Sharing Content and Experiences in Smart Environments

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1 Introduction

Once upon a time... Stories used to be the only way to pass a message. The story teller would take his audience through the events by mere oration. Here and there he would hesitate, whisper, or gesticulate to emphasise his story or induce the right emotions in his audience. No doubt troubadours were loved, they both brought news of the world as well as entertainment.

The urge to share the highlights of our lives with other people has not changed. The means we have available to do that have changed radically. From photo albums we have arrived at an age where anyone with a little computer skills is able to create his/her own multimedia show. Sharing is a matter of pressing the send button in your e-mail system or publishing it via web based publishing systems like Flickr or YouTube.

In this chapter we will examine how sharing experiences can be supported by new developments in smart environments. As web-based sharing is reviewed in various other sources, we will limit ourselves to the particularities of sharing in "smart environments", where we will interpret these environments as including home and public environments as well as nomadic use of services.

In order to better understand the nature of our quest, we will first try to elaborate what experiences are and how they could be shared. Subsequently we will review the changing role of end-users of digital services - no longer are they just consumers of ready-made content, but active producers of experiences. In order to introduce smart environments we will identify three stages of ubiquitous computing research and briefly review how they have supported experience sharing. From our own research we have selected some projects to highlight different aspects of experience sharing. Finally we will conclude this chapter with a discussion and some indications for future research.

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2 What is Experience, Can You Share It?

The greatest motivator of people to produce and carry digital content with them is their willingness to share such content with other people. Digital content and sharing such content can be easily understood to deal with videos, photos, music, etc. In contrast, the concept 'experience sharing' is more difficult to define, explain and understand because the term 'experience' can not be defined unambiguously without some semantic analysis.

2.1 Defining Experience

The word experience has different nuances in different languages [29]. The meaning of the term can be understood at least in three different ways: 'Primary Experience', 'Secondary Experience' and 'Emotional Experience'. The primary experience focuses on receiving and processing a certain personal knowledge of experience. The secondary experience consists of individual experience on the context and objects in the context with their subjective meaning and significance to a person. The emotional experience is a personal emotional feeling.

The primary experience is clearly not serving our purpose in this context. This kind of experience deals with accumulated experience of skills, e.g. working experience and routines gathered during a career.

Secondary experience can be used to refer to a more common and everyday experience, which refers to the past and to something that has happened to a person before, and which is familiar to him or her. A person might have a feeling, an expectation or an attitude towards the thing to be experienced, which is based on something already known to her/him from the past.

Finally, the term experience may refer to a deep and multi sensorial emotional experience, enabling changes to one's behaviour. This type of experiencing is stronger and might more deeply influence a person compared to the previous experience definitions. An experience according to the second definition above can lead to this kind of deep and meaningful experience, but not necessarily vice versa. A meaningful and deep emotional experience has a nuance of novelty and uniqueness [28, 29].

All experiences (regardless of their type) that people have gained and which they accumulate, have some impact on the person's future, and former experiences either shut down or open up access to future experiences.

2.2 Experience Design Modeling

Is it possible to design, produce and share experiences? If it is possible, what kind and what level of experiences?

Emotional and deep experiences, that may lead to personal changes, are very subjective. Hence, an experience can not be produced with absolute certainty. But the settings which are ideal for producing this kind of experiences can be objectively created [24].

It has been stated [26] that "The elements that contribute to superior experiences are knowable and reproducible, which make them designable". And further: "What these solutions require first and foremost is an understanding by their developers of what makes a good experience; then to translate these principles, as well as possible, into the desired media without the technology dictating the form of the experience."

If agreed that experiences can be designed into products and services, we need to know the elements of experience design based on experience modelling. What are the factors of user experience in smart environments? As an example of the experience modelling efforts, we will mention two of them.

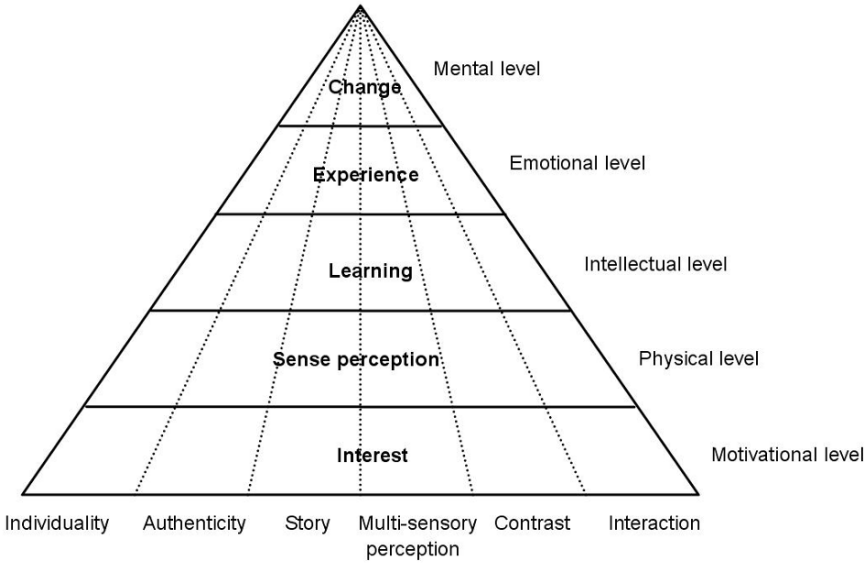

Fig. 1 Experience pyramid (redrawn from [28])

