Brokering based balancing of viewpoints –
experiences from pre-product development of mobile services

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Abstract

In this paper we describe the challenges that the wide variety of different viewpoints set on the innovation prototyping approach and methods that we are developing. The innovation prototyping methodology is intended for the pre-product development of mobile and ubicomp service ideas. For the development of such services, it is necessary to involve for example such experts as usability and user study expert, business expert, safety, security and privacy related experts, various technology experts with hardware, software and network skills, as well as design experts. Here the categories of viewpoints are defined according to three factors. First, service developed represents the viewpoint of the applied ontology. Second, the used methods and their feasibility requirements determine a viewpoint. Third, the objectives and goals set a viewpoint for the developers. A set of examples is related to each of the three categories are used to determine some important characteristics are drawn as requirement for the brokering based balancing of the viewpoints. These include avoiding synchronization and straightforward conversions, preferring pull-based integration as opposed to checkpoint approaches, and autonomy of the viewpoints. The framework for brokering-based balanced viewpoint integration and related approaches, methods and tools are introduced very shortly.

Introduction

The rapid technological progress and its social impact make discussion across various development and realization viewpoints crucial and inspiring. It is necessary to study how future technologies will affect the everyday life of people as well as how other viewpoints will contribute or set constraints on technology applications. Likewise there is a need to carry out research on the future users and their environments as well how other viewpoints relate to the user aspects.

In the development of future mobile and ubicomp service ideas the involvement of various viewpoints seems to be particularly important, since these services lie in the intersection several fields that each currently develop in a turbulent manner. Examples include wireless and ad hoc networks, adaptive applications and context aware systems, augmented reality and adaptive interfaces, evolving new business chains and ideas, new challenges for the security and privacy of users, the needs and cultures resulting from the allowed mobility of users etc. Thus, it is crucial to experiment and analyze potential service ideas from various viewpoints already during the early idea generation in order to ensure their feasibility, improve user acceptance and predict potential consequences.

Our innovation prototyping methodology emphasizes a balance in the collaboration of various viewpoints. This means that no single viewpoint is allowed to override others. Therefore we are developing guidelines and methods for brokering between the viewpoints and this way avoiding clashes and opposed positions. Since we are developing the innovation

prototyping methods in particular for the pre-product development stage, the aim is to support the representatives of different viewpoints in introducing, negotiating and concretizing still vague ideas to each other. It is crucial to be able to integrate the very early descriptions of the service ideas and thus allow the service ideas to evolve through hybrids, merges and absorption, i.e., to progress whenever possible even beyond straightforward connecting, assembling or mixing the ideas.

The core challenge of the collaboration of the viewpoints lies in the language clashes. Several approaches have been experimented to overcome this challenge by for example defining common core ontology for the communication or by defining straightforward mappings to relate ontology to another. The usage of various standards, ontology definition and management tools and semantic approaches provide examples of these. Another approach is to give a primary role to the ontology of a chosen strategic viewpoint. Examples of such approaches are the user centered design methodologies that emphasize the ontology of the target users and the ontology of the user study or usability test experts.

The idea generation, service development and implementation of mobile and ubicomp services involve among others the network, software, gadget, business and various security related viewpoints. It is obvious that these expert viewpoints differ from each other not just by ontology but also in many other respects. Each of them relies on their own methods that have different requirements and have different execution durations. A further profound difference of viewpoints lies in the objectives of the experts during the development and implementation, i.e., what they are promoting and why. For example, marketing experts typically emphasize profit, usability experts may focus on ease of learning and technology experts wish to apply newest technology intentions.

We have been carrying out constructive idea generation and service development in the application area of mobile and ubiquitous computing for four years. Through the practice based research we have collected cases and developed our innovation prototyping methodology. The brokering based approach allows a better balance in the collaboration of experts coming from different disciplines.

This paper first introduces the viewpoint integration problem in the pre-product development of mobile and ubicomp services. Then, the three viewpoint aspects are discussed in turn: applied ontology, feasible methods and particular objectives. This is followed by a short introduction of the viewpoint integration approaches and methods of innovation prototyping. Finally, some are presented.

