

## Scenarios and use cases in innovation prototyping of VHO Play

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### Abstract

The paper is based on the Innovation prototyping for vertical handover project (VHO project) of Ericsson, TeliaSonera, Radionet and Helsinki University of Technology. The innovation prototyping methodology of PM&RG is applied and enhanced in the project. The core of the methodology is information management that allows experts to collaborate and share information. Use cases and scenarios are proposed as a promising approach for brokering design viewpoints and capturing the rationale for service development. Although use cases and scenarios appear to be familiar tools for software, mobility management and user interface designers, it has been found that successful utilization of them is not obvious. Therefore it is necessary to capture definitions and best practises for applying use cases and scenarios in the collaborative service development. This paper uses the VHO Play prototype as a case study to explain the modelling framework of innovation prototyping methodology. The development of the VHO Play prototype was triggered by the need to carry out initial user studies on vertical handover enabled services in the very early stage, i.e., prior to having a real vertical handover enabled application to experiment with. The paper explains how use cases and scenarios were used as means for brokering between the different experts in order to define an experimentation setting to allow user study with the mimicking VHO Play prototype. A mimicking prototype only represents the features of a real prototype without real functionality or simulation of the real prototype.

### 1 Introduction

The VHO project is a collaborative project of Ericsson Finland, Helsinki University of Technology, Radionet and TeliaSonera. The aim of the VHO is to realize real-time multiaccess in heterogeneous networks. This enables a user to utilize several networks (such as WLAN, GPRS, UMTS) in parallel. Vertical handover allows the application services to be seamlessly transferred between different networks.

The results of the project include functional solution that provides vertical handover capability in a real-time multiaccess heterogeneous network. Furthermore, the development of innovation prototypes and innovation prototyping methodology and the application development documentation are also included.

In the project the innovation prototyping approach of PM&RG is extended with practices and features that in particular support development tasks related to the network and IP level. Methodologies that are researched include modelling tools to capture and structure data and methods to model experimentations, scenarios and use cases.

The challenge of developing mobile and ubiquitous services for future lies in being able to predict potential user needs in future environments. Observation and other user study methods applied on current users are insufficient for discovering what kind of needs will appear and how well users will

accept service features in the future conditions and contexts. The objective of VHO project is to experiment vertical handover enabled services. However, even product developers and experts are not yet able to comprehend the ultimate effect of simultaneous multi-access.

The research in VHO project is rather problem oriented than solution oriented. In particular, the development of services concerns the understanding of the characteristics of vertical handover enabled services. Only after the problem is well understood it will be possible to concentrate on evaluating the different solution possibilities. Therefore, the project decided to implement an experimental prototype that runs without the vertical handover environment, only mimicking it. This prototype realised in parallel with the implementation of the first vertical handover enabled demonstration.

An important objective of the VHO Play was to reach common understanding of the VHO research team and to focus its work properly. It was a concrete demonstration that allowed the team to check that the network, mobility management, application programmers and usability researchers were working on the same topic and had consistent objectives. VHO Play allowed studying and defining the problem in order to combine the viewpoints of different experts. Furthermore, it allowed running the first initial usability tests. In this stage, the usability tests were used to determine the requirements for future actual prototypes and experimentation settings for usability studies.

The second chapter discusses modelling framework of innovation prototyping, the third chapter discusses how vertical handover was comprehended with use cases, the fourth chapter explains about scenarios made for VHO Play prototype and the fifth chapter consists of the rationale gathered during the design process.

## **2 Modelling framework of innovation prototyping**

The innovation prototyping approach and methodology are here explained with an example that shows how the pre-product development may progress when the starting point is a potential new technology and the objective is to facilitate usability viewpoint to affect already the technology development stage. The focus is on the utilization of scenarios and use cases as means for brokering between the different objectives, methods and ontologies of experts. In particular, the examples allow comparing and relating use cases and scenarios written from the viewpoints of application programmers and usability experts.