A model (so called experience pyramid) suitable for experience design into products and services is reported in [28]. The model has two kinds of levels: vertical levels of subjective experience (individuality, authenticity, story, multi-sensory perception, contrast, interaction) and horizontal levels of experience product/service elements (e.g. interest on motivation level, sense perception on physical level, learning on intellectual level, experience on emotional level, change on mental level). A good experience product includes all elements of the experience at each level of subjective experiencing. Still, the possibility to meet 'meaningful experience' by

a person depends on his social and cultural background, expectations towards the service or product, etc. [29].

User experience is an experience that the user obtains when interacting with a product under some particular conditions. Based on this definition, an experience model has been suggested, which classifies different factors of experiences into five groups [2]. The groups are as follows:

- User internal factors (values, emotions, expectations, prior experiences, physical characteristics, motor functions, personality, motivation, skills, age, etc.
- Social factors (time pressure, pressure of success and fail, explicit and implicit requirements, etc.)
- Cultural factors (sex, fashion, habits, language, symbols, religion, etc.)
- Context of use (time, place, accompanying persons, temperature, etc.)
- Product aspects (usability, functions, size, weight, language, symbols, aesthetic characteristics, usefulness, reputation, adaptivity, mobility, etc.)

These factors will be integrated via user interaction, which produces the user experience related to the case at issue.

2.3 On Sharing Experiences

To clarify the concepts of 'Experience design' and 'User experience design', it has been stated [23], that 'experience design' uses the interactions of customers with products and services to optimise the overall impressions left by these. 'User experience design' applies a similar approach to specific set of products - computer related ones. Hence, user experience design covers traditional Human-Computer Interaction (HCI) design and extends it by addressing all aspects of a product or service as perceived by users. The 'user experience' refers to the overall impression, feelings and interactions that a person has while interacting with these systems. In practice, this applies to almost all electronic and mechanical products we own/use since they often rely on computers for their functioning [23]. The user experience research is focusing on the interactions between people and computer based products/services, and the user's experience resulting from the interaction. Without doubt, the user experience may be of subjective nature, and although it is possible, it does not necessarily lead to deep emotional feelings and behavioral changes for the user (emotional experiences). Still, user experience design should be extended to concern all aspects of experiencing the product or service, including physical, sensitive, cognitive, emotional, and aesthetic relations [14].

The success of sharing one's experience with other people is embedded in the conscious production of experiences. Sharing an experience with other people may give additional content and meaning to an experience and thus deepen one's personal emotional experience. 'Co-experience' is the user experience, which is created in social interaction driven by social needs of communication and where the

participants together contribute to the shared experience [3]. If the capability of design and production of user experiences is agreed (although not self-explanatorily), the ability of sharing or transferring experiences between people is - in many cases - a technical challenge, too.

Although it seems to be possible to advance creation of favourable circumstances for certain experiences and hence to design, produce and share experiences, one can not be sure or guarantee, that the other person's experience is as intended. At least, an emotional experience is very subjective, being a complex mixture of a person's earlier experiences, personality, values, behavioural norms, preferences and expectations - all issues to be treated in vertical levels of the experience pyramid. - Probably, no one is able to experience the emotional experiences of another person exactly in the same way. Nevertheless, we may create circumstances for converging individual experiencing, the subjective user experiences will hardly be exactly the same.

3 The Changing Role of the User in Content Provision (Prosumers)

Currently, many of the most popular web applications are characterised by increasing user participation. Users create and import their own content for others to share in the public virtual spaces, and add value by commenting, recommending or tagging existing content. This phenomenon is called social media or Web 2.0. Users themselves produce topical and personal content and recommendations from other users help in finding relevant content. User communities created around shared interests are efficient tools to share information. Social media has started as entertainment but it has a huge potential also in everyday and working life applications that involve people interacting with information, content and each other.

Another change that is happening is the way to access content. Technologies such as RSS feed enable push-type solutions: it is possible to keep up-to-date on almost anything, which changes the way people interact with content and media.

To allow ordinary people to get the most out of the opportunities of social media, we need to be aware of potential bottlenecks of adopting social media in different user groups. Those bottlenecks include security and trust, digital identities, everyman's rights in the digital domain, usable tools for content creation, sharing and storing as well as efficient tools to manage and benefit of information flows from the outside world.

Increasing user participation also challenges traditional application and service design paradigms. Our digital environment is evolving into an ecosystem of services, where new services have to compete for their share of user attention with already existing services. The designers cannot design new services in a vacuum - in addition to designing the service itself, the designer also has to design how the new service fits into the service ecosystem. In fitting the service to the constantly evolving service ecosystem, users again get an important role. The design does not

end on the designer's drawing board but the design continues by users as long as they are using the system or service. As the users adopt usage practises and create content to the service, they actually finalise the design. Lead users who are the first to adopt new services also have an important role in creating the first contents and helping other users to adopt the service by showing the way to them. Design and usage are integrating and are not as separate activities as they used to be. More information on the changing faces of innovation can be found in [12].