The viewpoint integration problem

The pre-product development of mobile and ubicomp services consists of idea generation, development of innovation prototypes and experimentation of both the ideas and realizations. The process iterates the idea generation based on different inspiration sources, the constructive prototyping according to engineering methods and the experimentation using for various testing and analysis methods. Service development as such requires integration of such fields as business economics, engineering, industrial design and usability testing [6]. The mobile and ubiquitous computing application field requires special skills of such specific engineering topics as mobility management of wireless networks, programming of distributed systems, embedded systems, gadget design and testing of mobile usability.

Figure 1 illustrates an example of a design team of representatives of different viewpoints. Here, the number of the stakeholders is limited to the typical expertise needs that we have met in our projects. Notice that the stick figures are symbolic, which means that in some cases a stick figure might represent a team of several persons and in another case a single

person might act in the roles of two or more different stick figures. A list of the shown experts is given below.

- Usability and user study experts are represented by the first stick figure from left. They promote the happiness of the end-users by ensuring that their needs and preferences are fulfilled throughout the development. Their methods have origins in such fields as cognitive science, sociology and ergonomics. [6, 4, 7]
- Business experts are shown as the next stick figure from left and their responsibility is to ensure that the services are marketable. They plan profitable business consortiums based on careful analysis.
- Safety, security and privacy aspect are combined into the stick figure in the centre. These counsels control and defend the viewpoints of various legislation, consumer protection, data security and user's privacy issues.
- The various technology experts are combined into the next stick figure. Necessary engineering viewpoints include e.g. network, hardware, software and media expertise that each in turn consists of several experts of more specific fields.
- Design experts are illustrated by the second stick figure from right and they refer to the industrial designers, authors and various contents providers that advocate the formulation, design and coherent styling of the service.
- The rightmost stick figure represents the producers and project managers that take care of making and keeping the schedules.

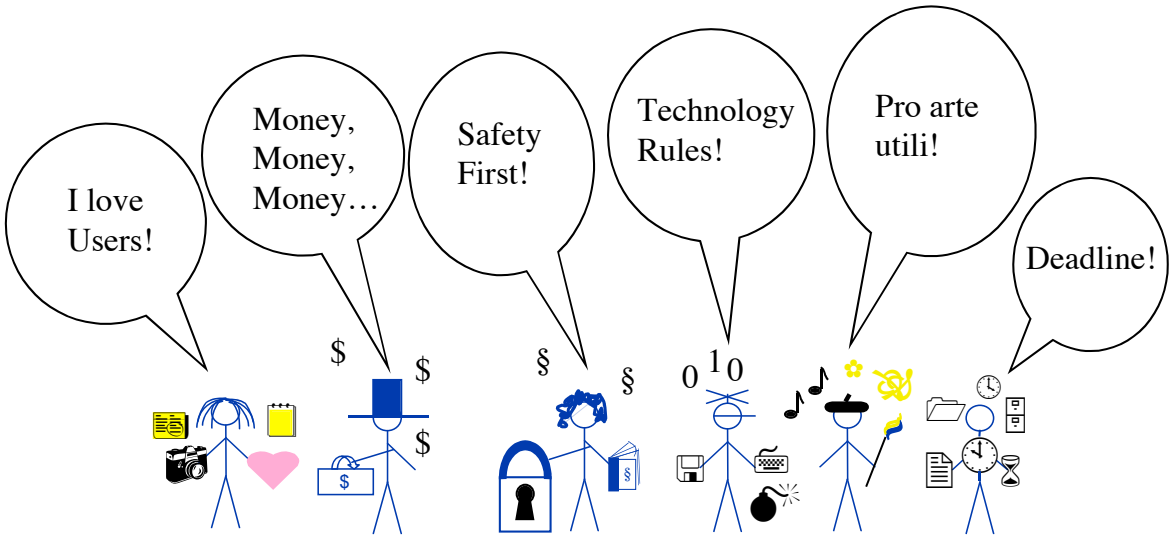

Figure 1. Viewpoint integration in the development of mobile and ubicomp services

