Report on user needs and expectations for mobile stereo-video

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Abstract: This report describes user needs and expectations about the novel system mobile 3D television. Based on a methodological triangulation of online survey, focus groups and probe study, we studied user requirements of mobile 3DTV. After a literature review about user requirements of Mobile TV and 3DTV, we conducted three studies in order to get a broad view about user requirements of a novel system that combine Mobile TV and 3DTV into one system. With respect to three categories of user, system and services, and context, we analyzed the studies. The results show that users have clear expectations about mobile 3D television. The usage of the system will strongly depend on contextual situations. Users do not expect only television content of entertainment and information. Popular services according to our studies will be also navigation, product information or interactive guidance. The results are concluded in first guidelines to design user experience for mobile 3D television and video.

Keywords: Mobile 3D TV, User Experience, 3D TV, Mobile TV, User Requirements, Methodological Triangulation, user-centred design
Executive Summary

The introduction of novel mobile services needs to provide seamless and attractive user experience. To develop the new system and services like mobile 3DTV, researchers hence need to understand its user requirements. In mobile 3DTV, two running systems – mobile TV and 3DTV – are combined to one new system providing mobile 3D television. To study the user requirements of mobile 3D television, we applied user-centred design choosing a methodological triangulation of survey, focus groups and probe study to get a broad view on the topic of user needs and expectations.

In chapter 1 of the report we give an introduction to our main principles of human-centred design and show how user-centred studies will impact on the results of the project and the development process. We also introduce the idea of methodological triangulation and discuss the goal of combining three studies all targeting user requirements of mobile 3DTV.

In chapter 2 we present a literature review about user requirements of mobile TV and 3DTV. Although the existing requirements should not limit the user requirement elicitation process, it is important to get a basis for all studies from the already existing knowledge of the singular systems. The literature review is divided into three parts covering the three main aspects of user, system and services and usage context.

Chapter 3, 4 and 5 cover the documentation of the three studies used to elicit user requirements of mobile 3D television. All the studies targeted the goal to get a broad view about the user and his needs and expectation regarding the novel system. We aimed to gain knowledge about user characteristics and user groups, different system requirements, the kind of services and their related content which is expected in future mobile 3D services, and usage scenarios of mobile 3D television.

Chapter 3 presents our online survey study on user requirements. Due to an exploratory design of the questionnaire, the survey study was intended to reveal preference data of the user. Based on 350 respondents of the questionnaire, the preference data will form important features that will determine the novel system. The chapter includes description of the method as well as a detailed analysis of the results.

Chapter 4 describes the focus group study that was conducted with 8 groups in Germany and Finland and presents its results. We conducted focus groups to get information about usage scenarios. Using a scenario-based design of the groups, we were able to collect information about usage context with respect to physical, temporal and social contexts which describe how the users will use mobile 3DTV services in the future.

The probe study which is the third study of our methodological triangulation approach is presented in chapter 5. A probe study is applicable to target the more implicit user needs and expectations. The method of the probe study is described in this chapter. The results of this study allow complementing our knowledge gained from online survey and focus groups with results of a long-term in-the-field observation of future users. This way, we are able to better describe especially the usage contexts.
The results of all three studies are finally concluded in chapter 6. Based on our knowledge about user requirements we derive first guidelines to design user experience in the context of mobile 3DTV. The guidelines show that users have clear needs and expectations about mobile 3DTV. The main motivations of the users to use mobile 3DTV services are entertainment and information needs. Nevertheless, our studies also show that mobile 3DTV is not only television service. Users also expect non-television content like interactive guidance, games or product presentation services to be part of the system. We also outline in our guidelines that usage of mobile 3DTV will depend on the contextual situations. Users will use mobile 3D television in private and public locations, indoors and outdoors.

Our guidelines are a first starting point for researchers in the field of mobile 3D television and video for conducting user studies. But they can also provide help for all members of a production chain in the field of mobile 3DTV – from content producer and device manufacturers to service providers who will finally deliver the content to the user.
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1. Introduction

1.1 Motivation

To develop a new system or service like mobile 3DTV, it is important to understand the user requirements. Knowing user’s needs and expectation about the upcoming technology will finally provide a seamless and attractive user experience of the system and services.

Mobile 3DTV is regarded to be the next step of 3DTV systems and services. In the field of 3D, a lot of work is in progress concerning the whole production chain from capturing content, coding and transmitting content to the final presentation on different stereoscopic devices. However, only few systems are currently available on the market and the only way to enjoy 3D regularly are 3D cinemas which are becoming more and more popular.

By extending 3DTV with the possibility to take it with you on mobile devices, mobile 3DTV combines 3DTV with mobile TV which is a second novel approach to enjoy television. Mobile TV also has become a running system with only few available services. However, mobile TV is still regarded to be popular in the future. A study of Goldmedia [16] asking 500 citizens of Berlin, Germany, about the attraction of mobile TV shows that 59% of the participants would change their provider if he doesn’t offer mobile TV services. Mobile TV is very much accepted among the future users and according to Carlsson and Walden [3] there are still 58% of the population who believe that mobile TV is going to be popular.

To understand a system which combines mobile TV and 3DTV, it is important to know about the user requirements of each separate system, but the knowledge should not restrict the design of the novel system. To understand user requirements of the novel mobile 3DTV system, we apply user-centered design in our studies [20]. User-centered design is an iterative process of interacting with the user during the whole process of system development as can be seen in Figure 1. By applying user-centered design the development process will result in a better end-user satisfaction or lower development costs [43].

![Figure 1 Iterative process of human-centered design for interactive systems based on ISO 13407 [33].](image)

In this early stage of the system development process, user-centered design will help us to understand user’s desires and concerns about the system. This knowledge will help to work on problems that hinder the user in accepting the system, but also show opportunities to improve the quality of the system so that the user requirements represent finally any externally visible function, non-functional property or constrain that is required to satisfy the user needs and expectations [20][41].
Human-centered design for mobile 3DTV will also be our main principle in studying the critical components of the system [36]. The user requirements will thereby form the basis of all studies providing the knowledge about users, system and services and usage context from the user’s point of view.

1.2 Methodological triangulation elicitation process

To form a basis for planning and conducting the studies, we conducted a literature review about user requirements of mobile TV and 3DTV. As already mentioned above, mobile 3DTV will be a system combining mobile TV and 3DTV. In our requirement elicitation, we aimed to cover a broad view on user requirements for mobile 3DTV.

To do so, we conducted three studies following a methodological triangulation during the user requirements elicitation process. The goal was to tackle explicit and implicit aspects of user needs and expectations. We examined user, system and usage context in three different studies of online survey, focus groups, and a probe study. By using online survey and focus group in an exploratory design, we aimed to gather user requirements explicitly. Survey and focus groups were designed to explore user characteristics, current practices and usage concepts, and the users’ desires and expectations about the novel system [8][51]. The online survey thereby was meant to collect preferences of the users about important features that will finally determine the new mobile 3D television system. Additionally, focus groups targeted users’ needs, expectations, and desires profiting from the fact that the group discussion can bring up ideas and concerns that could easily be forgotten or that no one thought about to ask. Hence, focus groups can broaden the view on user requirements from the online survey. In contrast to online survey and focus group studies where participants are asked question directly, the probe study is a new, innovative way of data-collection which targets the more implicit needs of the users. The results of the probe study complement the knowledge about user requirements with a long-term in-the-field observation of future users targeting especially contextual knowledge about how users will use mobile 3D television.

All studies were designed following the key aspects of user, system and services and usage context. Hence, their characteristics are comparable: First, we targeted the user of mobile 3DTV systems with regard to his characteristics and his motivation to use the service in the future. A second part aimed to collect user requirements of the system and the related services that will form mobile 3DTV. The third part of each study finally examined contextual aspects of using mobile 3DTV systems regarding physical, social, temporal and task environments.

In this report, we first present a literature review about user studies of mobile TV and 3DTV. We focus on the main topics of user, system and services and contexts. Second, we present the methodology and the results of our online survey about user needs and requirements for mobile 3DTV. The third part of the report covers the focus group study, and fourth, the probe study about user expectations and user needs including description of the method and the results are presented. Finally, we conclude the results and give guidelines to design user experience.

1.3 Definition of terms

Following, we define the terms that are important for this report on user experience.

**User:**
- A user is an individual interacting with the system [33][34]. It is also defined as the person or persons, who operate or interact directly with the product [31]. The term user is also used in the same meaning as consumer. A user and consumer can represent the same individual.
- The user as an individual interacting with the system can be characterized with aspects of individual including needs, motivation, experiences, expectations, mental state and recourses (adapted from [59]).
User need:
- User needs refer to problems that hinder users in achieving their goals, or opportunities to improve the likelihood of users’ achieving their goals. An important factor affecting on user needs is the context of use [41]. To highlight, user needs as a term have both aspects of user’s desires and concerns. In this text, we use the term user expectation as a synonym for user need.

User requirement:
- A user requirement is an externally visible function, property or constrains that system must provide to fill the needs of the system's intended users [1]. User requirement describes user goals and tasks that the user must be able to perform with the product [69] and they are the first steps towards defining the system and to become successful. Every system needs to satisfy its end-users [65].

Context:
- There exist several ways of defining the context or context of use. Some of the definitions include the user as well as the system environment in the definition of the context. Dey et al [9] define it as ‘any information that characterizes a situation related to the interaction between humans, applications, and the surrounding environment’. Similarly, definition of ISO 13407 [33] standard defines it as follows: Context of use compromises user characteristics, task, as well as technical, physical, and social environment.
- The aspect is to separate the user and system from the other context components. This distinction reduces the overload of the term of context and highlights the importance of user and system interaction. Following this path context can be divided into physical, social, temporal and task contexts.
- Reflecting ISO 13407 standard [33] the definition of usage context, Belk [2] divides context into physical, social, temporal, and task contexts and in additionally to antecedent state.
- Physical context has the apparent features of situation or physically sensed circumstances, e.g. geographical, institutional location, decor, weather, lightning, sounds, and other material surrounding (adapted from [2]).
- Social context describes the other persons present, their characteristics, their apparent roles, and interpersonal interactions [2]. It can describe other people’s influence on user and user’s social contribution goals [59].
- Temporal context describes the dimension of situations which may be specified in units ranging from time of day to season of the year [2]. Temporal context also describes the time available for task execution [59]. Describing the actions in the temporal dimension, the intensity of actions varies and can be classified e.g. to acceleration, normal, and waiting [68].
- Task context describes the multitasking and possible interruptions that are related to the execution of the task [27][59] e.g. mobile television viewing.
- In mobile usage contexts, physical and social environments are heterogeneous and may change during the usage session e.g. from personal usage to group situation, from goals to unplanned actions, or from acceleration to waiting [68].

(Interactive) System:
The system required for the examined product to work or to be useful [59]. The aspects of the mobile system from the user’s viewpoint can be device, browser or player, connection and site or content (adapted from [59]).

Combinations of hardware and software components that receive input from and communicate output to a human user in order to support his or her performance of a task [33].

Content:

- We use the term content to refer to any video or moving images with the service.
2. State-of-the-art of user requirements of mobile TV and 3DTV services

The literature review of existing user studies of 3D and mobile television and video is a base for thinking future mobile 3D video applications. User requirements are relatively well for mobile TV and video. Currently there are available results of field trials or studies conducted in several countries [6][50][63] as well as results of prospective focus groups [38] and online surveys [3]. Controversially, there is only one focus group study [13] available in the topic of 3D, but none available to describe the actual behavior in the level of field studies. All other 3D studies focus on experimental research to raise the feeling of presence in the systems or to decrease visual discomfort [55]. This section reviews user requirements of user, system and service and context in these studies one by one.

2.1 Users

2.1.1 General user description

Before we describe state-of-the-art of user needs and expectation studies for mobile TV and 3DTV services, we will focus on the description of the user itself. The table below shows first descriptions of the general user of both services. It is noticeable that knowledge about mobile TV users exceeds clearly the knowledge about 3DTV users. One explanation can be the availability of both services. While mobile TV services are already running and are available for public, 3DTV services have not started yet in any European country. Thus, the description of the general user is still hard to do.

Based on pilot studies with people trying out mobile TV services for a longer time, a general user description of users of mobile TV services is as follows:

**Typical User of mobile TV:**

- According to Carlsson & Walden [3] the typical user is:
  - Is 23-35 years old
  - Is male
  - Has an university degree
  - Has an income of 20001-30000 Euros
  - Owns a new / advanced Nokia phone and uses it regularly
  - Watches TV 1-2 hours per day between 21.00-23.00
  - Watches more during week than weekend
  - Watches news
  - Is not fully concentrated on watching
  - Talks to family and friends while watching
  - Watches mobile TV 15 minutes/day in the evening between 18.00-21.00, mainly news
  - Reads daily newspaper and uses internet
  - Listens radio less than 1 hour/day in the morning 06.00-9.00 without concentrating on listening while driving

**Motivation of the User:**

- According to Mäki [44]
  - To kill time (43%)
  - To stay updated while being on the move (40%)
- According to Chipchase et al. [6]
  - While waiting
  - While being in the rest-/bathroom
  - To stay up to date with popular events
  - Music, sport, game shows
Novelty, desire to be the first

According to O’Hara [50]
- To own and to exchange content
- To have content is important for young users
- To get content onto device
- To get free content from internet
- To plan ahead and load content for future events

Regarding the usage of the mobile TV service, it is interesting how the service is accepted by the users. It can be seen that there is general interest in using the service even there, where no running service is available yet.

**General Acceptance:**

- According to Goldmedia Study [16]
  - General acceptance for mobile TV in Germany of about 80% [16]
  - About 50% mentioned that they would change the provider if he doesn't offer mobile TV
  - In general, German users often relate TV to a free of charge TV program
- According to Carlsson and Walden [3]:
  - 58% believed that mobile TV is going to be popular
  - Interest to try: 59% in 8 countries
  - Interest in Korea: 90%
  - Interest in Finland: 15%

Regarding the studies on user description of 3DTV services, one can recognize that the knowledge looks different there. The user is more related to why he should use the service. Studies focus on describing the user experience and classify the additional profit of watching content in 3D compared to traditional 2D television. We classify 3D experience by two groups: again a general description and the descriptions of “presence” – the feeling of being there [62]. Presence is the experience mentioned most by the users when talking about 3D expectations.

**General 3D experience:**

- Depth impression was the most reported subjective attribute [21]
- Benefits of stereoscopic gaming [22]
  - Enhanced game play experience
  - Better user interface
  - Better overall user experience
- According to the focus group study of Freeman and Avons [13]
  - Feel to interact with the scene content
  - Cinematic feeling
  - Interest
  - Content more interesting and salient
- Sense of reality [52][55]
- Naturalness [32]
- Higher positive emotions [55]

**Descriptions of Presence:**

- Presence is described as the feeling of “being there” [13]
According to Häkkinen et al. [21]:
- Presence or immersion are often described by "being transported to the film"
- Presence is a significant experience factor with stereoscopic contents
- Subjective transportation theme by Freeman
- Feeling of presence and engagement [55]
- Users feel less present when the depth appeared unnatural [13]

But 3D experience not only brings positive factors and enjoyment for the user. Users often report so called simulator sickness. This is a physical discomfort that users feel while watching or interacting with 3D content. The influence of simulator sickness is not understood in detail yet. However, to fully describe the user of 3DTV and his characteristics, we also need to consider the results of simulator sickness studies.

**Simulator Sickness:**
- Eyestrain [56]
- Häkkinen et al. report in their study [21]:
  - Most reported symptoms were all kinds of eye-related symptoms
  - "Focusing difficulties": descriptions of symptoms indicating accommodative difficulties
  - "Dizziness", "general discomfort", "perceived double images" rarely reported
  - Absence of symptoms interesting, as current human factors research has been focused on sickness studies
- Results show that sickness symptoms were elevated in the condition where stereoscopic depth was used with head-worn display [23]
- Results suggest that simulator sickness is not a major problem in virtual gaming [23]
  - Using a virtual display as an accessory to a mobile device is probably not affected by adverse symptoms experienced by the participants
- Computer game playing frequency had a clear effect to the sickness levels, as the participants who played more often reported less sickness symptoms [22]

**Influence on simulator sickness:**
- Participants who report to have motion sickness also report more simulator sickness symptoms [22]
- Participants who reported having less computer skills experienced more symptoms during the test [22]
  - Attitude towards new technology affects symptom levels
  - Selection of participants might have a strong impact on assessment results

**Excitement:**
- Participants are having more fun with the virtual display even if they get more symptoms

### 2.2 System and Services
#### 2.2.1 Contents
There is no service without content. To understand service acceptance and users’ interest in a service, we have to know what kind of content is expected and which content is suitable for 3DTV and mobile TV.
First, mobile TV content is described. Beside a classification of suitable or unsuitable content, there are specific content features that the user demands and that contribute to the success of the service.

**General content description:**
- No complicated content as user doesn't have the time to catch it [16]
- Formats need to consider the average usage time - exceptions are extraordinary events like life broadcasts [16][Goldmedia2006]
- According to Carlsson and Walden[3]
  - Content requirements
  - Standard form might cause difficulties
  - On-demand non-stop loop 20 min for news
  - Customized contents for short and occasional viewing
- According to Södergård’s field study [63]
  - On demand to catch missed programs
  - Summaries of existing programs

**Genre:**
- Content expectations (26 focus groups, 3 countries) according to Knoche and McCarthy [38]
  - News & weather, disaster management, live services, MTV/ Radio, language programs
- Preferred content in Germany [16]
  - News, movie trailer / short films, existing TV channels, sports programs, regional Information
- In [16] cited ECO's survey with 70 mobile TV experts on suitable content
  - Sports, news, music and video clips, erotic
  - Only 2% see movies to be valuable for mobile TV
- According to Södergård’s field study [63]
  - News, short part of programs
  - Music videos
  - Short info commercials
  - Local traffic / forecast
- Sport, news popular, documentaries out [3]
- News all the time [44]

**Specialized content:**
- According to Södergård’s field study [63]
  - Summaries of existing programs
  - Game related to programs
  - Current TV format with changes
  - News flashes
  - Young: entertainment, series
  - Short reports on sport events
  - Local and context related advertisements
  - Chat
  - User-created content
  - Reports on weather / traffic
• Betting on ice-hockey game
• Familiar [3]
• Published and user-created content [50]
• 30 min. sitcoms and movies [66]
• Shorter programs of conventional TV [66]
• According to Chipchase et al. [6]:
  o Own content / exclusive content
  o Rebroadcasted normal TV
  o Broadcast games, like the RTS video game “Starcraft” popular in South-Korea

We show above that user description of mobile TV and 3DTV users is based on totally different approaches. In contrast by comparing content for the services we can now find similar factors for both mobile TV and 3DTV. A classification of content for 3DTV can be done using suitable and unsuitable genres plus general user needs on content.

**General content description:**

• According to Häkkinen et al.’s user study based on IBQ method [21]
  o Significantly more descriptions on the content of 3D compared to 2D
  o Need to have longer scene length in stereoscopic material (>20sec)
  o Too short scenes might miss the aesthetic potential of stereoscopic content
  o Complex natural objects to be regarded as interesting
  o Longer scenes decrease stress for the viewer
  o Contradictory attributes: 3D scenes described both as real and life-like, but also many references to artificiality
  o Being artificial did not necessarily mean perceived bad image quality
  o Real-unreal continuum does not necessarily reflect image continuum from goo to bad quality
  o Validity of reality-likeness as quality attribute might differ according to content qualities
  o Stereoscopy to change life-likeness of the contents
  o Increased artificiality or unrealness with stereoscopy
  o Stereoscopic scenes contain more interesting details compared to the two-dimensional scene
  o Viewer did not have enough time to check everything and even felt stressed and exhausted by this
  o Ability to enhance atmosphere and emotional theme in the material is one of the most significant criteria of stereoscopic image quality

**Genre:**

• Suitable content genres
  o Action movies [13]
  o Live events (sports - football, theater, concerts) [13]
  o Advertisement in 3D [37]
  o Content with complex, spatial relations [35]
  o Games were most often mentioned as a possible application for a stereoscopic display in a mobile device [22]
• Unsuitable content genres
  o According to focus group study of Freeman and Avons [13]
    ▪ News “were not thought to suit 3D”
    ▪ Soap operas
    ▪ Documentaries
    ▪ Talk shows
  o A stereo display was not thought as being necessary for text based applications or for the basic functionality of a mobile phone [22]

2.2.2 Devices
After regarding contents of services, the next point of interest are the devices used to access the content. Design and technical features are important factors that influence the usability and acceptance of the devices with the users and make them successful. User requirements on devices are generally very similar in 3DTV and mobile TV services. Additionally, Flack et al. [10] state that traditional communication devices will more and more change into multimedia devices. First, mobile TV devices and the related user requirements are presented.