Another paradigm shift caused by social media is that services do not really exist without user generated content as the services have no value without the user-generated content. Before the service is ready to be put onto the market, it has to have some forerunner user groups who create content and encourage other users to join. These forerunner users should have a strong role in the design. The design should also focus on user communities and their practices to share information. If design and usage can be combined as early as possible, new social media services have better foresights for success.

Also in smart environments the design continues in actual use where users shape the technology by producing content as well as designing and adopting usage practices. Smart environments need to be flexible enough to allow this kind of "local design" [15]. Social media is getting an important role also in smart environments that include content created and shared by the users. Users of smart environments are not just passive objects receiving information and guidance but active producers and consumers of media (prosumers). Users should be given an active role in the design and setup of smart environments. In addition to individual users, we have to focus on user communities and usage practices in them.

4 Smart Environments and Experience Sharing Features

4.1 From Ubiquitous Computing to Digital Ecologies

As we have seen in the previous section, the smartness of the environment in our view will be very dependent on the users in the environment. Whereas the ubiquitous computing vision promoted by Weiser [31] was very much emphasising the increasing interoperability and computational power of our environment and the increased intelligence of services building on that, we would like to view the smartness of the environment as a result of the cooperation of humans and technology in a certain environment. Weiser recognised the importance of focussing on people, and the Ambient Intelligence vision, (see e.g. [1]) made this aspect already more concrete by explicitly stating that interaction is an inherent part of ambient intelligence. Our approach is viewing the environment as an ecology, where people and technologies are in constant change. This ecosystem is shaped both by design and usage activities.

When reviewing our previous research, as will be done in the next section, we can see the same evolution of the smart environment concept; initial research followed the ubiquitous computing vision (UBI), soon succeeded by the more interaction-oriented Ambient Intelligence notion (AmI) and now culminating in the participatory Digital ecology (ECO). The examples provided mainly represent the AmI approach, but some (e.g. ExpeShare and m:Ciudad) already point forward to the digital ecology paradigm. We should also mention a wide national research project on Smart Environments where a great number of Finnish research institutes cooperated on the research of systematic methodologies for the creation of smart environments or ecologies. The results of this research can be found in Finnish [9]

UBI: Our initial research focussed on interconnectivity of autonomous components in the environment. We perceived these components as performing specific tasks; sensing the environment, actuators controlling the environment, means for user input and feedback, and computational tasks adding the intelligence into the environment. We called these environmental components "smartlets". The main issues of research included wired and wireless (ad hoc) communication, abstraction of sensor input, sensor fusion, and decision making support. Context awareness was aimed at detecting the device environment or environmental conditions of the user.

AmI: Soon the user was put at the centre and research started to focus on adapting services to the user by using information about the user's context or preferences. New interaction paradigms were researched aiming to facilitate mobile interaction, the main focus in the Northern European countries. Experiments with lesser used modalities like gestures were done. User feedback and usability became more important and user centred design methods were applied to the development of new services. Ontologies were not only applied to reflect hidden features of devices, but also for domain specific concepts, tagging content and setting up user profiles.

ECO: Recently our research has started to focus on designing the environment as a system consisting of people and digital services provided by the environment. The research has drawn from developments in the web, where end users more and more participate in building services and providing content. Our research has focussed on how to provide affordances; enhancements in the environment that aim to form a natural bridge between digital and physical worlds. Design methodologies are now aiming to design a service not just as stand alone components, but to be incorporated in services orchestrated by the users themselves. Interoperability is now considered more on a semantic level, than on a physical communication level. Interaction research aims to empower users to tweak their environments with a minimum of effort, instead of automatically adapting to the best guess of the user's wishes.

4.2 Features for Sharing Content and Experiences

The survey of the term experience resulted in the somewhat critical note, that experiences can not be actually transferred from one person to another. It is possible to induce a similar experience, however, by triggering the right memories, providing

content and encouraging emotions. For the remainder of this chapter we will take a pragmatic approach and limit ourselves to supporting sharing (past) experiences and creating shared experiences. Here we assume that sharing (past) experiences is possible by presenting multimedia content and conveying relevant details about the original context. Creating shared experiences refers to the collaborative creation of a collection of such experiences. Note that also reviewing past experiences in a new context or with other people can create a new experience. In all cases we assume that proper interaction methods will be instrumental to the success of the solutions. Furthermore we identify that managing experiences must be addressed as well.

4.2.1 Multimedia Storage and Retrieval

Before the digital age sharing multimedia content was limited to showing paper pictures or slides to one another and exchanging records. The content was intrinsically associated with the carrying media. Sharing content meant sharing media, and there were very limited possibilities to copy the content. Only photographs were relatively easy to reproduce from their negatives. Storage happened on shelves and in albums, much like books had been kept for generations. Libraries and other owners of large quantities of content usually used a card-system and a basic classification system to keep track of the content items.

