased levels of planning, resources and guiding directions for the teachers conducting the active learning session (Thompson 2013).
- **Interactive learning**
  The learner will use networking platforms to engage and retain material as a part of the learning session, either in pairs or on their own. An advantage with this instructional method is the exclusion of geographical boundaries – the learners may connect to each other via internet. Of course this assumes that the learners have the tools for this interactive learning such as computers, internet connection and appropriate software (Thompson 2013).
- **Hands-on-instruction**
  A form of active learning where the learner is physically manipulating objects, or conducting experiments for evaluation and obtaining information. An advantage with this instructional method is that knowledge "becomes real" when the learner notices the causality between object manipulation and the resulting response. Though, there is a risk that hands-on instructions may shift the focus from acquiring knowledge and learning new skills, to only having fun and socializing with peers (Thompson 2013).
- **Direct instruction**
  Direct instructions is a traditional method of delivering instant feedback and instructions during a class, a seminar or a presentation. This is an

appropriate and fast alternative to use when transferring larger amounts of information to an individual. A disadvantage is that not all individuals are susceptible to direct instructions and especially not when they are in auditory form. Since the learner getting direct instructions is not always actively participating in the lesson, the individuals may find problems engaging (Thompson 2013).

Described above are four of the most common and adaptable instructional alternatives. The author lists further instructional options, such as cooperative learning, flipped learning or reflective discussions (Thompson 2013).

2.3.2 Instructional Media

There are several possible media one can use when instructing someone. The instructional media are channels through which information is transferred from the teacher to the learner.

Kraetsch (1981) presents a scientific experiment where oral instructions on a person were evaluated. A twelve-year-old individual, attending a tutorial clinic [3] a few times a week got to write about a given stimulus picture.

When the test leader gave oral instructions, asking the individual to increase the writing output, the individual's word productivity (the number of written words per time unit) highly increased and the sentence structure (such as the use of adjectives or length of sentences) improved (Kraetsch 1981).

In the experiment, the pictures were randomly selected and the same picture was never shown twice. Though, the tutor noticed that the individual was more motivated to write about some pictures than others (Kraetsch 1981).

Kools et al. (2006) at Maastricht University in the Netherlands, evaluated and compared how pictures and text aided in instructions for various medical equipment; such as asthma devices. *Ninety nine* individuals were tested on textual instructions (bullet-list instructions for an inhaler chamber or a peak flow meter) and text-picture instructions (the same textual instructions, but aided with illustrations). No significant differences in reading time were noticed between the test groups. With the inhaler chamber, the text-picture groups recalled significantly more instructional steps than their text instruction counterpart. The inhaler chamber group who got text-picture instructions also recalled a significantly higher number of correct propositions (in the article defined as 'meaningful text elements') than the text-instructions group. Further observations from the study, show that in the inhalator chamber text-picture groups had fewer doubts and made fewer mistakes when following the instructions compared to the text-only group. In the peak flow meter group, similar deviation as above was observed but were not statistically significant. It was concluded in the study that pictures ***contribute positively*** to text instructions when the instructions

[3] A measure to help students with studying hardships at schools or universities, providing extra classes in different subjects.

can be experienced as ambiguous. Though, the value of visual instructions also depends on the clarity of the device with the included text explanations (Kools et al. 2006).

Surburg (1968) conducted a study to compare three types of instructions when instructing tennis students on developing their forehand drive. Audio, visual and audio-visual instructions were compared. 183 individuals were divided into 7 groups: Three groups with that had either audio-, visual- or audio-visual instructions. Three similar groups, but also with 10 minutes mental practice session included. The mental practice consisted of conceptualizing the forehand movements for 10 minutes. The seventh group was a control group.

The 183 individuals met three times a week for 8 weeks. Concluded from the study was that the three groups using mental practice showed a *significant* difference in the improvement of their forehand tennis drive (in a positive manner). The group utilizing auditory instructions combined with mental practice was the most effective in improving the tennis forehand movements. Between the other three groups which utilized different instructions without mental the practice, showed no significant differences (Surburg 1968).

Richey, Klein, and Tracey (2010) tells that a majority of instructions is built up by sentences and words, in text, as written language. The author explains that information is easy to remember when it has structure, a pattern in its explanations and redundancy of its content. It is important, in written instructions, to evaluate the length of sentences, to use examples, and utilize different font- or text sizes. Laplante (2018) has utilized some of these examples and applied it to when writing about technical information. The author has defined 5 good characteristics in technical writing; the 5 Cs. These 5 Cs stands for *Correct information* in the text, *Clarity*; the text must not have several interpretations, *Completeness of information*; information must not be missing, *Consistency* in internal or external document structure and *Changeability*; the possibility to update information without dependency issues.

2.3.3 Instructions in Society

Richey, Klein, and Tracey (2010) says that learning can be increased when using both visual- and auditory instructions. This is because the individual gets to use both the auditory- and visual working parts of their memory. Since the introduction of the internet, *mediated instructional communication*, e.g. YouTube videos, has become the most dominant in the way of instructing. This technique transfers information using a combination of different media. Colorful illustrations, animations, the use of sound and text among others.

Commonly used mediated communication types are blogs, cell phones, messaging and so on. The mediated instructions can be used both face to face and from distance via the internet. The choice of instructions depends on the learning situation.

Schumacher (2020) gives several examples of instructions used in today's society. One example is IKEA who has got rid of almost all words in their instructions. In 2015 they received the *"Design for Function Award"* and got internationally recognized for their user instructions. Apple's iPhone is another example where there hardly is any instructions at all. Since the product is easy to use and limits user options, the need for instructions is reduced.

The Internet has enabled users themselves to create instructions for products with a lack thereof. Ifixit.com is one such example, providing thousands of instructions and user guides for different devices (Schumacher 2020). As this section shows, there are a variety of instructional types being utilized depending on different use cases. The usage of instructional media such as written text, oral instructions or pictures, allows us to create instructions using a variety of medial tools, such as videos, blogs or online photo pages. The choice of instructional type and method needs to be carefully considered to suit the specific use case.

2.4 The Usage of Instructions – Futuristic Perspective

The previous chapters have described the historical- and current state of the research on *instructional learning* and *instruction giving*. What the future will hold for these fields of science remains to be seen, but technical progress enables the giving instructions through new mediums that have not been seen before. One such technique is *Artificial Intelligence*, which can help with, for example, information seeking. There are also new possibilities with *Augmented Reality*, which allows a user to interact with the product while seeing the instructions on how to use it (Schumacher 2020).

Schumacher (2020) continues by citing Paul Ballard – a managing Director of a company that specializes in technical writing – when predicting the future of the technical writing industry: *"The basic requirements that people have in their relationship in buying a complex product haven't changed. That gap between the product and what the user is expecting from having bought that product, will always exist – and the gap will get filled somehow."*.

Davidson and Goldberg (2009) writes about a digital future and how digital technology encourages learning, e.g. how it, via the internet, can increase the accessibility of information and collaboration possibilities between individuals. The authors predict a future where internet-based learning is common, in which social cooperation and interactivity constitute an integral part. Davidson and Goldberg (2009) gives a few further examples of tools. These take the form as virtual worlds – single- or multiplayer educational computer games, where learners can interact and collaborate to assimilate new knowledge. These can be made for all ages and adjusted for the learner's technical capabilities.

Haythornthwaite et al. (2016) continues with a prediction of the future of e-learning and foresees its integration with artificial intelligence and smart devices.

Future e-learning will rest on disaggregated, more specialized tools; giving the learner increased control of when and how to receive information.

By letting the e-learning software analyze the learner's behavior, the education process can be customized to the learner's unique needs. There will also be an increased diversity of platforms on which e-learning is used, such as phones, tablets and smartwatches – to always make information available for the learners. E-learning can also be implemented in virtual- and augmented realities, using 3D-printing as the bridge between the digital world and reality (Haythornthwaite et al. 2016).

3 Methodology

This report's working methodology is based on a problem-solving method called *Design Thinking*. It was chosen among other method alternatives such as *Set Based Concurrent Engineering* and *The Value Model*, as it was assessed to have a heavier focus on problem investigation and testing of ideas. These two reasons are beneficial since they heavily connect theory to practice; to verify if project statements and premises have a solid foundation in reality.

Design Thinking is a human-centered work process and is generally described as having the user needs in focus. There is no unequivocal definition of the concept however – the definition may vary between researchers. While Design Thinking may be perceived as a linear method, it is actually iterative. Design Thinking is sometimes used in an inaccurate way as a trademark to sell small work courses and make a profit. It is based on finding hidden and non-hidden user needs, defining the underlying problem before starting the solution process and is a holistic working method with different scientific disciplines included, such as engineering and psychology (Brenner and Uebernickel 2016).

This report adopts the definition made by Brenner and Uebernickel (2016) in their book *Design Thinking for Innovation*. They split the work process into five working phases described below and illustrated in figure 1.

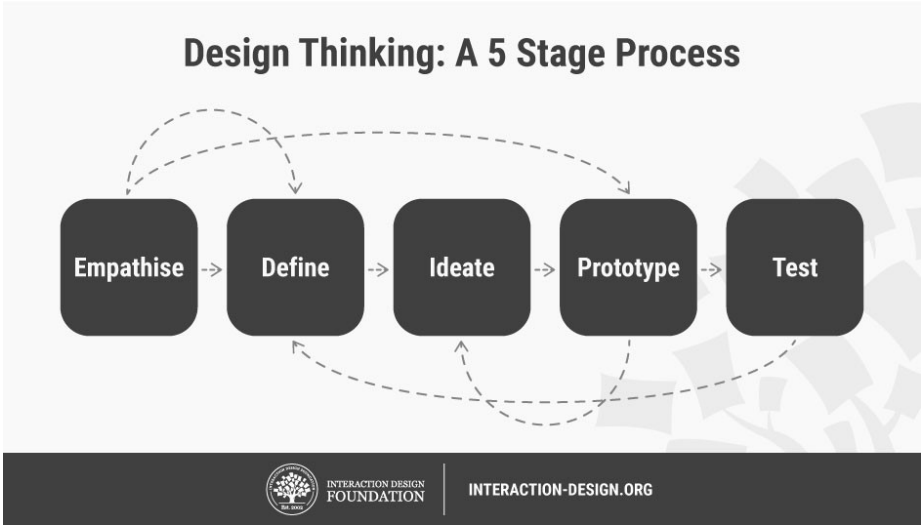

Figure 1: The five phases of 'Design Thinking'. The arrows are showing that 'Design Thinking may be used in an iterative way; for example, after creating a prototype, new ideas might be created and implemented before heading further to Phase 5 - Test. The figure is used with permission from The Interaction Design Foundation (The Interaction Design Foundation 2020).

1. **Phase 1 – Empathise** Phase 1 consists of gaining an understanding of the problem and empathising with users. It is crucial to set assumptions and expectations aside to truly understand the users and their needs. This is done for example through interviews – consulting experts and empathising with individuals to get their point of view about the perceived problem (Brenner and Uebernickel 2016).

2. **Phase 2 – Define** After investigating the perceived problem, an information analysis is made with the collected data from Phase 1. This is to concretize the issue in words – to define the core problem (Brenner and Uebernickel 2016).

3. **Phase 3 – Ideate** Ideate is normally the upcoming phase after investigating & understanding the problem. It is the identification of different ways to solve the now *defined* problem. There are several ideation techniques available. On the way of creating a "winning" concept, the set of possible solutions may diverge and converge several times before choosing a solution (Brenner and Uebernickel 2016).

4. **Phase 4 – Prototype** The fourth phase is an experimental phase to examine how users may behave when interacting with the product. One or several prototypes are created with the "winning" solutions (from Phase 3 - Ideate), trying to solve the defined problems from earlier phases. The solutions are investigated and may be accepted, remade or rejected. The goal is to identify the best possible solution to each problem found. The created prototypes may be tested within the department who created it or in the design team, before heading to Phase 5 - Testing (Brenner and Uebernickel 2016).

5. **Phase 5 – Testing** The last phase in 'Design Thinking' is the testing of a prototype, with the set of solutions developed from earlier phases fully integrated. This phase may help to redefine and understand stated problem – understanding the users and how they behave. In this phase, refinements are continuously made with the product and tested again and again to get as deep understanding as possible of how the users interact with the product. (Brenner and Uebernickel 2016).

Below follow the five phases from the Design Thinking method and how they were applied in this study.

3.1 Phase 1 – Empathise

Phase 1 describes the problem definition procedure – a process conducted through interviews.

The project's prior study was initiated with an examination of installation hurdles, hurdles which have been experienced by Ericsson personnel. A series of interviews were held to concretize the issues with the existing EEC installation

process. In total, seven semi-structured interviews were held with persons holding different work roles at several Ericsson departments. These persons had in some aspect worked with the EEC installation or its documentation. Interview questionnaires are attached in Appendix (see A and B), with eight questions about the installation process – covering areas such as hurdle identification, installation time and an installation verification (clarification on whether the solution has been correctly installed). By doing these interviews and so concretizing the underlying installation problems, it was possible to refine the project scope and create a foundation for upcoming improvements on the existing installation process.

3.1.1 Interview Preparations

To respond to research questions one and two, separate questionnaires were produced for the *EEC installation instruction creators* and the *EEC installers*. The questions were iterated with Ericsson supervisors to ensure questionnaire comprehensibility and that the questions were non-misleading. It was essential that the questionnaire and interview sessions were unprejudiced.

The first questions were about the interviewee's background, to make sure he or she was put in the correct group (creators/installers). The consequent questions were aiming to identify if any prior knowledge was needed when conducting the installation and if there were any hurdles or strengths with the installation process. If any were put fourth, follow-up questions were asked to find out if these hurdles were systematic or if they followed a certain pattern. The questionnaires were concluded with questions about *estimated installation time* and if there were any *definition of done* in the installation process.

The conducted interviews were *semi-structured*, allowing both the interviewee and interviewer *some degree* of deviation from the prepared battery of questions. This type of interview is a hybrid between structured- (strictly following the questionnaire) and unstructured (short to no questionnaire) ones. According to Esaiasson et al. (2017): *"when one wishes to know how people themselves perceive their world"*, it's recommended to use interviews as means of data collection. This was the case with these background interviews – how did the installers experience the installation? The semi-structured nature of the interviews allowed the interviewees to bring up interesting points, not covered by the questionnaire; yet permitted the interviewer to steer a diverging conversation back towards the scope of the project's research questions.