General user requirements:
• Easy and intuitive to use [3]
• Field trials showed that users prefer small devices (portable on pocket) [63]
• Image quality [3]
• Image and sound quality [57]
• Short loading times [57]
• Flexible use in other devices, if paid [50]

Functionality:
• Phone functions should not be traded off for mobile TV features [3]
• Transfer information between devices (home/mobile) [63]
• Technical functionality should be sufficient, good and reliable [3]

In mobile TV services, the people already know the device. It’s their mobile phone and they use it daily. Thus, user requirements are rarely about special user features of mobile TV service phones. Reviewing user needs of 3DTV devices, we find the opposite situation. Here, users have a clear idea of the functionality of devices. They have clear expectations about the look, features and functions of the devices. However, only few requirements really come from user studies. Most of the requirements presented below are based on researchers’ experience.

General user requirements:
• Kalva et al. state in their paper on 3D video coding [37]
  o High viewing comfort
  o Compatibility
  o Costs (of deployment and use)
• Autostereoscopic display [25]
• Viewing freedom, freedom for (head) movements [52]
• Short viewing distance [25][52]
• Impact of strategy and previous experience on finding the sweet spot [35]
• High efficiency, display efficiency, long operation time while display running on high brightness [25]
• Users could not imagine relevant use for a stereoscopic display in a mobile device [22]
• Good stereo effect for the whole display [35]
• Wider field of view [35]
• Brightness [52]
• Sharpness [52]
• Minimal pixel artifacts [25]
• Low cross talk [25]
• Immersive feeling in the space [35]
• Depth perception [13]

**Functionality:**
• Switchable 2D/3D display mode [13]
• According to Harrold [25] talking about mobile 3dtv displays:
  - Full 2D performance
  - Increased number of views
  - Low thickness
• User control over the depth impression [56]

2.2.3 **Service design**

Finally, the third part that describes system and services is the service design. Users have clear ideas how to access content via their device. An important point thereby is also payment and the question how users expect service usage to be paid. Again, we will first present user requirements for mobile TV services.

**Accessing content:**
• Explore possibilities interactive TV, calling/messaging/gaming/camera and mobile internet facilities [66]
• Content download, similar to PC [66]
• Rather pull than push [63]
• On-demand [66]
• Navigation needs to provide a fast orientation [Goldmedia2006]
• There is few time for directed content search [Goldmedia2006]
• Consumption paradigm of Knoche [39]:
  - Proposed design for future mobile TV services
  - Interface design of mobile TV services
• Four different service scenarios: [16]
  - Passive mobile TV: usual TV program is broadcasted for mobile TV
  - Interactive mobile TV: adds backchannel to introduce user feedback for additional services
  - Near-Video-on-Demand (NVoD): content is collected based on the requirements of different users and is then broadcasted
Mobile Video-on-Demand (VoD): content is stored to a mobile phone storage and can be viewed independently - Carousel Mode for example allows for actual content and content updating

- Launch of service
  - European soccer championship in Germany 2008
  - Olympic Games in Beijing 2008

Watching content:
- Short viewing sessions and the possibility to interrupt viewing [3]
- Interaction requirements [66]
- Without fixed start and end, real time streams [66]
- Program should be manifold to satisfy different user groups [16]

Payment:
- Pricing model [3]
  - Suitable price of 10€/month
  - Fixed pricing preferred
  - Pay per view wanted for e.g. football games / formula 1
- Monthly [63]
- Pay per view [63]
- In Germany, users would pay 5-12,50 EUR per month for mobile TV [16]
- Mobile TV is still related to free accessible TV without any payment [16]

User requirements or expectations about how to access 3DTV in designed services are rare. The same problem occurs: users don’t use 3DTV services and hence they don’t have clear expectations about the service design. A second point is that 3DTV is often related to existing traditional television services and these services are free to access. So the users don’t think about new service design or even don’t expect a change in the services.

Assessing Content:
- Availability of content [37]
- Access to content [25]
- Compatibility [37]
- Availability of infrastructure [25]
- Availability of software [25]

2.3 Context
Contextual studies and the resulting information of how services are used and what motivates people to use them is one of the key factors in user-centered research. The knowledge of usage scenarios gives a lot of information about the acceptance and success of a service and helps to further develop the service goal-oriented. Context and usage scenarios have got influence on quality perception. The situations thus influence the user requirements. Users orientate their needs and expectations on situations where they use the service or where they expect to use the service.

Unfortunately, contextual studies on 3DTV are rare. This might arise from the fact that a) 3DTV services are not running yet commercially and b) 3DTV is not seen to change the TV habits of the users significantly compared to traditional TV. 3DTV is seen as entertainment and people enjoy the
enhancement of entertainment given through the new 3D experience. They want to see the image to jump out the screen and expect the content to be in front of them. [53][55]. This “wow”-effect is what the users want to see and what makes the entertainment. This entertainment task is fully fulfilled with 3D cinemas like IMAX. These cinemas are located either separately or integrated in entertainment parks.

On the other hand, we have mobile TV. Here, researchers have conducted a lot of contextual research. Context and its influence on the service expectations are very well known. We divide the context according to locations, time and tasks. Following, we present the review on contextual usage of mobile TV services.

2.3.1 Physical context

First, context is formed by the location where usage of the service takes place. These locations determine everything else like tasks or time. There are two main locations where people use mobile TV. Home and work seem to be the most interesting locations for mobile TV watching. We do not take into account the time of commuting or being on the way here. This point that was already mentioned in the section describing the user is presented in temporal context.

Home:

- According to O’Hara [50]:
  - Watching at home
  - To be together
  - Wait for lunch
  - To be in same physical space e.g. children watching TV and parents watch mobile TV
  - To give control for others about TV
  - To support togetherness while watching different contents
  - Not to be together
  - Private watching in bedroom
- According to Chipchase et al. [6]:
  - Watching at home
  - Private watching in bedroom
  - No need to negotiate with others
  - Control of location
  - Convenience to conduct other activities in the same space
  - Access to power source
  - Comfort (bed)
  - Bath / toilet activities
  - Viewing habits may be differ from other locations (lean back, forward, ambient viewing)

Work:

- Also in the locations where normal TV was available [50]
- Break from work [51]
- Vehicles, lounges, work cafeterias, people’s desktops in the office, café’s gym, the hospital, on the walk to school and the school playground [50]
- Traveling on public [51]
- Lunch breaks [50]
Transitions between spaces: possibility to settle down to view, shape mob video experience, or decide to view [50]

2.3.2 Temporal context
Not being located on a fixed position or in a fixed situation, but being on the go is also typical usage scenario for mobile TV. For us, this is related to temporal context – context that is connected with spending time or also wasting time.

Temporal context of mobile TV
- Time period that user is able to dedicate for the system given the contextual restrictions
- Visually too demanding to watch between transitions compared to listening [50]
- Commuting [6]
- Journeys need to be long enough to start viewing [50]
- If bus is not too busy, and seats available then watch [50]
  - Otherwise listen to music
- Micro / macro breaks as moments between activities [6]
- Macro: select channel, receive channel, channel changing, delays between changes, need locate and use headsets [6]
- Passing time [51]
- While waiting [51]
- Bus stop - requires visual attention [50]
- Bus, visual monitoring about leaving the bus [50]

2.3.3 Media and context
Beside location and time, context influences the content to be suitable for different situations. These situations relate to what is presented above in sections physical and temporal contexts. Media covers everything from content to service design. The review shows that service usage of mobile TV strongly depends on the context of use.

General relation media and context:
- Explores media choices in different situations with news content [51]
- Films and long programs only when conventional TV is not available [44]
- Live broadcasts when conventional TV is not available [44]
- In noisy environments: text easier [51]
- Headsets in public places [51]
- What is different to text messaging and mobile TV viewing [6]
- Messaging user controls what happens next [6]
- TV continues on its own regardless what user is doing [6]
- Context-aware services [63]

Being on the move:
- Music / radio on move [38]
  - Transitions from mobile TV (musicTV) to radio changing from still to move
• User on move: audio [51]
• Series, entertainment during short waiting periods of time [44]

**Being in a fixed location:**
• User sitting / standing still: text / video [51]
• Transitions from mobile TV to conventional when arriving to home [44]

2.3.4 **Social context**

**Private viewing:**
• According to the study of O’Hara [50]:
  o Saving, transforming or keeping certain piece of content for this purpose
  o Possibility to humor
  o Managing solitude
  o Lunch breaks
  o Habit
  o To gain own time and space
  o Video as a private space
  o Transitions between spaces
  o Impact on choice of content: throw away / easily put down
  o Secret watching
  o To privatize the content in which viewing would be very boring
  o To disengage others
  o Avoid possibilities to social engagement
  o Excluding himself from others environment
  o Traveling: boredom and gain of private space
  o Also visually engaged
  o Journeys need to be long enough to start to view
  o If bus is not too busy, and seats available then watch
  o Otherwise listen music
  o Passing time
• According to Chipchase et al. [6]
  o Secret use
  o Socially unacceptable use (meetings, school)
• Mostly alone; but young people in a group [63]

**Shared viewing:**
• According to the study of O’Hara [50]
  o Coordinating with family
  o Shared / public settings
  o At work or at waiting places
  o In social settings managing relations with others around
  o Sharing experience
  o Limited to small group of people
• Watching certain type of content was like a ritual or about showing the commitment or sharing the joke or story
  • Belonging into a group
  • To spend time with children
  • Showing for others
  • Sharing with others

• According to Chipchase et al. [6]
  • Shared mobile TV
  • Co-viewing on lunch
  • Involuntary / passive sharing
  • Lending devices
3. Study 1: Questionnaire on user’s needs and expectations on mobile3DTV

Surveys can be used as a method for eliciting user needs. As the nature of the requirement elicitation process is rather explorative in the early phases of the development, and therefore the role of the questionnaire is also exploratory. The explorative questionnaires do not aim to build a theory building as do confirmatory questionnaires. In the exploratory use, surveys can help to identify the current practices, needs and attitudes to new system ideas in the design process [54]. Even the role of the questionnaires is explorative, their significance is to confirm or disprove the hypothesis of user’s needs, but they might have limited ability to facilitate the new prospects [24]. The main assumptions for our questionnaire development were based on the literature review of mobile television and 3D television and the current state of multimedia products and services on the markets. Aim in the usage of questionnaire in this study is to get the preferred features for the novel mobile 3D television.

Literature review was used as base to formulate the five part user requirement questionnaire. The first part examined demographical and psychographic information. The significance of demographical and psychographic data collection is to describe the sample of the study resulting to external validity of the study and to examine the user requirements for different user groups. The basic demographical data included age, gender, education, occupation, household size and income. Psychographic data-collection focused on examining existing experiences of television, video and 3D viewing, gaming and use of mobile services. The experiences were targeted mainly from the viewpoints of consumed contents, frequency of usage and used applications or devices. Finally, we examined the technology attitude using validated Domain Specific Innovativeness scale [11]. The measurement tool was originally introduced by Goldsmith and Hofacker [17] and it has later been widely applied in the measurements of goods and services in various fields [18] and use in various languages [19].

The second part of the questionnaire examined the user’s requirements for the mobile 3D content and system. The part plays a significant role in forming the user’s requirements for the content and the system. The content questions targeted not only broadcasted television content and genres, but also other type of video contents like user-created videos, product presentations, and navigation. The assumed viewing length was also assessed. System characteristics considered questions about the preferred size of the device, service models (e.g. pull, push) and pricing. The needs for the different presentation modes, output modalities and interaction with the content, like saving, sharing and editing were also inquired.

The third part of the study examined the main motivations for the usage of mobile 3DTV. The covered topics were entertainment, information requests, killing time, relax, social and private aspects.

The fourth part targeted the context of use. The aspects of temporal, spatial, physical and task contexts were examined. These aspects are significant for creating the use cases.

The fifth part of the questionnaire examined the acceptance of the presented mobile 3DTV scenario. At the beginning the broad scenario of the service was presented and it was followed by the claims formulated applying Technology Acceptance Model and its further forms, relevant to mobile context [4][40][49][45][61]. The covered aspects impacting to the intention to use a service were entertainment, attitude, social influence, perceived usefulness, and perceived ease of use, cost, mobility, perceived quality and context of use [4][40][49][45][61]. Aim of this part is to examine early phase acceptance of scenario and model impacting factors of acceptance. The results of this part of the questionnaire are not provided in the phase of requirement elicitation.

3.1 Data-collection

Data-collection process was carried out by using online questionnaire in Finnish and German languages. Prior to the publishing the questionnaire the expert evaluation was done by three external evaluators to improve the internal content validity of the questionnaire. The final questionnaire is presented in section
8.2. Web pages and advertisements, commonly used discussion forums and email-lists were used as main sources for the respondents’ recruitment. The online questionnaire was open for three weeks between 16.04.08 - 06.05.2008.

3.2 Method of analysis
Different methods of analysis were used. The data from questions measured on 5-point Likert scale were nonnormally distributed (Kolmogorov-Smirnov p>.05) forcing to use the non-parametric methods of analysis. In the pre-processing, ordinal data was converted into a nominal form. McNemar’s test was used in the analysis of the nominal data to test the differences between two categories in the related data [7]. To compare ratings between the different groups we used Chi-square test, which is applicable when testing the frequencies between categories in the independent measures [7].

Both language versions of the questionnaire were combined to represent overall view to user’s requirements of mobile 3DTV. The figures separating the countries are presented in the appendix. One should keep in mind that this research aims the user need elicitation, but is not a market research and therefore one should not interpret these as a cross-cultural research as the samples are not representative to the whole population of these countries.

3.3 Results
3.3.1 Demographic and psychographic data
Demographical and psychographic data illustrating the sample of the questionnaire respondents is presented in detail in Table 1. The total number of respondents was 342. To summarize the main characteristics, the majority of the participants were aged between 18-35 years. The respondents represented both genders, both employees and students, and they were mainly from maximum two person’s households. The sample was also described by the wide range of the different levels of education and technology attitude.

3.3.2 TV consumption
The respondents were categorized according to their daily television consumption in four viewer groups. 10.4% of the respondents were attributed to “heavy viewers” (watch more than 4 hours), 32.5% to “medium viewers” (watch 2 to 3.5 hours), 46.2% to “light viewers” (watch 0.5 to 1.5 hours). 10.9% of the respondents don’t watch television at all.

3.3.3 Media services
The use of mobile services was surveyed and three user groups were defined. 61.4 % of the respondents are “light user” with a regular (weekly, daily) use of 1 to 4 services. 30.7% of the respondents could be seen as “heavy users” which use regularly more than 5 services. 7.9 % don’t use media services on a regular basis.
<table>
<thead>
<tr>
<th></th>
<th>Finnish and German</th>
<th>Finnish</th>
<th>German</th>
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<td>144</td>
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<td></td>
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<td>2.5%</td>
<td>0.7%</td>
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<td>18-25</td>
<td>37.7%</td>
<td>33.8%</td>
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<td>26-30</td>
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<td>29.3%</td>
<td>30.6%</td>
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<td>1.4%</td>
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<td>2.0%</td>
<td>0.7%</td>
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<td>Student</td>
<td>47.1%</td>
<td>39.9%</td>
<td>56.9%</td>
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<td>50.5%</td>
<td>38.2%</td>
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<td>Executive, entrepreneur, self-employed</td>
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<td>5.0%</td>
<td>2.8%</td>
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<td>Persons in the same household (including respondent)</td>
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<td>19.4%</td>
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<td>2</td>
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<td>33.8%</td>
<td>31.3%</td>
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<td>3</td>
<td>18.4%</td>
<td>12.1%</td>
<td>27.1%</td>
</tr>
<tr>
<td>4</td>
<td>10.5%</td>
<td>8.6%</td>
<td>13.2%</td>
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<td>≥5</td>
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<td>3.0%</td>
<td>9.1%</td>
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<td>Monthly household net income</td>
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<td>Below 1300 €</td>
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<td>2600 € to 3600 €</td>
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<td>6.9%</td>
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<td>3600 € to 5000 €</td>
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<td>Above 5000 €</td>
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<td>1.4%</td>
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<td>24.7%</td>
<td>59.8%</td>
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<td>&lt;University</td>
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<td>17.2%</td>
<td>0.0%</td>
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<td>University</td>
<td>58.5%</td>
<td>57.1%</td>
<td>36.7%</td>
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<td>0.5%</td>
<td>0.0%</td>
</tr>
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<td>Study / work in the field of information technology</td>
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<td></td>
<td></td>
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<tr>
<td>Yes</td>
<td>57.3%</td>
<td>55.1%</td>
<td>59.7%</td>
</tr>
<tr>
<td>No</td>
<td>42.1%</td>
<td>44.4%</td>
<td>39.6%</td>
</tr>
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<td>0.5%</td>
<td>0.7%</td>
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<tr>
<td>Technology attitude</td>
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<tr>
<td>Innovators</td>
<td>0.3%</td>
<td>0.5%</td>
<td>0.0%</td>
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<tr>
<td>Early adopters</td>
<td>32.7%</td>
<td>21.7%</td>
<td>47.2%</td>
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<td>Early majority</td>
<td>32.2%</td>
<td>47.5%</td>
<td>11.8%</td>
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<tr>
<td>Late majority</td>
<td>26.0%</td>
<td>21.2%</td>
<td>32.6%</td>
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<tr>
<td>Laggards</td>
<td>5.6%</td>
<td>5.1%</td>
<td>6.3%</td>
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<td>Not specified</td>
<td>3.2%</td>
<td>4.0%</td>
<td>2.1%</td>
</tr>
</tbody>
</table>
Table 1 Demographic and psychographic data of the respondents separate for Finnish and German and for both questionnaires combined.

3.3.4 Game playing experience
Game players were categorized into three different groups: “heavy game players” (daily, weekly), “light game players” (monthly to every now and then) and not at all game players.

3.3.5 3D viewing experience
The majority of the respondents has got some kind of 3D viewing experiences (57.3%). Those who had viewed on 3D reported the viewing locations mainly been in the cinema or theme or amusement parks (41%). The most viewed contents were documentaries (22.2%), fantasy (20.2%) and nature movies (19.6%).

<table>
<thead>
<tr>
<th>Game experience</th>
<th>Finland and Germany</th>
<th>Finland</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>15.3%</td>
<td>16.6%</td>
<td>14.2%</td>
</tr>
<tr>
<td>Light players (monthly / less frequently)</td>
<td>51.5%</td>
<td>52.4%</td>
<td>50.8%</td>
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<tr>
<td>Heavy players (daily / weekly)</td>
<td>32.5%</td>
<td>30.3%</td>
<td>34.0%</td>
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<tr>
<td>Not specified</td>
<td>0.9%</td>
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<td>1.0%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>3D viewing experience</th>
<th>Finland and Germany</th>
<th>Finland</th>
<th>Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not at all</td>
<td>42.4%</td>
<td>58.4%</td>
<td>20.7%</td>
</tr>
<tr>
<td>Tried once</td>
<td>23.4%</td>
<td>12.2%</td>
<td>38.6%</td>
</tr>
<tr>
<td>Several times (two to five times)</td>
<td>30.7%</td>
<td>27.4%</td>
<td>35.2%</td>
</tr>
<tr>
<td>Regularly</td>
<td>3.2%</td>
<td>1.5%</td>
<td>5.5%</td>
</tr>
<tr>
<td>Not specified</td>
<td>0.3%</td>
<td>0.5%</td>
<td>0.0%</td>
</tr>
</tbody>
</table>

Table 2 Game experience and 3D viewing experience of the participants.