Tape recorders and copying machines brought a change. The possibility to record content made it possible to separate the content from the original carrying media and a number of people could enjoy the same content. Copying was still a slow task - it took as long as the record lasted - but it was sufficiently easy to have the record companies start worrying. As there was still a physical medium, the tape, necessary to store the content storage, there was no fundamental difference in storage methods.

The compact disk was the first commercial digital medium for musical content storage. While the first systems only allowed to play CD's, in time the recordable disk was developed, making copying even easier and eventually also faster. Still, also CD's and DVD's are physical media, and no difference in storage methods was necessary.

Only when the memory capacity of PC's, portable players and digital photo cameras had grown sufficiently to comfortably hold a number of CD's or DVD's managing content has made great progress. Also the development of efficient compression algorithms like MP3 was important in this process. Now content can be copied at will and stored in large "containers". The content is now fully separated from the media, and only exists in digital format as a file in a device with sufficient memory. Exchanging content now no longer requires exchanging media. And what's more, it doesn't necessarily occupy shelf space. The absence of a physical medium requires new ways to archive our content, and there is more to it than just reproducing our card-system in electronic form.

The digital age has also seen a vast increase of end-user created content. Taking a picture is no longer associated with high development and printing costs, so one can shoot as much as one likes. Users of digital cameras typically take thousands of

pictures, probably an increase of more than 10 times the amount taken by a paper film camera. While some users make the effort to collect the best shots, combine them into a (digital) album and provide them with some annotations, most will rely on the system to store the shooting date and try to retrieve their pictures that way.

Sharing of content, regardless of it being pictures, videos, music, games, or something else, happens by copying files. If any physical medium is used, it is often temporary and the same for all types. All content can be published on the web, allowing anyone to copy it. Sharing is instantaneous and universal, without transfer of physical carriers.

While it seems that the digital age has opened the way for infinite exchange of multimedia content, it has simultaneously created a new dilemma. With the vast increase of own content and content obtained from elsewhere, how do we manage all this? Categorising is not sufficient, as few people find the time to manually annotate the content. And while this might still be possible with pictures, videos hardly even provide the options for that.

4.2.2 The Role of Context and Metadata

The semantic web insists on enhancing content with semantic information to help finding and associating web content. It emphasises the use of ontologies for this purpose - structured vocabularies defining how real-world terms are associated with each other. Metadata consists of terms from these ontologies categorising the content. Users of the content can set up profiles consisting of ontology terms and their personal relationship to them (usually how much they like content categorised with that term). These profiles can be used to personalise content provision and content search results, but also how the user interacts with the system can be personalised by means of profiles.

Ontology construction is a surprisingly difficult and laborious task. While efforts have been done to provide an ontology of everything [16], practical ontologies are usually limited to a certain application domain. Finding the right level of abstraction, limiting the domain and agreeing on the meaning of the terms and their associations belong to the challenges for ontology creation. Several web-based services have completely abandoned the idea of basing metadata on strictly specified ontologies and have allowed users to create their own keywords. The vocabularies that are developed in that way are called folksonomies [6]. They serve their own purpose, but have no way of associating related terms with each other.

The metadata associated with the content can provide more than just a description of the content. Information about the context - i.e. where, when and in what circumstances the content was created - can be also very informative and may be added to the metadata. Furthermore also the content description can be done at several levels serving different purposes. The first description coming to mind is “what’s in the picture”, or musicĚ While this is very interesting metadata, it is also one of the most difficult to provide as it often relies on the willingness of the creator to annotate the content. Descriptions may also tell something about the characteristics of the data,

like colour histograms, beat per minute, etc. This kind of metadata can be added to the content by analysing the content with suitable algorithms and requires less effort from the user. Advanced algorithms can even categorise the content, recognise faces, etc., and in this way come close to user annotations.

For experience sharing metadata is important both to help with managing and selecting content, and as a means of conveying more of the experience when the content was created. Cues in the metadata provided with the content may be used to reconstruct part of the experience. For example music played when a picture was taken, people present at a meeting, etc.

In addition to metadata, also explicitly associating content with other content may be a way to convey the experience. Combining content created by several people at an event and including personal annotations may together provide a better reconstruction than content from a single user could do.

4.2.3 Interaction to Enhance Experiences

The viewing and creation of experiences naturally relies on proper content rendering and manipulation means. We would not like to go into detail about the best means to show multimedia content. Suffice it to observe that current A/V equipment does a good job, and that mobile solutions are developing rapidly, but display limitations will impose problems for proper viewing of images and videos. Neither will we look at immersive environments or virtual reality as an option, but focus on home, public and mobile environments in everyday life.

In these focus domains interaction technologies can enhance the management of the content, the annotation of the content, the provision of the content and the linking of devices for exchanging content or rendering content. In the next section we will give several examples of such interactive systems.

