

# Challenges in designing viable business models for context-aware mobile services

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## Abstract

Emerging technologies offer, in principle, huge opportunities for developing innovative context aware services. However, successful innovations demand innovative business models as much as innovative technology. The objective of this paper is to give an overview of the key challenges in designing viable business models for context-aware mobile services, based on a series of expert interviews in three European countries. Our findings show that the key challenges are (1) the definition of a compelling context-aware proposition for particular consumer segments, taking care of privacy issues and creating trust in the service, (2) the integration of emerging technology platforms, (3) the combination of multiple revenue models, and (4) the division of roles in a complex value network, including new business roles.

## Keywords

Mobile services, context awareness, business models, expert interviews

## INTRODUCTION

The strategic goal of the MobiLife Integrated Project, part of the Wireless World Initiative (WWI) in IST-FP6 (MobiLife, 2006), is to bring advances in mobile (context-aware) applications and services within the reach of users in their everyday life. The emergence of new technologies and evolving capabilities of 3G as well as B3G systems enable, in principle, the collection of information from sensors, systems, or (mobile) devices in order to compose the context of entities like users, places, or objects. The context obtained in this way can be used to automatically adapt the behaviour of services, which results in so-called context-aware services (Hegering, 2004).

However, successful innovations demand innovative business models as much as innovative technology (Chesbrough, 2003; Kijl et al., 2005). Despite all technological possibilities, the amount of successful (context-aware) mobile Internet services in the marketplace is still limited (Carlsson, 2006). For profitably exploiting context-aware mobile services in a dynamic and converging mobile marketplace, sustainable business models are needed which will include new business roles and may follow novel earnings logic (Li and Whalley, 2002; Ballon, 2004).

The applications considered within the MobiLife project typically combine multiple forms of context (physical, social and group awareness as well as personalization) into nontrivial mobile context aware services. Literature provides several explanations for the slow uptake of nontrivial context-aware services, including a lack of applications with sufficient added value (Ojala et al., 2003), users' unwillingness to pay for mobile services (KPMG, 2006), a mismatch between launched applications and the everyday needs of target users (Carlsson 2006, Steinfeld 2004), legal aspects related to privacy (Pitkanen, 2003) and ineffective business models in general (Carlsson 2006, Steinfeld 2004). Hegering et al. (2004) state that a nontrivial context-aware service can only be realized in an interorganizational manner. They advance several management challenges that are specifically hard when provisioning context-aware services, such as configuration of the context value chain, fault management, accounting, performance (quality of context) and security.

The objective of this paper is to give an overview of key challenges in designing viable business models for context-aware mobile services. We structure these challenges using a component based business model framework for designing mobile services' business models that was developed within the MobiLife Project. The overview is based on a survey involving a series of 18 semi-structured expert interviews with academics, industry representatives and practitioners from three leading European countries with respect to mobile service provisioning (Finland, Italy and the Netherlands). In order to concretize our research results, we present a business model for an illustrative case example from the MobiLife project.

The paper is organized as follows. First we elaborate on context-aware services and on the business model concept. Following this we present our research approach and consequently our main results. The paper ends with conclusions and a discussion of the research results.

## **CONTEXT-AWARE SERVICES**

A service is called context-aware if in its operation it uses context information other than explicit application logic related input (Abowd et al., 1998). The most well known form of context awareness is location awareness, which is used to adapt services to the current location of the user. Giaglis et al. (2003) provide a taxonomy of location based services including emergency services (e.g. automotive assistance), navigation services (e.g. personal navigation), information services (e.g. mobile yellow pages), marketing services (e.g. mobile advertising), tracking services (e.g. vehicle tracking) and even billing services (e.g. location-sensitive billing).

More subtle forms of context awareness include social awareness and group awareness. Relevant social context information may include a person's status (e.g. free, busy, available) that may be used by a service to recommend a means of communication (Ter Hofte, Mulder, Verwijs, 2006). Context aware services for groups typically take into account the context of the group members and the group context like proximity when adapting the behaviour of the (group) service. Sharing of social context information has the potential of supporting (dynamic) groups of people within social networks to more efficiently and effectively perform their activities (Ter Hofte, Mulder, Verwijs, 2006).

## **BUSINESS MODELS**

A business model can be defined as a description of how a network of organizations co-operates in creating and capturing value from technological innovation (cf. Chesbrough & Rosenbloom, 2002). The business model concept was one of the great buzzwords during the Internet boom. A company didn't need a strategy, a special competence, or even any customer - all it needed was a web-based model that promised wild profits in some distant, ill-defined future. The business model concept fell out of fashion nearly as quickly as the dot-com hype itself (Hawkins, 2003).