3.4 Content
3.4.1 Television content
Both entertaining and informational contents are interesting for the mobile 3DTV presentation. The films are the most appropriate content followed by documentaries, news, animations, music videos and television and weather forecast, respectively (p<.001 compared to the other contents; Figure 2). Foreign television series, sitcoms, sports and current affairs programs are also within the list of the ten most interesting contents (p<.05).

Impact of demographics and psychographic data on the top ten of the mobile 3DTV contents were also analyzed. There were only few notable differences. Firstly, the female respondents were less excited about viewing sports ($\chi^2=3.9$, df=1, p<.05), but more interested in viewing foreign television series than the male respondents ($\chi^2=4.2$, df=1, p<.05). Secondly, the examination by the age groups revealed that the music videos were less interesting for the group aged over 40 years compared to the younger age groups (p<.05).
3.4.2 Genre

The most interesting genre types for the mobile 3DTV are science fiction, action films, comedy and thrillers (mentioned by over 40% of participants), whereas drama and romance were seen to be less interesting contents (p<.05; Figure 3).

There were some gender and age related differences between these genre preferences. The male respondents preferred equally much science fiction, action movies followed by thrillers and comedy over the drama and romance with significant differences between these three groups (p<.01). For the female respondents comedy was clearly the most attractive genre (p<.001), followed by drama, action films, thriller and science fiction. In the age group by age group examination, the group of respondents aged over 40 years were less interested in watching action films and the science fiction compared to the other age groups (p<.05).

**Figure 2 Most interesting television contents for mobile 3D television.**
Figure 3 Interests in viewing different genres on mobile 3D television.

3.4.3 Other content types
In addition to the conventional television contents, 3D presentation is interesting for other type of presentations as well. Tailored contents for mobile 3D television and navigation are the most interesting video content types for the mobile presentation (p<.05; Figure 4). The film trailers, animations, games, and special presentations, like virtual museum or city guides are also highly interesting contents for 3D video presentation on mobile device (mentioned by over 40% of respondents). Over 35% of respondents mentioned also instructions of use, 3D videos in games, product presentations, short movies, user-created videos, event and location based contents and video phone calls being attractive for 3D mobile presentation.

There were some gender and age group related differences between the preferences of the other mobile 3D video contents, especially in gaming. Gaming, 3D videos in games (p<.001) and user-created videos were more attractive for the group of male respondents (p<.05). In contrast the female respondents were more interested in special presentations, like video guides than male respondents (p<.05). In the age-group examination, the oldest age group, over 40 years, were significantly less interested in mobile 3D gaming or videos in the games than the other age groups (p<.001).
Figure 4 Interests in viewing different video or animation contents on 3D mobile device.

3.4.4 The length of viewing

The expected length of viewing on mobile 3D television was surveyed. The most suitable length of viewing for mobile 3DTV are from couple of minutes to 15 minutes (p>.05 difference to others p<.001; Figure 5). Viewing for half an hour was also significantly preferred over the long lasting viewing options (an hour lasting and full film viewing, p>.05) (p<.01).

Figure 5 Expected length of viewing of mobile 3D television.
### 3.4.5 Content and media features

Different content features supporting especially short viewing times were also studied. Viewing just a short part (33.8%) or the flashes (32.3%) of the current television programs on 3D were seen suitable for the mobile 3DTV. However, the looped television programs were not seen to be an attractive option for mobile 3DTV presentation (18% of respondents; p<.001).

The needs for the different audio, visual and audiovisual presentation modes were surveyed. The results showed high level of interests in audio only (p<.001; Figure 6), audiovisual presentation and the fluent shifts between these two modes (over 65%). In the side of the visual presentation, the visual presentation should be possible to change from 2D to 3D fluently (48.4%). The least interesting option, but still highly needed, is the video only presentation mode (48.4%).

![Figure 6 Needs for different audio, visual and audiovisual presentation modes.](image)

The examined features for interacting with content remained the same as functionalities in SMS or multimedia messaging including saving, receiving, sending, recording, editing and sharing. Interaction with the content was highly interesting for the majority of the respondents (over 57% of participants). Storing, receiving, sending and recording 3D content on mobile devices were preferred over editing the content and its sharing to wide audience in the internet (p<.001; Figure 7).

![Figure 7 Needs for interacting with the content.](image)
3.5 Device and service

3.5.1 Device

The preferred display size was the examined feature of the mobile 3D television device. A display size of 4-5 inch is seen as most suitable for viewing 3D television or video on a portable device [Figure 8]. In addition, display sizes of 3-4 inch, 5-7 inch and larger than 7 inch are considered as suitable. A display of 2-3 inch is less imaginable.

![Figure 8 Preferred display sizes for watching 3D TV on a portable device.](image)

3.5.2 Service type and payment

The examined service options were on-demand and push service. The majority of the participants assessed mobile 3DTV being rather on-demand service (70.4%) than push type of the service (26%). The surveyed methods of payment were constant monthly payment and pay per view. Most of the participants (60.8%) would prefer monthly payment of the use of mobile 3DTV. However, pay per view was also highly rated (39.2%) resulting the both options would be needed for mobile 3D television.

In a monthly payment method, a price between 5.00 €-9.99 € is the most preferred price [Figure 9]. It is followed by the price of 10.00-14.99 € per month while other options were clearly less mentioned. 7.8% of the participants are not ready to pay for the use of mobile 3DTV.

![Figure 9 Suitable prices for the monthly payment.](image)

In a pay per view method, a price between 0.07 € and 2.99 € is primarily seen as appropriate, followed by a price up to 3.99 € [Figure 10]. Being in the line with previous question, 7.5% of the participants are not ready to pay for watching mobile 3DTV.


3.6 Contexts

Different aspects of social, temporal, physical and task contexts were surveyed.

3.6.1 Social context

Social context examined the interests in private and shared viewing. The majority of the participants would mainly watch mobile 3DTV on their own (79.5%; p<.001). However, a significant number of respondents would also watch it together with someone else (34.6%) or in a small group of people (28.9%).

3.6.2 Temporal context

Temporal context focused on examining the length of the situations in which mobile 3D television would be watched. Viewing during a long transportation trip is seen as the most interesting option, followed by short waiting situations (p<.001; Figure 11). The other options (watching during the trip to or from work or school, during short coffee or lunch breaks or waiting situations) are also seen as possible usage situations.

Figure 10 Suitable prices for pay per view.

Figure 11 The most interesting temporal viewing contexts for mobile 3DTV.
3.6.3 Physical context
The examination of the physical context investigated the interesting locations for mobile 3DTV viewing. The most imaginable locations to watch mobile 3DTV are lounges and public transportations [p<.001; Figure 12]. For over 40% of respondents also watching mobile 3DTV in hospital, at home, in busy environments is highly interesting. In addition watching in a park, car, cafe or at home before going to sleep is seen as attractive for 3D television and video (over 29% of respondents).

![Figure 12 The most interesting physical viewing contexts for mobile 3DTV.](image_url)

3.6.4 Task context
The questions of task contents determined different viewing habits. Mobile 3DTV viewing is mainly assumed to be primary task in which viewer gives full focus on viewing task (36.6%). Parallel tasks of viewing and chatting are the next interesting option (25.6%). In contrast, viewing as a secondary task, e.g. keeping television as a background sound is seen the least interesting option for mobile 3DTV (17.3%).
Figure 13 The most interesting task contexts for mobile 3D television.

3.6.5 Motivations

The viewing motivations were broadly examined including mainly aspects of mobile television viewing. The main motivations for mobile 3D television viewing are to become entertained, kill time, to get information and relax (over 54%, $p<.05$; Figure 14). Other highly assessed motivations are change to experience 3D privately, learning and get information in the events (at least 40%).

Figure 14 Motivations for mobile 3DTV viewing.
3.7 Summary
The user’s motivations and needs for the mobile 3DTV contents, service and usage contexts are summarized here based on the conducted online survey.

User’s main motivations for mobile 3DTV viewing are to become entertained, kill time, to get information, to relax. Learning can also be a possible motivating factor.

Not only conventional television contents, but also other video contents are interesting for mobile 3DTV. Main entertaining conventional television contents are films, animations, music videos, foreign TV series, sitcom, sport whereas informational contents are news, documentaries, weather, current affair program. Other video contents are specially tailored content for mobile 3DTV and navigation. In addition, film trailers, animations, games, special presentations, like virtual museum or city guides, instructions of use, 3D videos in games, product presentations, short movies, user-created videos, event and location based contents, video phone calls are possible contents.

The service should provide flexible service types and payment options. Primarily on-demand service, but push option should be available as well. Both monthly payment (max 10€) and pay per view (max 3€) options are also needed.

There is a need for versatile interaction features on a mobile device.

1. The preferred size of a device is 4-5 inch, but screen sizes larger than 3-4 inch are considered as suitable.
2. Both mono- (audio or visual only) and multimodal (audiovisual) presentation modes and fluent shifts between multimodal and visual 2D/3D presentation modes are required.
3. Interaction possibilities including saving, receiving, sending, recording needed are highly appreciated as well as the support for viewing short parts or flashes of the programs.

The usage contexts of mobile 3DTV contain different social and task situations, various physical locations and extra time situation representing the temporal aspect of the context.

1. To describe the social context, mobile 3DTV is mainly for private viewing, but there is a need for shared viewing.
2. Viewing context illustrates that mobile 3DTV is expected to be viewed under relatively focused viewing in contrast to background sound, like conventional TV. Other simple tasks, like chatting can be done parallel to viewing.
3. Physical context describes that mobile 3DTV will be viewed in the public and private locations and outdoor and indoor conditions. The potential places are lounges and public transportations, in hospital, at home, in busy environments, in a park, car, cafe, at home before going to sleep.
4. Temporally, mobile 3DTV will be used in the situations in which there is extra time. Possible situations are long transportation trips, short waiting situations, trip to or from work or school, coffee or lunch breaks. Two different viewing habits resulting different preferred length of viewing are assumed. Mainly, short time viewing from couple of minutes to 15 minutes or half an hour is expected. Minor, long viewing periods lasting more than an hour can be also potential.
3.8 Further work
The reported results are able to reflect the main user’s motivation, user’s desires for content, system and service of mobile 3DTV. The provided results enable to start the next activities of user-centered design. Further work in more detailed analysis of questionnaire data can be considered. The possible aspects are to examine the interests according to different background factors. However, this part of the work was not possible to conduct within the stage of requirement elicitation in the project. Similarly, the analysis of technology acceptance is left to further work.
4. Study 2: Focus groups on user’s needs and expectations on mobile 3DTV

Focus groups are a qualitative research method and were introduced as “focused interviews” in the 1930s. The U.S. Military used them in the 1940s to improve soldiers’ lives, marketers adopted them during the 1950s and they have become one of the most used marketing research tools. They are an appropriate way to quickly and inexpensively study users’ needs, expectations, desires and priorities about a new product or service [8][42].

In focus groups, a group of usually 8-12 people is brought together. The participants are carefully chosen and usually form a homogenous and thin slice of the future target audience. The focus groups task is to discuss ideas, expectations and visions about topics that are introduced to the group by a skilled moderator. The goal of a focus group discussion is not to test hypotheses or concepts, but to explore new input to form hypotheses or concepts. That is, what and especially how people think about a future product or service. According to Courage et al., the key benefit of a focus group interview is to build up a group dynamic that ‘brings up topics you may never have thought to ask about’ [8]. This makes focus groups an effective way of collecting important points affecting the later introduction or design of new services or technologies. In contrast to semi-structured interviews or surveys, the participants in focus groups might also talk about things that they never would have mentioned in a single task. This stimulates, as Courage mentions, a broader view about new concepts. [8][42]

According to our research task, focus groups seem to be appropriate for the following reasons: A prototype is not available, thus our studies have to rely solely on the imagination of the participants at the moment. The imagination of users can be enhanced by using the synergies of a group discussion, thus generating more ideas as by a single user alone. Also, it is important to us to be able to define a user experience close to what the target consumers want. Users should be able to provide firsthand information about the later design of the products and services. This requires a method, which cheaply and quickly provides a solid foundation of information, which is what the focus groups can provide. Furthermore, the absence of a prototype will most likely lead to irritations and questions concerning the final product. In contrary to personal interviews, questions can be answered to several participants at a time, rather than one at a time. Additionally, the user synergies might help to restrain the users’ ideas to more realistic approaches. Other methods, such as interviews or surveys are unlikely to be applicable, as they would need much more time and preparation and/or massively larger samples [8][42].

As there are several types of focus groups, regarding the questions the group is supposed to answer, we decided to use the focus groups as a mixture of the ‘explorative’ and ‘feature prioritization’ group types. As Kuniavsky [42] describes it, while the former are a good measure to ‘get at general attitudes’, the latter ‘focus on what features are most attractive to the group and why. [T]he assumption is, that […] the discussion centers on what kind of things they would like that product to do for them.’

Reviewing literature about related studies, Knoche and McCarthy [38] used focus groups to study users' needs and expectations of future multimedia services. In their study, Knoche and McCarthy used the focus group method to test several scenarios of multimedia services regarding the interest of participants. They introduced mobile scenarios like “news and weather” or “disaster management” and asked the participants about their personal opinion and ideas of the usability and feasibility of the scenarios. In a study about exploring presence through advanced broadcast services, Freeman and Avons describe their focus group method to be “designed to elicit non-expert descriptions of stereoscopic television (3DTV)” [13]. The goal of their focus groups was to describe the feelings and identification of users with 3DTV scenes and services and to outline programs and contents to be best-suited for related services.

4.1 Research question and objectives

The focus group conducted in the context of mobile 3DTV was designed to answer to different questions concerning the introduction of the new service. The focus groups aimed to a) gather understanding of the
service mobile 3DTV and its relation to existing services like mobile TV and 3DTV, b) identification of suitable content and future service scenarios, c) description of future devices and service design regarding e.g. costs or accessibility and d) identification of the context of use.

4.2 Description of the method
Following, we will describe the design of the focus group in detail. We present our discussion guideline and outline the importance of every step and its meaning. The complete discussion guideline can be found in section 8.5.

4.2.1 Welcome and warm up
The primary task of welcome and warm up is to make the participants relax, to inform them about the method, and to warm them up for the method. This task is very important for the success of a focus group as the researcher (or moderator) can clarify the goal and task in advance and familiarize the participants with the situations.

4.2.2 Starting the focus group – introduction to 2D- and 3DTV
The idea of the introduction is to extend the ideas of the group from 2D television to 3D television.

Discussion guideline:
- The first task is dedicated to your personal habit of watching TV. Why do you normally watch TV? What functions does TV have for you in your life?
- I’d now like to move the discussion towards situations in which you found 2DTV to be insufficient and would prefer to have a 3D system.

4.2.3 Introduction to mobile devices
To paraphrase that mobile isn’t confined to mobile phones, participants will be questioned about their use of mobile devices in general.

Discussion guideline:
- What kind of mobile devices are you using and what are the typical situations you’re using them in? Also think about new mobile services like MMS, mobile browsing or video calls.

4.2.4 Introduction to mobile 3DTV and mobile 3DTV scenarios
We will now guide the participants to mobile 3DTV using “imaginary prototypes” and certain scenarios which we’ll draw like a map of a town on a whiteboard.

Discussion guideline:
First, there is a house and inside the house two people are watching TV together on their mobile 3DTV device. Second, there is a boy in front of a cinema who downloaded the actual movie trailers from a cinema service and checks the trailers before he decides for the film to watch. Third, there is a man in a car on the street who uses his mobile 3DTV device as 3D GPS navigation.

- Now, think about everything mentioned about 3DTV and mobile services before. You will have 5 minutes to think about additional scenarios or to add something to the given ones. You can also comment on the scenarios already shown on our map.
- I’d like you to discuss the scenarios we’ve provided you with, imagine more scenarios, and fill the empty gaps on the map. Remember, there’s no wrong idea or technical limitation for the applications you can imagine.
We finally ask the participants to write down on a sheet of paper the three most important scenarios that they can identify on the whiteboard.

4.2.5 Mobile 3DTV services
The next step will be to paraphrase “mobile” in mobile3DTV.

Discussion guideline:
• You have developed scenarios where you could imagine using your imaginary mobile 3DTV device. Now, we will have a look on that device. How does your imaginary device look like? What functions does it need to have?

Finally we discuss the future service of mobile 3DTV. How do the people plan their program? How does mobile 3DTV service look like? What would they pay and how?

4.2.6 Closing Task
With the closing task, we’ll combine everything mentioned in the focus group.

Discussion guideline:
• Fine, I think we are nearly done. You have told us a lot about your expectations during this focus group. Before we close the group, we would like to ask you to write down a final statement about the future service of mobile 3DTV.

4.3 Participants
Participants were recruited through advertisements in student forums and online news tickers. 8 focus groups were conducted in Germany (6 groups) and in Finland (2 groups). All participants were classified using 4 different profiles. The profiles were adapted from mobile TV user profiles and user description was used according to Kuniavsky [42].

<table>
<thead>
<tr>
<th>The pupil</th>
<th>Age</th>
<th>16-19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>High School</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>not important</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>€ 30 – 70 per month</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>uses broadband internet; uses portable devices, moderately uses extended device capabilities (like music player, camera) or mobile services</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>early mainstream, light/moderate use, novice/experienced user</td>
<td></td>
</tr>
</tbody>
</table>

| The technical student | Age | 18-30 |

---

1 This refers to the kind of technology the participant uses or at least is accustomed to.

2 Participants’ attitude towards technology.
<table>
<thead>
<tr>
<th>The non-technical student</th>
<th>Age</th>
<th>18-30</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>non-technical courses</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>not important</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>€100+ surplus per month</td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td>uses broadband internet; uses portable devices, moderately uses extended device capabilities (like music-/video-player, camera, MMS, etc) or mobile services</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>early mainstream, light/moderate use, novice/experienced user</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>The employee</th>
<th>Age</th>
<th>25 – 50</th>
</tr>
</thead>
<tbody>
<tr>
<td>Education</td>
<td>High School or higher</td>
<td></td>
</tr>
<tr>
<td>Gender</td>
<td>not important</td>
<td></td>
</tr>
<tr>
<td>Income</td>
<td>€1500+ net per month</td>
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</tr>
<tr>
<td>Technology</td>
<td>uses broadband internet; uses portable devices, moderately uses extended device capabilities (like music-/video-player, camera, MMS, etc) or mobile services</td>
<td></td>
</tr>
<tr>
<td>Attitude</td>
<td>early mainstream, light/moderate use, novice/experienced user</td>
<td></td>
</tr>
</tbody>
</table>

The focus groups were conducted at different locations so that we could assure to catch location specific ideas as well as a general view about expectations and user needs for mobile 3DTV service. Altogether, 46 participants took part in the focus groups. Although, according to literature [8], the optimum number of participants is 6-10, it turned out that a group with >6 participants were hard to handle. This can arise from the task-oriented or scenario-developing design. Ideas and expectations about the service to be developed are very different and this heterogeneous mix suppresses the deeper development of scenarios and future service design. Following, we present the results of the focus groups ordered by country and target group.