The VHO Play development was chosen as a running example for this paper, since it illustrates clearly the need of means for brokering the viewpoints of usability and prototyping experts. In this case the service idea generation was launched by the expected availability of new network facility, i.e., vertical handover that allows the application to utilize different networks without restarting the device or application. The objective for designing and implementing VHO Play was to allow experimentation of user's viewpoint to future vertical handover enabled services. Notice, that the particular challenge was that both the target service and gadget were still undefined. In particular, the objective at this stage was to determine some interesting features to give a rationale for selecting what kind of services or gadgets might be promising directions for future experimentations. Figure 1 shows a compressed rough view of the following development stages that lead to the definition of the VHO Play experimentation setting and usability study methods:

1. Use cases from the viewpoint of application development
2. Interpretation of the use cases according to the usability interests
3. Scenario describing the user study
4. Scenario written from the viewpoint of the end-user
5. Plan for the VHO Play prototype

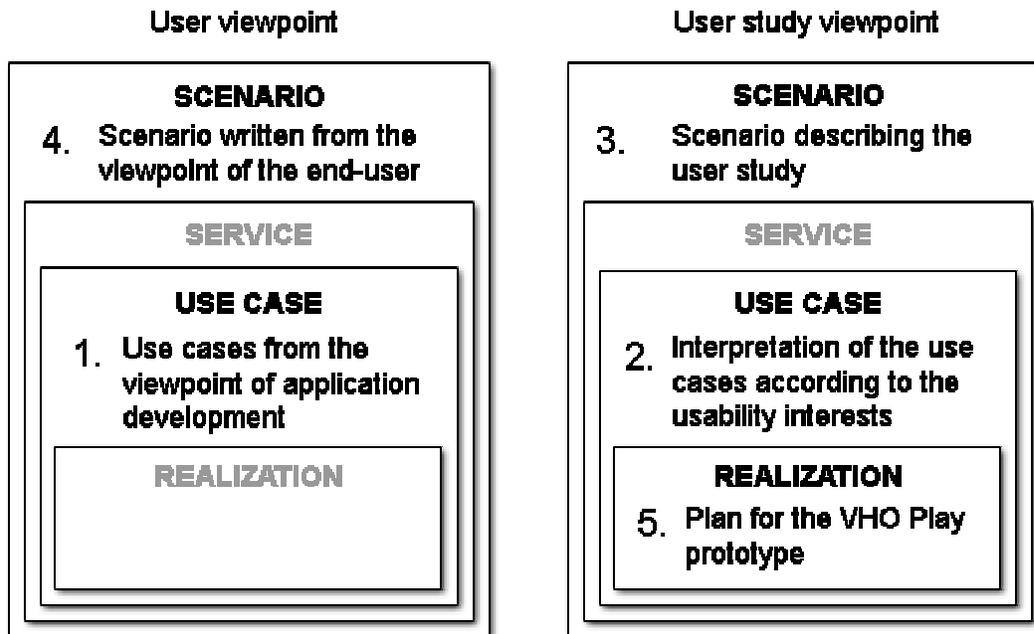


Figure 1 - Development stages of the VHO Play experimentation setting

The stages are explained in the following starting from the two use case types, then proceeding to the two variations of scenarios and finally we present few implications to the realisation.

### 3 Comprehending vertical handover with use case

There exists numerous definitions for uses cases and everybody has at least an intuitive understanding of their meaning. For example, Rumbaugh gives a compact definition as “The specification of sequences of actions that a system, subsystem, or class can perform by interacting with outside actors” (Rumbaugh et al. 1998). Their purpose is “to define a piece of behaviour of a [system or subsystem or class] without revealing the internal structure of the [system]”. The origins of use cases are in software engineering where they are typically defined as interaction between a user and the computer system. In the innovation prototyping approach of PM&RG use cases are also used to model interactions between various parts of a system (Asplund and Ranta 2003). The use case structure defined by Larman (Larman 2002) has been adapted as a basis for the use case model of innovation prototyping, however, it has been evolved according to application area of mobile and ubicomp services and the objectives of communication between various experts.

As shown in Figure 1 use cases are interlinks between realisation and service. They act as kind of handles to the realisation possibilities, i.e., they characterize the realisation without yet binding it to a certain technical solution. Obviously a service contains several use cases and a use case is intended to appear optimally in several services.