3.1.2 Interviewee Selection

In collaboration with Ericsson supervisors, several interviewees were identified. These persons were expected to have valuable information about the state of the current installation process. The *principle of centrality* was applied, aiming to get interviewees as close to the core of the concerned issue as possible. In case an identified interviewee had insufficient information, a *snowball selection*

methodology was used. The interviewee was instead asked to refer to someone this person believed to be a better choice of interviewee for the study and to have more valuable information (Esaiasson et al. 2017).

The interviewees were divided into two distinct groups: *EEC installers* and *EEC installation instruction creators*. The interviewees were put in a group based on their role in the installation process. If they have had part in collocating and creating installation documents, they were put in the group *EEC installation instruction creators*. If they had experience with the installation and deployment of the EEC, they were put in the group *EEC installers*.

3.2 Phase 2 – Define

A collocation of the gathered interview data was made to define the project scope and to concretize the problem in words.

3.2.1 Collocation and Analysis of Interview Data

The interviewees were recorded anonymously during the interviews. Their answers were collocated in a table. This procedure was done separately for the two interviewee groups *EEC instruction creators* and *EEC installers*. This was to be able to compare the answers between the two groups and examine if any opinions differed. These tables will not be publicly available due to Ericsson's non-disclosure policy.

This way of working was inspired by the *KJ Method*. The *KJ Method* is a way to structure gathered and widely diverse data into an organized, comprehensible form. The idea is to gather information with common characteristics, into labeled groups (Scupin 1997).

The data is gathered from brainstorming or other information collection methods such as interviews or observations. The data is then reviewed and clustered into groups. Data which in some way could be viewed as belonging together or display the same characteristics, is put in the same group (Scupin 1997).

When all of the collected data has been sorted, the groups are labeled (given a name) – even if some of the groups contain few data points. The group label might be a single word or a shorter phrase, describing the perceived *core value* of the group. This makes the collected data easy to overview. The method shapes an informative chart over the issues within the researched subject. The method makes helps to decide what information is important and could be further used in the project (Scupin 1997).

3.2.2 Defining Project Scope

In Phase 1 - Empathise, three areas of improvement in the EEC installation process were identified (see section 4). These areas were discussed with Ericsson supervisors to decide which areas to focus the project study on. The choice was

based on which area(s) was considered most valuable for Ericsson and what areas were not already under development within the company. One areas was not possible to work with since it included script editing which requires a high security clearance.

3.3 Phase 3 – Ideate

This phase describes the project's concept generation process. Here, conceptual solutions are made to solve the issues put fourth during phase one and two.

First, a series of conceptual installation solutions at system level was created (see section 4.3). These were developed in continuous iterations with Ericsson supervisors and Ericsson Training Department, to ensure that they fitted with Ericsson standards. The solutions were chosen and sorted out based on their ability to be implemented within the final delivery to Ericsson. The criteria's *support in pedagogic literature* (see section 2) and *grade of user-friendliness* was used to do this selection. Ericsson's training department also got to put forth an advisory opinion about the generated concepts, comparing them to prior similar experiences.

When an installation solution had been chosen, a series of features were developed. These features were derived from the learning theories described in chapter 2, work experience from the training department and Ericsson supervisors. Some of these features were to be evaluated in the upcoming data collection and further iterated, going though from Phase 3 to Phase 4 and back from Phase 4 to Phase 3.

3.3.1 Elimination of Features

After the creation of features, some were to be selected and some were to be eliminated. This eliminating process was done with the help of a tool called *Kesselring matrix*.

A Kesselring matrix is used for evaluating and successive elimination of solutions (features) not fulfilling system requirements. This kind of matrix is based on absolute comparisons. All solutions (features) in the matrix get a score based on the same, weighted criterion. A Kesselring matrix is more precise than many other elimination matrices. It does not utilize relative comparisons, such as the Pugh elimination method, which compares solutions against each other (Malmqvist 2020).

A set of criteria was chosen to evaluate the established features. The criteria were allocated with a weight from 1-5, where 1 is the lowest value and 5 is the highest, according to how important the criterion was assessed to be in the streamlined installation documentation at Ericsson. For example, the criterion 'Easy to maintain' might have a weight of 4 since a suggestion of new instructions must be easy to maintain at the company. The idea with weights of the criteria

is that some criteria are assessed to be more important in a final solution. This weighting of criteria is showed in column **'w'** in the Kesselring matrix.

Furthermore, a feature was allocated with a weight (from 1-5) depending on the impact the criterion would have on the feature. For example, the feature would be given the weight 4 or 5 according to a feature **Cost**, if it was estimated to be very cheap to produce and implement. This is showed in the column **''v'** in the Kesselring matrix. Though, it is important to add that putting a certain weight on different criteria or features is based on discussion and in the end subjective opinions.

The value of **'w'** and **'v'** are multiplied and the product is shown in column **'t'**. For each feature (A-K), the sum of **'t'**, for all criteria, is its score. The features' score is then compared to each other and used to select which feature is to be implemented and which is to be eliminated. The Kesselring matrix helps to choose the best solution (feature) to a problem. In the matrix is an ideal solution as reference. This solution has a maximal value on every criterion. The ideal solution is used to calculate a relative total (score of feature divided with the ideal score) to provide a ranking to the different features; starting with a '1' for the best feature, a '2' for the second best and so on.

It is important to state the uncertainties in the usage of the Kesselring matrix. It is possible to manipulate values unconsciously, the weights might be difficult to choose and the solutions (features) to be evaluated in the matrix must be on the same detail level (they must be equally developed) (Malmqvist 2020).

3.4 Phase 4 – Prototype

If one thinks of the features "ideated" in the previous phase as bricks, it was now in this phase time to put these bricks together and build a prototype. The different features were to be integrated and put together as one unit ready for testing. It was deducted during the previous phase that, this project's focus and scope were to be on developing *a new installation instruction documentation* for Ericsson (see section 4.2)

As stated in section 1.2, was the overall goal of this project to *streamline* the installation process. In the decision on working with the installation instructions were two additional requirements added by Ericsson supervisors, to fit the new instructions into Ericsson standards:

1. **Easy to maintain**
   The EEC solution is constantly changing (updates, security patches, etc.) and therefore so does its installation process. The new instructions and its features must therefore be very flexible and adjustable so it can be easily changed throughout the solution's life cycle.

2. **Easy to use for *both* experienced and non-experienced installers**
   The EEC-solution is to be installed in many instances. Every customer that buys an EEC installs a local Packet Core instance on their servers.

If many EEC:s are sold, it will require a lot of installers – whom all will not be equally experienced. The installation instructions have to both accommodate the needs of new installers (explanations illustrations etc.), without being tiresome and cumbersome for the experienced ones.

The prototype was made with the following methodology:
The features from phase 3 were gradually integrated into the initial installation documentation and added at appropriate places. For example, the feature *Jumping CPI helper* were inserted where the initial text instructions transitioned between different CPIs (document libraries).

The initial instructions with the new features then became *"the new installation documentation"* or *"the streamlined installation instructions"* and in the next phase, the *new instructions* were tested against the initial ones, to measure whether the adding of the features increased efficiency.

3.5 Phase 5 – Testing

A test for the created prototype was produced and developed. This was done to evaluate what amount of understanding the streamlined EEC installation documentation was able to deliver to the installer. Time was also measured during the test to state if the streamlined installation documentation would reduce installation time compared to the initial installation documentation.

3.5.1 Planning

The test sessions were estimated to last one hour each and the material needed (for each test person) was a computer with internet access and screen-sharing software.

Due to the outbreak of Covid-19 (see section 1.4), the test persons could not borrow the test leaders' computer (which was initially planned). Instead, they had to connect their computer to the test leaders'. This was done with *Secure Shell Protocol* (SSH), using either *Linux Terminal* or *MobaXTerm* as working environment.

A part in the new, streamlined installation documentation was selected for testing. This section included the features *'Video explanation'*, *'Help icons'*, *'Concatenating documents'*, *'Including illustrations'* and *'Test editing'*, see section 4.3. The corresponding part in the initial installation documentation was chosen for comparison.

The test section stretched over *two* different documents in the streamlined documentation and over *three* in the existing documentation:

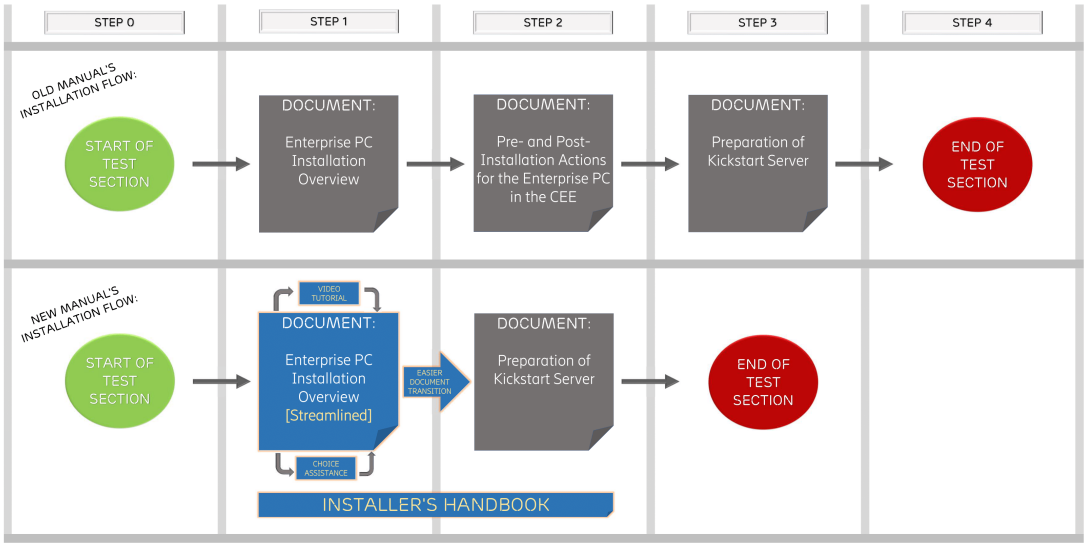

Figure 2: Installation flow for the streamlined instructions compared to the initial documentation. The applied features in the streamlined instructions is marked in blue, with golden text

The test section were split into sub parts: *six* in the streamlined documentation, *seven* in the initial documentation (one sub part was rationalized away when creating the streamlined documentation). Each section was timed during the test to enable detailed comparison between the two instructions and to identify possible bottlenecks.

The total time for test completion was also noted, however with a maximum time limit of 45 minutes.

Ten persons were chosen for testing and sorted into the three *competence profiles* (Beginners, Intermediates and Proficients) according to the criteria stated in the table below:

Criteria \Group	**Group 1** Competence profile: BEGINNER	**Group 2** Competence profile: INTERMEDIATE	**Group 3** Compentence Profile: PROFICIENT
Professional experience (university or work related) in engineering:	–	For at least 3 years	For at least 5 years
Are/have been employed by Ericsson:	–	–	For at least 5 years
Are/have been working with Ericsson Enterprise Core:	–	–	For at least 1 year

Table 1: Competence Profile Criteria

Half the number of test persons in each competence group were assigned to test the new streamlined installation documentation. The other half got to test the initial installation documentation. The group testing the initial installation documentation was thus a reference group. As a cause of the Covid-19 outbreak, only two persons in group three (competence profile: PROFICIENTS) were able to participate in the testing. This is compared to four participating persons in each of the other competence groups.

3.5.2 Execution

The test persons were given the test instructions written on paper. This was to ensure equal information to all participants. The participants' screen and mouse clicks were recorded. These recordings were saved anonymously and the participants were thoroughly informed about this. During the test, the test leaders observed the test persons following the installation documentation and measured their *time of completion* for each sub part within the installation documentation (see section 4.5). The participants only got help from the test leaders with technical issues, such as connecting to the recording software – **no** help regarding following/understanding the installation instructions was provided.

3.5.3 Post-Session Analysis

After the test session, the participant were asked to fill out a survey regarding their opinions/experiences of the instructions during the test. The participants' answers were collocated into a graphical representation (see appendix F) – giving data regarding user opinions of both the initial- and the streamlined instructions. This data enabled comparability between the two solutions.

Notes of user behavior were also taken during the test sessions by the test leaders, with the aim to catch deviating and unexpected user behavior not found by the other, above described, measurements.

3.6 Ethical Perspective on Chosen Methodology

The work with the improvement of the EEC installation process is ethically and ecologically defensible. The main part of the work was conducted behind a computer screen, writing documentation. Interviews were conducted in this study. Here were the *ethical principals of research* (Vetenskapsrådet 2020) applied. All of the interviewees were thoroughly informed about the fact that they were participating in a study, which later was going to be made public. They were also given information on what the study was about. The results and interviewee answers in the report is presented in such a way that they are not traceable back to the interviewee from which the information was received.

4 Results

In the following chapter are the results of this thesis. The information is presented under the specific phase during which it was retrieved.

4.1 Phase 1 – Empathise

A total number of seven interviews were conducted to fully understand the problem; five with EEC installers, two with the EEC installation instructions creators.

During the interviews, a lot of different installation hurdles and other information were put forth. Patterns emerged and **three** main hurdle areas were distinguished – being adduced by several interviewees independently:

1. **The document structure is confusing. There is a deep document hierarchy with a lot of cross referencing.**

   "What I think, it [Author notes: the documentation] was very scattered,it is hard to know where you're to next. There was not a really clear path through the document."

2. **The installation documentation assumes that the installer has a lot of prior knowledge (IP networking, 3GPP, etc) when executing the installation.**

   "If you look at how we're designing our products today and how we assume that you [Author notes: the installer] are having prior knowledge before you can work with this [Author notes: the installation of the EEC]. Then it is, I want to say impossible to tackle an EEC installation as it looks today, without going through a lot of courses such as: you'll have to learn Packet Core, you'll have to learn UDM, you must know how 3GPP have thought things should work between each other. Then, when we enter Enterprise Core, you used a cloud deployent, you have to learn OpenStack,you have to learn CEE...and then there is the case that we does not use all capabilities of a cloud deployment. But as soon as you start using terms which are natural there, you have to know what they mean."