The introduced viewpoints differ from each other according to different categorizations such as professional education, responsibilities of one's role, field of discipline and focus of the current task. However, three main categories can be defined to understand what separates the viewpoints from each other and what is needed for the integration of the viewpoints:

- The applied ontology determines a viewpoint
- The methods and their feasibility requirements determine a viewpoint
- The objectives and goals set a viewpoint (see the slogans of Figure 1)

Obviously this categorization is far from complete, however, it provides a promising basis for approaching the problem and potential improvements towards brokering-based balancing of the viewpoints. The ontological viewpoint differences are often discovered through hectic arguing between experts that do not have common understanding of the key concepts. However, the differences of the methods or the objectives of stakeholders are often difficult to discover or at least it is more demanding to recognize and allow their consequences. In the following these three viewpoint factors are explained and justified by giving a compact definition, some examples and characterizations.

Applied ontology

The first basis of different viewpoints is the applied ontology. The service developers use in the discussions and documentation the concepts of their own field of expertise. They have learned the concept definitions during their education and professional work. Typically a discipline, a branch of industry and application area has its own well-established ontology. However, ontology is rarely stabile, since research groups, companies and new fields of interest continuously enhance and construct new versions of the ontology that fit their particular purposes.

Examples

The concept of a prototype is a good example of how the meaning of a concept varies according to the viewpoint. A researcher with background in cognitive science interprets a prototype as a typical representative or example of something. For a mechanical engineer a prototype is the first full-scale functional implementation of a designed gadget. A software engineer may use the word to refer to a very initial version that aims to demonstrate just some of the most important features.

A concept that regularly causes confusion with its several definitions is user. According to the viewpoint it may be defined as an end-user of a service, a controller or an interactor of a system, a customer or a subscriber of a service, as well as a viewer or audience of a production.

Another example is the concept of mobility. A usability and user study expert defines mobility according to the area in which the user is allowed to move around. For a network expert mobility management means maintaining the connection while the access points change as a result of users movements. Notice that a mobile user for the usability expert does not necessarily require any mobility management of the network. Likewise, mobility management of a network maybe required even while the user is not considered to be mobile.

The given examples are cases where the same concept is applied in different meanings by different viewpoints. Another type of viewpoint specific concepts is the cases where different experts refer to same thing with different expressions. For example the different stakeholders may refer to the same end result or deliverable of a project with the following concepts

- Service and its manifestations
- Hardware application
- Software application
- Production
- Product

Characteristics

- The balancing of viewpoints must avoiding synchronization cores. The foundation for balancing the viewpoints is to understand the mappings that relate applied ontology to another ontology. Common core ontology is not a promising approach, since it would require that the concepts of the other ontology would have be converted into concepts of the core ontology. This would lead to lose of information and make it difficult to maintain the context for interpretation for each concept.
- The brokering of viewpoints must allow pull-based iteration. A pre-requirement for successful brokering is that the service developers understand the scope and limits of their own ontology and respect the ontology of others. This is motivated by giving the developers a responsibility to make their results understandable and interesting to others.
- The viewpoints benefit of autonomy. Each viewpoint must be allowed to maintain own ontology without being enforced to learn a common ontology that lacks nuances.

Feasible methods

The second basis of different viewpoints is method selection. The methods for the iterated planning, realization and experimentation stages are selected according to the requirements of the discipline, area and goals. For example the methods of usability engineering, software technology, mobility management of networks, and ubiquitous computing each have different conditions for feasibility, durations of iteration rounds and other profound differences. Thus, the feasible methods determine viewpoints for the developers.

Examples

The following are a couple of examples of method related viewpoints that appear in our projects that develop mobile and ubicomp sevices like the Ämppäri music player [1].