#### 3.1 Use cases in the development of the VHO Play

When the idea generation and development of the VHO Play prototype started, PM&RG had no previous experience on the implementation of vertical handover enabled services. The VHO project developed the first functional application VHO Ämppäri in parallel with the VHO Play (Nikkilä et al. 2004). The objective of VHO Play was to produce feedback for the development of the first VHO Ämppäri and also for future prototypes of usability, application and network experimentations. Therefore, the great challenge lied in comprehending the possibilities and

characteristics in a correct way. This was a challenge for the application programmers, not to mention the usability engineers.

As figure 1 shows the idea generation for VHO Play started with writing use cases 1. from the viewpoint of application development and 2. interpreting these to reflect potential interests of usability. According to previous experience of PM&RG, use cases provided a suitable tool for communication between the different experts. The prototype builders were mainly software experts and they consulted the network experts to capture a few basic use cases on how vertical handover appears on the network level. According to this input they wrote a set of application use cases such as the examples in appendix 1. Next, these use cases were interpreted into descriptions of interest points for usability testing. Examples of these are shown in appendix 2. This utilization of use case for describing the viewpoint of usability engineering was an extension to the modelling practices of innovation prototyping.

#### **4 Scenarios for VHO Play**

Scenario is a story of situations and actions written in a narrative form. It resembles a movie or play script and is written in colloquial language. Scenario describes concrete details of real world conditions and circumstances, e.g. place, time, named participants, objects like gadgets used, contents like music or news article etc. Because of their concrete nature, scenarios support communication between different expertises and even users very well. Usability research offers several good and coherent definitions for scenarios (Anderson et al. 1992, Karat 1995, Carroll 1995).

Scenarios are used in the innovation prototyping development methodology instead of just writing requirements for a new service because they include a lot of details, which might be lost when trying to map scenario into requirements. Scenarios also give a lot of rationale and explanations that are very valuable. In pre-product development it is not reasonable to make too detailed decisions about the service in early stages of development. Here scenarios help to postpone the decision what is relevant and what is not because different levels of accuracy may be used and even fuzzy things may be expressed (Ranta and Asplund 2003, Ranta et al. 2003).

##### *4.1 Scenarios in the development of the VHO Play*

Figure 1 shows how the writing of use cases was followed with writing scenarios, again from the two different viewpoints. First, a draft scenario was written to describe a potential story about the intended experimentation, i.e., what kind of the user studies and usability tests could be carried out. This scenario is based on and has to be in coherence with the previously written use cases. Second, a draft scenario was extracted from the first one, this time describing a conventional scenario written from the viewpoint of the user of the VHO enabled services and applications.

Appendix 3 shows the first scenario that was written from the viewpoint of the user study. The scenario explains how the user study of a vertical handover enabled music and video service should happen. In this case the story is told from the viewpoint of the usability researcher, Jarmo. The user, Olli, is seen as a real test person from this viewpoint. In the test he is taken through the second scenario.

Appendix 4 shows the second scenario that was written from the viewpoint of the end user, i.e., in the conventional way of applying scenarios in usability tests. The scenario is about a vertical handover enabled music service used by an imaginary user Olli who works as a computer scientist at Helsinki University of Technology. The scenario tells a story about 15 minutes of Olli's day at work. It shows some characteristics of the service and how the user interacts with the service. After the scenario table there is an illustrative series of pictures that is a hybrid of a storyboard familiar

from film making and a normal comic strip. The text version of the scenario is connected to pictures with numbers.

The viewpoint is the main difference between the scenarios presented in the Appendix 3 and Appendix 4. The utilization of scenarios for describing experimentations is proposed in innovation prototyping in order to emphasize the importance of careful planning and specification of the experimentations. According to our experience it is crucial to explicate the experimentation plans to ensure a common understanding among the user study and prototyping experts. Otherwise the experimentations may fail due different ontologies or misinterpreted objectives. Examples of hazardous issues include the affect of GPRS-WLAN handover to the quality of the transferred music or the criteria for the places used as the test setting.

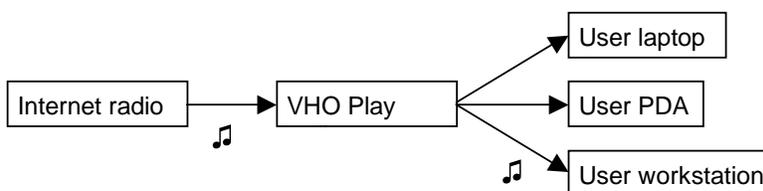
## 5 Rationale of some features of the VHO Play

In the beginning it was known that developing VHO Play must take much less time and resources than a functional prototype. Otherwise VHO Play would just consume resources from building functional prototypes. It was also important that it was easy and fast to develop in order to provide input for the first prototyping round of the functional prototype. Because of these reasons developing a mimicking prototype instead of functional prototype was preferred. A mimicking prototype only represents the features of a real prototype without real functionality or simulation of the real prototype.