3. **The verification of various technical parameters is poor and there is no installation confirmation unless traffic is run on the deployment.**

   "Interviewer: In the end, do you have to run actual traffic to know if everything is correct?"

   Interviewee: "Eeeehm, yes. You can verify all the parts themselves,but not test end to end without running real traffic. And with that, here is

nothing, normally you could test but after all, but you encapsulates things and like, it is not a cord, it is a lot of milestones all the time. Everything really need to match."

Further interviewee quotes supporting the selection of the three above distinguished areas, are attached in appendix C.

4.2 Phase 2 - Define

As stated in the previos section, were three main areas in the EEC installation process notably expressed by the interviewees as the largest areas for improvement:

1. The document structure is confusing. There is a deep document hierarchy with a lot of cross referencing.
2. The installation documentation assumes that the installer has a lot of prior knowledge (IP networking, 3GPP, etc) when executing the installation.
3. The verification of various technical parameters is poor and there is no installation confirmation unless traffic is run on the deployment.

In collaboration with Ericsson supervisors (this project's main stakeholders), it was chosen to divide the project scope roughly into 80% focus on area one, and 20% focus on area two. This division was estimated as a guideline, to be the most valuable for both Ericsson and the EEC solution's further development. It was wished for by Ericsson's supervisors to have a larger focus on the documentation structure since they had perceived troubleshooting in this area before the conductance of this master's thesis.

Area three was crossed out. This would have required script editing, which in turn would have required security clearance to work with. Ericsson also already has projects working on this area, and hence it was not considered as valuable to steer the study in this direction.

4.3 Phase 3 – Ideate

Phase three consists of the subsections "Alternative solutions" and "Create a winning concept". Here it's explained how several alternative solutions were processed down to a single concept – a prototype.

4.3.1 Alternative Solutions

In the consideration of alternative instructional solutions, meetings were held with different employees at Ericsson (Ericsson supervisors and the Training Department). The options being suggested and discussed with these employees were based on ease-of-use, internal structure and possibilities to implement pedagogical features.

- **E-learning software tool: Articulate 360**
  A software program package to create and manage interactive e-learning courses. Included in this package are Articulate Storyline 360 and Articulate Rise 360 among other tools (Articulate 2020). This e-learning software tool is interactive, pedagogic and easy to use regarding the EEC installer. It would in an effective way, guide the installer step by step in the installation process. Meanwhile, the license for this program is expensive and there might be too much time needed to learn how to manage this software for an installer (Eliasson 2020).

- **Microsoft Powerpoint; interactive presentations**
  A software program part of the Microsoft Office package. It is used to create and design illustrative and informative presentations, using animations, pictures and icons to effectively convey a message (Microsoft 2020). The software could be made interactive and there already is a Microsoft Office license in place for all departments at Ericsson. Microsoft Powerpoint is also a well-known tool among the employees. Though, it might be hard to manage and maintain, since it would be a very extensive presentation if the high number of references (that's in the instructions today) were implemented (Eliasson 2020).

- **Video instructions**
  This solution is thought to convey the installation information through an explaining movie, which the EEC installer can play, pause and manage in several ways to help him or her conduct the Enterprise Core installation. A tool like this could be made informative, easy to use and engaging for the installer in the installation process. Though it might be difficult to overview when searching for information. (Eliasson 2020).

- **Installation text documentation**
  This solution aims to further develop the installation text document to make it easier to overview and easier to access the information when conducting the Enterprise Core installation process. Editing, adding or removing information in the already existing installation documentation. A text document could be made pedagogic and written in a PDF-format which all departments in Ericsson has access to. Though, it might not be as interactive or engaging (Eliasson 2020).

The E-learning software tool was eliminated as a solution since the requirement of a license for using the program would be too expensive for Ericsson. Microsoft Powerpoint was eliminated as an option since it was assessed that a final solution of instructions would be very long, difficult to maintain and not solve the problem of a confusing document structure. Also video instructions was eliminated as a solution since it would be too difficult to overview when searching for information by the installer.

4.3.2 Creating a Winning Concept

From inventing alternative instructional solutions or tools, the chosen solution was to create an improved 'Installation text documentation'. To start developing this solution, a series of features (or concepts) were established via brainstorming and literature (see chapter 2). These features were going to be implemented in the 'Installation text documentation'. The features are illustrated in full in appendix D.

A) Feature: Glossary A feature that explains specific words and abbreviations to simplify an installer's understanding of the installation documentation.

B) Feature: Video explanation A short video explaining terms or notions when further/deeper explanations are needed.

C) Feature: Help icons To have help icons when questions might arise. The installer may click or hoover with the mouse pointer on these for further information. Example of help icons are a "Question mark", or a "Video button", see appendixD. This is to make the text document more user friendly.

D) Feature: Concatenating documents Concatenation of several installation documents into a single document – collocating installation information.

E) Feature: Including illustrations Input explanatory illustrations into the instructions to simplify the installation process for the EEC installer.

F) Feature: Text editing Editing, removing, further explaining or moving text blocks to simplify the installation documentation.

G) Feature: Including documents for further help To provide the installer with general information as further help when the installation documentation is not enough.

H) Feature: Creating learning material for enhanced prior installation knowledge Some technical areas are good to know and be oriented within *before* trying to install the Enterprise Core. This document is aiming to provide and train the installer in this basic technical information.

I) Feature: Include error message explanations Explain why there are certain error messages when installing the EEC and explain what they implicate.

J) Feature: Software version control A feature to make sure that the installer always uses the correct software version – minimizing compatibility issues during installation.

K) Feature: Jumping CPI helper A text box explaining when and why the installer needs to jump in between documentation libraries (CPIs).

4.3.3 Elimination of Features

From the created set of features, some were selected and some features were eliminated. This elimination process was based upon the results from a Kesselring Matrix (see table 2 below.) The criteria for the Kesselring matrix are listed and described below. These criteria were produced to sort out the most suited features to be directly implemented within Ericsson's official installation documentation, while simultaneously maximizing the installer's learning.

- **Cost** - How much is the feature expected to cost to produce and implement in the documentation for Ericsson? This might be a one-time payment or an ongoing payment, such as man-hours, material et cetera. In the Kesselring matrix, see table 2, 'Cost' was assigned with a weight of 2. Since the EEC solution is newly developed and many efforts are put in the solution at Ericsson, the cost criterion was not assessed as crucial.
- **Time to utilize feature** - How much time is the feature expected to consume when utilized by the installer during an installation? In the Kesselring matrix, see table 2, 'Time to utilize feature' was assigned with a weight of 4. Since reducing installation time is a part of this project's purpose, it was assessed as an important criterion.
- **Easy to use** - How easy the feature is to use. For example, if there is a video button, how easy is it for the installer to play the video with both audio and video? If there is a need for any prior knowledge/skill to use a feature, the score gets affected negatively. In the Kesselring matrix, see table 2, 'Easy to use' was assigned with a weight of 5. Since reducing installation complexity is a part of this project's purpose and essential for completing the installation, it was assessed as a very important criterion.
- **Easy to maintain** - When a new version of the EEC solution is released the feature might need to change with it. How easy is the established feature to maintain (update, remake, improve, et cetera) for Ericsson? In the Kesselring matrix, see table 2, 'Easy to maintain' was assigned with a weight of 4. The implemented features must be maintainable as a cause of many, continuous documentation updates. This was also a requirement made by Ericsson stakeholders. The criterion was hence assessed as an important criterion.
- **Pedagogic ability** - How pedagogic the feature is assessed to be. How much understanding does the installer gain by using the feature? Is the

feature shown to enhance learning in pedagogical research (including memory research)? In the Kesselring matrix, see table 2, 'Pedagogic ability' was assigned with a weight of 5. Since reducing installation complexity is a part of this project's purpose and essential for completing the installation, it was assessed as a very important criterion.

- **Feasability** - An assessment of the feature's possibility to be created/implemented in reality. An example of a non-feasible feature could be a Virtual Reality Interface interacting with the installer on how to conduct the whole EEC installation. In the Kesselring matrix, see table 2, 'Feasability' was assigned with a weight of 5. If a feature has low feasibility Ericsson might discard the option even if the feature has a high score in other criteria. To save time and energy at Ericsson in the development of instructions, it is important with feasible features. This criterion was assessed as very important.
- **Easy to incorporate in existing document structure** - How well the feature fits into existing EEC installation documentation layout and with Ericsson standards? In the Kesselring matrix, see table 2, 'Easy to incorporate in existing document structure' was assigned with a weight of 4. Ericsson has a certain document structure where implemented features must suit, if not they are assessed to not be kept by the company in the closest future. This criterion was assessed as important.
- **Ethically defensible** - Is the creation, implementation and usage of the feature ethically defensible? In the Kesselring matrix, see table 2, 'Ethically defensible' was assigned with a weight of 3. It was assessed that implemented features must be ethically defensible to contribute to a sustainable environment. This criterion was assessed as relatively important.

Chalmers University of Technology		**Kesselring matrix:** Streamlined Installation Documentation for Ericsson Enterprise Core																					
Issuers: John Henriksson, Johan Poddig		**Date:** 21th of April, 2020																					
Criteria		**Features**																					
	w	**Ideal**		**A**		**B**		**C**		**D**		**E**		**F**		**G**		**H**		**I**		**J**		**K**	
		v	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**	**v**	**t**
Cost	2	5	10	5	10	2	4	3	6	2	4	3	6	5	10	3	6	3	6	3	6	3	6	4	8
Time to utilize feature	4	5	20	5	20	3	12	5	20	5	20	4	16	4	16	3	12	3	12	4	16	4	16	4	16
Easy to use	5	5	25	5	25	5	25	4	20	5	25	5	25	3	15	3	15	4	20	3	15	3	15	4	20
Easy to maintain	4	5	20	5	20	3	12	4	16	3	12	4	16	5	20	3	12	3	12	2	8	2	8	4	16
Pedagogy ability	5	5	25	3	15	5	25	4	20	4	20	5	25	5	25	4	20	5	25	3	15	4	20	3	15
Feasability	5	5	25	4	20	4	20	3	15	2	10	5	25	5	25	3	15	4	20	2	10	3	15	4	20
Easy to incorporate in existing document structure	4	5	20	5	20	3	12	3	12	3	12	3	12	5	20	3	12	5	20	3	12	3	12	4	16
Ethically defensible	3	5	15	5	15	5	15	5	15	4	12	5	15	5	15	5	15	5	15	5	15	5	15	5	15
Total			175		151		140		136		130		152		161		119		145		106		110		129
Rel Total			1.0		0,86		0,80		0,78		0,74		0,87		0,92		0,68		0,83		0,61		0,63		0,74
Amount of week points			0		0		0		0		0		0		0		0		0		0		0		0
Ranking		Ref		3		5		6		7		2		1		9		4		11		10		8	

Table 2: Kesselring matrix for evaluation of features.

4.4 Phase 4 – Prototype

Attached in appendix E are images of the created prototype with features included. Due to Ericsson's non-disclosure policy, only a handful of sections are attached.

4.5 Phase 5 – Testing

The results of conducted test sessions.

4.5.1 Time Table

The test persons were timed when conducting the test sessions. Both for each section of the documentation, as well as for the whole processes (*Time of completion*). The results can be viewed in Table 3.

"Version" (written in the table below) is the document version where 'B' is the *Streamlined* EECdocumentation and 'A' is the *initial* documentation.

Abbreviations used in **Table 3** :

- **IO** – A document name: '**I**nstallation **O**verview'
- **PPKS** – A document name: '**P**re**p**aration of **K**ickstart **S**erver'
- **PPIA** - A document name: '**P**re- and **P**ost-**I**nstallation **A**ctions for the Enterprise PC in the CEE' (only existing in document version 'A')
- **DNF** – **D**id **N**ot **F**inish
- **N/A** – **N**ot **A**pplicable. E.g. Test section no 2. PPIA, was not present in the document version 'B' and is hence listed as N/A for the test persons testing document version 'B'.

	Section/Person	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10
	Version	B	A	B	A	B	B	A	A	B	A
	Found Movie?	Yes	N/A	No	N/A	No	Yes	N/A	N/A	No	N/A
no. 1	**IO** Sec 2.5.3 **vFuel in.**	09:07	2:45	2:54	02:06	2:09	1:41	3:08	00:26	00:19	00:37
no. 2	**PPIA**	N/A	1:03	N/A	01:17	N/A	N/A	1:10	1:44	N/A	02:11
no. 3	**PPKS** Sec 1 **Introduction**	02:49	2:19	1:52	02:04	1:26	04:13	DNF	01:05	00:45	00:39
no. 4	**PPKS** Sec 3.1 **Step 1**	DNF 05:20	08:12	DNF 07:44	DNF 12:10	DNF 11:19	DNF	DNF 1:17	01:31	1:56	02:25
no. 5	**PPKS** Sec 3.1 **Step 2**	00:30	03:11	00:36	00:22	00:32	00:22	00:20	00:20	00:22	00:24
no. 6	**PPKS** Sec 3.1 **Step 3**	01:05	00:37	00:36	00:05	00:58	DNF 04:01	04:24	00:12	00:14	00:33
no. 7	**PPKS** Sec 3.1 **Step 4**	DNF 25:42	DNF 26:59	31:14	17:58	20:12	DNF 32:56	26:00	02:31	09:36	06:13
	Time of Completion:	**DNF 45:00**	**DNF 45:00**	**DNF 45:00**	**36:03**	**36:39**	**DNF 45:00**	**37:06**	**07:26**	**13:16**	**12:28**

Test User Competece Profile:

BEGINNERS	INTERMEDIATES	PROFICIENTS

Table 3: Section completion time for each test person.
Time format: (min:sec)

4.5.2 Observations Made During Test Sessions

(i) B) Feature: Video explanation. Not found by all test persons. All test persons that found it understood that the video icon was clickable. Test persons using the video tended not to get as stuck in certain instructional steps as the test persons who did not use the video.

(ii) In the initial (version 'A') documentation, several test persons misread the lower-case letter 'l' (L) as the numeral character '1' (one).

(iii) BEGINNERS and INTERMEDIATES had a hard time understanding that the Linux terminal is case- and space sensitive [4].