- Usability tests and user studies are carried out applying various qualitative research methods [4,6]. The experts have to follow the feasibility and reliability criteria set by the methods by relying on their original disciplines of psychology, ergonomics etc. Most of these methods are very laborious and, moreover, the analysis stages require lots of time for transcription, structuring and reviewing the data [5, 8]. Thus, the usability and user study experts need sufficient time to at one's leisure carefully execute the methods. [4,7, 8]
- Implementation of software prototypes is based on system design, programming and coding tools and methods. The required effort and duration of software implementation is very hard to predict, since the realization is in most cases full of happy and unhappy surprises. Software engineers tend to be eager to work through trial and error that may result from their troublesome relation to both reading and writing documentation. In any case, software engineering methods are oriented to construction and practice-based experimentation.
- The methods of hardware prototyping differ quite drastically from software prototyping. An important reason for this lies in the fact that hardware prototypes can easily be broken in irrecoverable way. Thus, it is necessary to plan and assess carefully all constructions before realization. The trial and error approach of software engineers has been proven inappropriate method for hardware prototyping.

Other method dependent viewpoints include for example the business and project management viewpoints that apply various planning and modeling methods for assessment

purposes. Privacy and security aspects are examples of control viewpoints that utilize checklists and templates as evaluation methods.

Characteristics

- The balancing of viewpoints must avoiding synchronization cores. The service developers must be allowed to choose for example the length and duration of development cycles according to the feasible methods. It is crucial to avoid stalling or disadvantageous haste.
- The brokering of viewpoints must allow pull-based iteration. Every viewpoint checks the pool when it is ready to accept input and utilizes the results that are. Every viewpoint makes its results available to others by putting them into the pool.
- The viewpoints benefit of autonomy. The aim is balance of viewpoints instead of domination of some viewpoint. Therefore each viewpoint is free to choose its own input that fits its methods.

Particular objectives

The third basis of different viewpoints is the different objectives of the participants of the service development process. Each individual person and organizational entity has its own expectations, motivation and role in the service development. They promote certain interests and exploitation plans, which affect the focus of their efforts. The objectives of a stakeholder vary according to the role that they take or are given in the development process. For example a usability expert is an advocate of the end user and a marketing expert searches opportunities for the money making.

Examples

The topic of an ongoing project of ours is innovation prototyping for vertical handover and its aim is to research the requirements and opportunities simultaneous multi-access. An example of the services is a music player [1]. As typical for good research projects, not only the skills but also the objectives of the project partners are complementary.

- We represent the service development viewpoint and our motivation is twofold. On the one hand the construction objective is to realize software prototypes for experimentation settings that allow study on the user aspects of future multi-access solutions. On the other hand the methodological objective is to enhance our innovation prototyping methodology according to the experience of its utilization in the project [1, 5, 8,9].
- The partner representing the viewpoint of mobile networks has twofold objectives. Its interest is in the development of mobility management and particularly in the research questions of collaboration of networks. Furthermore, the partner also has the objective of being able to demonstrate and study the indications future network solutions as they appear for the end-user.
- The two other viewpoints are that of an operator and that of WLAN network technology. In addition to their own specific construction and testing objectives their objective is to obtain experimentation setting that covers the whole big picture.

Another example shows how ontology is a manifestation of different objectives. Content provider is a buzzword that regularly appears in the discussions on new mobile entertainment services. However, in the on-going preparations of a new project we recognized how the different partners used the content concept according to their viewpoints. The different viewpoints might be interpreted roughly as follows

- The viewpoint of mobile service development emphasizes functionality, service usability and features as characteristics of content.
- From the viewpoint of automation technology and robotics content is data that is input or output for the system.
- Researchers of virtual reality environments are interested in spatial data and looking for content that can be modelled by the virtual reality technologies.
- The media viewpoint is interested in the carriers of multimedia.
- For the researchers of arts and design the concept of contents refers to narration and they emphasize the container and appearance.