However, a viable business model was, is, and will be essential to every product or service. Over the years, the business model research field has developed from defining business models via exploring business model components and classifying business models into categories, to developing descriptive models of business models (for an overview see (Pateli and Giaglis, 2004)).

The majority of researchers focus on the actors, relationships, and value objects exchanged (see e.g. Weill and Vitale, 2001; Tapscott, Lowi and Ticoll, 2000). Less attention has been paid to cross-company collaboration in complex value networks. Especially in the context of (context aware) mobile service provisioning, cross-company collaboration in complex multi-actor value networks is often essential (Maitland, 2005).

In the MobiLife project, we used a component based business model approach by making use of the business model framework as depicted in Figure 1 (Killström et al., 2006). The framework consists of several components, which are essential elements for describing the value creation process behind a specific product or service as offered by one or more organizations in a value network. A short description of these interrelated components is given below:

- **Customers/End users:** every product or service should appeal to and deliver value to a specified group or segment of customers or end users
- **Products/Offering:** a description of all relevant value proposition elements
- **Earnings Logic:** a description of how revenues are being created and how these revenues as well as costs are shared within the value network
- **Resources:** a description of the needed resources, tangible (e.g. people, equipment, technologies and cash) as well as less or intangible resources

(product designs, information, brands and relationships with suppliers, distributors and customers)

- **Suppliers/Actors:** different organizations are needed for the development, implementation and exploitation of new mobile services (e.g. telecom operators, hardware manufacturers, mobile service providers, etc.). In this component, we describe these actors and the co-operation between them.
- **Organization:** a description of the organizational arrangements needed for co-operation within mobile service value networks (think of service level agreements, confidentiality agreements, etc.)
- **Processes:** a description of primary business processes needed for offering a specific service (e.g. payment processes, customer service processes, etc.)

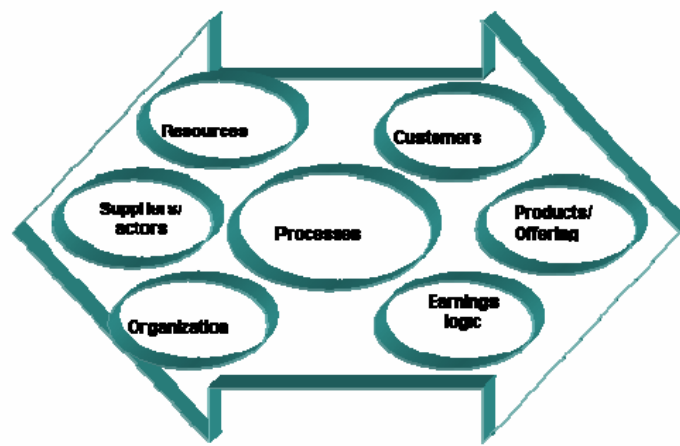


Figure 1 Business model framework

### **Business models for context-aware mobile services**

Some context-aware mobile services have been successfully introduced to the marketplace. A popular example in this context is OnStar, an in-vehicle safety and security system offered by General Motors to the owners of select GM vehicles (OnStar, 2006). OnStar started in 1995 and currently the system is provided as an exclusively factory-installed option. Owners of the vehicle have the choice to subscribe to the OnStar service. The service provides for example emergency assistance based on the vehicle's location. However, the main incentive to offer the service appears to be to differentiate GM vehicles from competitors, rather than being a separate viable business in itself. OnStar Europe's primary focus is GM brand image, not profit (Hamprecht, 2004). This example shows that design choices and challenges in the different business model components are closely related. In the OnStar case the earnings logic, the definition of the exclusive service offering and the target segment are closely related.

Often the challenges in creating viable business models cannot be considered in isolation (Haaker, Faber and Bouwman, 2006). For example the combination of little added value combined with traditional pricing may hamper adoption. It is interesting to note that mobile services may not only provide customer value to end-users or consumers, but may also provide advertisers or other type of business

customers with a valuable platform to reach their customers. In particular contextual advertising, i.e. advertising based on users context and profiles appears as a promising additional revenue source (Immonen et al., 2006).

## RESEARCH APPROACH

We used the results of a series of expert interviews that were performed within the MobiLife project to get an overview of critical business model challenges for context-aware services. One part of the interviews focused on new perspectives for business models for context-aware mobile applications and services. In particular challenges were discussed related to personalization, group awareness, context awareness, trust and privacy, and multimodality. Another part addressed critical points in designing business models for future mobile services, e.g. (new) business roles and actors, and (new) revenue sources.

Interviews were conducted as semi-structured conversations, i.e. a list of questions were used as a common track across all the work but some freedom was allowed in order to get out the most interesting results from each specific meeting, according to the expert profile. Interviews were tape-recorded and transcribed. The answers to each question were collected and consequently categorized. Categorization was based on the kind of issues that were discussed under that particular question. The relative importance of each issue was derived from the number of interviews the issue was discussed in. In the final list of discussed issues the more important issues were bolded.