(iv) Several test persons, from all competence profiles and both document versions, skipped/missed out on whole- or parts of *essential* installation steps. One test person stated: *"I don't know how to do this step so I'll skip it"*.

(v) Consistent with the background interviews, did some test persons experience a lack of confirmation that they'd executed the installation steps correctly. One test person stated: *"I'll guess that's that?"* when executing section no.4 PPKS, section 3.1, step 1 (see Table 3).

4.5.3 Test Session Survey Results

Attached in *Appendix F* are the survey results for all test sessions.

[4] Case- and space sensitive means that you have to put in an command *exactly* correct – every space and character has to be in the correct place for the command to execute. There is no parsing functionality to help. E.g:
apt-get purge libvirt is correct, where as
apt-get purge Libvirt will throw an error.

5 Discussion

This section reviews and discusses the study's test results.

5.1 Background Interviews

During Phase - 1 (Empathise), seven background interviews were conducted with different employees at Ericsson to get to know the *instruction creators'* understanding of the solution installers' needs.

It is worth discussing whether a vague definition of the terms *creator* or *installer* could have had an impact on the answers given in the interviews. If an individual is classed as a creator, it might implicate that the person is very experienced and hence giving weight to their arguments. This might not be the case however. There was no prerequisite in the study on how long the individual should have been working with the EEC, to be classified as an installer or creator. It is also worth mentioning that the structure of the interview questionnaire might affect the outcome of the results. In the background interviews, the interviewees were first asked about hardships regarding the EEC installation process and then about positive sides with the installation material. The interview questionnaires were constructed in this way since identifying hurdles in the installation process was assessed to be very important, compared to identifying positive sides in the installation process.

Conducting the background interviews, all of the individuals asked to participate, partook in the study. There might be discussed if there is "a fear of answering" or any similar cultural impediments that could result in skewed data. With the interview persons participating voluntary and anonymously (which were told before the interview), efforts was made to reduce skewed data. Also, there was an advantage using semi-structured interviews. If it was noticed that a person was trying to avoid a question, the interviewer might ask more or different questions around the topic, to receive more information.

Three areas of improvement were identified in the background interviews. The first one, a *confusing document structure*, may be explained by the design of Ericsson organizational structure. Ericsson is a large company with many independent departments, creating different business solutions in some form. The department creating a specific product owns and manages the documentation belonging to that product. It is that department's responsibility to update the documentation if written information does not correspond with their product or solution.

Since the EEC solution is a combination of several Ericsson products, the EEC installation documentation often refers, from its own documentation library to other products' documentation libraries. It is essential that the EEC solution documentation **refers** to the responsible department's documentation when the installer reaches an instruction step requiring them to do so. For example, one core product in the EECis the virtual machine EPG. When it is time to setup

EPG, the EEC documentation **refers** to EPG documentation. instead of copying information. This so dependency- and merging conflicts don't occur.

If texts were copied, the text would not be updated in all documents. The copied version stays the same while the original document is updated. Therefore, it is not possible to simply copy other documentation and include in a single document to be used by EEC installer. The EEC documentation must be maintainable and it can't contain "old", out-of-date information. Hence it is necessary for the EEC documentation to refer to other departments' documentation, since they are not the ones responsible for the updating it in some cases.

This might be an explanation of why this problem area of a *confusing document structure* has arisen. Ericsson's organizational structure makes it difficult to collocate information in a single document. With this stated, other alternatives than copying information may still be possible to solve a confusing document structure.

The second area of improvement, identified in the interviews, was an expectation of the installer to have prior knowledge in certain technical areas to be able to conduct the EEC installation. This could be understood given that the EEC is a highly complex solution, created by engineers with many years of experience at Ericsson. When a newly recruited installer aims to conduct the installation, it is understandable that this person may not possess all the knowledge needed to complete the installation (such as knowing Packet Core structure or the 3GPP standard). The instruction creators with many years of experience may have an expectation of the installers possessing more knowledge than they actually are. Providing a new installer with further information directly in the instructions, would not make he or she reach the competence level of an expert, but it could make the leap shorter from installation start to finish.

The third area of improvement – a verification of technical parameters and installation confirmation – were decided not to work with in this project (see section 4.2). Even if there could exist several solutions for this area, a difficulty is that it might be hard to generate an installation confirmation that covers the several thousand possible faulty outcomes and errors in a final solution at a customer's personalized solution set-up.

When analyzing the interview answers between the EEC instruction creators and the EEC installers, some differences in their opinions were noticed. It seems that the two groups generally share the same opinions about the importance of prior knowledge in certain technical areas, to be able to conduct the EEC installation. The documentation is not written for a novice to execute the installation, that person would most likely lack the knowledge needed (Reminder: It would've been good if a wider group of people (including novices) could execute the installation, since it would help solve the installation-installer bottleneck described in section 1.1.2. This is hence something that is within Ericsson's interest to correct.)

A suggestion/prototype on new instructions was made in this study as an example of how to *reduce installation complexity*. In the creation of the suggestion/prototype, knowledge about how the human mind works were utilized, written about in section 2.3. If, for example, new features were created – it can be useful to know information as Retrieval Strength, Storage Strength and the way an installer creates a cognitive structure of new information he/she receives from the installation instructions. The theoretical framework can work as a guideline when creating more features.

Where opinions seem divided is regarding the confusing document structure in the documentation. Given that the installer has enough prior knowledge to be able to conduct the installation, the EEC documentation creators agreed that the documentation is quite straight forward – made to be followed step-by-step. They express that if the installer needs more information, it is clear where he or she may find it. This was not the case when asking the installers.

It is expressed in the interviews that each customer has their own deployment demands of the EEC solution, the installer may have to implement modifications in the installation. There is no standardized installation which is executed exactly the same way at customers. Each and every EEC installation can be customized to fit the specific use case. Since modifications may look very differently among the installations, all of these modifications can not be covered in the EEC documentation. Every EEC installation is unique. This is something which seem to be highly noticed among the installers. One installer expresses that the installer has to read between the lines in the documentation, the installation steps are not written clear. The installers are uncertain what information in the documentation should be used for their specific installation.

When conducting the installation, it is assumed in the initial documentation that the installer knows at what department further technical information exists at Ericsson. The installer needs to know where to ask for help or find more information when needed. To find persons withholding crucial information about a specific EEC installation, the installer need knowledge of existing departments at Ericsson and a network of contacts there. It is also important to have knowledge about existing internal websites at Ericsson; much information is stored online at the company.

Even if prior knowledge in technical areas would exist, there are still hardships for the installers to follow the EEC installation documentation. Knowledge about the organizational structure, existing departments at Ericsson and a contact network are thus needed to conduct the installation process.

Regarding an installation confirmation in the end of the EEC deployment, all of the interview persons seemed to agree; to know if the installation has been conducted successfully, it is required to connect the solution to actual traffic at the customer.

It is important to mention that the interview persons also seemed to agree about the estimated time needed to complete the EEC installation. Given that the

installer has all information and all software and servers are prepared, with no problem arising during the installation, the time estimation is correct. Though, the installers expressed that this is rarely the case in practice.

In the creation of new streamlined instructions, several alternative solutions and features were successively eliminated during the work process. During the elimination of alternative solutions (or work tools), a continuous discussion was held with Ericsson supervisors and Ericsson Training Department to ensure the features lived up to Ericsson standards.

the theoretical framework also played a major role in the creation and elimination of features. For example, in the creation of new features during Phase 3 - Ideate, it was tried to establish features that made use of different instructional strategies and instructional media (mentioned in section 2.3). To state an example: the implementation of the feature 'Help Icon', utilized 'Active learning' and illustrations to help the installer. The feature 'Jumping CPI helper' utilized 'Direct instruction' and was using text and illustrations to provide understanding to the installer.

5.2 Test Sessions

This section discusses results from the conducted test sessions; the time table, the observations and the survey.

5.2.1 Time Table

Analyze of Table 3. In table 3 there is a big variance in the *Time of Completion* between the Beginners, the Intermediates and the Proficients groups. The individuals in the Beginners group did not finish ('DNF') their test session or needed much time when conducting it. There was a small variance in Time of Completion between the Beginners and the Intermediates group, but if these results depend on individual performance within groups or a general difference between the groups remain to be seen.

What can be seen in the table is that the Proficients needed significantly less time in the test ('Time of Completion') and this might depend on their prior knowledge of the Linux command line and that they have conducted similar installation steps during their employment at Ericsson. They also have prior knowledge about the Packet Core, the EEC-solution, and the VNF:s included in the EEC-solution. Furthermore, they know how product documentations at Ericsson usually are structured, with documents referring to other documents and how these documents are supposed to be read. The Beginners were not familiar with this cross-referencing structure which may have had an impact on their Time of Completion.

In the Time Table (Table 3), there is a wide variance regarding the Time of Completion for the individuals within the group Intermediates. This might either depend on their individual performance but could also be a result from a

wide definition of the group INTERMEDIATES. The requirement for being placed in this group was 'Professional experience in engineering; 3 years'. It was created for test persons which were expected to be able to handle larger amount of technical information but still were no experts in the concerned technical areas. It was assessed that there are many persons at Ericsson which were no experts but still not beginners; they would be placed in the INTERMEDIATES group. This group were aiming to test people with similar competence and therefore it was wider defined than the BEGINNERS and the PROFICIENTS.

An example is test person eight (T8 in Table 3) – although within competence profile INTERMEDIATES – completed the test on a time comparable to the PROFICIENTS. More specifically defined test groups would require more persons to conduct the test session. A higher number of test persons could be utilized to find a behavior pattern among the participating individuals.

It is necessary to add that almost all the persons which did not finish (DNF) the test due to the time limit, were tested on the streamlined installation documentation (document version B). One perspective is that the video was hard to understand but another perspective is that the movie was an added 10 minutes long feature in the 45 minutes test session. Even though this did increase the Time of Completion compared to the initial documentation (document version A) the video might contributed with an understanding for the installer and would maybe reduce the total Time of Completion in a real installation which exceeds by far the 45 minutes of testing.

On the other hand, the individuals with the initial documentation (document version A) had another added moment in their test (no.2, 'PPIS'). This was though a very short step: reading a line and continue to another documentation, which also may be understood reading the time for conduction in step no.2, 'PPIS'.

5.2.2 Observations

This chapter discusses the results presented under section *Observations Made During Test Sessions* on page 43.

Observation i & ii are a result of problems with the documentation's layout, not content. The video icon (observation (i)) was not found by some users during the test sessions. The button was intentionally put outside of the main flow – out in the margin for it "not to be in the way" for experienced installers (see Ericsson's prerequisites on the solution, section 3.4, page 29). The current design was made with this prerequisite in mind, but seem to have resulted in some less experienced users not finding the feature – users who would likely benefit from it (2/5 persons found the movie, see table 3). If this concept is to be used in the official documentation, it has to be a more prominent button than today, so all users finds it.

Apart from the flaw mentioned above, this feature got a *positive* user feedback,

with a mean value of 7.2 of 10 in the user survey.

Observation (ii) uncovers a possible problem with Ericsson's chosen font for documentations. The lower-case 'L':s and the '1':s are too similar and confused *several* test persons. Ericsson is recommended to review the choice of font and/or re-deign the characters 'l' and '1' to mitigate this problem in the future.

Observation (iii) – The users had issues utilizing Linux command line. All test persons from competence profile BEGINNERS and INTERMEDIATES experienced this problem; all but one, test person eight (see table 3, Note: **PPKS** Sec 3.1, **Step 4**, page 42).

What differed this test person from the rest? Applying *the law of parsimony* [5] (Occam's razor) gives the hypothesis that this test person had prior experience using Linux command line. Something that was not considered when splitting the test persons into competence profiles, but seem to have significant implication on *time of completion* Adding an additional question to the Phase 5 -test session survey, asking about the test users previous experience working with Linux command line, would give the necessary data to draw any conclusions. This is a recommended course of action for possible replications of this work.

Observation (iv) – The test persons skipped or missed several *essential* installation steps. **This result is critical** and this phenomenon needs to be urgently addressed since skipping out on certain installation steps could destroy the whole installation instance. The installer may have to reset the installation and start over – a very expensive measure.

Neither the initial- nor the streamlined instructions specifically mention the necessity of following the instructions meticulously. It has been assumed that the user does this. The results *clearly* indicates this not to be the case and due to the severity of this transgression, appropriate measures need to be taken. Perhaps could a checklist be implemented at the end of each chapter, letting the user do a self-check if he/she has executed all steps. This should be prioritized.

Further, test persons having the streamlined installation documentation (version B) were *less likely* to skip section than the ones having the initial (version A). This might be because of the vast amount of *direct-form* instructions (see section 2), that may disengage the user, making their concentration fade over time.

5.2.3 Survey Results

The survey started with 4 control questions for both test groups – making sure the test persons had the corresponding technical background to their competence group (1, 2, or 3) placement. Furthermore, was the survey only filled out

[5] Assume that the easiest and most likely explanation is the true one

by test persons who had participated in a test session. It was, therefore, ten answers (equal to the number of test persons) in the survey, giving an *implication* on how the features were performing. The survey participants were however too few to draw any conclusive conclusions from the results.

When analyzing survey results, 80 % of the tested individuals with the initial documentation (version A) found it *easy*, 20% found it hard. A majority also stated that these instructions provided the information needed to succeed with the installation steps. In document version B, 60 % thought it was *hard* to follow the instructions and 20 % found it easy to follow the instructions. 20% thought it was neither hard nor easy, see appendix F. The opinions were divided regarding how well the instructions for version B provided the information needed to succeed with the installation steps.

The document version B seemed to perform slightly better than document version A, regarding how clear the instructions were explaining what to do in each step. The test persons also seemed divided in how much aid the illustrations provided, with scattered results from 1 to 10 within the used scale of 1 to 10. This result was a bit surprising with the scientific experiment regarding pictures in instructions for asthma devices in mind, mentioned in chapter 2.3. The illustrations in document version B were highly expected to aid the installer during the test session. One explanation of the results might be that the illustrations were not very helpful to the test persons. Another perspective though, might be that the test persons gained understanding from the illustrations without knowing or thinking about it, since they expressed a need for more illustrations in the survey.