5 Examples of Research in Sharing Content and Experiences

This section will review some of our own research and how it has contributed to solutions for sharing content and experiences in smart environments. While early research has also included ubiquitous computing research in the sense described in the previous section, this research has mainly provided the infrastructure for communication and exchange of content and context and hardware platforms for our interaction research.

5.1 Video Content Management in Candela

The Candela project (Eureka/ITEA, 2003-2005, see [4, 7]) identified the challenges related to the growing amount of content. Solutions for this problem were sought by enhancing the content with metadata describing the content. A related problem identified in the project is the problem of delivering the content over slow networks, for example to mobile clients. The project worked on various ways to allow contents and user interfaces (mostly web-based) to be scaled for the available network and rendering client. The main content considered in the project were videos, and effort was dedicated to the automatic analysis of this content as well.

Fig. 2 Candela project vision to facilitate video retrieval

The use of metadata with videos allowed the enhancement of videos with information about their contents, the situation in which the video was made, and other relevant information. This allowed for the efficient retrieval of videos, or their parts, in retrieval tasks. MPEG7 was used as a format for storing the metadata with the videos. Some metadata was added manually. This was done by providing video creators with tools to annotate their video using keywords from a predefined ontology. The domain was restricted to keep the ontology simple. Also some experiments were done allowing users to extend the ontology themselves. Other metadata was automatically generated by analysing the videos and their audio tracks. Provisions for enhancing the metadata with context information, for example shooting location and author, were made but not utilised during the project (information was entered manually) [25].

The system built in the project was capable of delivering videos to fixed and mobile web clients via direct internet connections and wireless connections. When a mobile phone client was detected, the user interface and the content would be scaled according to the characteristics of the client. The scaled video and user interface made it possible to use the system also over very limited connections, naturally with a loss of quality in the video.

The user interface allowed the user to specify criteria for searching video clips. The criteria for the search can be given using terms of the same ontology as used for annotating the video clips. Clips found may be complete videos or takes of a video, as annotation can be done for each separate take of a video. The video clips and their metadata were stored in a relational database to allow for easy extension.

As the project focussed on technical issues, no extensive user tests were done. From a user perspective the system was at that time state-of-the-art but very cumbersome to use. The creation, annotation and addition of videos to the system required various tools and needed nearly professional skills. The retrieval of the videos was rather simple and implemented as a regular web service. All scaling details were hidden from the user. Another lesson learnt from the project was, that producing ontologies, even for the limited domain at hand, was rather cumbersome and seemed to be insufficient for the home videos produced by the test users.

From an experience sharing point of view the content delivery system developed in the project catered for mobile users. Annotating and automatically analysing videos for sharing was experimented, but the results were not yet feasible for the end user. The use of ontologies was helpful in the retrieval of content, but might be only of limited use for user annotation of content due to the necessarily limited (and often unavailable) ontologies and the laborious annotation task.

5.2 Context Aware Delivery and Interaction in Nomadic Media

The Nomadic Media project (Eureka/ITEA, 2003-2005, [22]) was concerned with developing ways to ease how people accessed and managed mobile content and services independent of time, location or device. The project particularly focussed on the use of context information for adapting the services to the user's need, but also interaction issues related to managing content were addressed.

From the point of view of a service provider, the variety of mobile platforms that could possibly be used to access their services is a real problem. Due to the difference in interaction capabilities and screen size, each device requires their own service. Maintaining such services would be sheer impossible. In the project, a set of tools was developed to alleviate this problem. The tools allowed to build a flexible service, that adapted themselves to the features of the client device or even user preferences. The tools were based on an extensive modelling system starting from tasks and automatically generating web pages or pages adapted to different sized mobile devices. Besides the devices, also user preferences could be modelled and taken into account when rendering the services on the client device. The tools were

based on a UIDL (User Interface Description Language) developed in the project [20].

Another branch of the project worked on interaction technologies. Particularly the use of gestures to enhance mobile interaction and to control the environment was researched [11]. The gestures were recognised by means of motion sensors. During the project a vocabulary was developed for semantic gestures. A particularly interesting application used a throwing gesture to transfer pictures from a mobile phone to a TV with set-top box.

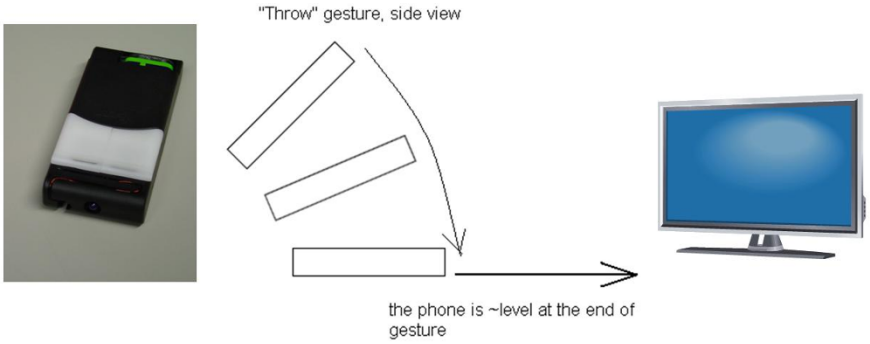

Fig. 3 Throwing pictures at the TV set

Besides the technical work, the project also enhanced the user centred design methodology to be applied to the kind of adaptive services developed in the project. The methodology was applied to the pilot services developed in the project. The early prototypes and the components developed by the participating companies were evaluated with end users. The results showed, that home consumer and entertainment electronic device prototypes and mobile device based services for sharing digital content between users from device to device (e.g., photos and music) by using gesture UIs and NFC based touching or pointing paradigms were found useful, enjoyable and usable. The services included, e.g., personal guidance and navigation systems and entertainment facilities, e.g., mobile multi-user gaming either using personal displays or by using public screens at public spaces (e.g., airport) and when moving from location to another [27].