### 4.4 Method of analysis

The qualitative analysis was based on grounded theory originated from Strauss & Corbin [67]. Grounded theory approach is applicable in the research areas with little a priori knowledge and when the research
aims at understanding the meaning or nature of a person’s experiences. The theory or its building blocks are constructed from data with systematical steps of analysis. At the beginning, all lettered focus group materials were read though to initiate open coding. Open coding was done for all material to discover the concepts and their properties. The concepts were organized into categories and further concepts were grouped under three main UX factors, user, system and service and context. Total number of created categories and frequency of mentions in these categories are presented in Table 3.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Focus groups</th>
</tr>
</thead>
<tbody>
<tr>
<td>No.</td>
<td>Freq.</td>
</tr>
<tr>
<td>User</td>
<td>16</td>
</tr>
<tr>
<td>System</td>
<td>38</td>
</tr>
<tr>
<td>Context</td>
<td>25</td>
</tr>
</tbody>
</table>

Table 3 Categories and their frequencies of the focus groups

### 4.5 Focus groups conducted in Germany

#### 4.5.1 Target group „Pupil“

<table>
<thead>
<tr>
<th>Location</th>
<th>Paul-Pfinzing-Gymnasium Hersbruck</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>02.05.2008</td>
</tr>
<tr>
<td>Number of participants</td>
<td>7</td>
</tr>
<tr>
<td>Attitude towards technology</td>
<td>early majority</td>
</tr>
<tr>
<td>Mobile devices</td>
<td>phones, laptop, camera, mp3 player; many participants have had several separate devices</td>
</tr>
<tr>
<td>Mobile services</td>
<td>mobile browsing, video podcasts, mobile gaming</td>
</tr>
<tr>
<td>Television or video viewing habits</td>
<td>To pass time, to get entertained. Certain programs are watched due to social importance so that you are up-to-date when talking to friends. Also sharing of content and the status to have videos on the mobile phone are important for these young people.</td>
</tr>
</tbody>
</table>

#### 4.5.1.1 Content

**Content types**
The most interesting usage scenario for the pupils is to use mobile 3DTV services for waste time situations or during your free time to relax. During these situations, mobile 3DTV is entertainment and the panelists prefer movies or watching traditional TV program in 3D. Another very important content to watch while being on the go is live broadcasts of special events. Panelists mention the approaching broadcasts of the Olympic Games in Beijing or Soccer World Cup. They like the idea of experiencing the content and the atmosphere in 3D and the advantage not to miss an interesting part if they are not at home.

*If there is something like Olympic Games or World Cup and you can watch live broadcasts on your portable device if you don’t have the possibilities to be in the stadium...*

The idea of mobile 3DTV being an information service in unknown cities is a second popular example for content among the participants. Panelists wish to have a service that combines navigation, event guide and tourist information. This combination is something that the people don’t know yet and therefore the interest in this application is very important. They hope to get a better picture from the town or certain sights when it is 3D and additionally they can get additional information. This information can be useful when you are in the city. But you can also use the information to plan a trip or to look for hotels or accommodation in a foreign country like in a travelling agency. In addition, panelists would like to get information about what they can expect when they visit a certain building (event guide) or a restaurant (3D menu).

*I think about a service comparable to Google Earth where you have got a city map and there you can zoom into this that interest you and you don’t know what to do and you search for the market place or the theatre and you check what happens there. Just like Google Earth, but actual information all the time.*

Extending the described guidance service, panelists also mention the idea of using it while being shopping. On the one hand, mobile 3DTV can be a navigation service in shopping malls to find the right shops that sells the products you are looking for. But users also expect to use it as a service to get additional information about the products or to see the latest trends to compare products before buying them.

But for pupils the aspect of mobile 3DTV being a source of information is also suitable for school. Getting support from seeing content in 3D is said to be helpful to imagine things better or to be able to remember easier when you have to learn them. The service may provide possibilities to investigate certain topics more detailed. But also people learning languages can profit of 3D content as the teacher is more realistic and some kind of face-to-face communication can be established.

**Added value of 3D**

The added value of 3D for the pupils was a raised realism in the content. This count for navigation services where people want to identify their surroundings easier in the application as well as in information systems about foreign countries or holiday destinations where people may get a better idea of how it looks like there and what you can expect. Related to sport broadcasts the raised realism means a better experience of the atmosphere in the stadium which comes along with the feeling of “being there”.

*In a travelling agency for example: [...] it would be certainly nice to see different locations or what you can expect about Egypt in 3D and not only on a picture.*
4.5.1.2 Context
We already described waste time or waiting situations to be suitable context for mobile 3DTV service. Mobile 3DTV is useful in these situations to bridge situations and not to feel bored. Physically, mobile 3DTV will be watched while being somewhere outside relaxing, in the car, while commuting in bus or train, while shopping, or in school for educational purposes.

Another important aspect is the social context of mobile 3DTV. Panelists expect mobile 3DTV not only to be a single-view service. Shared viewing of sport events and the feeling of shared atmosphere is an important fact for the panelists.

During the Olympic games [...] I can image to say: ”Let’s meet to watch together”. You just feel as if you are right in-between.

4.5.1.3 Service

Device

According to the panelists, mobile 3DTV does not need to be integrated into existing mobile devices. They are used to carry several mobile devices like mobile phone, mp3-player or digital camera. The advantage for them would be that they could decide if they take the device with them when being on the go or to leave it at home. Recently, they also have got mobile phones plus extra mobile devices to listen to music. This arises from the available features in each of the devices as they often have had just simple mobile phones that did not offer special functions like listening to music. But the main reason is that they are just used to have several devices.

I don’t mind [if mobile 3DTV would be a separate device]. Actually, I have got so much stuff in my backpack that it doesn’t matter if there is one device more or less. I mean that I wouldn’t take it with me all the time and I wouldn’t mind.

Nevertheless, panelists have clear ideas about how the device should look like. The main criterion for them is the size. It decides if a device is mobile or not. The maximum size is related to the size of modern mobile phones. The device needs to fit into the trouser pocket. Fitting in there is the main fact to be a portable, mobile device.

It makes sense that it fits into one's trouser pocket. Otherwise, no one would take it.

The device will be controlled via touch screen. Panelists want to replace physical buttons with buttons on the touch screen as they want to get a screen as large as possible. In fact, the size of the display is the second important feature that participants name while talking about the devices.

To get a display as large as possible, the pupils develop several ideas. As for them mobile 3DTV also means co-viewing or shared viewing, they expect features to connect several devices to a larger one when watching together. A second idea is that the display can be unfolded. This would combine the need for small displays that fit into the pocket and the need of large screens to watch 3D content.

The third idea was thoughts about holographic mobile devices. Panelists do not want to depend on the size of the display. They expect the picture to break out of the display and to get a larger image. This feature can also be combined with connectible displays which allows for a larger projection surface.
I have one question: Should it work in a way that the image to appear has got the same size than the display or is it like a beamer that enlarges everything, because then it would be alright. If you would have got a display like a mobile phone display and then the image itself is enlarged. The further you are away, the bigger is the image. Then it is about the same size as it is on a TV, but then I can imagine watching it.

So that you can connect it on a table and then it comes out of the screen so that no one needs to look at the screen, but to watch the things that come out of the screen.

Payment
Panelists wish to have simple payment models to pay for using mobile 3DTV services. It is interesting to see that payment is a very natural thing. The participants do not expect that mobile 3DTV services will be accessible for free. The only content that should be free is TV program which shows the attitude of people that television is freely available and shall be available for free in the future. But all the additional services may cost and the costs should be covered by flat rates. Thereby, it is important that these additional services differ clearly from the content which is available for free.

Service type
The preferred service type is an on-demand service. Panelists expect to get internet access and to download content from several platforms or other service providers. On-demand services would support the idea that people on the go want to access content whenever they like. Nevertheless, pupils are concerned how to assure that no one else can use the content which they had bought from the internet.

Well, I would do it in a way that you can just watch ii (your content) on your device.

But if there is free content, then I will expect that you can give it to your friends.

4.5.2 Target group “technical students”

<table>
<thead>
<tr>
<th>Location</th>
<th>Technische Universität Ilmenau, Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>08.05.2008</td>
</tr>
<tr>
<td>Number of participants</td>
<td>5</td>
</tr>
<tr>
<td>Attitude towards technology</td>
<td>early majority, early adopters</td>
</tr>
<tr>
<td>Mobile devices</td>
<td>laptop, camera, mp3 player; multimedia phones; PSP</td>
</tr>
<tr>
<td>Mobile services</td>
<td>audio podcasts, gaming, mobile browsing</td>
</tr>
<tr>
<td>Television or video viewing habits</td>
<td>Television is just kill-time scenario. Participants mostly use internet-based solutions, podcasts or video-on-demand services to get informed or to get entertained.</td>
</tr>
</tbody>
</table>

4.5.2.1 Content

Content types
A very prominent content developed during the scenario task was 3D mobile gaming. These games cover every genre from board games to interactive types where the mobile device is some kind of mediator between the user and the game. The gaming applications would benefit from the mobility aspect so that
you can play your games everywhere. Gaming was very much related to children as the main user group. The idea is connected to the current popularity of the Nintendo Wii console where gaming is combined with interaction.

*Everyone says that children become more and more lazy as they do not move anymore. I don’t know how to do it but it would certainly be possible to use 3D animation to make the children become active.*

Another very interesting content or application was navigation and the extended idea of the introduced GPS scenario. Talking about navigation scenarios, the participants mention to extend this as a service for people coming to a new city. The idea was finally further extended to guide services in different location. Beside the idea of having guidance through a shopping mall to find products, the idea of the device guiding you through a museum was very much appreciated by the participants. They want to get additional information about the exhibits. Here, participants highlight historic information and additional contextual knowledge.

*There [in a museum] is this shrine and you can get from your mobile device where the exhibit was found, how it was restored or how it was used in former times.*

But there was also content being unsuitable for mobile 3DTV services. Although participants highlighted the great experience of watching music videos or live concert broadcasts in 3D on a big screen, they doubt that they want to see this content on a mobile device. They are concerned that the display cannot create the fascination of being part in the concert. The feeling of being there – the main added value of 3D for the participants – is also described in the next section.

*You have got mobile 3DTV and I don’t know if I’d watch a concert on such a device, because I will need a big screen to experience this. Big screen, fine, ok! But mobile? I don’t know.*

**Added value of 3D content**

The added value of 3D content is described with being there and a better sense of reality. Watching content in 3D is very much related to raised emotions and feelings.

*I think it is just stronger and that it comes across better and that it touches me more emotionally.*

The feeling of being part of the action is the main desire of consuming 3D content. Thereby, it does not matter if it is action movie, concerts or cultural content like theatre. The people would like to be part of the action and want to get better experience of the content they are watching. People also mention that 3D content can transmit atmosphere and that one had a feeling of really having been there after watching a concert movie in 3D.

*It is just like a normal concert, but in 3D. It Bono was there right in front of you and you could shake his hand, then you really feel as if you were really there.*

**4.5.2.2 Context**

*If I would be on a bus stop or in the bus, always when you need to bridge time gaps, then I would play the 3D mobile games that I just invented.*
Mobile 3DTV as an application for killing time was a very clear statement in the focus group. Thereby, waste time situations are meant to be somewhere on the go. At home, panelists still would prefer watching TV on a traditional television or on a big 3DTV screen. But these waste time situations are the only temporal context mentioned in the focus group. Moreover, mobile 3DTV has got informational character. This can be seen in the popularity of navigation applications or guidance services in museums. In these situations, mobile 3DTV is a one person application that uses the device to get the information he or she is looking for.

But related to social context, mobile 3DTV applications are also seen as an instrument to create interaction. Especially children are mentioned as target group for connecting people. 3D gaming is imagined to be a suitable application for social interaction.

... so that children are sitting next to each other on a playground can still play [their games]. It is the same thing that they are doing at home or everywhere else, so it is independent where they play. But they can still play together.

4.5.2.3 Service

Device

My device? Like the Apple iPhone. Very flat, a big display, less gadgets. Just something that has got the essential functions and therefore, it is easy to use.

This statement describes very well the expectations about mobile 3DTV devices. The first important thing about the device is its size. Panelists expect the device to fit perfectly into their hands. The size should, on the one hand, not limit the display size to become too small, but, on the other hand, the device should still be portable. Being portable is related to the fact that the mobile device still can be put into the trouser pocket. Being asked about laptops as a proper device for mobile 3DTV services, the panelists thus clearly stated that laptops are not portable in a sense of being a mobile device. Using more than one hand to hold the device during usage is a “no go”.

Yes, it should fit into your hand. Not too small and not too big, because holding it like this [with two hands] would be very annoying […]. And as I said, a laptop is a very nice device, but a laptop is not mobile.

Another very important user need about mobile devices is enough storage space. The need for storage space is a reason why people still have separate multimedia devices like mp3 players and not using the mobile phone as a combined device for everything. Related to mobile 3DTV, participants mention that podcasts need a lot of space on the disc. People want to watch or listen to what they like when they are on the go and they do not want to depend on what they have stored on their device.

But using 3D services is not only related to visual features of the device. The device also needs to be equipped with good loudspeakers. Participants outline that watching video three-dimensionally is very much connected to hear sound around them accordingly. To integrate surround sound into mobile devices, they come up with the idea of using headphones.

Finally, panelists talked about interfaces of the device. A wireless connection to the internet via WiFi or WiMax is very important to access all services. To connect your device with others’ devices, they also expect Bluetooth or Infrared connectivity. One important expectation is that these interfaces do not influence the size of the device. USB interfaces are said to be too big. The panelists thought about
possibilities like docking stations. But traditional docking station should change. One just puts his device on a plate and then it automatically connects and the battery gets recharged without cables.

There is this technology that can recharge your mobile phone. You just put your phone on a plate that is connected [...] and you can recharge the device without a cable connection. Then you can recharge the battery and transfer data at the same time – nice technology!

**Display size and characteristics**
A very important point of discussion was the size of the display and its characteristics. Even if panelists outline that the device mustn’t be too big to keep it portable, they expect to need a screen as big as possible to experience 3D content sufficiently. To fulfill both requirements, there are two solutions.

The first idea is to have a projection device that shows three-dimensional content detached of the device. This can be either beamer like or in a holographic way.

... it is about different projection technologies not directly on the mobile device.

The other idea is to have a separate display for mobile 3D applications. People think of displays that can be folded or rolled. They compare their display to e-ink-readers. The idea is that users want to unfold the screen when they need it to be big, i.e. in three-dimensional applications. To roll or to fold the screen would combine portability and the need of enough space to enjoy 3D content and to feel what they expect of 3D content.

So if I am allowed to think about fancy features, then my screen can be convolved. This means, it is able to be convolved like a sheet of paper or something like that, like an e-ink-reader...

... and if needed, then I can unfold it (the display), for example while using city map applications or something comparable. This would be great.

**Interaction functionalities**
Beside the physical characteristics of the device, the usability and controlling of the functions is very important for the panelists. Intuitive controls are very much expected to be integrated in the device. Hardware buttons are not appropriate anymore. Participants prefer to have touch screens that display the buttons and control elements. But people are also annoyed of having dirty displays.

They came up with the idea of directly navigating in the 3D content. The device should recognize interaction with the content and the user doesn’t need to touch the display. This functionality also covers zooming and browsing. But also controlling the device via speech recognition would be a solution.

**Service types and payment**
First, it must be mentioned that panelists distinguish between content that is available and usable for free and services that cost money. Free accessible content is often meant as kind of a basic service. The
participants compare 3D television services with traditional television program. Public broadcast services are still expected to be free and private television services should be financed by advertisement. Financing by advertisement and hence free service usage is also appropriate for services where there is a certain interest of the service provider.

*But there should also be free services, for example in a shop where the provider profits from the fact that I find the products easier. These services should definitely be free.*

Services with costs should offer additional information or additional features for the user. These additional features are the difference between basic service and this kind of premium service. The importance is that the difference is noticeable. Then, according to the panelists, they would be willing to pay extra fee to access the premium service.

Regarding payment models the panelists thereby show a clear preference for pay-per-use models. For them, it is very important just to pay for the services that they use. The models need to be customizable to adapt the payment directly to the user’s preferences. Content of the chosen service should be accessible on-demand and without delay.

*I’d suggest a subscription service that is highly customizable as I do not want to pay for something that I don’t use. And it can just annoy me if two of five points don’t fit into my preferences]. It’s already enough to kick the whole subscription.*

Generally, the participants agree that payment finally should be flat rate-based and compare the service access and payment with well-known ways of paying for MMORPGs in the internet (cf. World of Warcraft).

### 4.5.3 Target group “non-technical students”

**Group 1**

<table>
<thead>
<tr>
<th>Location</th>
<th>Technische Universität Ilmenau, Germany</th>
</tr>
</thead>
<tbody>
<tr>
<td>Date</td>
<td>15.05.2008</td>
</tr>
<tr>
<td>Number of participants</td>
<td>6</td>
</tr>
<tr>
<td>Attitude towards technology</td>
<td>early majority, early adopters</td>
</tr>
<tr>
<td>Mobile devices</td>
<td>laptop, camera, mp3 player; multimedia phones; GPS</td>
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</tbody>
</table>
Mobile services
Online calendar, mobile browsing, online storage

Television or video viewing habits
To pass time, entertainment, to be updated. Participants use online news portals to get information on actual news and events.

### Group 2

<table>
<thead>
<tr>
<th>Location</th>
<th>Technische Universität Ilmenau, Germany</th>
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<tbody>
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<tr>
<td>Attitude towards technology</td>
<td>early majority</td>
</tr>
<tr>
<td>Mobile devices</td>
<td>phones, laptop, camera, mp3 player; multimedia phones</td>
</tr>
<tr>
<td>Mobile services</td>
<td>Online calendar, contact synchronization, mobile browsing, file exchange</td>
</tr>
</tbody>
</table>

**Television or video viewing habits**
To pass time, entertainment, to be updated. Watch often internet television or podcasts.

4.5.3.1 **Content**

**Content types**

Interactive three-dimensional games are an interesting application for the panelists. Mobile gaming is preferred over watching 3D television programs in waste time situation. Nevertheless, gaming applications can also be seen as entertainment. Participants also mention to watch TV in situation where they need to bridge time gaps, but they did not tell any more detailed information about the content. But entertainment program is seen as something very person specific and everybody is said to watch the content that he would like to see in a certain situation.

... and I don't have time to go home because I will have another appointment at 10pm. I think that I will then go to a café and I just will watch TV for an hour [on my mobile device].

Beside entertainment applications and television program, information systems are very much appreciated to be offered by mobile 3D services. Most attractive application thereby is navigation possibilities combined with additional information about locations or sights. Panelists expect to be guided to points of interest in 3D, but mostly being on the walk. Car navigation is doubted as distraction arising from three-dimensional presentation is expected to be dangerous.

But information systems can also offer how-to guides or instructions of different things. Mobile 3D services are interesting for people working in the field. They can get instructions how to repair something or they can get visual explanations of how things are to be done. Further discussion about instructional services revealed the case to use mobile 3D services in emergency situations. You can connect your mobile 3D device to medical services to get information what to do if you are in a first aid duty.
Then you will be connected with the doctor in the hospital and he will explain to you what to do.

The idea of interacting with another person was extended to videophoning applications. Panelists assume that if you can access three-dimensional content then you can also capture content in 3D on your device. Participants had got first job experience in internships and thus videophoning was a very well known situation for them. They hope to be able to initiate conference calls with other people independently of the location.

I know from my internship that partners are never in the office at the same time. But you can always make telephone calls and hence I can imagine that it would be beneficial for some bosses to make conference calls while being on the move.

Added value through 3D
Three-dimensional content is more realistic according to the panelists' opinion. This leads to different advantages depending on the content. Relating to television program and videophoning, 3D helps to identify better with other persons, i.e. actors or phone partners. In informational or documentary applications three-dimensional content offers a better imagination of the things and additional realism can help to experience content better than in 2D or to get better understanding of how things work and need to be done.