However, the video feature got high scores in the survey. One person did not find the video during the test session, which caused him/her to give a grade of '1' in the survey. This is expressed as a comment in the last question. Two more persons did not find the video during the test session either but chose to watch it after the test session to respond the question in the survey. The other answers regarding the video were more positive and unanimous, with grades of nines and tens. This indicates that the video seem to be a very helpful tool during the installation.

When the test persons were asked on *what could be changed to improve their understanding in the installation documentation*, the answers were divided in opinion. For document version A, the test persons expressed that some instructions left them perplexed, not knowing what to do. They expressed *the lack of* examples and explanations on the actions they were supposed to perform. This does not seem to be the case with the group testing document version B. They expressed a need for *more illustrations* and also stated how the video helped them in the installation. The test persons had the choice not to utilize the video, but all the persons that found it used it for the rest of the test session. Though, the icon which had to be pressed to watch the video could have been more prominent. This is understood when reading the row '**Found Movie?**' in table 3; only 2 of 5 persons found the video.

Some persons with document version B were not able to finish ('DNF') within the given time frame. This might depend on the usage of the 10 minutes long instruction video during the test session. Though, it was noticed that when they used the instruction video, they did not get stuck in certain instructional steps as the individuals with document version A did.

It is hard to draw any general conclusions from the survey, even if some patterns are present. More test sessions are needed to minimize the influence of the test persons' personal traits effecting the results (since there are so few tests, a test person with exceptional skill could give skewed results. With more test this effect is minimized).

Looking at the data in Table 3, it is clear that the new and streamlined documentation (version B) generally takes longer time to conduct than the initial documentation (version A). However, one has to keep in mind that these sessions only evaluate a few instructions in the whole, 1000+ pages-long installation documentation. As said in observation 'iv' above, test persons using document version B (streamlined) were *more accurate* in their execution of the test. This will *likely* in the long run, result in a payback time-wise since dependency errors are a common hurdle for installers (see Appendix C). These errors are also often the most time-consuming ones and they can be avoided if all the installation steps are correctly done the first time.

As a cause of the spreading of the Corona virus during the spring of 2020, only two persons within competence profile PROFICIENTS were able to participate in the test sessions. Though, since the background interviews revealed that the installation process is more difficult to conduct for non experts, the effect of this limitation is not viewed as critical.

5.3 The Usage of Instructions – Outside Ericsson

This master's thesis treated the usage of technical instructions at Ericsson. As written in section 2.3, a variety of instructional strategies and media may be used when creating instructions. The choice of certain instructional methods is, in the end, depending on the specific use case. Some methods suit better when creating instructions for technical installations like the one in this study and other methods suit better when, for example, long memory retrieval is necessary. In this study, the feature 'Video explanation' was discovered as the most helpful for installers during the test sessions. With this feature in mind and the knowledge of future possible instruction media described in section 2.4, a toolbox for instructional learning is created.

The use of videos, *augmented reality* and *artificial intelligence* for learning, e.g. the concatenation of illustrations, audio, and text comes with possibilities and risks. The production of videos clearly consumes more time, involves more people, and also material or props than producing a text document. The creation of instructions in augmented reality may utilize even more resources such as powerful computers. It must be considered that not all products or services

even reach the market - the number of resources put in the video- or other instructions must be carefully planned. It must also be said that the usage of a certain type of instructions does not eliminate the risk of accidents or faulty usage of a product. Choosing video instructions might easier transfer knowledge than some other media but this does not mean the errors will not exist.

These types of instructions unlock a range of possibilities as well. Specialized instructions for learning, which include illustrations, might reduce the room for mistakes when using a product, reducing the number of doubts for the user. This implies both in ethical aspects, reducing the risk of error-handling or accidents among consumers but also the saving of capital when fewer products are broken. Complex systems and artifacts might be provided to a wider range of people if these are explained in a simple way - artifacts which in the end aim to increase peoples' life quality.

6 Conclusions

The aim of this project was to reduce installation time and decrease installation complexity in the installation process for Ericsson's solution *Enterprise Core*. To achieve this, the goal was split into three research questions answered below:

1. ***What are the current hurdles in the EEC installation process?*** A couple of hurdles were identified during the background interviews. The three major ones are presented here being motioned independently, by several interviewees:

   I) There is a confusing documentation structure.

   II) General computer-, networking- and telecommunication knowledge (for example about the Packet Core structure and the 3GPP standard) is required to be able to complete the installation process.

   III) There is no actual verification of installation completion.

   All hurdles are not disclosed in this report, due to Ericsson confidentiality policy.

2. ***How is the EEC installation instruction creators' understanding of the solution installers' needs?***

   The EEC instruction creators and the installers agreed that prior technical knowledge in some areas is needed to conduct the EEC installation. For an unexperienced installer, it might be difficult to conduct the installation without this knowledge.

   The opinions were divided between the instruction creators and the installers regarding the document structure. The instruction creators expressed that the documentation is straight forward, made to be read step by step. The installers felt they had to read between the lines to understand the information. They did not know how to find further information, not written in the installation documentation, if they needed.

   Regarding a confirmation at the end of the EEC installation, the interviewees were in agreement. To know if the EEC has been successfully installed, it is *required* to connect the solution to real traffic at the customer, it can not be satisfactorily simulated.

3. ***How to support the EEC installation process for a more effective deployment?***
   Many routes could have been taken to further support the EEC installation process. In this thesis, a prototype of new and streamlined installation instructions were constructed and presented. The prototype takes the identified hurdles in the initial installation documentation into consideration and gives solution suggestions to these. The new instructions utilizes features such as tutorial videos and illustrations. During the test

sessions, it was not clear if these instructions reduced the installation time but they seemed to decrease installation complexity. An additional system overview documentation called *Installer's Handbook* was also provided to further support the installer during the EEC installation process. In the test session of the streamlined installation documentation prototype, the feature 'Video' was shown to be the most helpful for the users.

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Winston, Patrick H. (Dec. 1980). "Learning and Reasoning by Anology". In: *Communications of the ACM* 23 (12), pp. 197–202. DOI: 10.1145/359038.359042.

A Interview Questionnaire - Installers

1. What is your background? Education, telecom experience, work role.
2. How experienced are you with the EEC installation process?
3. What was your initial thoughts when you got the installation material (manuals, files etc.)?
4. What knowledge would you say a **new**, non-telecom experienced EEC installer needs to know before taking on the EEC installation?
5. Have you experienced any hardships while installing EEC?
   (a) If so:
   Why do these problems occur and in what shape?
   (b) Do hardships occurs systematically?
   (c) Who gets affected by poor installation instructions?
6. What is good about the installation material of today?
7. How much time did it take to complete the installation? If you didn't finish, how far did you come?
8. How did you verify installation completion? Definition of done?

B Interview Questionnaire – Writers

1. What is your background? Education, telecom experience, work role.
2. How experienced are you with the EEC installation process?
3. What knowledge would you say a **new**, non-telecom experienced EEC installer needs to know before taking on the EEC installation?
4. Have you experienced/heard about any hardships in the installation process?

   If so:

   (a) Why do these problems occur and in what shape?

   (b) Do hardships occurs systematically?

   (c) Which is the intended target group of the installation instructions?
5. Any lessons learned from writing the installation process?
6. What do you want to point out as current strengths in the installation instructions?
7. How were the installation time estimations estimated and how were they verified?
8. Is their any way to verify installation completion? Definition of done?

C Phase 1 - Empathise

Since the interviews were held in swedish, both the original and the translated quotes are shown below. The quotes written below are comments which had significance when Defining Project Scope (see section 4.2). Though, these are only some of the interview answers, other answers were considered being of less significance or contained Ericsson confidential information and thus not written below.

1. **The document structure is confusing. There is a deep document hierarchy with a lot of cross referencing.**

   " Det som jag tycker, det [författarens anteckning: dokumentationen] var väldigt splittrad, det var svårt att veta vart man skulle gå nånstans. Det fanns ingen jätteklar röd tråd genom materialet."

   " What I think, it [Author notes: the documentation] was very scattered, it is hard to know where you're to next. There was not a really clear path through the document. "

   – Senior Solutions Engineer

   " De [författarens anteckning: dokumentationen] var kanske bra för någon som redan är insatt [författarens anteckning: med installationsprocessen]; för oss var det inte så. Det fanns ett översiktsdokument som jättegärna refererade till andra dokument hela tiden. Och det förstår man ju att det måste vara så kanske, men det var verkligen ett hoppande mellan olika dokument som vi hamnade i. Gärna flera nivåer av referenser."

   " They [Author notes: the documentation] were good for someone who is familiar [Author notes: with the installation process]; but for us that weren't the case. There was an overview document, which gladly referred to other documents all the time. And you might understand why that's the case, but it was really a jumping between documents in which we were thrown. Often multiple-level references. "

   – Summer Intern

   " Det är mycket såna här länkar till befintliga dokument, CEE existerar under CEE-dokumentation för mer information. Som helt ny så, det har

hänt mig med, man läser typ ett dokument, så finns det massor med referenser till andra dokument som du kanske inte kan få tag i. Länkarna är inte helt klara, står bara ett dokumentnummer, hur ska du få tag i det här dokumentet?"

" There are many of these links to existing documents, CEE exists under CEE-documentation for further information. As a completely new, it has happened to me as well, you are sort of reading a document, and there is a bunch of references to other documents which you perhaps have no access to. The links are not really completely, there is just a document number, how are you supposed to get access to this document? "

– Solution development Engineer

Examples of confusing document structure in initial installation documentation for the EEC-solution, e.g. cross referencing, are shown in figures below.

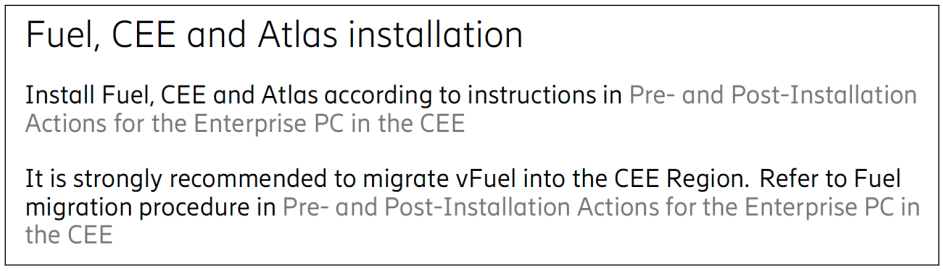


Figure 3: Subsection 5.2 in 'Enterprise PC Installation Overview' referring to 'Pre- and Post-Installation Actions for the Enterprise PC in the CEE'.

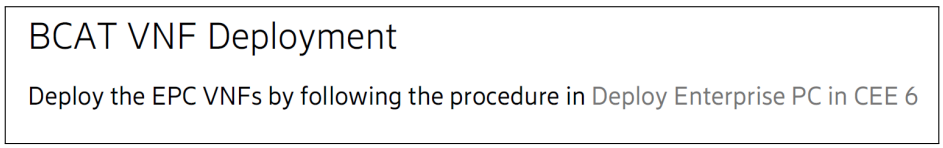


Figure 4: Subsection 6.3 in 'Enterprise PC Installation Overview' referring to 'Deploy Enterprise PC in CEE 6'.

2. **The installation documentation assumes that the installer has a**

lot of prior knowledge (IP networking, 3GPP, etc) when executing the installation.

" Om man tittar på hur vi designar våra produkter idag och hur vi förutsätter att man [författarens anteckning: installatören] ska ha en kunskap innan man kan jobba med det här [författarens anteckning: installationen av EEC]. Då är det ju, jag skulle vilja säga: det är omöjligt att ge sig på en Enterprise Core installation så som den ser ut idag, utan att gå igenom en massa vanliga kurser i form av att; du måste lära dig Packet Core, du måste lära dig UDM, du måste ha koll på hur 3GPP har tänkt sig att saker ska fungera mellan varandra. Sen när vi kommer in i Enterprise Core så använde man sig av en cloud deployment, så du måste lära dig om OpenStack, du måste lära dig om CEE... och då är det ju så att vi använder oss inte av alla kapabiliteter av en cloud deployment. Men så fort du börjar använda dig av termer som är naturliga där, så måste du förstå vad de betyder."

" If you look at how we're designing our products today and how we assume that you [Author notes: the installer] are having a pre-knowledge before you can work with this [Author notes: the installation of the EEC]. Then it is, I want to say impossible to tackle an EEC installation as it looks today, without going through a lot of courses such as: you'll have to learn Packet Core, you'll have to learn UDM, you must know how 3GPP have thought things should work between each other. Then, when we enter Enterprise Core, you used a cloud deployent, you have to learn OpenStack, you have to learn CEE...and then there is the case that we does not use all capabilities of a cloud deployment. But as soon as you start using terms which are natural there, you have to know what they mean. "

– Product Management

" En del är liksom, min erfarenhet är att många [författarens anteckning: ingenjörer] som sitter och installerar de här grejerna [författarens anteckning: EEC] ute hos kund och mer dagligen är ju just, jag tror inte det är många som löser det på egen hand. En stor del i att faktiskt lyckas [författarens anteckning: med installationen] är att ha ett gott kontaktnät [författarens anteckning: människor på Ericsson] och veta var man ska vända sig."

" Some are like, my experience is that many [Author notes: engineers] sitting and installing this stuff [Author notes: the EEC] at the customers', more on a daily basis is... I don't think many solves it by themselves. A big part in succeeding [Author notes: with the installation] is to have a

good network of people [Author notes: people at Ericsson] and know where to turn."

– Senior Solutions Engineer

" Intervjuobjekt: Ja, du bör ju kunna hur du installerar en server från scratch....Det som krävs av oss är att få servern och boot att installera CEE. Det är väl den processen man ska kunna. Man ska kunna lite hårdvara, hur man får servern att boota från nätet och ladda en image, eller hur man installerar CEE då...

Intervjuare: Men det är ingen ämnesspecifik kunskap?

Intervjuobjekt: Nä, du bör veta hur du sätter upp det, kopplar in det i samma switch, och vet hur man konfar portar och switchar på samma WLAN och har lite hum om hur PXCboot eller DHCP fungerar."

" Interview object:Yes, you should know how to install a server from scratch...What is required from us is to get the server and boot to install CEE. That is the process to have knowledge about. You are supposed to know some hardware, how to get the server to boot from the internet and load an image, or how to install CEE...

Interviewer: But that is no subject specific knowledge?