Also the experimentation setting had to be either static or extremely fast to set into operational condition. This is because the planned usability tests could not be scheduled to take place one after another and also because tests should not be dependent of some rare and special skills required from the staff members running the tests. This kind of stability would have been hard to implement on functional prototype that is developed by three different development teams that are geographically distributed, like in the VHO project.

In the scenario (Appendix 4.) the user is on the move and walks in and out of hotspot areas. Although the user route was fixed, there was great variance in walking times from 3<sup>rd</sup> floor to the office room between different users. That is why simply playing music with statically timed quality changes would not have been good enough and solution that allowed dynamically timed quality changes was developed.

Also use cases were carefully studied with network and application experts in order to ensure the correct implication of network change to quality changes in video and music content delivered to the test user. After all this is very important to the success and reliability of the experimentation.



**Figure 2 - Basic idea of music delivery on VHO Play prototype. Arrows represent music streams.**

Basic idea of music delivery in our innovation prototype can be seen in Figure 2. The VHO Play radio station acts as a proxy between the Internet radio and devices used by the test user. With this setting test users can listen to music stream broadcasted from public radio station but the test personnel can invisibly control the choice of the stream. This was very convenient because one can change the quality of music whenever vertical handover use case occurs in scenario.

In the case of video content, VHO use cases were realized simply by playing a video clip that had statically timed quality change. This was considered satisfactory because creating as convenient solution as in the case of music delivery was not an easy task.

Device handover use case was implemented by playing the same content synchronically on both devices.

## **6 Conclusions**

It is important to notice that the VHO Play case shows just an example of utilising the modelling framework of innovation prototyping framework. Obviously, this paper presents a compressed view to the development stages and the development process included a lot of iteration and refinement rounds to make the use cases and scenarios coherent with each other. Notice in particular that innovation prototyping allows chronological freedom in producing the different parts of the model. For example, if the ideas are found from user observations, the scenarios are usually the starting point from which the characteristics of the services and use cases are searched for.

Since the work is done in the mobile and ubicomp environment of the VHO project, the work is aimed to be research of future use and the future environment. Also, it is impossible to do the work as a research in a laboratory, but the researchers must be able to move around with the gadgets in the real VHO environment.

Before the functional prototype is made, it is important to ensure that the plans of the research team are correct. In order to do this, it is worthwhile to create a mimic prototype. This may slow down the research team a bit, but since mimic prototypes are light to create, the gained certainty that the team is doing the right thing is more important than the small loss of development speed.

The VHO Play was proven to be an important means for reaching a common understanding on the consequences, potential and challenges of vertical handover. In particularly the use cases and scenarios allowed the software and usability experts to exchange and comprehend the viewpoints of each other. However, the experience proved that it is worth putting even more effort on the careful analysis and illustration of use cases and scenarios. In order to ascertain that the team has a shared understanding about what they are about to develop, a video or some other kind of illustration of the problem should be created.

The work is in the pre-product development stage. Due to this, there are no specific, well defined research questions. Instead, the task has been and is the finding of the questions. This makes the work problem oriented instead of solution oriented – the questions must be defined before they can be answered. This makes it possible for all the disciplines to affect the development in the very early stage.

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## 8 Appendix 1: Example use cases for vertical handover enabled applications

### 8.1 Music playing application transfer from desktop to PDA

Name of the use case	Music playing application transfer from desktop to PDA
Part of the scenario	Olli is leaving the office and takes the PDA with him
Primary actor	PDA
Stakeholders	Olli, WLAN operator, GPRS operator
Preconditions	Olli is listening to the music via desktop computer
Postconditions	The music player application is transferred to the PDA
Basic flow	<ol style="list-style-type: none"><li>1. The music player is working via the desktop computer</li><li>2. Olli plugs the headphones into the PDA</li><li>3. The PDA creates a GPRS connection</li><li>4. The PDA signals the desktop computer that music playing application must be transferred</li><li>5. Music playing application is transferred to the PDA</li></ol>
Alternate flow	<ol style="list-style-type: none"><li>3.a.1. No GPRS network available</li><li>3.a.2. Desktop computer continues playing the music</li></ol>
Additional discussion	What should be done when there is no network available? Is the decision to continue playing via the desktop computer OK?