Characteristics

- The balancing of viewpoints must avoiding synchronization cores. Each viewpoint is allowed continuous concentration on its own objectives
- The brokering of viewpoints must allow pull-based iteration. The viewpoint integration is based on vantage points instead of synchronization points, i.e., the viewpoints are not enforced to some externally defined checkpoints but are given responsibility and right to keep updated on the useful results of other viewpoints.
- The viewpoints benefit of autonomy. The aim is to allow the stakeholders to concentrate on their own objectives and acts according to them. Viewpoints typically set own long-term objectives that ensure that each round produces the reusable information and knowledge, i.e., viewpoints cumulate the practices, patterns and expertise.

An overview of the balanced brokering-based viewpoint integration

The balanced brokering based viewpoint integration is illustrated in Figure 2. The user, technology and profit driven development viewpoints are shown on the top. Each of these viewpoints may generate new ides, carry out constructive prototyping and realize experimentation. The resulting scenarios, service ideas, use cases, prototype realizations as well as rationales of design decisions and analyzed experimentation results are all inputted to the innovation prototyping pool that is shown in the centre. The bottom of the figure shows the control viewpoints of privacy, consistency and security viewpoints. These viewpoints rarely initiate development processes by novel ideas. However, it is crucial that all these viewpoints are taken into account as early as possible. The empty boxes at the top and bottom of the figure demonstrate other viewpoints that will be included to the development process in time and according to specific design cases. [1, 4, 5, 7, 8, 9]

The crucial characteristics of brokering-based balancing can be summarized again as:

- The balancing of viewpoints must avoiding synchronization cores. The different viewpoints proceed concurrently in contrast to being stages of a join conventional process.
- The brokering of viewpoints must allow pull-based iteration. The processes of the viewpoints are not bound to each other by pre-defined checkpoints that would join the threads. Rather each viewpoint proceeds in own speed and check at vantage points what kind of inspiration and usable solutions have become available.
- The viewpoints benefit of autonomy. Each viewpoint has its own long-term objectives that ensure the methodology and platform development and knowledge acquisition. Thus the individual ideas, services and realizations are regarded as intermediate results and the

ultimate deliverables are the generally applicable practices, patterns and strategic research.