Interview object: No, you should know how you set it up, connect it to the same switch, and know how to configure gates and switches on the same WLAN and has a bit of understanding about how PXCboot or DHCP works."

– Solution Development Engineer

Examples in the initial installation documentation where prior knowledge might be necessary to execute the EEC installation, are shown in figures below.

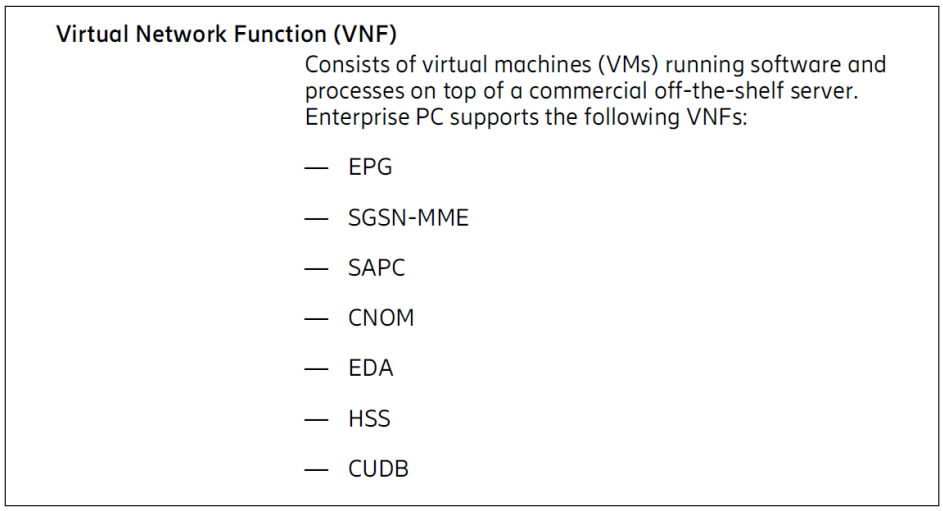


Figure 5: Subsection 2.1 in 'Enterprise PC Installation Overview' presenting included Virtual Network Functions (VNF:s) in the EEC -solution.

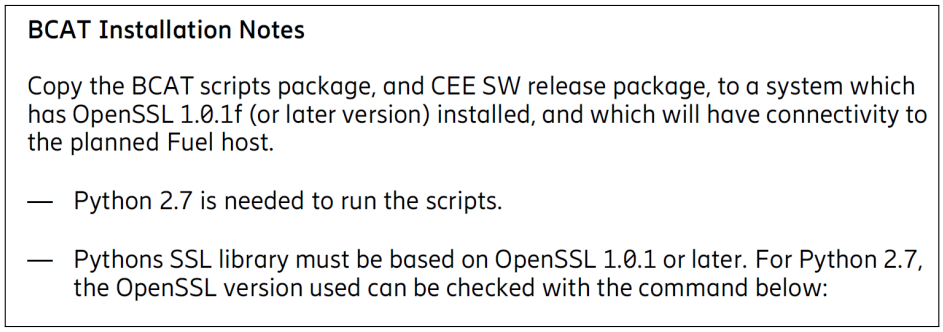


Figure 6: Subsection 2.3.1.1 in 'Pre- and Post-Installation Actions for the Enterprise PC in the CEE' presenting terms as software as OpenSSL, Python and Pythons SSL library.

3. **The verification of various technical parameters is poor and there is no installation confirmation unless traffic is run on the deployment.**.

   " Det [författarens anteckning: installationsverificationen] är väl en sak som är lite bristfällig generellt för vår dokumentation. Nu vågar jag inte svara om det är så specifikt för Enterprise Core men en healthcheck efteråt är generellt sett inte så starka, så svårt och veta om allt är okej. Oftast

tycker jag i våra kurser att våra mått på grejerna när vi skickar trafik på grejerna... Oftast vill man inte ha det upplagt sådär att man måste säga till kund "vi tror det är klart, koppla gärna in den här och resten av miljön så hoppas vi trafiken går igenom, gör den inte det får vi koppla ur den igen"."

" That [Author notes: the installation verifications] is a thing which is a bit insufficient in general about our documentation. I can't say if it is specific for Enterprise Core but the healthchecks afterwards are in general not so powerful, it is hard to know if everything is OK. Usually in our courses I think that our measurements on the stuff, when we send traffic on them... Most usually you don't want to have it organized in a way that you have to tell the customer that: "We think it is completed, connect this and the rest of the environment and let us hope the traffic passes, if it don't we must disconnect it again"."

– Senior Solutions Engineer

" Intervjuare: Vet man också att dom [författarens anteckning: VNF:erna] pratar på korrekt sätt, är det nåt sätt ni testar det, eller kör ni trafik mellan dem? Att VNFerna pratar med varann?

Intervjueobjekt: Det enda sättet är ju och köra trafik, vi har ju ett separat team här, SWDP, de satt där ni sitter nu men flyttade bort."

" Interviewer: Do you also know that they [Author notes: the VNF:s] are talking in a correct way, is their any way you test it, or do you run traffic between them? That the VNF:s talk to each other?

Interview object: The only way is to run traffic, we have a separate team here, SWDP, the sat where you are right now but they moved away."

– Solution Development Engineer

" A: Måste du köra riktig trafik i slutändan för att veta om allt stämmer?

B: Öööh, ja. Sedan kan du verifiera alla delar i sig, men du kan inte testa end to end utan att köra riktig trafik. I och med det, här är ju inget, normalt sett kan man ju testa men man inkapsulerar ju saker och liksom, det är ju inte en sladd, det är ju massa delmål hela tiden. Allt måste verkligen passa ihop."

" Interviewer: In the end, do you have to run actual traffic to know if everything is correct?

Interview object: Eeeehm, yes. You can verify all the parts themselves, but not test end to end without running real traffic. And with that, here is nothing, normally you could test but after all, but you encapsulates things and like, it is not a cord, it is a lot of milestones all the time. Everything really need to match. "

– Solution Development Engineer

Example in the 'Customer Questionnaire'- documentation where where various parameters are being inserted, are shown in the figure below.

Subrack used by Fuel - cee_subtrack_ctrl_sp			
Fuel IP Address/ Mask bits		[redacted]	Fuel IP Addr in the subrack management network.

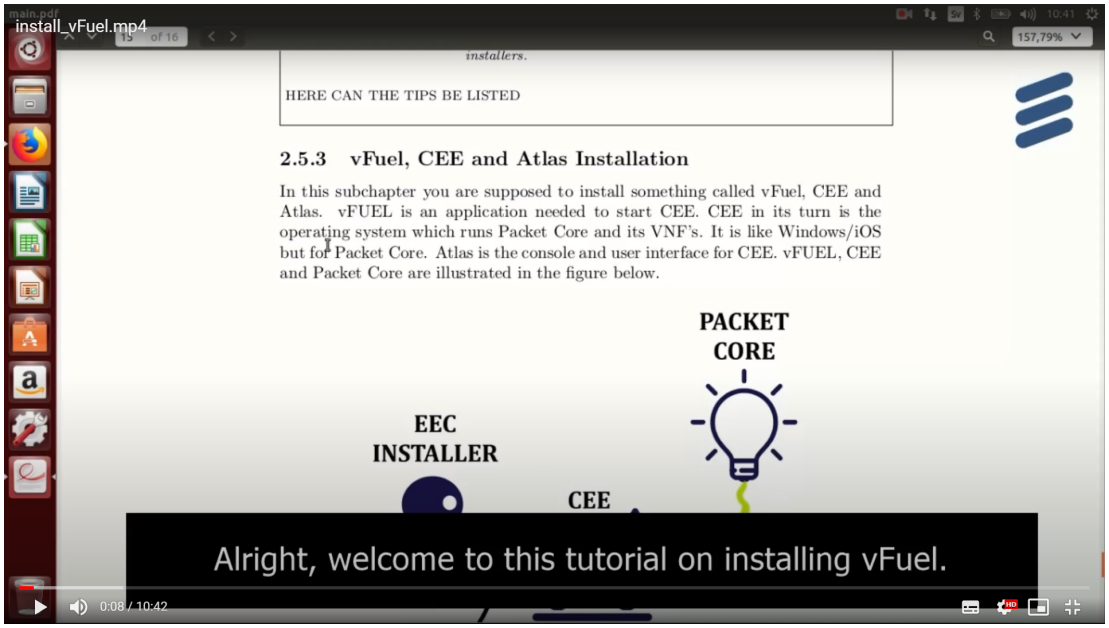
Figure 7: Subsection 1.2.1 in 'Customer Questionnaire for Enterprise PC' presenting a value being inserted by customers.Column 1 is the parameter, column 2 is the customer's value, column 3 is an example value and column 4 is a description. There is no verification on how the customers may know that their customer's value is correct in the installation of the EEC-solution.

D Phase 3 - Ideate

Attached below are features created in Phase 3 - Ideate.

A) Feature: Glossary A feature that explains specific words and abbreviations to simplify an installer's understanding of the installation documentation.

B) Feature: Video explanation A short video explaining terms or notions when further/deeper explanations are needed.



C) Feature: Help icons To have help icons when questions might arise. The installer may click or hoover with the mouse pointer on these for further information. Example of help icons are a "Question mark", or a "Video button", see appendix D. This is to make the text document more user friendly.

(a) Open video button

(b) More information

(c) Jump to other CPI

Figure 8: Implemented help icons

D) Feature: Concatenating documents Concatenation of several installation documents into a single document – collocating installation information.

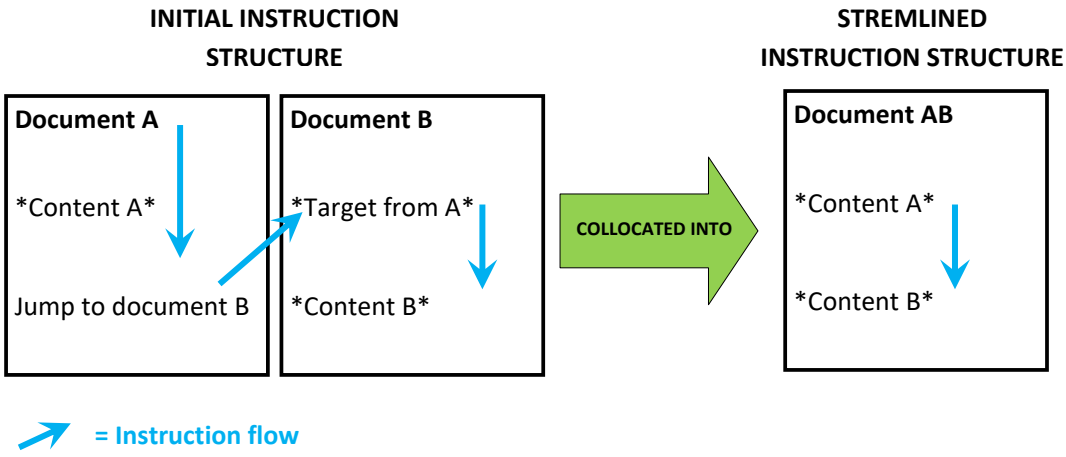
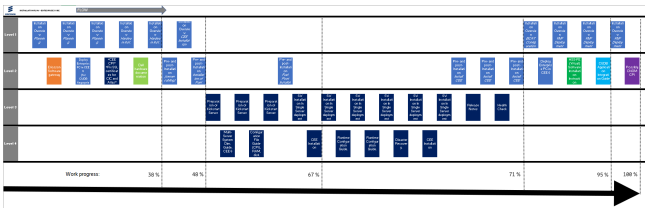
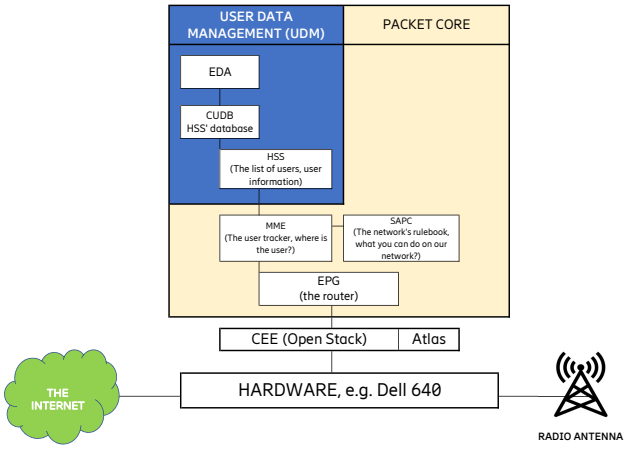


Figure 9: An illustration showing the concatenation of several documents into a single document

E) Feature: Including illustrations Input explanatory illustrations into the instructions to simplify the installation process for the EEC installer.



(a) An image illustrating the work flow in the initial documentation.



(b) An image illustrating a system overview explanation of the Enterprise Core solution.

Figure 10: Implemented illustrations

F) Feature: Text editing Editing, removing, further explaining or moving text blocks to simplify the installation documentation.

G) Feature: Including documents for further help To provide the installer with general information as further help when the installation documentation is not enough.

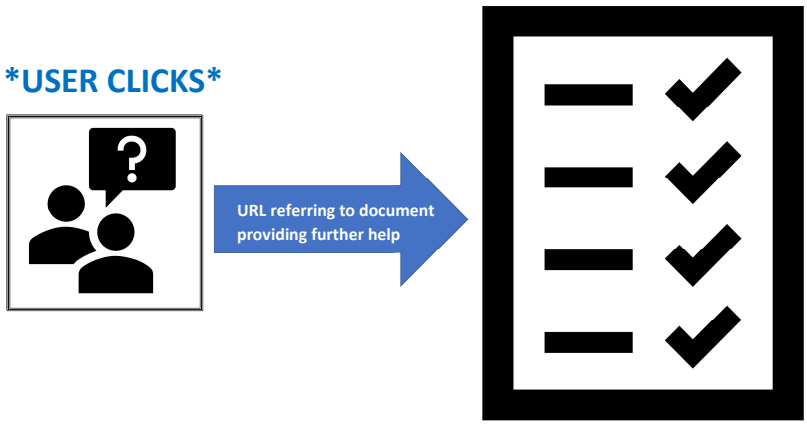


Figure 11: When the icon is pressed, the installer is referred to an additional document providing further information.