### 8.2 Olli walks across the coverage area of GPRS to WLAN

Name of the use case	Olli walks across the coverage area of GPRS to WLAN
Part of the scenario	Olli walks past the PM&RG studio
Primary actor	Music playing software
Stakeholders	Olli, GPRS operator, WLAN operator
Preconditions	Music is played via GPRS network
Postconditions	Music is played via WLAN network
Basic flow	<ol style="list-style-type: none"><li>1. Olli walks and listens to music, which the application plays via PDA and GPRS.</li><li>2. Olli walks past the PM&amp;RG studio, which is at the border of WLAN.</li><li>3. Music playing software notices that there is a WLAN connection available</li><li>4. PDA transfers the connection to WLAN network</li></ol>
Alternate flow	<ol style="list-style-type: none"><li>3.a.1. Using WLAN network is not possible</li><li>3.a.2. Music service continues using the GPRS network</li></ol>

## 9 Appendix 2: Example use cases for vertical handover related user studies

### 9.1 Observing change of music listening device

Name of the use case	Observing change of music listening device
Part of the scenario	Olli is leaving the office and takes the PDA with him
Primary actor	Usability engineer Jarmo
Stakeholders	Olli, Jarmo, desktop computer, PDA
Preconditions	Olli is listening to the music via desktop computer
Postconditions	Olli is listening to the music via PDA
Basic flow	<ol style="list-style-type: none"> <li>1. Olli is listening to music via the desktop computer. Jarmo is observing.</li> <li>2. Jarmo gives instructions about a task motivating Olli to start using the PDA.</li> <li>3. Olli plugs the headphones into the PDA. Jarmo is observing.</li> <li>4. Music playing is transferred to the PDA and Olli keeps listening. Jarmo observes.</li> </ol>
Alternate flow	<ol style="list-style-type: none"> <li>3.a.1. No mobile network available</li> <li>3.a.2. Desktop computer continues playing the music</li> </ol>
Additional discussion	The motivation to start using PDA is a need to start moving around and a following use case must concern listening to music while walking.

### 9.2 Transfer from GPRS to WLAN while walking

Name of the use case	Transfer from GPRS to WLAN while walking
Part of the scenario	Olli walks past the PM&RG studio
Primary actor	Olli, the user
Stakeholders	Olli, Jarmo, PDA
Preconditions	Olli listens to music via PDA while walking
Postconditions	Olli listens to music via PDA while walking
Basic flow	<ol style="list-style-type: none"> <li>1. Olli is listening to music via PDA while walking with Jarmo, who is observing and making notes</li> <li>2. Olli walks past the PM&amp;RG without knowing that it is relevant in any way. Jarmo knows that this is the place that triggers a mimicked change in the music.</li> <li>3. The music changes in a way that is mimics the change between music via WLAN and music via GPRS. Jarmo is prepared to observe the change and capture the reactions.</li> <li>4. Olli and Jarmo continue walking and listening to music.</li> </ol>
Alternate flow	<ol style="list-style-type: none"> <li>3.a.1. GPRS level music stream is not available</li> <li>3.a.2. Music service continues using the WLAN level music stream</li> </ol>
Additional discussion	More exact description of observation and possible means need to be attached.