4.5.3.2 Context
Related to physical context, panelists mention that mobile 3D service will only be used in mobile situations. The idea of using the service at home was not accepted. Mobile 3D services will be used in buses or trains, in cities while being shopping or visiting sights, in cafes and bars or in free-time situations “somewhere outside far away from any buildings”.

Aspects of social context where also mentioned. Mobile 3D service is not only a single user application. Of course, waste time or waiting situations are typical context where one user is watching content on his device. Also shopping or navigation are said to be one person applications. But entertainment in free-time situations is also seen as a multi-user scenario and panelists also expect shared-viewing there.

There are people who spend their free-time lying on the grass far away from any buildings. They use their device because they want to have media around them. Otherwise they would feel bored. Mobile 3DTV will be what a ghetto blaster was in former times.

4.5.4 Service
Device
The question if mobile 3DTV should be integrated into existing devices was discussed very controversially. For some panelists, it was very important to have one devise for everything so that mobile 3DTV devices should be integrated in existing devices. These panelists prefer to have a mobile phone with mobile 3D facilities as they do not want to carry around numerous devices just to access different services. A concern that needs to be solved is that what happens “if I watch a thrilling movie or any football match, the player just scores and in the same moment there is an incoming phone call. This is something that I cannot imagine at all:” Nevertheless, there was also the opinion that mobile 3D applications need to run on a separate device. The reason for this is that users expect to use mobile 3D
function just in special situations and that mobile 3D devices will offer very different functions than an existing mobile device does. They do not want to overload the functionality of the device.

But I am not sure yet if it will be a device only for mobile 3DTV or something which is combined with my cell phone. [...] This 3D services offer a lot of functionality and I think that I want to use every available function if I’d decide for mobile 3D services.

The functionality of mobile 3D devices also reflects the contradiction between “small and portable” and clarity. Again, small and portable is limited by the fact that the device needs to fit into your pocket. Panelists say that there is a trend back to larger devices, but actual mobile phones have reached the limit of portability and mobility. But then mobile 3D services need to be displayed on larger screens. Participants expect that the size of the content will affect their experience of the content and the experience and added values of three-dimensionality. To combine both needs the idea of modular devices was born. Your mobile 3DTV device will be extendable with an additional display if you want to access 3D services. This additional screen can be convolved to fulfill the criterion of portability. The modularity can also mean to be able to connect several devices to one large screen in shared-viewing context.

... so that it (the display) can be convolved and if you want to use 3D services, it can be attached to the mobile phone. I assume that this would be very useful. It would solve the conflict between size (of the display) and compactness (of the device).

Interaction functionalities
To use the device all physical buttons should be reduced to a minimum. Panelists expect to control the device via touch screen. For them, actual mobile phones and mobile devices represent a perfect way of usability. Touch functions should also work to browse content or to interact with the content by intuitive zooming or switching.

Service type and payment
Concerning payment panelists differentiate between paying to access services and the data transfer that is needed to use the service. The statement about data transfer needed for service access is clear. Only a flat rate based payment will be accepted. People do not want to think about the amount of data to be transmitted when using mobile 3D services.

For reasons that I want to be available on the phone all the time and that I always want to receive data, I will definitely need a flat rate. Otherwise it would not be entertaining. Well, I do not want to watch a half of a football match, a movie or something in a café because it is too expensive [...] All the super fancy 3D magic would be destroyed again.

Watching 3D television should be paid the same way as traditional television is paid. In Germany, there is a special toll collecting agency called GEZ. Panelists expect that fees to access mobile television services are included in GEZ fee.

Paying additional fees is only accepted to access added value services or premium services. Premium services extend traditional services and allow for extra features or special content providing interaction features for example.

4.5.5 Target group “Employee”
Group 1
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<tr>
<th>Location</th>
<th>Heinrich-Hertz-Institut Berlin, Germany</th>
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<td>Number of participants</td>
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<tr>
<td>Attitude towards technology</td>
<td>early majority, early adopters</td>
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<tr>
<td>Mobile devices</td>
<td>phones, laptop, camera, mp3 player; multimedia phones</td>
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<tr>
<td>Mobile services</td>
<td>mobile browsing, gps, videophoning</td>
</tr>
<tr>
<td>Television or video viewing habits</td>
<td>To pass time, entertainment, to be updated. Watch often internet television or podcasts.</td>
</tr>
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</table>

**Group 2**

<table>
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<tbody>
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<tr>
<td>Number of participants</td>
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<tr>
<td>Attitude towards technology</td>
<td>early majority, early adopters and innovators</td>
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<tr>
<td>Mobile devices</td>
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<tr>
<td>Mobile services</td>
<td>mobile browsing, navigation, games</td>
</tr>
<tr>
<td>Television or video viewing habits</td>
<td>To pass time, to entertain, to get some free time from the daily routine. TV is often related to just see what is going on. Important information from internet-based applications.</td>
</tr>
</tbody>
</table>

### 4.5.5.1 Content

#### Content types

Traditional television content is also attractive for mobile 3DTV applications. Television content is mostly regarded to be consumed as entertainment media. Panelists wish to watch action movies, sport programs or lifestyle shows. Additionally, documentaries are appropriate content for mobile 3DTV applications. In the sector of information news programs and technology related programs are preferred. But also advertisement, usually regarded to be annoying can win in popularity if produced and presented in 3D.

Television content that is regarded not to be suitable for mobile 3DTV applications is sitcoms or entertainment series. These programs are regarded not to offer any added value so that panelists don't see why to watch it three-dimensionally.

*I agree and I think that a "banal" television program does work in 2D on a screen, a beamer, or whatever. In this case, I don't need it (3D television) and I can't imagine to use it there.*
Prominent, mobile 3D content applications are again tourist guide services or information services about locations or sights. These services are described very in detail by the panelists due to their popularity. First there is a wish to get information about the sight. People expect to enter buildings virtually if they are not accessible in real or to get additional information about exhibits in museums. Additionally, they want possibilities to travel in time, i.e. to see how a ruin nowadays looked like in former times or how a building that is planned or build actually will look like in the future.

A third category of content is user-generated content. Panelists expect to be able to record content in 3D. They can use the generated content in their applications or to use content that other people have provided. This content can help to improve services with user information. Panelists mention the idea of a wiki where everybody can participate.

**Length of viewing**

The length of viewing depends on the physical context of usage. In most situations panelists expect to watch short clips with a maximum length of 15 minutes. During this time they want to get compact information from news program or short entertainment clips sitting in cafes, waiting with the dentist or while commuting. Longer clips are expected if mobile TV applications and services are used to spend time while relaxing in a park. In these situations panelists can imagine to even watch full Formula 1 broadcasts.

**Added value of 3D**

Even if it sounds simple, but I wish to have three-dimensional content always when it makes sense that it is three-dimensional.

The point of added value is very crucial for the acceptance of 3D content and mobile 3D services. As already outline above describing suitable content, three-dimensional content is not accepted if it can't offer any added value. For the participants, added value of 3D is related to better imagination of and identification with the content. This means better possibilities to explain complex technical things or raised thrill while watching horror films or action movies.

Realism is a second point which is seen to be an added value of 3D content. 3D content offers more details and panelists imagine to be able to better explore the content. Depth impression is splitting up the content and therefore offers a clearer structure than the corresponding 2D content.

A third point is some kind of wow effect that is very important when watching 3D content just rarely. To see content in 3D is something unknown and unexpected and hence means fascination and raised interest. But panelists outline that this point only counts when introducing the service. They expect decreasing wow effect and resulting fascination after a long-term usage of 3D services.

**4.5.5.2 Context**

Typical physical context of mobile 3D services is in cafes, commuting in trains or buses, waiting situations with the doctor, but also somewhere outside in a park or while walking around in cities. In the last situations, users are expected to stand still in the moment of usage as distraction of the device while walking is regarded to be dangerous.

Socially, mobile 3D service is single-user context. Group-viewing is not mentioned. Shared-viewing is always combined with fix large displays.

**4.5.5.3 Service**

**Device**
Panelists expect to get an all-in-one entertainment device. The device should fit in one's pocket and should be light so that you don't feel it while carrying around. However, mobility of a device depends on the context. Panelists mention that usually a laptop is not mobile as it is neither easy to carry nor light enough to not feel it. But in situation where laptop offers possibilities like work space or a bigger screen to watch videos more comfortably, it is worth to carry it with you.

The device must offer a high degree of interaction with the user and the user's surrounding. Concerning controls, panelists either which to have touch screen or direct control of the three-dimensional content. The latter one is preferred and would represent a new killer feature of 3D devices. But interaction also relates to communication with the environment. Especially in tourist guidance scenarios, users wish that the device recognizes points of interest when framing it with the integrated camera.

Recording content is a must have feature of the device. Possibilities to save interesting content for yourself or to capture longer programs that one had started to watch for example while commuting but he can't follow anymore because he arrived at the destination will make also longer content more interesting in physical context usually related to short clips. To have possibilities to store your content, the device needs to provide enough storage space.

Describing the optimum device, panelists expect that the device does not have a screen any more. The device itself is only providing functionality and calculation power. The image will be projected into the user's eyes via glasses. This would free the limited screen size due to the need for small devices. Another possibility would be semitransparent head-up displays. The idea of using a small, maximum 4” display is a compromise at the moment as in-eye projection is still seen to be idealistic, but is not accepted to be a long-term solution.

### 4.6 Focus groups conducted in Finland

#### 4.6.1 Target group “students”

<table>
<thead>
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<th>Location</th>
<th>Tampere University of Technology, Finland</th>
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<tbody>
<tr>
<td>Date</td>
<td>09.05.2008</td>
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<td>Number of participants</td>
<td>majority and early adopters</td>
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<td>Attitude towards technology</td>
<td>phones, laptop, PDA, camera, mp3 player; multimedia phones</td>
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<tr>
<td>Mobile devices</td>
<td>radio, mobile browsing, email, playing, ticketing, GPS</td>
</tr>
<tr>
<td>Television or video viewing habits</td>
<td>Two main habits: purposeful viewing based on own choices and sporadic viewing when television happens to be on (e.g. in parents). For learning, relax and entertaining purposes. TV does not control the life, people record and view interesting contents when they want. All viewing is not focused; people keep it as a background sound when doing something else at the same time</td>
</tr>
</tbody>
</table>
4.6.1.1 Contents

Content types
Entertaining television contents and films are attractive for mobile 3D television. Soccer, ice-hockey represents the interesting sport contents. Among the lifestyle programs, decoration and traveling programs would benefit of having the 3D presentation mode. Children programs were also mentioned to be highly interesting for 3D. Fantasy, adventures, nature programs, horror, police series and science fiction represented different genres suitable for 3D programs and films. In the informational programs the spots of the current affair programs were evaluated to be impressive in 3D.

The other interesting contents or applications were related maps and navigation, user-created contents and contents offering interactivity in some degree. Maps and the navigation was popular content in the discussions. The natural view to the environment, like 3D Google maps including the images or paths in the actual environment were seen attractive for mobile 3D.

User-created contents are interesting option for mobile 3DTV. Capturing the content on own 3d mobile camera as well as viewing the other’s content among the certain group of people were mentioned as an interesting chance. In a broader sense, viewing the shared user-created contents (e.g. YouTube), were seen as a captivating option, but it was highlighted that the quality should be high enough. The shared user created content was also seen beneficial for mobile 3D due to their length fitting well to the short time usage.

Other ideas offered more active role for the viewer to interact with content. Product presentations, visualizations and modeling were hoped to benefit of 3D presentation. The presentations and modeling would especially beneficial for testing the idea, simulating the situation and in the decoration. Interactive content as such and games were also mentioned. Mobile 3D presentation could also improve the performance of instructions:

3D modeling or presentation would fit for presenting any instructions of use of any device, for example at home or anywhere, in the shop, at home, at the moment of selling or afterwards at home [47]

Length of viewing
There were clearly two different situation dependant viewpoints to the expected length of viewing. The short term viewing was evaluated to be approximately 20 minutes and fit to the situations of use, like
length of traveling to work. The long lasting viewing, lasting form one to several hours, was described in the relation to long distance traveling situations.

**Added value of 3D content**

The added values of 3D presentation are to strengthen atmosphere, authenticity, the feeling of involvement and interaction. The reinforced atmosphere of 3D is more impressive and emphasized the emotional experiences compared to 2D presentation. Authenticity is described as realism and as a change to get more detailed information depending on the interest regions of the viewer. 3D scene would also give the impression of being part of the scene, excite the active interaction with scene, provide somehow the impression of touch ability, and finally awoke interests for peeping around.

**4.6.1.2 Context**

Physical, social, and temporal contexts were shortly handled in the discussions. The attractive physical contents for mobile 3D television were mentioned to be outside during the summer, traveling by bus or train. For example, when enjoying summer and lying on the grass together with friends, mobile 3D television could be part of a situation. On the other hand, mobile 3D television was seen as an option for newspaper in private activities (toilet). The viewing was seen both private and shared action representing the social aspects of the context. Mobile 3D television viewing is the entertaining activity for killing time situations.

**4.6.1.3 Service Device**

Mobile 3D TV should be integrated into existing mobile devices, like phones or PDAs. Its size should be small enough to be carried in the pocket and comfortable to hold in a hand. The small size was also justified because of its effortless to pick it up on the pocket or the bag on move. The viewing habit on small mobile devices is assessed to be rather short.

However, the other discussed size of the device was the laptop. The laptop, as the current laptops should be in the size of the bag portable device. The laptop option was seen beneficial when traveling the long distances. In this case, effort of picking it up on is not significant factor anymore. In contrast to small mobile devices, the viewing habit on laptop is assumed to be more focused and long-lasting.

Independently on the size of the device, it would be important to be able to access same contents depending on the situation.

*But it would be very nice, if these mobile TV would be in the size of mobile phone even it is very small or on the size of PDA, which is then a bit bigger but still quite a small. Somehow I see – that it is not necessary to have only one (device); similarly as you can browse internet in many different places*

To continue the discussion about the different device sizes, some features could be abandoned in the small mobile devices to improve the viewing experience. Firstly, the sub-titles were not counted as a necessary feature. If are included, the ideas of balloons or comic type of presenting was composed. Secondly, the number of views can be limited only to the level that content is still possible to see by one person. Thirdly, the high-level of audio quality is not necessary for mobile presentation.
Mobile device was also wished to become more than a display. It was hoped that the image would not be framed by the device anymore. Thoughts of projective or holographic mobile devices were also presented. The ultimate option would project the image into the whole room remaining the function of the lamp. Interoperability or ambient functioning was mentioned in the futuristic ideas to replace the all small devices.

**Interaction functionalities**

The interaction with system illustrated the aspects of presentation modes, capturing, player functionalities and zooming. There is a need for mode shifts between visual 2D and 3D presentation. In the presentation mode discussions, it was also mentioned that it would be interesting to have some kind of audio markers to tell that 3D presentation is starting. The panelists were interested in capturing, storing and sending 3D images and videos among the small group of people. They also thought that children could use these options in teaching to collect images e.g. self-made artifacts and for showing it for others.

The player functionality should offer the support for the occasional viewing. Especially playing-pausing-playing was described to be important in move e.g. to bus and from bus situations. To support the occasional viewing the contents should be able to be stored on a device. Zooming into the background attractions of the content to get more information or different viewpoint was also described to be one of the most interesting chances for the interaction.

**Payment**

The different payment options are needed. The panelists described 40-50 cents to be suitable amount of money about the pay per view. The monthly payment option would be preferred when viewing regularly, like daily (e.g. 12 Euros). The mobile 3D television should be supplementary service, in which the children’s use could be constrained. To improve the attractiveness of the service, the free trials or samples should be available. Other topics of the payment touched the price of the device and possibilities to have household wide television fee for all television devices.

**Service type**

The desired mobile 3DTV service would work on an on-demand principle. It was described that on-demand service would easily fit into the short time viewing, e.g. on the travel to work.

**4.6.1.4 Mobile 3D television concerns**

The concerns of the mobile 3D television touched the usage in the public settings, offending the privacy and loosing the sense of reality. In the public settings, people worries about people around. For example, they would not watch programs that could be harmful for children in public transportation. If the mobile 3D television was projected on holographic display, panelists would decline to use it in the social environment in which other people can be disturbed. Offending the privacy was mentioned in the discussions. The panelists would not like experience jumping objects out of the screen all the time or in the case they are not fully concentrating on viewing. Loosing of sense of reality was also mentioned if the scenes become too realistic.

To conclude, there is a contradiction between the added value of 3D to enhance the emotional experience and anonymity in the mobile environments.

*When you view 3D in a train, so the point of 3D is to get stronger emotional experiences. But then – it is very complicated or in contradiction with that you are surrounded by unfamiliar people, so, the ideas are
kind of fighting against each others. So, that the emotional experience is reinforced while you among all other things.

4.6.2 Target group “Employee”

<table>
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<tbody>
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<tr>
<td>Attitude towards technology</td>
<td>early majority, early adopters and innovators</td>
</tr>
<tr>
<td>Mobile devices</td>
<td>phones, laptop, camera, mp3 player; multimedia phones, PSP</td>
</tr>
<tr>
<td>Mobile services</td>
<td>mobile browsing, playing, ticketing, GPS</td>
</tr>
<tr>
<td>Television or video viewing habits</td>
<td>To pass time, entertainment, to be updated and learn. Mainly want to watch based on own need, but sometimes relaxing just to open and see what is going there. Does not have a significant role in life and mostly people record the contents they want to watch.</td>
</tr>
</tbody>
</table>

4.6.2.1 Contents

Content types

Discussions of the contents for mobile 3D television touched both informational and entertaining contents from the conventional television. News, documentaries and current affair programs were interesting programs for the 3D presentation. In the news content, the spots of the attractions and would rather be interesting than seeing the 3D-newsreader. Natural documentaries and group discussions of the current affairs programs were also mention to be attractive for mobile 3DTV.

From the entertaining contents, films, live shows, lifestyle programs, sport, science fiction and horror were attractive for mobile 3D. In high-motion sport, like rally, slalom or ski-jumping, soccer or ice-hockey, 3D was thought to improve the feeling or atmosphere. For the lifestyle the travel programs would be highly attractive to explore the destinations in more detail. Horror and science fiction films were seen
very attractive fields of contents. In the discussions, the suitability of the films for mobile 3D presentations was also criticized. To summarize, the 3D form would be desired for the content in which the atmosphere is crucial.

*all in which the atmosphere is more important than information itself, mobile 3D content would strengthen it*

Use of the 3D in any other mobile videos was also seen attractive. To improve the informational value, product presentations, instructions to use, navigation and maps, learning and medical imaging are good fields of applications. Parallel to animates instructions of use also scenarios for more interactive instructions were discussed. These systems could use pattern recognition of mobile device to detect the needed items of the packet, for example when constructing the furniture, and illustrate better the correct order of the building up. From the user-created videos, imaging or video recordings were attractive whereas the watching shared user-created videos (e.g. in YouTube) were not seen interesting at all.

**Added value of 3D content – atmosphere, authenticity and peeping**

Value of 3D is to improve the feeling or atmosphere, authenticity and peeping. It can be powerful for highlighting scariness or motion in the entertainment, but also to illustrate crudity of the topical global catastrophe. 3D is expected to improve the realism, authenticity, concretize and offer the chance to feel yourself being part of the viewed environment or story. In addition, peeping behind the objects and zooming into interesting details are listed as added values of 3D presentation. Beside of these positive aspects of value of 3D presentation, panelists were also worried about if the presented content start to feel too real and if the viewer needs to be afraid and peeping around all the time.

**4.6.2.2 Context**

Mobile 3DTV would be viewed in the killing time situations, mostly alone and in the heterogeneous physical contexts. The application is seen useful when killing the time describing the temporal dimension of the context. Potential physical contexts for mobile 3DTV viewing are on move, at home, in the offices while queuing and at school in the educational purpose. On move the potential viewing situations are when traveling on the long distance.