H) Feature: Creating learning material for enhanced prior installation knowledge Some technical areas are good to know and be oriented within *before* trying to install the Enterprise Core. This document is aiming to provide and train the installer in this basic technical information.

Figure 12: A created document providing further help for the installer - *'Installer's Handbook'*.

I) Feature: Include error message explanations Explain why there are certain error messages when installing the EEC and explain what they actually implicate.

J) Feature: Software version control A feature to make sure that the installer always uses the correct software version – minimizing compatibility issues during installation.

K) Feature: Jumping CPI helper A text box explaining when and why the installer needs to jump in between documentation libraries (CPIs).

TIME TO MOVE TO ANOTHER CPI

You have now come to a part in the installation where we have to refer you to another Ericsson product's CPI.

Why is this?

Ericsson Enterprise Core is a complex product made up by several other Ericsson core products, such as CEE and MME. For documentation maintenance reasons, we cannot describe the whole installation process here, hence is the appropriate CPI linked below. We will of course do our best to help you get through it, and are doing so by giving you some tips and tricks when reading the CPI. Also the whole installation process of vFuel and CEE can be viewed in its entirety when done by one of our professional installers.

Tip when installing vFuel: make sure to install the *exact* version of the Linux packages stated in the CPI

Figure 13: A text box and illustration explaining when the installer needs to continue reading in another document.

E Phase 4 - Prototype

Attached below are images from the two document prototypes 'Conceptual Manual' and 'Installer's Handbook'.

E.1 Conceptual Manual

Shown below are images from the Conceptual Manual, e.g. the created prototype with applied concepts from Phase 3 - Ideate.

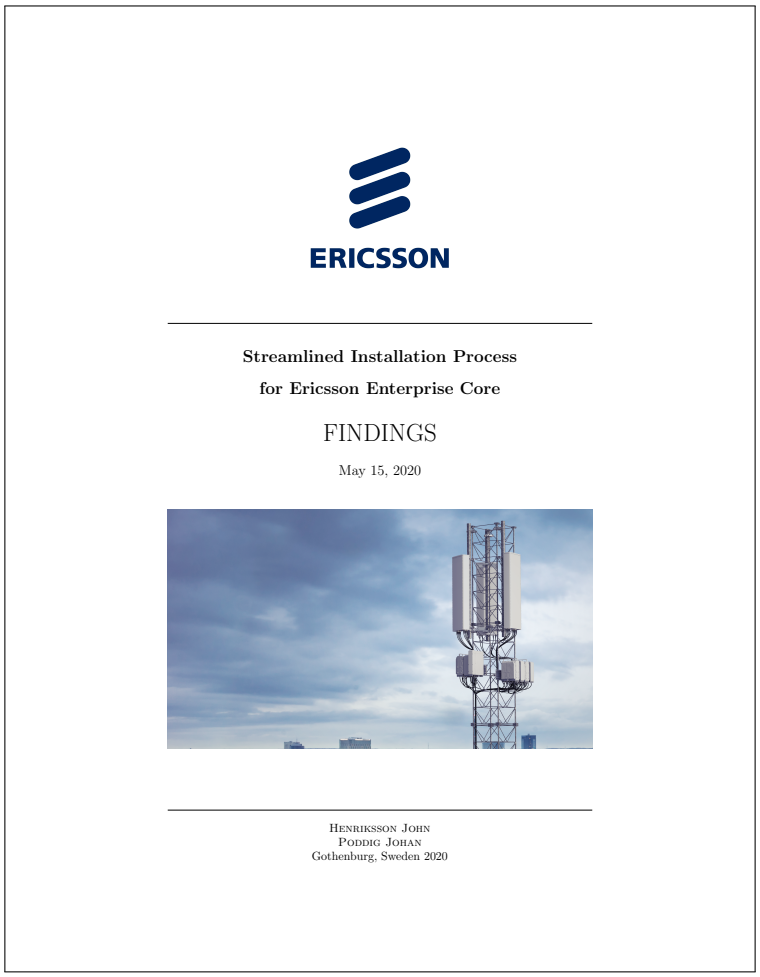
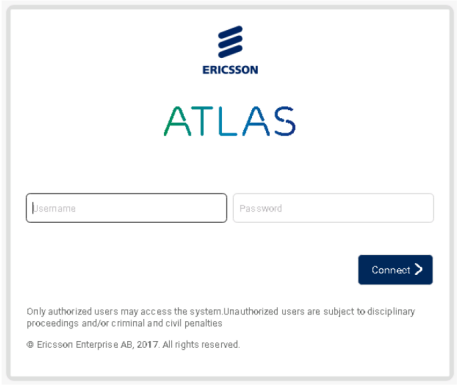


Figure 14: The image is showing the frontpage of the created prototype 'Conceptual Manual'.

2.3.1 Terminology

- **Atlas**
  Atlas is a console and the user interface for CEE.



- **Box Cloud & Automation Tools (BCAT)**
  A collection of scripts for configuring and deploying Enterprise PC.

Figure 15: Section 2.3.1 - Terminology. The image shows Ericsson CEE user console *Atlas* being explained in the Terminology chapter.

Simplified installation:
The simplified installation is the recommended installation procedure, optimized for quick EPC configuration and deployment. This installation will result in the Basic Enterprise PC Setup, described in *Enterprise PC Overview*.

Advanced installation:
The advanced installation is used when the Basic Enterprise PC Setup does not match the customer requirements. The BCAT EPC configuration file is prepared manually, which provides more flexibility when defining parameters for the VNFs.

Note: After CEE update or upgrade, the pre/post configures specific by Enterprise PC might not kept, please check and redo all the steps.

Should I use the Simplified or Advanced installation?

Figure 16: Section 2.3.2 - Installation Procedure. The image is showing the feature 'Help Icon'. If the installer hoover with the mouse pointer on the help icon, an information box with further information is shown.

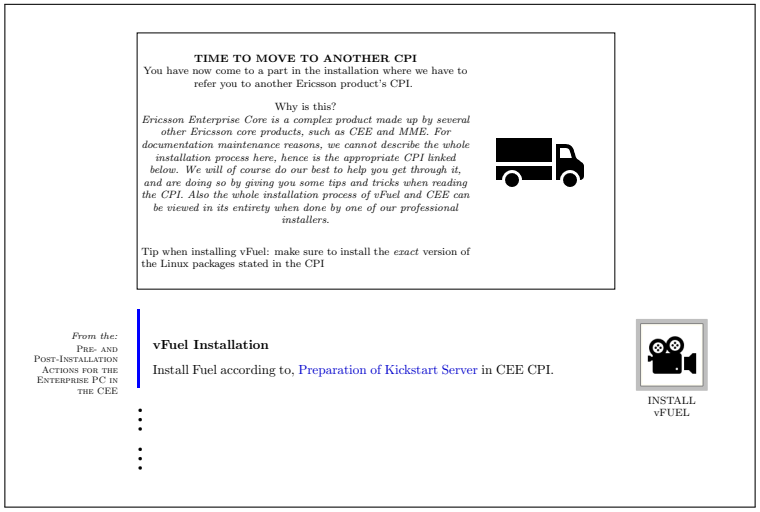


Figure 17: Section 2.5.3 - showing the applied feature 'Jumping CPI helper' and 'Help Icon Button'. When the help icon is pressed, the installer gets redirected to an information video about the certain section.

E.2 Installer's Handbook

Shown below are images from 'Installer's Handbook, e.g. the created prototype with applied concepts from Phase 3 - Ideate.

Figure 18: The image shows the front page of the created document called 'Installer's Handbook'.

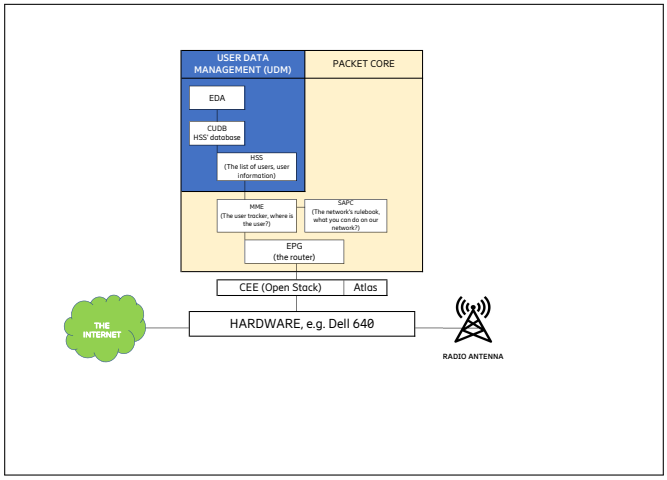


Figure 19: The image shows a system overview explanation and a created illustration of the Enterprise Core solution structure.

F Phase 5 - Test Session Survey Results

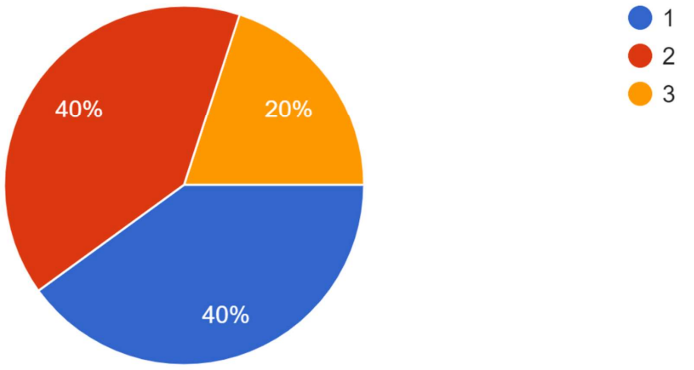
Shown below are results from the test session survey: document version A and B. Document version A is the initial installation documentation, document version B is the streamlined installation documentation.

F.1 Test Survey - Version A

Shown below are results from the test session survey - version A.

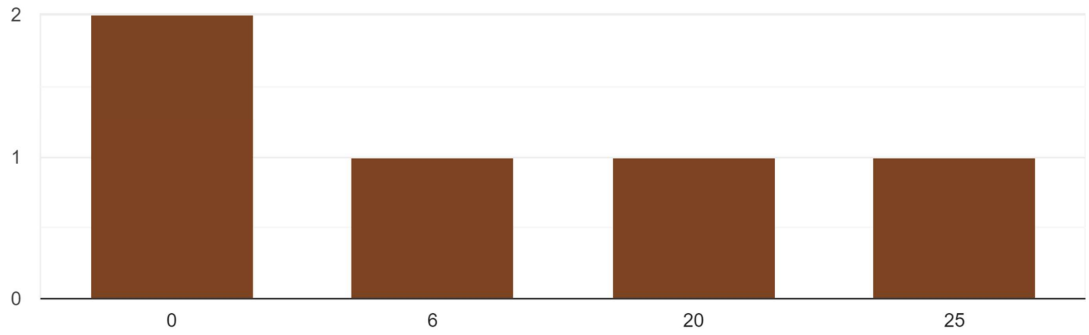
What group are you belonging to? Your test leader will tell you this.

5 svar



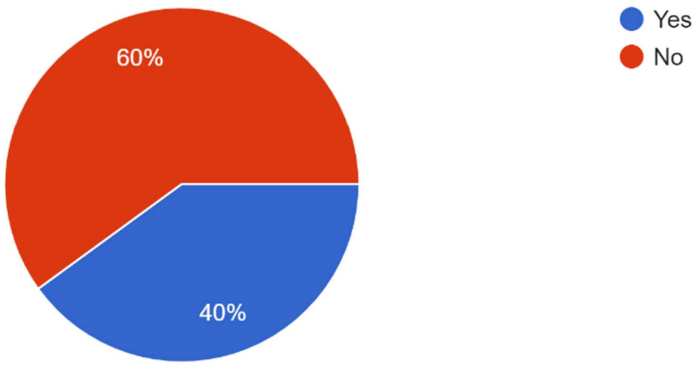
How many years of professional experience do you have with IT/Data communication? Relevant education at university level counts.

5 svar



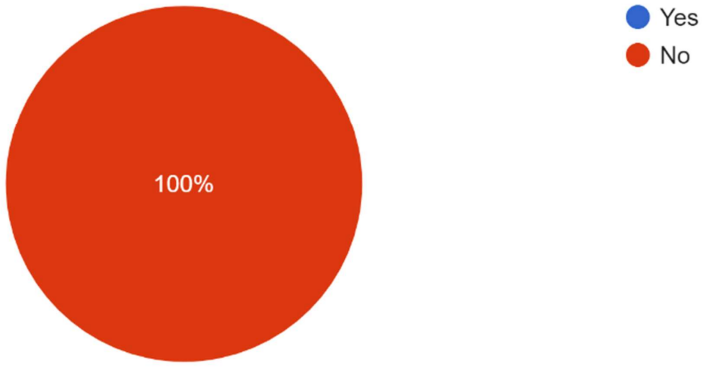
Have you been employed at Ericsson for 3 years or more?

5 svar



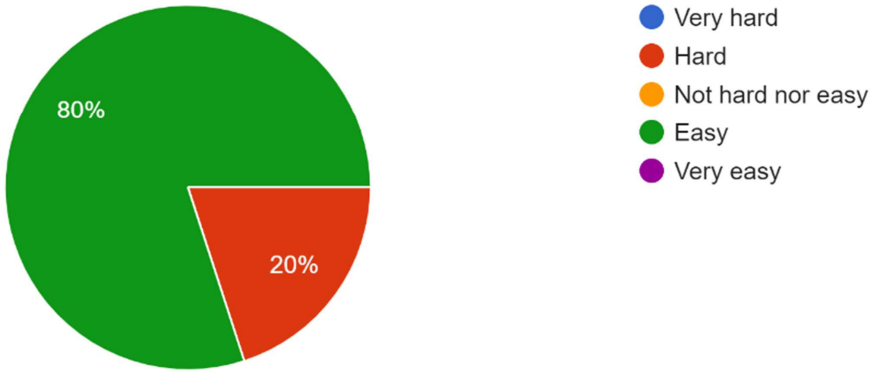
Have been working with Ericsson Enterprise Core for at least 1 year?