Like in the case of Candala, also here the creation of content was only marginally addressed by the project. Content storage and provision was done by servers, which were able to serve mobile users in the way best suited to the client device and user situation. Creating a collaborative experience was best exemplified by the set-top box allowing users to “throw” pictures to be combined in an existing presentation. In this way the resulting picture gallery represents the joint experience of those participating in the session.

5.3 Kontti - Context Aware Services for Mobile Users

Mobile services and applications are used in varying contexts and surroundings. When the services are made context-aware, they can offer contextually relevant information to the user. This facilitates the finding of data and creates new purposes of use.

The Kontti (Context-aware services for mobile users) project (January 2002 - December 2003) designed and implemented a context-aware service platform and services. The platform enabled management and sharing of contexts, presence information and contextual content, and it provides context adaptation and context-aware messaging. Also, personalisation and context tools were implemented.

The goal of the project was to develop concepts and tools for offering context-aware mobile services. Methods for adaptation and personalisation for managing these services were also created. Development goals included example services, which adapt to the terminal, network, context of use and user preferences. The match between the services, users' and service providers' requirements was ensured by using human-centred design methods.

The design process was started with a series of interviews. A separate research track in Japan charted the upcoming technology. Along the project, user requirements were gathered to ensure that user-friendly implementations and concepts of the technology would be used.

The developed solutions were evaluated in the laboratory and in the field trials. Improvements in the design could be done "on the fly" as well as in larger, distinct phases. The contact between the developers, evaluation team and users worked for the benefit of all parties.

The project developed a context-aware service platform and applications. The platform provides personal management and sharing of contexts and presence information; content adaptation and context-aware messaging. Contextual information can be viewed and managed within the system.

Several user experience studies were performed during the project. The evaluated applications included everyday services, event services, tourist services and friend services. Some parts of the concept were also evaluated with mock-ups. Generally, in the evaluations, the implemented system proved very promising and already usable. In addition, we got a lot of feedback from different user groups and views from service providers on the business aspects of context-aware services.

A result of the context study was the specification of frame-based context ontologies. The implemented basic types included: time, weekly, location and user-defined type-of contexts. In addition, there were specified context operations applied to form context object hierarchies of any level. The platform manages several kinds of content objects (links, notes, media files, directories) as well as friends and groups. In particular, contextual content provides the means of context-aware views to object repositories and messages. The adaptation module performs content adaptation and media conversions to the user's terminal according to current delivery context. The user can create and edit contexts, monitor the state of contexts, and publish contexts

to be visible to other users and groups. The friend and group objects were also used to specify targets to context-aware messages.

The platform enables a user to send messages context-aware to the specified target contexts of recipients. Further, it is possible to attach into a message any kinds of objects (contexts, content objects) handled by the platform. This forms a base to the implemented content sharing, which is one of the novel aspects of the developed system.

Fig. 4 With the Kontti service the users could themselves define contexts and share them with other users

Fig. 5 In Kontti field trials the users were very creative in defining their zones

In the Kontti system users could define their own contexts, called "zones" in the system. Users could choose which contexts were visible also to others, who they were visible to and what kind of description was shown. In Kontti field trials, communicating ones own situation to others turned out to be the primary reason for

creating an own context, "zone" in the system. The users found defining the contexts fun and easy. Verbal description gave unlimited degree of freedom to describe and to control the information they conveyed to others. Maintaining the currently active zone manually however required too much efforts in mobile use. Contexts themselves were found a nice informal way to communicate but context-aware messages related only to certain contexts were not found very important.

In the Kontti project, user-defined contexts were often related to user's mind set rather than physical elements of context such as location. This provided evidence that users should have a stronger role in defining and sharing contexts. Sharing context information can be a very efficient way to share experience.

The results of the Kontti project indicated that the most promising applications for context-aware services are event guides and professional use. Also, conveying context information proved to be very interesting for the users. Further, contexts can be used for opening new communication channels for messaging. Context can be used as a mediator where any recipient can pick up a public message.

5.4 m:Ciudad - A Metropolis of Ubiquitous Services

The starting point of m:Ciudad (EU-FP7/ICT, 2007-, [17]) is the vision that the mobile devices carried by people and used for service access should allow for service provision as well.