To assure a variety of expertise in our panel, we selected the interviewees based on two dimensions. The first dimension was their occupational background, we held interviews with business people and entrepreneurs (9 interviews total) and with academics and scholars (9 interviews total). The second dimension was geographical, i.e. we interviewed experts from three different areas in the EU, i.e. Finland, The Netherlands and Italy. The exact division is shown in Table 1.

**Table 1:** Overview of the number of interviewed experts in each country

	Finland	Italy	The Netherlands
Industry / entrepreneur	6	2	1
Academic / scholar	6	1	2

The results presented here represent all the relevant business model challenges that appeared in the interview results. These challenges have been derived from the categorized list of discussed issues and the collected lists of answers to the interview questions. We assigned each challenge to one or more of the business model components to gain insight in the most relevant challenges in each business model component. The interview questions dealt with general expectations about hurdles and opportunities for mobile services and business models, as well as with opinions regarding specific challenges for context-aware mobile services.

## RESULTS

The interview results are collected in the Table in the appendix. Below the most important challenges are discussed within each business model component. The challenges in the supplier/actors, organization and processes components have been taken together.

### **Customers / end-users component**

As one of the experts notes, one of the obvious questions regarding the user component is defining the customer and his or her needs. Several experts point out the importance of segmenting the user base, by differentiating youngsters from professional communities for example. A special issue for segmentation is the cognitive ability to deal with advanced services, especially considering elderly or disabled users. But cultural background is also important, as for example Japanese users are largely interested in entertainment and gaming services and want to have picture based information, while European and US customers prefer text-based content and business services.

The added value of personalization and context awareness for the end user has to be evaluated. Potentially, the complexity of services will become easier to manage because of personalization, and usage will become more comfortable. On the other hand, one of our experts fears that group awareness and context awareness will further 'fuel the information overload.' Another expert argues that there are limits to personalization, as users will still want to receive broadcast information, fearing 'to miss something if all the content is personalized.' As context-aware services will have to compete for the users' time and money, ease of use is a necessary condition for context aware services.

Ease of use is a variable relevant in the trade-off with privacy. Most of our experts find privacy and trust an important issue with context awareness, and a considerable part even claims it is the most prominent one. Legislation, efficient sanctions and common rules will be important, as well as putting the user in control of defining their privacy levels. The experts point out that users have a certain extend to which they allow others to know about their context, and that this 'limit is different in different cultures, contexts [and] situations.' Others warn against overestimating privacy constraints and the creation of excesses, underlining that privacy measures should be no stricter than 'good enough.' Furthermore, privacy may be given up partly in case certain user benefits are involved.

### *Conclusions*

Segmentation is important in defining the user component of context aware services, especially regarding the ability to use advanced services and cultural background of the user. The added value of context awareness and personalization in making it easier to use mobile services is debated by the experts. Although the importance of privacy is not disputed, measures have to be designed such not to hinder ease of use.

### **Services / products component**

The 'products and services component' in the business model defines the intended customer value of the service provided.

It is important to determine what to do and what not to do in this component. For example, replicating the service in other geographical areas or focusing on pure technological innovation might be a waste of money.

Context awareness is considered an interesting technology, but uncertainty about the added-value for customers repeatedly raised the question “what is its real business potential”? It is important to “do better than Internet-based services, which offer already plenty of information about everything.” Also, “despite the fact that group awareness is a long debated and researched theme in the industry, there is still a lack of convincing services on the market.” Still, according to one expert, “in [the] context aware services area developments are underestimated from a long-term perspective and overestimated from a short-term perspective.”

Next to the challenge of service value creation the experts consider the creation of trust the most important challenge. One expert considers the “Internet too dangerous and therefore not suitable for the mobile phone”. One other critical issue mentioned is how to find customer groups with common denominators large enough for profitable exploitation. A suggested approach is that a service provider makes two versions of a service to serve multiple segments. Another critical design issue mentioned by the experts is related to trust and privacy: “trusted players are needed [for context-aware services], to whom you are willing to give your information.”

The experts pointed out that knowledge about customers and their preferences is, as always, crucial. The degree of personalization determines to what extent the service environment can be made “more simple and manageable for the user”. This is related to the actual design and implementation of digital applications for interactive media and music, mobile information services as well as broadcasting services designed for mobile devices. As one of the interviewees expressed it: “Personalization is important, it is one of the topics that differentiates the mobile environment from the [‘fixed’] Internet world. Locality combined with personalization”. From a value perspective, “personalization potentially gives the consumer the idea that he still has full freedom of choice [and] can do all he wants.” However, from business processes point of view, “somebody has already made some choices for the end user in advance.”