*-- all that(situations) in which I have to kill time, like train journeys, -- or situations you have to be without nothing to do -*

Social context of mobile 3DTV viewing is mainly seen as an individual viewing task. However, the individual viewing is also a matter of the size and the type of the device. On a small mobile device single viewing would be the most common situation and the co-viewing would happen only in the exceptional cases.

*If I need to view it on a small device, then it (viewing) would definitely happen on my own. Individual-centric would this -- viewing be. There is hardly space for couple of more people and this would also make an exception, if there is not some kind of projector available there*
4.6.2.3 System

Device

Mobile 3D television should be included in multimedia and multifunctional mobile devices. The panelist described that it should be multifunctional, not separate device and combined to mobile phone. It should be portable in the pocket setting the maximum requirement for the size. In addition to combining 3D to mobile phone, the scenario of holographic device was presented. Device would be a cube on a size of one centimeter by its side and present the image in air.

Interaction functionalities

Mobile 2D device should provide the support for recording, saving and sending. Recording own content was interesting for the participants. Similarly, storing both self-recorded and broadcasted content was attractive for the participants. Sending the content was described similar to SMS or multimedia messaging happening within a small group of people. The conventional editing of content was not desired feature but bookmarking the content was interesting idea of light-level of editing. In the bookmarking, the certain parts of the programs could be marked and shared with friends.

Beside of these messaging features, also other interaction functionalities were discussed. There is a clear need for the shifts between 2D and 3D the presentation modes. There is also need for basic video player functionalities including reverse function. The panelists were also interested in the possibility to vote in the television competition. Finally, the functions to interact with 3D models, like turning or getting 360 degrees views were thought to be attractive for example for sport content and in teaching.

Mobile 3D device was also seen interoperating with home media center. The idea was to keep it as portable media storage and play back the stored content on a wider screen in the home environment.

The panelists highlighted also that 3D is not only visual function. To create 3D experiences both 3D audio and visual presentation should be available.

Service type

There is a need for both on-demand and push service types in mobile 3D television. The on-demand option was mainly mentioned in the discussions. However, the push broadcasting is seen useful when one is willing to see if there is something interesting on without pre-defined will to view certain content. To sum, the need it was described that there is:

--- on-demand channels as a separate and then there are these conventional channels separately ---

Price

Different payment options were discussed. In the case of heavy usage, the constant monthly payment would be a good option, but requires enough wide and modifiable bundling to be attractive for the panelists. The on-demand option, with price of low enough, like two Euros would also a necessary option, especially for the occasional use. The third described choice is to charge the fee in the taxation.

Advertisements are acceptable to replace the all type of payments. The panelists had positive attitude towards visible over the subliminal advertising. They recommended having similar advertising system as in the streamed internet radio or television in which approximately 30 seconds of advertisements are played in the beginning of stream.
4.6.2.4 Mobile 3D television concerns

There were three main concerns of mobile 3D television to be taken into account. Firstly, 3D-presentation should not be too real and raise the feeling of being afraid of attacking objects of content all the time.

Secondly, viewing of mobile 3DTV should not disturb other people. When mobile 3D television is assumed to be used on move and in the public environments it is very important not to disturb other people around. To avoid interference the panelists described that they would not watch horror movies when traveling on plane or train. They also emphasized the importance of having the headphones to escape the disturbance in the audio environment.

Thirdly, mobile 3D contents should be accessible only for the target audience. The biggest worries were related children’s chance to retrieve the unsuitable content for them. This should be solved by constraining their access to certain contents. The other worry rose about the shared user-created contents. The panelists though that the 3D presentation would even increase the attractiveness of the dirty contents.

4.7 Summary of the focus group studies

User needs and expectations about mobile 3DTV contents, services and usage contexts are summarized here based on the conducted focus groups. According to panelists' expectations about mobile 3DTV services they will use the service either to be entertained or to get informed in very different contexts. Depending on the motivation, the contents that is expected to be provided varies significantly.

Relating to entertainment users expect to see action movies, sport live broadcasts, music videos, cultural events like concerts or theater, and surprisingly advertisement. Unsuitable content will be TV series or sitcoms. Users point out that suitable content offers clear added values. Otherwise, users will still prefer to watch content in 2D. Another important content of entertainment is mobile gaming. Gaming is expected to be one of the main applications to entertain you. Mobile 3D games are supposed to offer gameplay in 3D and interactive controlling to raise fun and experience. Not only action games like ego-shooters, but also puzzle games are attractive game genre for mobile 3D applications.

In the entertainment sector, attractive television contents are news clips, documentaries and knowledge program. Especially documentaries and program where users can watch how things work or where complicated issues are explained can profit of three-dimensional representation. But related to information the most popular usage scenario is a tourist guide. The service may provide navigation, information about sights and event guide. Other popular contents are product information and manuals.

In general, three-dimensional content must offer raised reality, naturalness and better identification for the user. The feeling of “being there” and “being part” of the action is very important and makes 3D content different from traditional 2D video.

Talking about service design and payment for the service, panelists differentiate between paying to access the service and the needed data transmission. Related to transmission, users will prefer flat rate-based solutions as they do not want to think about the amount of data while using a service. Service design to provide and access content is mainly expected to be on-demand. Service scenarios will be numerous and different so that the panelists expect to just select the personally appropriate content and services and payment shall be very specific. The only content that is expected to be free is broadcasted television program as users already pay usage fee (in Germany GEZ).

Devices to be used in mobile 3D services must be small and easy to carry. The limitation of the size is that the device must fit into a trouser pocket. Other important features of the device are:

1. The question if the device is a separate thing or if mobile 3DTV functionalities are integrated into existing devices like mobile phones is discussed contradictory. Both solutions are accepted and
both solutions have got advantages and disadvantages. But with better calculation power and interaction facilities, an all-in-one solution will be preferred.

2. Preferred screen size of the display will be about 4 inches. But panelists doubt that small displays can offer all added values that they expect to get from three-dimensional videos. Thus, there is a wish for projective or holographic solutions to break the limitations of small screens and to be able to experience 3D in larger size.

3. Device should provide interaction possibilities. The controls are expected to be presented on a touch screen. Physical controls are not appropriate for the display. More advanced solution of controlling content will be direct interaction with 3D content. The device has got included GPS and possibilities to capture, save and share three-dimensional content.

4. A fast data connection is a must.

The usage contexts of mobile 3DTV services cover various task contexts, different temporal contexts and depend on many different physical conditions.

1. Socially, mobile 3DTV is mainly for private viewing. But shared-viewing will be needed when mobile 3D device is used to entertain you and your friends by watching movies or while playing games. Also interaction with other devices mainly in gaming situations is related to social context.

2. Physical context of mobile 3DTV is mainly related to indoor and outdoor activities, but using the service at home is not expected. Typical locations to use the service are public transport, shops, while walking through cities, parks, but also cafes, stations, museums or waiting rooms.

3. Temporally, mobile 3DTV is appropriate for waste-time situations. This relates to entertainment content and informational television program. Mobile 3DTV is a gap filler in waiting situations and here, people expect short clips. Longer clips are preferred during journeys where mobile 3DTV offers distraction and entertainment to kill boredom.

4. Mobile 3DTV not only offers entertainment features to be used in extra time situations. Mobile 3D services are supposed to provide guidance and help in different task contexts which can be walking through unknown locations or museums, but also providing help in emergencies.
5. Study 3: Probe study on user’s needs and expectations on mobile 3DTV

Surveys and focus groups are user studies that focus on what people say and ask explicit questions about users’ thoughts concerning a product or system. Other techniques such as self-documenting tools and projective tasks aim to engage and provoke responses from users without observing or asking them directly. Potential end-users are involved in creative activities with the objective to create an artifact, for example a collage, a photo or drawing. The act of creation can allow the participants to express feelings, thoughts, and emotions that might otherwise have been inaccessible to a researcher [60]. The artifacts are used as an inspiration for e.g. designers, engineers or ethnographers.

In probe studies self-documentary tools and projective tasks have been applied in different ways. People were given tools to document, reflect on and express their thoughts on products and systems. One of the aims of the approach is to create a communication link between the user and the designer, and to inform and inspire the design team [29]. Different kinds of probes have been used to discover users’ needs, values and feelings for the starting point of design in several recent design studies: Cultural Probes [14][15][58], Technology Probes [5][30], Mobile Probes [29], Design Probes [47], and Empathy Probes [28][46].

In addition to a survey and focus groups we wanted to conduct a rather open and investigative study and planned a four-week probe study that combined different techniques of projective and self-documentary tools. In comparison to interviews and surveys, that gather information about memorized situations, we aimed to capture data in context. Especially for mobile technology understanding the contextual factors, such as changing locations, social contexts and different temporal contexts, is fundamental for the design process.

5.1 Research question and objectives

The user study should provide information on user needs and motivations related to the use of 3D-television or 3D-video on portable devices. We aimed to get users view on future usage scenarios especially through users’ in-the-field observations that should help us to understand contextual requirements of Mobile 3DTV. Moreover, we wanted to investigate requirements according to the system, the content and the context of use.

5.2 Description of the method

In our study we applied self-documentary tools and projective tasks. We compiled a probe-package that included material for self-documentation (diary, disposable camera) and a projective task (collage). The self-documentation tools helped to study users’ thoughts in different contexts (contextual situations). During the work with the diary and the disposable camera the participants were motivated to log their thoughts in different daily situations and therewith in different contexts about the use of 3D-television or 3D-video on portable devices. In recent studies [29][50][64] it was shown that diaries are an effective technique to capture data from mobile users. Collages are often a collection of pictures and sometimes also words, both abstract and concrete, which aim to convey an expressive message [29]. Collages have been used in different user studies and product design studies [29][48] and could help to gather data from people that cannot easily verbalize. While creating the collage participants worked reflective and thought about experienced and imaginable situations in their home environment (retrospective situation).

Ten selected participant were sent a probe package. After receiving the packages we gave a phone call to the participants and explained the study and participants’ tasks for the study period of four weeks.

To keep in contact with the participants during the study and to gather participants’ thoughts on special issues we designed a questionnaire as a set of four emails. Gaver et al. [15] have used postcards as an
informal, friendly and open approach to ask questions in their probe package. Within Gaver’s probe-packages, the participants could found cards with an image on the front and questions on the back. We modified this idea and used e-cards instead of postcards that in addition to asking questions had the purpose to be some kind of personal message to motivate them.

In the second and third week of the study we sent an e-card to the participants. At the end of the fourth week participants had to mail the probe package back to us.

<table>
<thead>
<tr>
<th>Planning</th>
<th>Probing</th>
<th>First interpretation</th>
<th>Deepening</th>
<th>Interpretation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dispatch the probe</td>
<td>Participants’ self-documentation (camera, diary) and projective tasks (collage)</td>
<td>Preliminary interpretation in the research team</td>
<td>Telephone interview with the participants based on the probe material</td>
<td>Interpretation of the probe by means of the interview data in the research team</td>
</tr>
</tbody>
</table>

![Figure 16 Process stages of the probe study.](image)

5.2.1 The probe package

The probe package contained a disposable camera, a small booklet and material for the collage: two sheets DIN A3, glue, 3D-sticker, different sheets of colored blank paper and three different magazines (a trade magazine about decoration, a magazine for young people and a TV guide). Within the probe package were also written instructions that described the project, participants’ tasks and the schedule of the study.

![Figure 17 The probe package.](image)
5.2.2 Projective task: collage
We asked the participants to create a collage to express their expectations and emotions regarding the use of 3D-television and video on a portable device. The collages were created on a sheet DIN A3 by using material from the magazines, the sticker and the colored blank paper. In addition or instead of the material we had provided participants could use any other material they wanted to use.

5.2.3 Self-documentary tools: camera and diary
Camera
The probe included a disposable camera. The participants should snap situations with the camera where they could imagine watching 3D-television or videos on a portable device. We wanted the participants to be observer and called on them to take the camera as much as possible with them to take spontaneously a picture in different situations (e.g. at work or school, en route or during their free time). For each picture they should make a short note in their diary what the picture is about and why they have photographed it. These notes should help us to interpret easier participants’ pictures in the analysis. Although the camera had 27 pictures the participants were free to take also fewer pictures.

Diary
A diary in form of a small booklet was also part of the probe package. In addition to make entries about the pictures of the disposable camera in this diary, the participants were given the diary to document their thoughts and feelings about the use of portable 3D-television or videos. We asked the participants to keep the diary at home as well as when they were mobile. Whenever needs arise, participants should record entries in the small booklet.

5.2.4 Questionnaire
Four e-cards in approximately the size of real postcards were designed consisting of an image and a written question. We used evocative images that also suit to the topic of the questions. At the beginning of each email a short message with greetings was written followed by the e-card. The questions concerned participants’ attention towards different issues such as the added value of 3D, shared viewing, motivation and value as well as suitable situations for watching 3D-television or 3D-videos on portable devices. Open questions were written to gather information about the issues mentioned above:

- How would it feel for you to watch your favourite TV program or favourite video three-dimensional instead to watch it two-dimensional?
- When and where could you imagine watching 3D-television or 3D-videos together with friends operating the same portable device simultaneously? When and where could you imagine watching 3D-television or 3D-videos together with friends, sharing the same application whereas everybody uses his/her own device?
- Why would you use a portable device that enables you to watch video content mobile and three-dimensional? What would be the value for you?
- Be once more somewhat crazy and creative! Mobile 3DTV can perhaps be different than you have imagined until now. Possibly, other situations (places, events, people and things) are interesting in which 3D-television could be watched that you haven’t had in your mind yet.

The e-cards were sent to the participants on Mondays and on Thursdays in the second and third week of the study. The participants were asked to write their responses according to these questions in their diary.
Furthermore, they could bring ideas about the questions on the e-cards in their work with the collage and the camera.

5.3 Participants
We recruited the participants for our study through a press release published in different newspapers, online newspapers and forums in Germany where we announced the upcoming user study. From the responses of this advertisement nine participants have been selected according to our defined user profiles beforehand.

All participants were living in different parts of Germany and from different age groups. Four young people in the age between 17-21 years, four adults in the age between 25-29 years and one adult in the age of 44 years participated in the study. While selecting the participants we paid attention to choose people with different backgrounds to investigate novel ideas about the use of Mobile 3DTV from a broaden population. Participants’ demographic data are summarized in Table 1. Each participant received a remuneration of 50 € after finishing his/her work for the study.

<table>
<thead>
<tr>
<th>Age</th>
<th>Gender</th>
<th>Occupation</th>
</tr>
</thead>
<tbody>
<tr>
<td>18</td>
<td>male</td>
<td>grammar school pupil</td>
</tr>
<tr>
<td>18</td>
<td>female</td>
<td>grammar school pupil</td>
</tr>
<tr>
<td>19</td>
<td>male</td>
<td>undergraduate student of computer science</td>
</tr>
<tr>
<td>21</td>
<td>female</td>
<td>trainee as occupational therapist</td>
</tr>
<tr>
<td>25</td>
<td>male</td>
<td>management assistant in IT-Systems</td>
</tr>
<tr>
<td>26</td>
<td>female</td>
<td>graduate student of biochemistry</td>
</tr>
<tr>
<td>26</td>
<td>female</td>
<td>graduate social pedagogue</td>
</tr>
<tr>
<td>29</td>
<td>male</td>
<td>graduate engineer</td>
</tr>
<tr>
<td>44</td>
<td>female</td>
<td>journalist</td>
</tr>
</tbody>
</table>

Table 4 Demographic data of the nine participants.

5.4 Method of analysis
The collected data through collage [Figure 18], pictures on the disposable camera and notes in the diary were analyzed using qualitative methods. After a first review the “probe” material was discussed in a small team. Afterwards the collage and photos were interpreted and grouped together with the diary entries according to the pre-determined categories as can be seen in table 5.

<table>
<thead>
<tr>
<th>Categories</th>
<th>Probe study No.</th>
<th>Freq.</th>
</tr>
</thead>
<tbody>
<tr>
<td>User</td>
<td>23</td>
<td>65</td>
</tr>
<tr>
<td>System</td>
<td>29</td>
<td>106</td>
</tr>
<tr>
<td>Context</td>
<td>41</td>
<td>195</td>
</tr>
</tbody>
</table>

Table 5 Categories and their frequencies of the probe studies
A semi-structured interview was conducted with the participants by telephone based on the “probe” material. The interview was included in the study to supplement the understanding gathered from the material and to avoid possible misinterpretations. Therefore the collage and pictures were equipped with notes on points where more information was desired. In the interview concrete question about those unclear things were asked.

The same interviewer conducted all interviews and worked also as note-taker. An interview lasted approximately 20 minutes. In addition to questions about the “probe” material some thoughts about the procedure of the study were asked from the participants.

5.5 Results

In the collages participants used different kinds of material to represent their ideas about the usage contexts, the content and their expectations and motivations on mobile 3DTV. Qualitative methods performed on the collages, pictures and diary entries resulted in the following interpretations that were summarized in the categories - user, system and service, and context.

![Selected collages of three participants.](image)

Figure 18 Selected collages of three participants.
5.5.1 User

Users’ motivation

Several aspects motivated the participants to watch 3DTV on a portable device. Comments were made about watching to become entertained and informed. An advantage of the portable device is seen in being mobile and the possibility nevermore to miss a program. Moreover, people would watch to relax, to distract themselves from something or to bridge time gaps:

“... to relax at home in each initial position (e.g. hammock)”

Watching to battle loneliness was also mentioned. People would also buy mobile 3DTV to have the newest technology and because it’s use is trendy. In general the use of mobile 3DTV was seen as comfortable and especially the possibility to watch outdoors in the sun and to enjoy the nature seems to be very attractive:

3DTV combines nature and technology; enjoy the sun and the fresh air.

Mobile 3DTV was described as alternative to normal TV and to the cinema:

... as an alternative to the cinema, or rival to an open-air cinema - 3DTV everywhere.

Added value

People expect to experience more realistic and authentic scenes through the three-dimensionality. One participant commented in her diary:

Three-dimensionality creates more reality and therewith more suspense, more emotion and more detailed shoots of my favourite actor.
Furthermore, there are several comments about the feeling of being inside, be close to or part of the program that is watched for example:

... the feeling to be on the place of the event that I'm watching.
    Be inside and not just present!
    Be inside in what you see... it's not just like a picture.

One participant mentioned the spatial experience and the feeling of being involved in the depth of the space

    The special value would be for me the spatial experience, to become involved in the depth of the space.

Through 3D educational program and lectures are expected to be easier to understand and more fascinating. Other value of 3D is seen in having different point of views and a new way of experiencing television and video as well as an increased information content:

    An increased information content arises through the three-dimensionality that can be very exciting (e.g. for football games) and useful (e.g. for navigation applications).

**Target group**

The participants saw not just themselves as a user of mobile 3DTV. Primarily, teenagers were mentioned and the collages showed mainly pictures of young people. Moreover, children, house wives and house husbands were imaginable target groups for mobile 3DTV.

**5.5.2 System and service**

**TV contents**

Both content for entertainment, information and for education purposes would be watched in 3D. News, sport (especially football), TV series, movies, nature and animal documentaries were mentioned TV contents. Other interesting contents seem to be music programs and videos, cooking shows, cartoon and animation movies. Furthermore, short clips of adult entertainment of approx. 5 min. length were seen as attractive content. One participant would also like to have program for children:

    Children hate shopping, the better when they can watch "Pumuckel" meanwhile.

Length of the contents was not described in most of the “probe material” but two participants saw short clips and summaries of sport events (e.g. football) as suitable for mobile 3DTV. Comments were made about receiving the videos as on-demand service.
Other contents and services

Not only TV contents were seen as very attractive for 3D presentation but also other contents and services. People mentioned navigation applications (e.g. interactive city maps, building plans), games (…special-produced small 3D games for in between) and video phone calls. Especially for advertisement, product presentations in shopping applications the three-dimensionality were seen as suitable 3D content. Through 3D educational content could be easier to understand and children could learn easier spatial relations. Furthermore, video chat, Second Life, user-created videos from YouTube, photography would be more exciting to experience it in 3D. People would also be ready to buy 3D logos or animations.