Due to the limited resources of mobile phone facilities, the user generated services in m:Ciudad should be relatively simple to create and use and should be equipped with a limited (but relevant) amount of information for the user group to be defined case by case. These have been called microservices. Hence, providing users with easy tools to become also service providers is one of the challenges of the m:Ciudad project. Such tools would enable the combination of the two roles of mobile service users and service providers (the users would become 'prosumers'. Furthermore, this approach will lead to more user-centric, targeted, relevant and usable services to be shared within the user community defined. In addition to the services and the content offered by them, the user interfaces, usability and entire user experience pay a central role in creation, manipulation and management of services by individual mobile device users [18].

User evaluations for researching user experience on micro-services will be carried out later on during the project. They will cover the entire micro-service life cycle, e.g., tools for creating and sharing the services within the community and the use of the services themselves.

5.5 Sharing with My Peer - ExpeShare

The ExpeShare project (Eureka/ITEA 2007- [expeshare]) took on the challenge to develop solutions for "experience sharing in mobile peer communities". It builds on previous projects like Candela, Nomadic Media and Minami and intended to go beyond content and focus particularly on (mobile) peer communication. For network solutions, it researches the feasibility of using peer networks between mobile devices for sharing the content. On top of these networks, services to manage communities are being provided. Also how to capture and share experiences, i.e. what extensions need to be made to the shared content, is an issue of research. Last but not least, interaction solutions that help mobile users to exchange content and experiences, e.g. via public screens or touching solutions, are also being researched.

Fig. 6 Vision of the use of ExpeShare services at a concert setting

The ExpeShare project is still ongoing. Here we will report some considerations related to peer to peer communication. The meaning of the term peer to peer communication is frequently used without being further defined. In the project we identified that there are several levels of peer-to-peer communication, which have entirely different challenges and only partly support each other.

On a physical level, peer to peer is used to indicate that two devices are communicating with each other directly. The term has become necessary to differentiate from communication via servers or base stations, like is usually the case in web-based or mobile phone communication. Solutions include short range wireless technologies like the widespread Bluetooth, and the initiation of this communication can be accomplished through physical browsing technologies.

On a network level, peer to peer communication is associated with the sharing of content via network technologies including Bittorrent, etc. These technologies use all participants in the network as hubs to pass the content. All participants are thus peers, each acting as receiver and sender of content from time to time. The technologies have particularly advantages in delivering content used by a large number

of users and helps to avoid congestion at servers. As the content is spread throughout the network, it is difficult to catch or trace once it has been released. For this reason, it has been used for the illegal spread of copyrighted content and has therefore obtained an undeserved connotation of illegality. The project intends to look for peer to peer networking solutions on wireless networks. This is not just the rather trivial issue of deploying P2P networking platforms as an overlay on - say - WLAN, but needs to take into account the features of mobile devices like battery life and ad-hoc networks.

From a service provider point of view peer to peer communication can be interpreted as allowing end-users of the service to have one-on-one contact with each other. In the project we extend this to peer communities - i.e. the communication of a community member to other members in that community (the peers of that member). This differs from publishing on the web, for example by means of a blog, because the audience is limited. Issues for research to consider here is how one manages communities - for example how can you join up, how to set up and ad-hoc community etc., and how to manage content and separate its visibility in the different communities you belong to. As the project focuses on sharing experiences, it also addresses how context and presence information is distributed among the peers and how life information (e.g. video streams) can be delivered (even over mobile networks).

Peer to peer services (or peer community services) can be provided over peer to peer networks, but this is no necessity. Currently it seems that the P2P services are rather independent of the underlying network technologies and the choice of P2P network technologies should be based on the nature of the content to be distributed and the performance compared to server based solutions rather than its benefits for P2P services.

5.6 Ubimedia Based on Memory Tags

Mobile devices are increasingly evolving into tools to orientate in and interact with the environment, thus introducing a user-centric approach to ambient intelligence (AmI). With a mobile device as a medium of communication, the user can interact with everyday objects and surroundings and get information and services from and related to his/her local environment.

MINAmI (MIcro-Nano integrated platform for transverse Ambient Intelligence applications, 2006-2009, EU-FP6, [19]) is developing a mobile phone platform that can access sensors and tags embedded in the environment and different objects in the environment. The project is also developing specific sensor and tag solutions. This mobile architecture facilitates different Ambient Intelligent applications. One part of the project is the development of memory tags.

Conventional RFID tags, e.g. Near Field Communication (NFC) tags, normally have very limited mamory capacity. The same is true with 1 or 2-dimensional barcodes [10]. Memory tags that are being developed in the MINAmI project will be

ultra low-power, small, low cost devices that can be attached to all kinds of everyday objects. The memory capacity will be several mega bytes and the communication capacity will be up to 50 Mb/s. The project is developing both readable and writeable tags. The memory tags will be passive, i.e. they do not have an own energy source but they get their energy from the mobile phone in read and write operations.

In parallel with the technical development of memory tags and the related mobile platform, MINAmI project has studied usage possibilities for memory tags as well as user acceptance of those usages. The aim has been to recognise usage and application requirements and to analyse their implications for the technical development of both the mobile terminal and the memory tags [8].