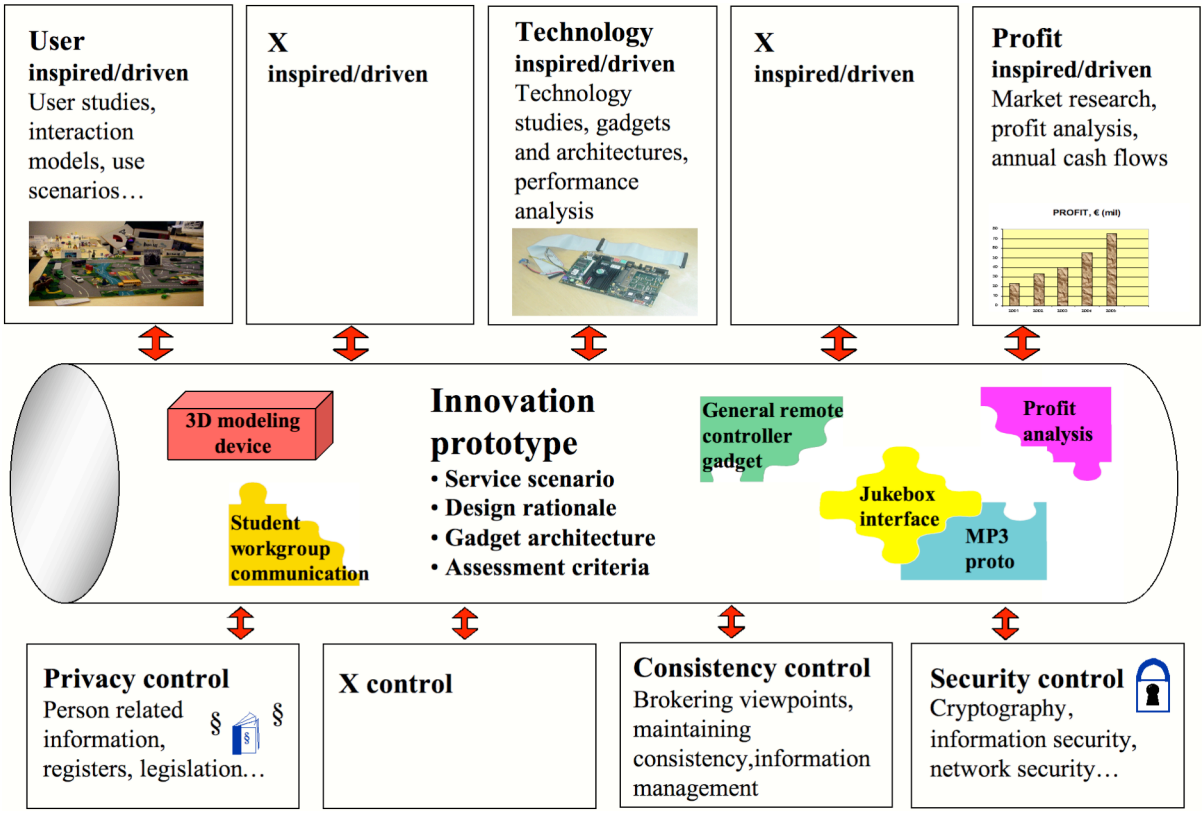

Figure 2. Balanced brokering-based viewpoint integration

Conclusions

Our experience on mobile and ubicomp idea generation and development has proven the necessity of involving different expertise [1, 4, 5, 7, 8, 9]. The variety of required expertise is so wide and deep that it is not possible for an individual to master all fields of expertise and act as an advocate of all necessary viewpoints. Thus, we claim that multidisciplinary is a feature of a team, not of an individual.

Various experts and even non-experts understand colloquial language. However, it still solves only a part of the problem and the price is vagueness of the communication. For precise analysis and communication the experts must be able to use the exact concepts of their discipline. Unfortunately it is not possible to find direct mappings between ontology definitions of viewpoints, since the relationships of the concepts are complex. Thus, the experts need brokering in order to be able to comprehend the languages of experts of other disciplines.

If the communication is based on the concepts and ontology of one chosen viewpoint, it is given too much dominance over the other viewpoints, which may lead to unnecessary and harmful compromises. Using the small set of concepts that might form a common ontology for all the viewpoints easily makes the discussion very limited and sets obstacles for rich communication. Thus, there is a need to allow any expert group to fully utilize their own familiar language and relate its concepts to the professional languages that are used by experts of other fields of expertise.

Innovation prototyping offers methods for pre-product development that provides the background and rationale that allows speeding up and increasing the efficiency of the actual service or product development. Thus innovation prototyping has its focus in the future and is more oriented to the understanding of the problems and challenges that can be predicted than on today's realizations and solutions. Thus, we claim that autonomy of viewpoints is necessary to give proper value to long-term objectives.

Future work

The brokering-based balancing of viewpoints enables coping with complexity without forcing the experts to compromise their expertise. Thus, we claim that the approach, methods and initial versions of tools are worth further development.

A promising approach is a combination of colloquial language and brokering based interpretation of the disciplinary concepts. For example, an idea of a mobile service may be expressed with a scenario that is written in colloquial language. Then each expert generates scenarios and complementary use cases on the issues relevant for own discipline and writes with own familiar professional language. The meanings of the use cases and their concepts are brokered to avoid misunderstandings that easily result from intuitive interpretations. Brokering is based on clarifying the relationships and differences of used concepts, i.e., applied ontologies. [1, 2, 3]

Information management is the foundation of innovation prototyping. It also is a crucial precondition for brokering-based balancing of viewpoints, since it offers approaches, methods and tools for sharing information, recording the trace of design information, as well as for structuring and modeling development related information. In addition to the scenario and use case modeling we are developing tools for capturing design rational and tools for structuring user data [1, 5, 7].

The ongoing work that is described in this paper is continued to further enhance the approaches, and to develop tailored methods for the development of mobile and ubicomp services. According to the experience and experiments we keep refining existing and implementing new types information management tool.

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