Interaction with content

In addition to watching content people would also use to record events or concerts and send it to friends. The possibility to send short clips as a souvenir from holiday to friends and family stayed at home was mentioned.

Device

A suitable appearance for a 3DTV device would be a device with a big screen and less buttons that people can easily carry around:

*In the size of a shirt or trouser pocket to carry it around…*

The mainly suggested device sizes for mobile 3DTV reached from mobile phones, PDA, iPod to iPhone. It was also said that for short clips small displays would be sufficient but for longer clips bigger displays would be preferable. As additional equipment headphones were seen as important to watch TV without disturbing people around.

5.5.3 Context

Physical context

Several contexts for using mobile 3DTV ranging from outdoor to indoor, from private to public environments were suggested. Participants would watch 3D television and videos in public transportation (e.g. train, tram, bus, metro), in a car and during other transportation trips (e.g. in a taxi, in a plane or in a boat). On the basis of the “probe” material the home environment can also be highlighted as an imaginable usage context. Here, watching in the kitchen while cooking or before going to sleep or waking up in the bed, in the bath tube, at the toilet, at the balcony or terrace and at the sofa was mentioned. Furthermore, mobile 3DTV would be watched both while being on the way, at a railway station or bus stop and at school, university or work. People commented to find it very attractive to combine watching television while being outside in the nature for example while being in a park, in the garden, at the beach, while camping or during a hiking trip. Other comments were made about watching while waiting for the order in a cafeteria or cafe, while queuing in a supermarket or at bureaucratic offices, in the waiting room of a doctor and as a patient in a hospital.

Social context

Primarily, mobile 3DTV was seen for individual viewing. However, the participants could also imagine watching 3D-television or videos together with friends on one portable device simultaneously. Then, participants would watch in a group while being in a park, at a picnic or at the beach, while traveling with and waiting for public transportation or while talking in a foyer. In addition to have fun together or to
relax while watching a football game or a movie people would also like to become informed while watching education programs or news. Nobody of the participants could see themselves being together with friends and everybody watches the same content on his/her own device simultaneously. Some participants would like to watch together with the girlfriend or boyfriend on a park bench.

**Temporal context**

Participants expressed that they would watch mobile 3DTV in waiting and boring situations and to bridge (unexpected) time gaps useful e.g. at a doctor or hairdresser, in a queue in the supermarket, in bureaucratic offices or as a co-driver in a car. In addition watching mobile 3DTV during short and long transportation trips (e.g. in a car, train), during the trip to/from work/university and while waiting for public transportation (e.g. for the bus) was described. Some people claimed to watch while waiting for the order in a cafe or cafeteria as well as in a break or free period at school or university or during a coffee break at work. Especially in the morning and evening people would watch at home in the bed.

**Task context**

In addition to focus fully on watching mobile 3DTV it was stated that watching while doing something else such as running on a treadmill, while cooking, while doing housework or during eating are imaginable.

### 5.6 Summary of the probe study

User’s needs and expectations on mobile 3DTV were investigated using a user-centered design approach called probes. The probes were explorative and based on self-documenting and projective tasks. The probe material provided useful information on user’s motivation and user’s expectations on content and context for mobile 3DTV and therewith enriches the results gathered from the focus groups and the questionnaire.

#### 5.6.1 Summary of the results

Users’ motivations for the use of mobile 3DTV on a portable device can be summarized as followed:

- People would watch mobile 3DTV to become entertained, to be informed, to relax, to bridge time gaps, to battle loneliness and to distract themselves from something. Moreover, the possibilities nevermore to miss a program and to watch TV outdoors in the nature are attractive. Using mobile 3DTV to have the newest technology, to use something trendy as well as using it as alternative and additional watching possibility to normal TV and to the cinema were users’ motivations.
- Through the three-dimensionality people expect to experience more realistic and authentic scenes that evoke the feeling of being inside, be close to or part of the program that is watched. The spatial experience and the feeling of being involved in the depth of the space were also stated.
- The probe material showed that the participants saw themselves and especially teenager, children and house wives and house husbands as potential user of mobile 3DTV.

In addition to TV content other video contents were seen as attractive for mobile 3DTV.

- TV content for entertainment, information and education would be watched in 3D. News, sport, series, movies, documentaries, music programs, cooking shows, cartoon and animation movies, adult entertainment and program for children were mentioned TV contents.
The length of the contents was mainly disregarded in the probe material, but two participants saw short clips and summaries of sport events as suitable for mobile 3DTV. Receiving videos as on-demand seems to be an important service.

Other described content and services that would be more interesting through a 3D presentation were navigation applications, games, video phone calls, product presentation, user-created videos, educational content and 3D logos or animations. In addition to watching content recording videos and sending should be possible.

A suitable appearance for a 3DTV device would be a device with a big screen and less buttons in the size of mobile phones, PDA, iPod or iPhone. For short clips small displays and for longer clips bigger displays were preferred. As additional equipment headphones were seen as important to watch TV without disturbing people around.

Mobile 3DTV was seen attractive in different physical, social, temporal and task contexts:

- Physical contexts ranged from outdoor to indoor, from private to public environments. Watching 3D video content in public transportation, in a car, during other transportation trips and especially in the home environment is seen as imaginable usage contexts. Mobile 3DTV would be watched both while being on the way, at a railway station or bus stop and at school, university or work. The idea to combine watching television while being outside in the nature (e.g. in a park, in the garden or at the beach) was seen as very attractive. Mobile 3DTV will be also viewed while waiting for the order in a cafeteria or cafe, while queuing in a supermarket or at bureaucratic offices, in the waiting room of a doctor or in a hospital.

- Mobile 3DTV was primarily seen for individual viewing. However, watching 3D-television or videos together with friends on one portable device simultaneously to have fun together, to relax and to become informed while being in a park, at a picnic or at the beach, while travelling with and waiting for public transportation or while talking in a foyer.

- According to the temporal context mobile 3DTV will be used in waiting and boring situations, to bridge time gaps useful, during short and long transportation trips, during the trip to/from work/university and while waiting for public transportation. Using the service while waiting for the order in a cafe or cafeteria as well as in a break or free period at school or university or during a coffee break at work was also described.

- It was expected to focus fully on watching mobile 3DTV but also watching while doing something else was presented.

### 5.6.2 Participants experience with the probe study

In the interview with the participants we also investigated their expressions and feelings about the study in general. All participants tried to take along with them the camera and the diary to take pictures and to make notes respectively in spontaneous situations. One participant preferred to use his PDA and not the diary to make notes. The e-cards were seen from the majority of the participants as an inspiration. The collages were created at the evenings or primarily at one to two weekends. Instead of using paper and magazines one participant created his collage with the computer.
6. Discussion and conclusions

6.1 Guidelines for designing user experience in mobile 3DTV contexts

Concluding our studies into user requirements of mobile 3DTV, we will provide guidelines to design mobile 3DTV system and services according to our requirements. These guidelines can be used by researchers as a basis for their studies, but they may also contribute to a decision-making process for all members of the production chain in the field of mobile 3DTV.

User – Mobile 3D needs to
- Provide a manifold program to satisfy the different motivations of users in different contexts.
- Fulfil entertainment and information needs. Users also want to relax, to spend time, and to learn by using mobile 3D services.
- Provide an increased realism and naturalness and evoke an emotional relation and a feeling of being there compared to existing systems.
- Offer high viewing comfort for the user by minimizing simulator sickness to raise, in return, the excitement and fun of 3D.

System & Service – Mobile 3D system needs to offer
- TV content which satisfies both the need of information as well as of entertainment reflecting the added values of 3D.
- Non-television content like games, interactive manuals, navigation, or product presentations to fully exploit possibilities and attraction of three-dimensional presentation.
- A device featuring a display size of 4-5’, or at least larger than 3’.
- Both monomodal (audio or visual only) and multimodal (audiovisual) presentation modes as well as fluent shifts between these modes and 2D/3D visual presentation.
- Attractive, but simple service navigation using the possibilities of touch displays or even three-dimensional content handling.
- Functions to save, to send and receive, and to record (own) content.
- Long battery life and high storage capacities.
- Spontaneous access to all preferred or needed services, independent of physical context, supporting multiple connection interfaces such as WiFi/Wimax, Bluetooth, or HSDPA.
- Simple and clear payment models to finance the service. Flat rate-based models are preferred by the users, but pay-per-view/use or advertisement-based financing must be provided as well.

Context – Mobile 3D viewing
- Takes place in public and private locations as well as outdoors and indoors, potentially on public transport, in parks, cars, cafés, waiting rooms, or at home.
- Is primarily private and focused viewing, but there is also a need for shared viewing.
- Duration depends on the usage context and varies from short time viewing in waiting situations to viewing of long clips up to 45 minutes during journeys.

6.2 Conclusions

In our study, we used a methodological triangulation to understand user requirements of mobile 3D television. Using online survey, focus groups, and the more implicit method of probe study allowed us to collect a broad view on the topic with regard to the key aspects of user, system and services and usage context of mobile 3DTV.
Comparing the user requirements of mobile 3DTV to the related requirements of mobile TV and 3DTV, we showed that the requirements of the combined system are similar to each of the singular systems, but they also show differences as the singular requirements are now combined into one system of mobile 3D television. With respect to the user characteristics, we can say that the requirements of mobile TV are still counting for mobile 3DTV. The user wants to kill time, to get informed or to just watch TV while being on-the-move. But the influence of 3D can be seen as entertainment becomes an additional motivation and also the information task profits from the three-dimensional representation of the content. Combining three-dimensional video presentation with the content also increases the realism and naturalness of the content and contributes to a raised feeling of being inside the content or presence at it is usually called in user experience research [13].

The motivations of entertainment and information in combination with the advantages of three-dimensional representation can also be found in the expected content of services. The appropriate TV contents of mobile TV (e.g. news, documentaries) are still expected by the users in mobile 3DTV services. Hereby, the added values of 3D are strongly contributing to a higher interest in the content through raised realism, atmosphere and emotional identification. However, mobile 3D television will need to add new content like movies to its services which fulfill the entertainment requirements of mobile 3DTV. But not only television content is regarded to be interesting for mobile 3DTV services. Users expect also non-television content to be part of the services and this might be even more interesting than TV content. Thereby navigation, interactive guidance, and games are the most appropriate services according to the user requirements.

Our studies show that the usage of mobile 3DTV will depend on the contextual situations. Short entertainment and information program is popular within mobile TV context and it also seems to be very attractive for mobile 3D television services. Nevertheless, we can also identify long-time viewing periods while travelling where movies are becoming attractive for the new system which were usually related to 3DTV services. These patterns can also be found in case of private vs. shared viewing.

The results presented in this report are a first overview of what users need and expect from the end-system that will be developed in the project. The results will impact on the development process of the end-system offering input in defining functional, non-functional and constrain requirements [41]. But they will also be a guideline on planning and designing the upcoming user studies user- and target-oriented by offering guidelines for selecting participants, test content or contextual situations that must be regarded to influence the quality of the system.

However, it is important to notice the constraints of the results presented in the report. First, we need to outline that the results only offer an initial point of understanding user requirements of mobile 3DTV and make no claim to be complete. We will need further analysis of the results to understand different user groups and user characteristics impacting on the requirements. Additionally, we need to deepen our knowledge about differences in usage scenarios to understand the contextual aspects of mobile 3DTV. This will result in a complex picture of user experience already in the design phase [26][12]. Second, inaccuracy must be expected as the users in the study only worked with an imagery, non-existing system which is a hard task for test participants [43]. Hence, iteration design according to ISO standards [33] and early phase prototyping [43] are needed to verify these initial requirements during the ongoing development process. Third, we need to work on the triangulation design during the requirement elicitation in order to evaluate its strengths and weaknesses.
7. References


[58] Roibás, A.C., Johnson, S. 2006. Unfolding the User Experience in New Scenarios of Pervasive Interactive TV, CHI 2006, April 22-27, Montreal, Quebec, Canada.


8. Appendix
8.1 Detailed results of the survey study
8.1.1 Content

Figure 20 Television contents for mobile 3D television compared Finnish and German questionnaire results.

Figure 21 Interesting television genres for mobile 3D contrasted Finnish with German questionnaire results.
Figure 22 Interest on television genres dependent on the gender of the respondents.
Figure 23 Attractive video contents for 3D presentation on a portable device in addition to television contents.
Figure 24 Expected length of viewing of mobile 3D television.

Figure 25 Different content features compared Finnish with German questionnaire results.
Figure 26 Interest on different audio, visual and audiovisual presentation modes.

Figure 27 Need for different features to interact with the content.
8.1.2 Device and service

Figure 28 Preferable display sizes for a portable 3DTV device.

Figure 29 Need for on demand and push service in both questionnaires.
Figure 30 Interest on different methods of payment in Finnish and German questionnaire.

Figure 31 Respondents mentioned different amounts that they are ready to pay for watching a short movie in 3D on a portable device.
Figure 32 Different amounts for a monthly payment to watch mobile 3DTV were mentioned by the respondents.

8.1.3 Context

Figure 33 Imaginable social viewing contexts for mobile 3DTV compared Finnish with German questionnaire results.
Figure 34 As temporal context, long transportation trips are seen as the most interesting option, followed by short waiting situations in both questionnaires.
Figure 35 Different private and public contexts, indoor and outdoor environments are attractive for the use of mobile 3DTV.

Figure 36 Viewing mobile 3DTV as primary task is mainly assumed in Finnish and German questionnaire.
8.1.4 Motivations

Figure 37 Users' motivation for using mobile 3D television and videos compared Finnish with German questionnaire results.
8.2 The online questionnaire of the survey study
Mobile 3DTV Questionnaire

Reply to the Mobile 3DTV questionnaire and win an Apple iPod nano!

Very welcome to the Mobile 3DTV questionnaire!

We are interested in your actual use of different media services and your thoughts about new technology - Mobile 3DTV. With Mobile 3DTV it will be possible to watch television programs and video contents in three-dimensional on portable devices anywhere and at any time. This questionnaire is part of the work for Mobile 3DTV, a research project funded by the European Seventh Framework Program.

The reply to the questionnaire will take approx. 15 minutes. It’s possible to answer the questionnaire between April 16 and May 03. While answering the questionnaire you can win something. Everyone who participates in the survey can take part in a drawing for an Apple iPod nano. Therefore, you should enter your contact details at the end of the questionnaire.

Your answers will be used only for scientific purposes and will be handled anonymously. We will not forward your data to third parties. If you are interested in the results of the questionnaire, you will find them at the Mobile 3DTV website www.mobi3dtv.eu in the end of the year.

Thank you very much for your participation!
The Mobile 3DTV team: Satu, Mandy and Dominik

Contact:
Satu Järvisuo-Pyykönens
Tampere University of Technology
mobile-3dtv@utu.fi

How well do the following sentences describe you?

In general, I am among the last in my circle of friends to purchase new technical devices or services.

Strongly agree
Somewhat agree
Neither agree nor disagree
Somewhat disagree
Strongly disagree

Do the following sentences describe you?

I study or work mainly in the field of information technology.

Yes
No

I am often in my work or hobbies in touch with video processing.

I am rarely related to television technology in my work or hobbies.

How many hours you use for watching TV (in hours)?

00:00-00:15 00:15-01:30 01:30-02:45 02:45-03:45 03:45-05:00

What kind of TV programs do you watch?

News
Documentaries
Fims
Sports
Animated films and cartoons
TV series
Music videos, music television
TV shows
Reality TV
Lifestyle programs (e.g. about health, travel, decoration)
Current affairs program
Adult entertainment

What is your favorite TV program?

How often do you watch the following types of video content or moving images?

Active videos
Film trailers
User-created videos (e.g. YouTube)
Self-recorded videos
Advertisement clips
Tailored contents for 3D
Short movies
Animations
Product presentations (e.g. internet shopping, camera shop around product, 3D-animation)
Navigation applications (e.g. navigation system)
Special presentations (e.g. video guides in museums, virtual city guides)
Interactive videos
Video phone calls
### How often have you viewed television programs or videos using the following devices?

<table>
<thead>
<tr>
<th>Device</th>
<th>Not at all</th>
<th>Watched once or twice</th>
<th>Half-yearly</th>
<th>Monthly</th>
<th>Weekly</th>
<th>Daily</th>
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<tbody>
<tr>
<td>Computer</td>
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<td>Portable DVD-player</td>
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<td>Digital television</td>
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<td>Video projector</td>
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<td>Mobile phone</td>
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<td>MP3 player (e.g., iPod)</td>
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<td>PDA</td>
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<td>PSP (PlayStation Portable)</td>
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<tr>
<td>Digital camera or video camcorder</td>
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</tbody>
</table>

### How often do you play computer games?

- Not at all
- Every now and then
- Half-yearly
- Monthly
- Weekly
- Daily

### How often do you play the following types of games?

<table>
<thead>
<tr>
<th>Game Type</th>
<th>Not at all</th>
<th>Played once or twice</th>
<th>Half-yearly</th>
<th>Monthly</th>
<th>Weekly</th>
<th>Daily</th>
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<tbody>
<tr>
<td>Jump 'n' run</td>
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<td>Adventure</td>
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<td>Strategy</td>
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<td>Sport</td>
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<td>Vehicle simulation (e.g., flight simulation)</td>
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<td>Simulation game (e.g., Second Life, Habbo)</td>
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<td>Roleplaying games, multiplayer online (e.g., World of Warcraft)</td>
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<td>Music games or dance games</td>
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<td>Quiz games</td>
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<td>Learning games (e.g., languages)</td>
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<td>Action games (e.g., fighting games, simple shooter games, Ego-Shooters)</td>
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</table>

### Others, what?

- Others, what?

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**MOBILE3DTV**

D4.1
<table>
<thead>
<tr>
<th>Mobile Services</th>
<th>Not at all</th>
<th>Tried once or twice</th>
<th>Half-yearly</th>
<th>Monthly</th>
<th>Weekly</th>
<th>Daily</th>
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<td>SMS</td>
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<td>Mobile email</td>
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<td>News</td>
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<td>Instant messaging (e.g., chat, Skype)</td>
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<td>Video phone calls</td>
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<td>Mobile blogging, mobile internet</td>
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<td>Mobile radio</td>
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<td>Listening music, podcast</td>
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<td>News, weather services</td>
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<td>Sport news</td>
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<td>Dowreloading, videos (e.g., YouTube, Blocks)</td>
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<td>Mobile browsing, mobile internet</td>
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<td>Search services</td>
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<td>Games</td>
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<td>Travel services (e.g., timetables)</td>
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<td>Events or location specific services (e.g., in museum)</td>
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<td>Maps or navigation services</td>
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<td>Social services (e.g., Facebook, Flickr)</td>
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<td>Navigation services</td>
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<td>Management services (e.g., Google Calendar)</td>
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<td>Health care services (e.g., sport, nutrition)</td>
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</tbody>
</table>

**Others, what?**

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**How often have you watched 3D movies and 3D video content?**
- Not at all
- Once
- Two to three times
- Four to five times
- Watch regularly

**What kind of contents have you watched in 3D?**
- Documentaries
- Concerts
- Animated 3D movies
- Nature / animal movies or documentaries
- Science Fiction
- Fantasy
- Others, what?

**Where have you watched 3D video content?**
- Cinema
- Theme or amusement parks
- At home
- At work
- Everywhere, where?