One of the most promising usage possibilities of memory tags is ubimedia. Ubimedia is a concept where media files can be embedded in everyday objects and the environment. The user can access those files with his/her personal mobile phone simply by touching the physical objects. The concept facilitates easy access to media related to physical objects: for instance, music files can be provided as a bonus to a concert ticket, a movie trailer can be downloaded from a movie poster, or assembly instructions can be found on furniture as a video. The user can even write media files onto the tag with his/her mobile phone.

The interaction paradigm, in which the user can access digital information and services by physically selecting common objects or surroundings, is called physical browsing [13]. Välkkynen et al. [30] have studied a physical browsing paradigm where RFID tags embedded in the environment are accessed with a mobile phone. In their studies touching and pointing turned out to be useful and complementary methods for selecting an object for interaction.

In earlier physical browsing studies tags have been used to store links to web services. To get to the actual information, a network connection is required. The MINAmI approach is different as memory tags facilitate storing large amount of data, which can then be downloaded without a network connection. This will facilitate easier, faster and more cost-effective access to embedded media. Mäkelä et al. [21] conducted a field trial in which they studied initial user perceptions of interacting with a tagged poster. Their results showed that the users who had not had any instructions about the technology expected the tag itself to store the digital information instead of providing a link to information in a network. This indicates that users may consider memory tag concept quite natural.

In the MINAmI project, the ubimedia concept has been studied by implementing proof of concept prototypes using existing technology, i.e. NFC tags and phones. The aim of the proof of concepts has been to illustrate as concretely as possible the user interaction. User evaluation of the proof of concepts has given concrete feedback on implementing physical browsing of ubimedia.

The proofs of concepts are presented in 7. The readable tag proof of concept illustrates downloading a movie trailer from a memory tag attached to a poster. The mobile phone screen shows a progress bar displaying how much of the video clip has already been downloaded. Finally the trailer starts playing on the screen.

The writeable tag proof of concept (7) illustrates sharing museum experiences with a photo frame equipped with a writeable memory tag. The user can view photos

and messages left by other museum visitors by touching the photo frame with his/her phone. If (s)he wants to open one of the messages, (s)he selects the message on the phone screen and again touches the tag for download. (S)he can also take a photo at the museum and store it to the frame with a message to share these with other visitors.

Fig. 7 Proof of concept of readable memory tag (left) and writeable memory tag (right)

The proofs of concepts were evaluated with users, the readable tag in a usability laboratory and the writeable tag in a real museum. The users clearly preferred ubimedia download over web downloads on cellular networks. The main reasons were the speed, cost, reliability and simplicity. The test users were very interested in the possibility to produce own content to memory tags to be shared locally. Also the writing interaction was found easy.

The main user concerns were related to control over the interaction between the mobile phone and the memory tag and issues regarding security and reliability. The users were concerned about knowing exactly what was being downloaded and also about protection against viruses and unwanted content. Other worries included possible compatibility problems with older phone models and ease of use for elderly and disabled people. Ethical challenges included effortless interaction that may lead to involuntary or accidental actions such as buying products, protection against viruses and other harmful content as well as accessibility to disabled and elderly people. However, ubimedia also facilitates alternative content formats, which could be utilised to the benefit for disabled users [10].

Social media is currently a common phenomenon on the web where people interact with each other and share content in virtual communities such as Facebook and Youtube. Memory tags embedded in the physical environment and physical objects will extend social media to social ubimedia. People can then interact with each other and share content in actual physical environments. This will facilitate different local

applications. However, writeable memory tags also introduce many challenges. How should the content be managed and what kind of metadata would it require? Should users have personalised access to the contents? Should the content be moderated and if so, by whom?

6 Discussion

This chapter has attempted to provide an overview of the methodologies and technologies needed to share content and experiences in smart environments. We have elaborated the meaning of experiences and shown that sharing the experiences should be understood as and attempt to induce similar experiences in other people. In practice this will be done by sharing content related to the experience, together with contextual information and personal annotations. We have also examined the way that content provision is changing and the separation of consumers and producers gets blurred. The reasons for this change can be traced back to technology developments allowing anyone to publish content and social and semantical developments in the web that are often coined by the term Web 2.0. We have tried to show how these new paradigms from the internet world might also carry over into our real world, into what we call smart environments. We reviewed the change in the research approach as exemplified by the ubiquitous computing and ambient intelligence paradigms and suggest digital ecologies as the next step in smart environment research. Then we gave an overview of some research issues and related projects that are relevant from this perspective.

Digital Ecologies may prove to be a major step forward in the provision of feasible technical solutions to real needs of people. The main emphasis of the research will not be on technical developments per se, but on empowering people to create an environment they want to live in, with the technical support they appreciate. Products developed in the future will need to take into account that they are part of an ecology, not just stand-alone single function devices. A significant part of the functionality provided by the digital ecology will be related to experience management, enjoyment and sharing. Digital ecologies thrive because they support people in their activities and in communicating with their communities, but mostly because they give the people the place they deserve - in the driver's seat.

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