5 svar



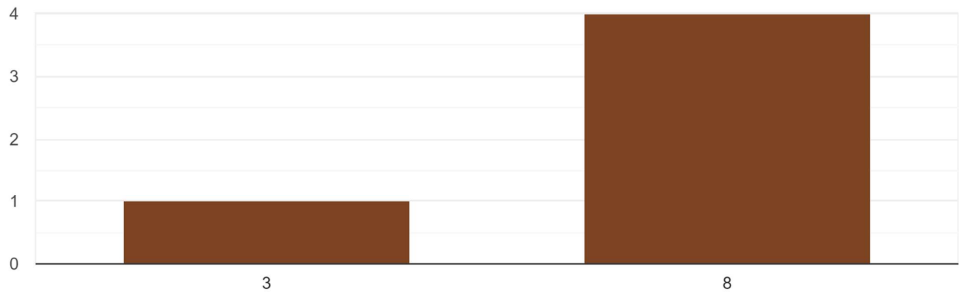
How easy was it for you to follow the installation steps in the documentation?

5 svar



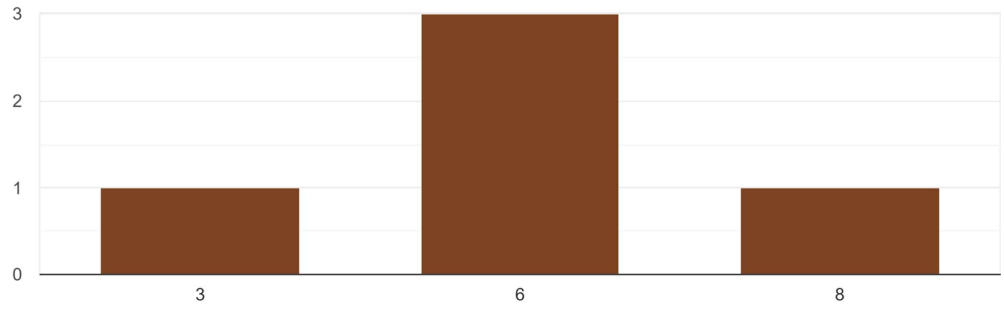
With a value 1-10, where 1 is the lowest and 10 is the highest: Rate how well the documentation was intuitive. Did it provide all the information/data necessary to succeed with the installation steps?

5 svar



With a value 1-10, where 1 is the lowest and 10 is the highest: Rate the clarity of the text, explaining what you were supposed to do in each installation step?

5 svar



What could have been changed or implemented in the documentation to improve your understanding?

- WTF does "change root shell" mean? And would it be possible to suggest a oneliner for the user to check/install packages, along with an explanation of the expected output? Like: packages=(python-yaml python-netaddr ruby libvirt-bin genext2fs virtinst qemu-utils qemu-system-x86 qemu-kvm sshpass vlan); for p in ${packages[@]}; do dpkg -l | grep $p; done Actually, why even check? Maybe just apt install $packages

- Some more explanations about version handling and actions

- Steps 3a and especially 3b were unclear, 3c was easily understandable. grep command responded in different ways or didn't respond at all. I was unsure of what version was installed or if it was installed at all. All in all everything turned out well however.

- Simplifying the steps with examples how to do them

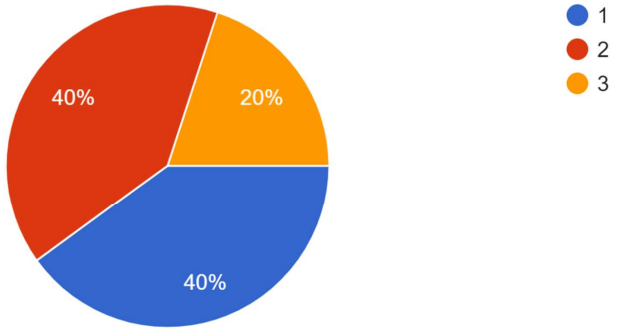
- Less references would be better

F.2 Test Survey - Version B

Shown below are results from the test session survey - version B.

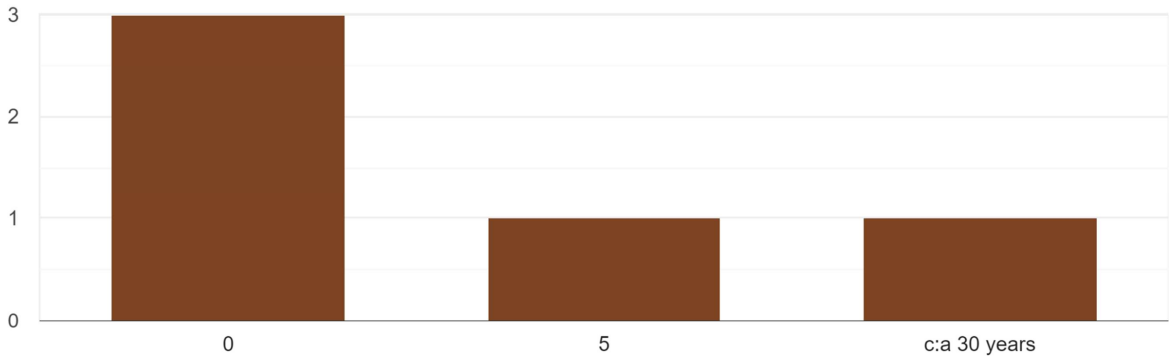
What group are you belonging to? Your test leader will tell you this.

5 svar



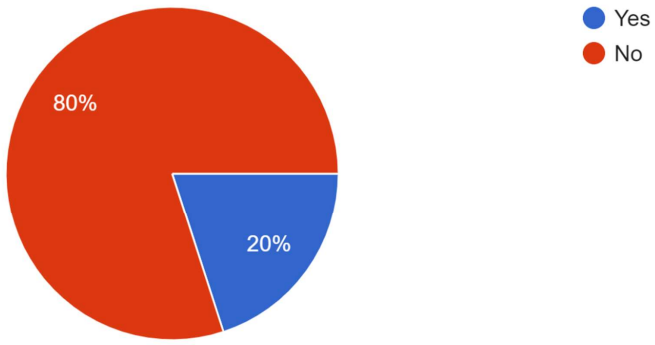
How many years of professional experience do you have with IT/Data communication? Relevant education at university level counts.

5 svar



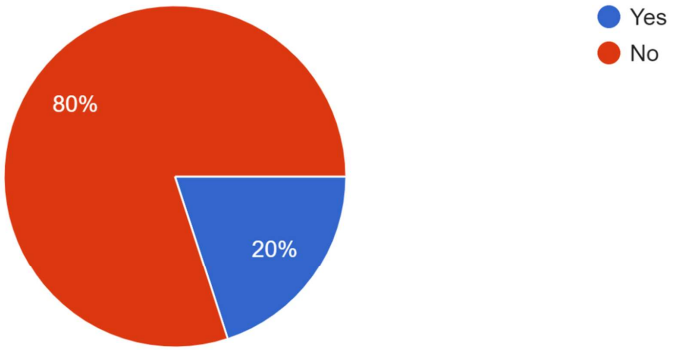
Have you been employed at Ericsson for 3 years or more?

5 svar



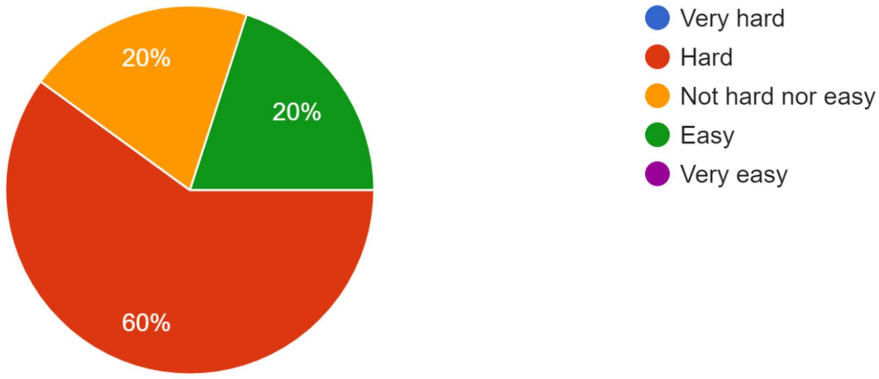
Have been working with Ericsson Enterprise Core for at least 1 year?

5 svar



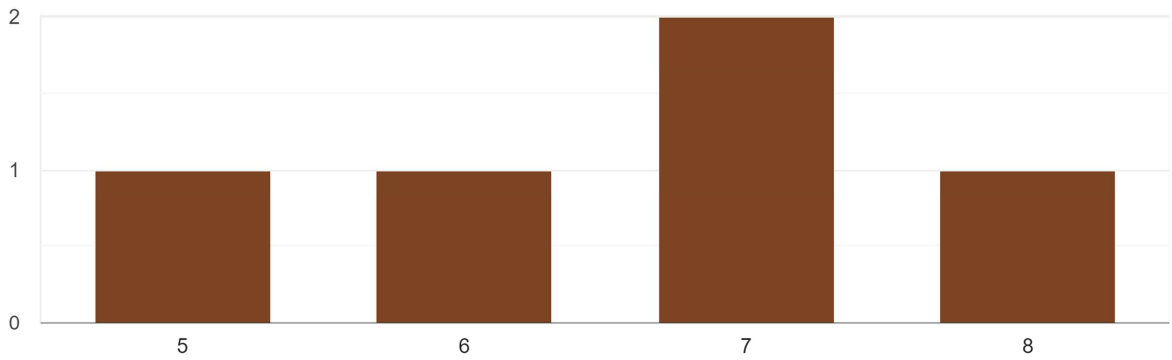
How easy was it for you to follow the installation steps in the documentation?

5 svar



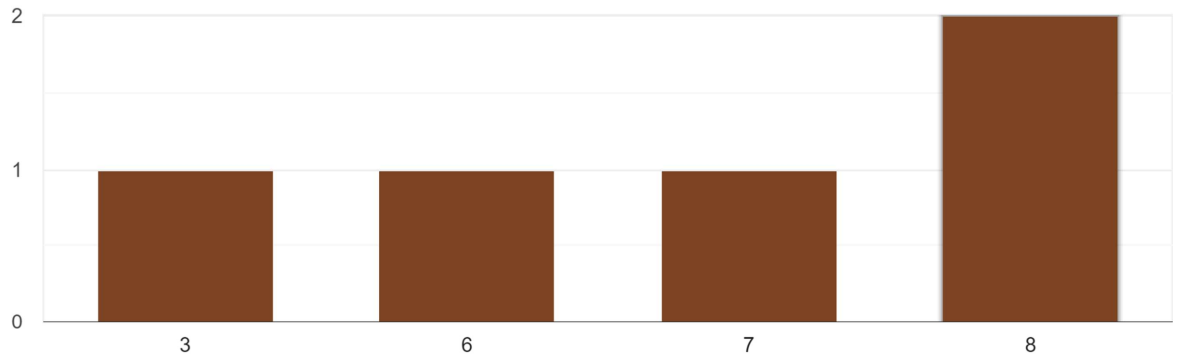
With a value 1-10, where 1 is the lowest and 10 is the highest: Rate how well the documentation was intuitive. Did it provide all the information/data necessary to succeed with the installation steps?

5 svar



With a value 1-10, where 1 is the lowest and 10 is the highest: Rate the clarity of the text, explaining what you were supposed to do in each installation step?

5 svar

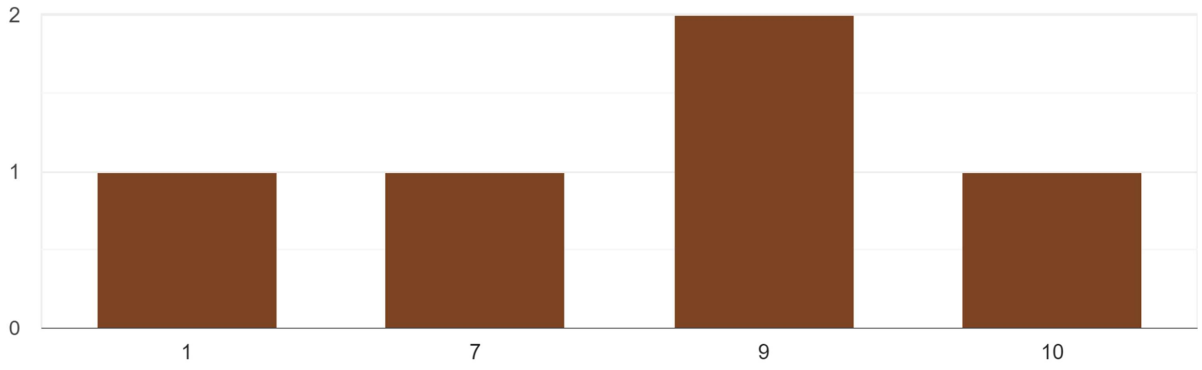


With a value 1-10, where 1 is the lowest and 10 is the highest: Rate how well the pictures helped you with your understanding of the installation process.

- 7
- 10
- 1
- 5
- 4

With a value 1-10, where 1 is the lowest and 10 is the highest: Rate how well the video helped you with your understanding of the installation process.

5 svar



What could have been changed or implemented in the documentation to improve your understanding?

- There is always good to have a note regarding the target group for the document. This specifies the knowledge needed to follow the instructions.

- Didn't see any video, therefore value 1. It could have been must more describing so you don't have to sit and guess. For example use the package from the table below.

- The written documentetation under section 3.1 could have been complemented with screen shots. I would prefer the lines of code in the written text to be a screen shot rather than printed text becuase in my case i misinterpreted the "dkpg -l" in the documentation to be "dkpg -1" which cost me a lot of time. What I also think should be done is for the system to give more feedback to the commands that are typed. For instance, if the video hadn't told me that an empty output is equivalent to a not installed package, I wouldn't have had any clue if my command had been processed at all from simply reading the written instructions under section 3.1. About the video: The icon could have been placed more centrally in the document or been highlighted or referred to in some case that the user is given an option, either to choose written instructions or video instructions. At first i missed the recording symbol and I don't think there was anything telling me that it was actually a hyperlink hidden in the camera picture that I could click on that would direct me to the video, so something that would've emphasized that would I prefer. I don't now if this is applicable either but instead of forcing the installer to check if all packages are installed, I think that a lot of time could be saved by consolidating a lot of the packages so that only one installation would be required. It's very time consuming to go through the different packages individually.

- Maybe a guidline saying that it is easiest done by clicking the video, I did not find it at first.

- dont know