**How often have you watched 3D video content on the following devices?**
- Television or video screens
- Computer
- Laptop
- Other

**Besides, where?**
### I would view the following type of TV programs on my portable 3D device:

<table>
<thead>
<tr>
<th>Category</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>News</td>
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<td>Weather forecast</td>
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<td>Documentaries</td>
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<td>Current affairs program</td>
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<td>Films</td>
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<td>Sports</td>
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<td>Animated films, cartoons</td>
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<td>Finnish/German TV series</td>
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<td>Foreign TV series</td>
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<td>sitcom</td>
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<td>Soap opera</td>
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<td>Music videos, music television, concerts</td>
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<td>Adult entertainment</td>
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<tr>
<td>TV games, quiz programs</td>
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<tr>
<td>Reality TV</td>
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<td>Lifestyle programs (e.g. about health, travel, decoration)</td>
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<td>Talk Shows</td>
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<td>Theater and opera</td>
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<td>Advertisement</td>
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<td>Cooking show</td>
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<td>TV show (e.g. life shows)</td>
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<td>Children’s program</td>
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<tr>
<td>Herring TV</td>
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</table>

I would view following genre of programs on my portable 3D device:

<table>
<thead>
<tr>
<th>Genre</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comedy</td>
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<tr>
<td>Thriller</td>
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<tr>
<td>Romance</td>
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<tr>
<td>Action film</td>
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<tr>
<td>Science</td>
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<tr>
<td>Reality</td>
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<tr>
<td>Drama</td>
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</tbody>
</table>

### I am interested in watching the following contents on a portable 3D device:

<table>
<thead>
<tr>
<th>Category</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Athletic videos</td>
<td></td>
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<tr>
<td>Games</td>
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<tr>
<td>Film trailers</td>
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<tr>
<td>User-created videos (e.g. YouTube)</td>
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<tr>
<td>Self-recorded videos</td>
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<tr>
<td>Advertisement clips (e.g. video clips about news, congratulations, events)</td>
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<tr>
<td>Tailored contents for mobile 3D TV</td>
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<tr>
<td>Event or location based contents (e.g. soccer, Olympic games, concerts)</td>
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<tr>
<td>3D videos inside the game</td>
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<tr>
<td>Short movies</td>
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<tr>
<td>Program preview</td>
<td></td>
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<tr>
<td>Programs of conventional TV but shorter</td>
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<tr>
<td>Animations</td>
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<tr>
<td>Product presentation (e.g. internet shopping, camerapath around product, 3D-animation)</td>
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<tr>
<td>Navigation applications (e.g. navigation system)</td>
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<tr>
<td>Special presentations (e.g. video guiding to museums, virtual city guides)</td>
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<tr>
<td>Interactive videos</td>
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<tr>
<td>Voice phone calls</td>
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<tr>
<td>Short animated instructions to use</td>
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</tbody>
</table>

Others, what?

[ ]
### How well do the following claims describe you using mobile 3D television or videos?

<table>
<thead>
<tr>
<th>Claim</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I would like to get 3D videos as on demand on my portable device.</td>
<td></td>
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<tr>
<td>I would have a need for push 3D TV service on my portable device.</td>
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<tr>
<td>I would prefer to listen music or radio when I am on move (e.g. walking).</td>
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<tr>
<td>I would appreciate only listening music if I am located in very busy environments (e.g. crowded by people).</td>
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<tr>
<td>It would be important to change frequently from viewing and listening from 3D video to listening only the content (e.g. when leaving the bus and continuing the way by walking).</td>
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<tr>
<td>I would focus fully on watching 3D television or video and minimize all other activities meanwhile.</td>
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<tr>
<td>I would use it as a background sound while doing something else.</td>
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<tr>
<td>I would watch 3D television or video while chatting with my friends or family members.</td>
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</tbody>
</table>

### How would you like to pay a about use of 3D television on move?

- Pay per view
- Certain amount per month

### How much would you be ready to pay:
- for viewing a short movie on a train (in euros)?
- monthly for the use of mobile 3D TV (in euros)?

### I see myself viewing a mobile 3D television content with the following lengths:

<table>
<thead>
<tr>
<th>Length of content</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>Short videos or short part of programs lasting only couple of minutes</td>
<td></td>
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<tr>
<td>Approximately 15 minutes lasting programs or videos</td>
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<tr>
<td>Approximately half an hour lasting programs or videos</td>
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<tr>
<td>TV shows or videos lasting approximately an hour</td>
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<tr>
<td>Long lasting movies or shows</td>
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<tr>
<td>Short parts of programs</td>
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<tr>
<td>Flashes about the current television programs on 3D format programs which has no fixed start and end times but they are rather looped</td>
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</tbody>
</table>

### What display size (diagonal screen) of the portable device would be the most suitable for viewing 3D content?

- Diagonal screen of 5 cm - 8 cm (e.g. display of mobile phone, mp3 player, iPod, digital camera)
- Diagonal screen of 8 cm - 10 cm (e.g. display of iPhone, iPod, SmartPhone)
- Diagonal screen of 10 cm - 13 cm (e.g. display of PlayStation Portable, navigation system)
- Diagonal screen of 13 cm - 18 cm (e.g. ASUS Eee PC)
- Diagonal screen of > 18 cm (e.g. display of portable DVD player)

### I would watch mobile 3D television or videos:

<table>
<thead>
<tr>
<th>Reason for watching</th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>To become entertained for entertainment purposes.</td>
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<tr>
<td>To get information and stay updated</td>
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<tr>
<td>To spend time together with my family or friends.</td>
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<tr>
<td>To relax.</td>
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<tr>
<td>To experience 3D on my own, not only in the cinema.</td>
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<tr>
<td>To feel good to have a newest piece of technology.</td>
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<tr>
<td>To battle loneliness.</td>
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<tr>
<td>To learn new things.</td>
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<tr>
<td>To kill time.</td>
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<tr>
<td>To be alone.</td>
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<tr>
<td>To entertain myself while travelling a long journey.</td>
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</tr>
</tbody>
</table>
### I would watch mobile 3D television or videos:

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>To entertain myself with secret watching at school or work.</td>
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<tr>
<td>To spend time with colleagues or friends on a break from work or school.</td>
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<tr>
<td>To spend time watching on a commute (e.g. train, bus, airplane).</td>
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<tr>
<td>To get current information while being on the go (e.g. soccer match, concert).</td>
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<tr>
<td>To check the latest news and weather while being on move.</td>
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<tr>
<td>To relax at home.</td>
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<tr>
<td>To relax with my friends.</td>
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<tr>
<td>To relax for a short time while having a break (e.g. at work, at school).</td>
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<tr>
<td>To gain peace and privacy in public environments (e.g. in busy surroundings or during travel).</td>
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</tbody>
</table>

### I would view 3D television or videos on a portable device:

<table>
<thead>
<tr>
<th></th>
<th>Strongly agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>In a public transportation (e.g. bus, tram, train, metro)</td>
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<tr>
<td>In a private car</td>
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<tr>
<td>In a cafe</td>
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<tr>
<td>At home</td>
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<tr>
<td>In a park</td>
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<tr>
<td>In special events (e.g. sport, attractions, concerts, festivals)</td>
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<tr>
<td>While watching</td>
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<tr>
<td>Lounge area (e.g. airport)</td>
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<tr>
<td>At work</td>
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<tr>
<td>In a restaurant (e.g. cafeteria, pizzeria)</td>
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<tr>
<td>In a hotel (e.g. gym, swimming hall)</td>
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<tr>
<td>In a hospital</td>
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<tr>
<td>In a library (e.g. library)</td>
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<tr>
<td>In a theater environment (e.g. cinema)</td>
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<tr>
<td>At home when going to sleep</td>
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<tr>
<td>At home when being together with others</td>
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</tbody>
</table>

**Elsewhere, where?**

___

### Description of the Mobile 3DTV service

Mobile 3D TV is a novel service providing a fascinating new type of viewing experience on different sizes of portable device. It will be on the market near future. The service enables you to view any television programs or video content in 3D dimensionally. It is a new technology that will make you feel like you are right there in the scene. You can enjoy watching movies, sports, concerts, and other events in 3D, as if you were right in the middle of the action. Mobile 3D TV can be used for entertainment, news, sports, and more. It is a perfect way to keep up with your favorite shows while on the go. Mobile 3D TV is a unique experience that can be enjoyed on-the-go. It is compatible with most mobile devices, including smartphones, tablets, and laptops. Mobile 3D TV is a revolutionary new service that is sure to revolutionize the way you watch television.
Please rate the following claims about your intention to use 3D video or television!

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that the 3D video or television provides various types of contents to view and capture.</td>
<td></td>
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<tr>
<td>3D video and television provide content that I need.</td>
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<tr>
<td>I think that services and information I can get when using service are valuable.</td>
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<tr>
<td>I think that service is reliable in use.</td>
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<tr>
<td>I think that service is secure to use.</td>
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<tr>
<td>I think that the content is presented on high quality.</td>
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<tr>
<td>I appreciate that using the service is independent on place.</td>
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<tr>
<td>I feel emotionally connected with having 3D video or television because I can do something interesting with it at my convenience.</td>
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<tr>
<td>I think that the price level of using mobile video or television is a burden to me.</td>
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<tr>
<td>I think that service is easy to understand for me.</td>
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</tbody>
</table>

Please rate the following claims about your intention to use 3D video or television!

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I find service entertaining.</td>
<td></td>
<td></td>
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<tr>
<td>I think using 3D video or television is favorable.</td>
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<tr>
<td>I think using service is pleasant.</td>
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<tr>
<td>It is expected that people like me use the service.</td>
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<tr>
<td>People important to me think I should use service.</td>
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<tr>
<td>I think that using the service is a good idea.</td>
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<tr>
<td>I think that using the service is beneficial to me.</td>
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<tr>
<td>I have positive attitude towards using 3D video or television.</td>
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<tr>
<td>I feel good because I can access service anytime.</td>
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<tr>
<td>I am pleased with 3D video or television capability that offers real time content in an ubiquitous basis.</td>
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</tbody>
</table>

Please rate the following claims about your intention to use 3D video or television!

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Somewhat disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>It is fun to use service.</td>
<td></td>
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<tr>
<td>I find service enjoyable.</td>
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</tr>
<tr>
<td>I intend to use 3D video or television in future.</td>
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</tr>
<tr>
<td>I recommend others to use 3D video or television.</td>
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<tr>
<td>I think that using 3D video or television is trendy.</td>
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<tr>
<td>I think that using 3D video or service gives me more reasons.</td>
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<tr>
<td>I think that service is easy to use for me.</td>
<td></td>
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<tr>
<td>I think that it is easy for me to become useful in using service.</td>
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<td>I think that viewing of content is easy.</td>
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<td>I think that the price level of using special (prioritized) service is reasonable.</td>
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<tr>
<td>If available, I intend to use 3D video or television frequently.</td>
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</tbody>
</table>
Please rate the following claims about your intention to use 3D video or television:

The purpose of watching and using 3D videos and TV includes relaxation, playfulness, fun, fantasy, and possibly sharing content with people important to you.

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I think that service is very useful in my life.</td>
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<td>I think that this service enables me to satisfy the purpose of using 3D videos or television.</td>
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<td>I think that this service enables me to fulfill the purpose of using service more efficiently.</td>
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<tr>
<td>I think that 3D video or television provides useful service and content for me.</td>
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</tbody>
</table>

I expect to use 3D videos or television on a portable device if:

<table>
<thead>
<tr>
<th>Strongly agree</th>
<th>Agree</th>
<th>Somewhat agree</th>
<th>Neither agree nor disagree</th>
<th>Disagree</th>
<th>Strongly disagree</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am travelling and I want to spend time.</td>
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<tr>
<td>I am travelling and there is no other similar service available.</td>
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<tr>
<td>I am willing to share some of interesting programs or videos with people important to me.</td>
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<tr>
<td>I have to wait for a long time unexpectedly.</td>
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</tr>
</tbody>
</table>

How old are you?
- Under 18

Which gender do you represent?
- Female
- Male

What is your current occupation?
- Unemployed
- Pensioner
- Student
- Housewife
- Employee
- Executive
- Entrepreneur, self-employed

What is your current place of residence?
- Abroad

What is your level of education?
- Secondary / Elementary school
- High school
- < University
- University

How many persons live with you in the same household (including you)?
- 1
- 2
- 3
- 4
- 5
- More than 6

What is your monthly household net income (in euros)?
- Below 1300
- 1300 - 1700
- 1700 - 2600
- 2600 - 3600
- 3600 - 5000
- Above 5000
- Not willing to tell

Submit
8.3 Participants’ photos of the probe study

Table 6 Selected photos of the participants that show imaginable mobile 3DTV contexts.
8.4 Participants’ collages of the probe study

Figure 38 Participant’s collage.

Figure 39 Participant’s collage.
Figure 40 Participant’s collage.

Figure 41 Participant’s collage.
Figure 42 Participant’s collage.

Figure 43 Participant’s collage.
8.5 Complete description of the focus group method
Following, we will describe the design of the focus group in detail. We present our discussion guideline and outline the importance of every step and its meaning.

8.5.1 Welcome and warm up
The primary task of welcome and warm up is to make the participants relax, to inform them about the method, and to warm them up for the method. This task is very important for the success of a focus group as the researcher (or moderator) can clarify the goal and task in advance and familiarize the participants with the situation.

At the beginning of the focus group, the moderator welcomes every participant and introduces himself and his assistant. Then all participants are asked to introduce themselves, too. As an ice breaker, people were also asked to tell about their favorite television program additionally to the usual information. These ice breakers can help to form a better identification of each participant with the group by telling more “intimate” information. After the introduction of the participants, the moderator introduces the project and tells briefly about the circumstances – consortium members, goals of the project and task of the user studies. Additionally, he introduces the goals and rules of a focus group.

Regarding rules of the focus group, the following points are very important to take into account. Participants are encouraged to tell everything they want to tell. Nothing is right or wrong as the goal is to collect their ideas and expectations. The moderator also needs to clarify his role in the focus group and that he is allowed to ask deeper questions, but also to wrap up a discussion and step forward to the next task.

Additionally, participants are taught that a) they can stop and leave at any time, b) they are allowed to ask questions at any time and c) that every data collected is kept confidentially and not given to any third parties. This is very important as focus groups will be recorded after this point and participants need to agree about the recording and the following usage of the records.

8.5.2 Starting the focus group – introduction to 2D- and 3DTV
The idea of the introduction is to extend the ideas of the group from 2D television to 3D television. Using four images of autostereoscopic displays taken from publicity brochures of different manufacturers, we wanted to stimulate participants' imagination of 3DTV without a possible negative influence that could arise from using real stereoscopic presentation as Freeman and Avons [freeman2000] did.

Discussion Guideline:
The first task is dedicated to your personal habit of watching TV. What are the reasons you normally watch TV and what functions does TV have for you in your life?
Show the stimuli on the slides and tell the people that this could be 3DTV. It will work without glasses.
I’d now like to move the discussion towards situations in which you found 2DTV to be insufficient and would prefer to have a 3D system.
(prompts: Soccer (maybe sports in general)? Action movies? Documentaries?)
8.5.3 Introduction to mobile devices
To paraphrase that mobile isn’t confined to mobile phones, participants will be questioned about their use of mobile devices in general.

Discussion Guideline:
We’ve now talked about the first part of m3DTV. But besides 3DTV m3DTV is obviously also about mobile devices. So, let’s focus now on mobile devices. What kind of mobile devices are you using and what are the typical situations you’re using them in? Also think about new mobile services like MMS, mobile browsing or video calls. Do you use these services? If yes, why? If no, why not and can you imagine to use these services if you know that your recent doubts and reservation are wrong?

8.5.4 Introduction to mobile 3DTV & mobile 3DTV scenarios
We will now guide the participants to m3DTV using “imaginary prototypes” and certain scenarios which we’ll draw like a map of a town on a whiteboard. We’ll provide support with the following three predefined ones, in case participants can’t imagine scenarios on their own: 1) two persons sitting at home, watching something; 2) person in front of cinema, watching 3DTV-trailers of currently running movies; 3) mobile 3D-GPS navigation in a car.

First, there is a house and inside the house two people are watching TV together on their mobile3DTV device. Second, there is a boy in front of a cinema who downloaded the actual movie trailers from a cinema service and checks the trailers before he decides for the film to watch. Third, there is a man in a car on the street who uses his mobile3DTV device as 3D-GPS navigation.

I always tell the people that they should once more think about the things said about 3DTV and mobile devices. Then, they have 5 minutes to think about additional scenarios or to add something to the given ones. They also can comment on the scenarios already introduced.

Discussion Guideline:
Imagine that you live in a town where mobile 3DTV is already an existing mobile service and appropriate devices are widely available. This whiteboard will be our town. I will first introduce three scenarios where people are using their mobile 3DTV device for different services. First, there is a house and inside the house two people are watching TV together on their mobile 3DTV device. Second, there is a boy in front of a cinema who downloaded the actual movie trailers from a cinema service and checks the trailers before he decides for the film to watch. Third, there is a man in a car on the street who uses his mobile 3DTV device as 3D GPS navigation.

Now, think about everything mentioned about 3DTV and mobile services before. You will have 5 minutes to think about additional scenarios or to add something to the given ones. You can also comment on the scenarios already shown on our map.

I’d like you to discuss the scenarios we’ve provided you with, imagine more scenarios, and fill the empty gaps on the map. Remember, there’s no wrong idea or technical limitation for the applications you can imagine.

The people are now allowed to tell their ideas and each scenario is drawn to the whiteboard. Like this, the town fills with scenarios. People are also allowed to add critics or additions to the scenarios. After all scenarios are drawn, there is a discussion about the scenarios. People are allowed to tell their concerns. As prompts, the moderator can use the things mentioned before about 3DTV to motivate the people again to think.

We finally ask the participants to write down on a sheet of paper the three most important scenarios that they can identify on the whiteboard.
8.5.5 *m3DTV Services*

The next step will be to paraphrase “mobile” in mobile 3DTV. Therefore, we'll take a look on mobile service integration, suitable devices, and possible risks.

**Discussion Guideline:**

You have developed scenarios where you could imagine to use your imaginary mobile 3DTV device. Now, we will have a look on that device. How does your imaginary device look like? What functions does it need to have?

(prompts: Screen size, functions, mobile phone, controls, quality)

Finally we discuss the future service of mobile 3DTV. How do the people plan their program? Do they have EPG or download the videos on demand or as push service? What would you want to watch, when you turn your device on? How does mobile 3DTV service look like regarding content offers, how to choose the program and how to integrate mobile services? What would they pay and how?

(prompts: Push or on demand services? EPG? Only TV or other content?)

8.5.6 *Closing Task*

With the closing task, we'll combine everything mentioned in the focus group. The goal is to get information from the participants what, in the whole discussion, has influenced their opinion about the imaginary mobile 3DTV service most.

**Discussion Guideline:**

Fine, I think we are nearly done. You have told us a lot about your expectations during this focus group. Before we close the group, we would like to ask you to write down a final statement about the future service of mobile 3DTV. Think about everything mentioned in the discussion, look at your pad again if there is still something important, and just think about having portable 3DTV. Would you use it? When? What would you do? Are there any worries that you have? We will not read aloud your ideas any more. So don’t hesitate to praise or to criticize the service!
MOBILE3DTV - Mobile 3DTV Content Delivery Optimization over DVB-H System - is a three-year project which started in January 2008. The project is partly funded by the European Union 7th RTD Framework Programme in the context of the Information & Communication Technology (ICT) Cooperation Theme.

The main objective of MOBILE3DTV is to demonstrate the viability of the new technology of mobile 3DTV. The project develops a technology demonstration system for the creation and coding of 3D video content, its delivery over DVB-H and display on a mobile device, equipped with an auto-stereoscopic display.

The MOBILE3DTV consortium is formed by three universities, a public research institute and two SMEs from Finland, Germany, Turkey, and Bulgaria. Partners span diverse yet complementary expertise in the areas of 3D content creation and coding, error resilient transmission, user studies, visual quality enhancement and project management.

For further information about the project, please visit www.mobile3dtv.eu.