## 10 Appendix 3: Example scenario – User study on Olli walking around

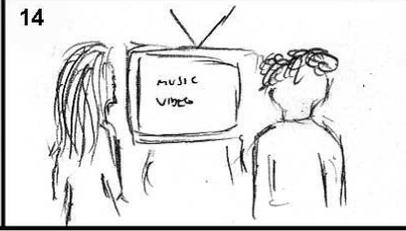
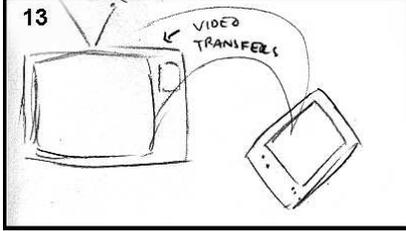
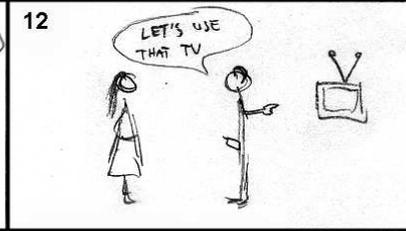
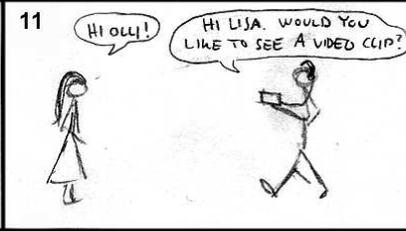
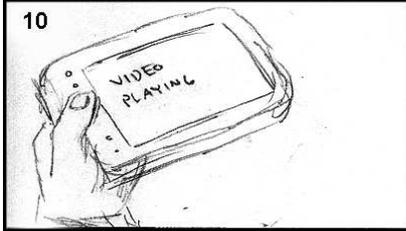
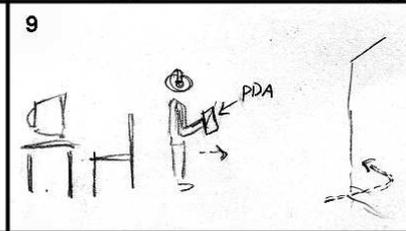
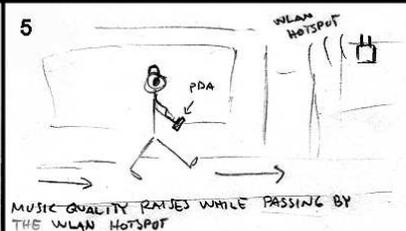
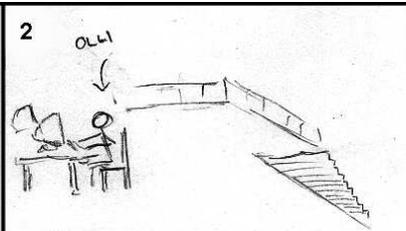
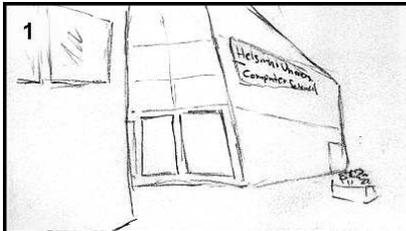
Scenario name	User study on Olli walking around
Participants	Jarmo, usability scientist of Product modelling and realisation group
	Seppo, technical assistant in the test, software specialist of Product modelling and realisation group
	Olli, 28 years old, technically experienced test person
Date and time	Monday 15.3.2004, 12:00 - 12:15
Location	Computer Science building, Helsinki University of Technology

Time	More specific location and story
	Jarmo is a usability researcher at Helsinki University of Technology (HUT). He is researching how users of vertical handover enabled music and video streaming service would react when changes in sound and video quality occur.
12:00	<b>Public work area at the 3<sup>rd</sup> floor of the building</b> Jarmo and Olli are standing in the 3 <sup>rd</sup> floor of the Computer Science building of HUT. Jarmo explains Olli the progression of the usability test and how he should or should not act in the test situation. They are both standing in front of a laptop computer that represents a public terminal computer. At first Jarmo lets Olli choose an internet radio station to be listened. When Olli has selected the station, Jarmo signals Seppo to start the same music stream in both laptop and a PDA device also present in test situation.
12:01	After short listening it is time to switch from Laptop to PDA. Jarmo asks questions about for example how Olli would perform the switching of the devices etc. After that Jarmo guides Olli to take the PDA with him and then they start walking downstairs.
12:02	<b>Corridor beside the hallway, near PM&amp;RG studio room</b> In the 2 <sup>nd</sup> floor hallway, when Olli passes by a certain point close to PM&RG studio room, where the WLAN hotspot is supposed to be located, Seppo switches music stream to better quality. Jarmo asks questions from Olli about that change. When Olli passes by another point in the hallway, Seppo switches back to worse quality. Jarmo asks questions again.
12:03	<b>Office room</b> After some walking, Jarmo and Olli arrive to the office room that represents the office of the user, Olli. Jarmo explains that there is an e-mail waiting for Olli and it is time to go check it out. Jarmo observes the actions of Olli when he begins watching the video that is linked from the e-mail. After a short period of watching the video, Jarmo tells Olli it is time for imaginary coffee, but the video would be nice to see, so how would it happen if the video stream would transfer to PDA. Jarmo listens how Olli answers.
12:10	<b>Corridor</b> After switching the video to PDA, Olli and Jarmo leave the room back to hallway. Again, at the PM&RG studio room, the video quality changes to better and Jarmo observes the user reactions. And the same again when the stream switches back to worse a little bit later.
12:11	<b>Public computer at the hallway – represents television at employee lounge</b> At the other end of the hallway, Jarmo explains that Olli will now meet his friend Lisa and he will show the video to her. Jarmo plays the part of imaginary Lisa. There is a computer that represents a television right next to Jarmo and Olli. How would it be possible to transfer the video stream to a television? Olli explains and Jarmo listens and makes notes.
12:14	Finally, Jarmo explains the test is now over and offers the test person some realistic coffee.

## 11 Appendix 4: Example scenario – Olli walking around while listening and watching

Scenario name	Olli walking around while listening and watching
Participants	Olli, 28 years old computer scientist at Helsinki University of Technology
	Lisa, 30 years old usability scientist at Helsinki University of Technology
Date and time	Monday 15.3.2004, 12:00-12:15
Location	Computer Science building, Helsinki University of Technology

Time	More specific location and story
12:00	<p><b>Public computer terminal at the 3<sup>rd</sup> floor</b> (pictures 1 to 3)</p> <p>Olli is a researcher at Helsinki University of Technology in the Laboratory of Information processing Science. He is working on a public terminal computer in the third floor of the Computer Science building. While working, he listens to music from the internet with a good quality sound. He is beginning to feel like having a cup of coffee so he decides to go and get some. But first he has to visit his office.</p>
12:01	<p><b>From terminal to the stairs from 3<sup>rd</sup> to 2<sup>nd</sup> floor</b> (picture 4)</p> <p>Olli does not want to stop listening to music even if he has to leave the terminal, so what he does, is that he takes his headphones (connected to his PDA) and the music transfers automatically from the loudspeakers of the terminal to the headphones. Olli barely notices that the sound quality is now worse for some reason because he is now moving and cannot concentrate listening to music so well. He leaves the terminal and walks downstairs to the second floor of the building.</p>
12:02	<p><b>Corridor beside the hallway</b> (picture 5)</p> <p>Suddenly when walking by a certain room (PM&amp;RG studio), the music quality rises for a while. Olli does not know why, but as a technical person he suspects a better network connection to be available at the moment. He is correct.</p>
12:03	<p><b>Office room</b> (pictures 6 to 9)</p> <p>When Olli arrives to his office, the music transfers to the loudspeakers of his office computer with a high quality sound. Olli sits down to read his e-mails. He has received a commercial note about a new music video of a certain band. There is a free preview available in the web, but just for next 30 minutes. Of course, as an enthusiastic fan, Olli starts playing the video immediately with his computer. But then he remembers his urgent need for coffee and so he picks up his PDA again. The music video transfers to the PDA and therefore Olli can leave the room.</p>
12:10	<p><b>Corridor</b> (picture 10)</p> <p>While Olli is walking in the hallway, the quality of the video suddenly drops. Olli does not care because he is mainly walking, not watching the video.</p>
12:11	<p><b>Hallway employee lounge</b> (pictures 11 and 12)</p> <p>At the other end of the hallway Olli runs across his friend Lisa. Olli knows that Lisa likes the same band whose music video Olli is watching right now but it is annoying for two people to watch the same small PDA screen so another solution would be nice.</p>
12:12	<p><b>Employee lounge</b> (pictures 13 and 14)</p> <p>There seems to be a TV screen available at the employee lounge near by. It would be great if the TV could be utilized for watching the video. Olli walks in front of the TV and the video transfers to the TV screen. Now both Lisa and Olli can watch the video.</p> <p>It is also known that eventually Olli was able to get his coffee and the life did go on.</p>



VHO Play storyboard  
PM&RG 2004