### *Conclusion*

According to the experts, the definition of an appealing value proposition for mobile context-aware services is the most difficult challenge. This is exemplified by the current lack of convincing context-aware services on the market. Another important challenge is seen in creating trust, related to the providing personal information. Personalisation is seen as an important value element in making services more easy to use, and as a differentiator with the Internet-world in combination with locality. Knowledge about customers, needed for personalisation, is therefore also regarded as important.

### **Earnings logic component**

The experts view the earnings logic for future mobile data services as a serious challenge. As one expert said: where is the money? Several experts argue that users are often not willing to pay for mobile (context-aware) services. One of the

reasons mentioned is that users are used to free Internet services and therefore also expect mobile services to be free. Mobile services' revenues (ARPU) are under further threat of price erosion, which is driven by a more open business environment.

One expert also argued that people are not ready to pay for context-aware services, as these provide just 'nice to know' information. Still, another claims that "mobility offers so much added value that it is possible to create services that people are willing to pay a premium for."

Most experts regard mobile advertising as a significant revenue source for mobile services. Especially if advertising can be made "more focused, personalized and contextualized" (cf. Immonen et al., 2006). Other experts also consider revenues from content consumption important, either subscription or transaction based. Our experts suggest that multiple revenue models will coexist, i.e. subscription models, transaction based models and advertising based models.

Regarding the division of revenues in the value network, one expert wonders who will actually profit from mobile data services. He suggests that "content providers and device manufacturers make a good chance."

### *Conclusion*

The experts view the earnings logic for context-aware mobile services as a serious challenge. Reasons vary from being used to free Internet services to uncertainty about the perceived added value of these services. Different revenue models are expected to co-exist, i.e. subscription, transaction and advertising based models.

### **Resources component**

When asked about challenges related to resources needed for offering context aware services, the experts paid a lot of attention to technological issues. In addition, they also regarded high quality content development as a critical resource.

With a plethora of emerging technologies, most experts saw huge opportunities for developing innovative context aware services. Personalization technologies like presence awareness and multi modality technology for example were seen as important technological enablers for context aware services.

However, most experts expected the provisioning of context aware services to be a very complex undertaking from a technology point of view. For provisioning such services, many advanced technology platforms are needed that all need to be tightly integrated as well. Think of identity, personalization, intellectual property right, payment, and trust management systems as well as intelligent rule engines.

In order to be able to integrate all these technologies, standardization processes and the usage of open interfaces are seen as essential by a great majority of the interviewees for effective and fast development of context aware services.

Besides, some experts mentioned that we also still need better terminal screens as well as more powerful energy sources for end user terminals in order to be able to offer real compelling and useful context aware services.

An important question in this context is where to put all the intelligence needed for the personalization of mobile services: in the network or is the end user terminal more appropriate? The experts had different opinions. Some of them saw centralized personalisation as a mega trend in the telecommunication world, whereas others expected that most of the personalisation would be done on the end user terminal because of usability, response time and privacy reasons.

#### *Conclusion*

Experts considered technological resources like personalization technologies, presence awareness and multimodality as important enablers for context aware services. Also high quality content development was considered a critical resource. A challenge was seen in the integration of many advanced technology platforms, making standardization processes and the usage of open interfaces essential. Regarding where to put the intelligence for personalisation opinions differed, i.e. centralized personalisation versus personalisation on the end user terminal.

#### **Supplier/actors, organization and processes components**

With the advent of context aware mobile services, most interviewees expect mobile services value networks to become increasingly complex with more as well as new value network actors like micro payment providers, aggregators and privacy and trust providers. With all these players cooperating in increasingly complex networks, the development of proper Service Level Agreements between parties in the network was regarded as increasingly important from an organizational point of view.

The interviewees could not clearly predict the role of value network actors like telecom operators or IT companies in the emerging context aware mobile services value networks. However, it was clear that, in the end, every actor should find its own niche in order to be able to deliver as well as capture value. Incumbents may extend their operations to cover new roles (think of telecom operators who start offering micro payment services for new mobile services providers) but there will also be plenty of opportunities for start-ups.

Some experts mentioned that powerful incumbents like telecom operators might try to slow down technological developments that may lower their profitability. Some interviewees stressed in this context the need for better regulation to stimulate the innovation and adoption processes of real innovative context aware services in open market environments. Most interviewees didn't expect the real innovations to come from telecom operators. However, because operators by nature already possess valuable context information of their customers (e.g. location information) they could also become important context information providers (despite the fact that also a lot of context aware information could be handled locally on the end user terminal). Because telecom operators also already have a billing relation with most of the users of future context-aware services, they are expected to become powerful players within the emerging context-aware services value networks.

#### *Conclusion*

Most interviewees expect mobile services' value networks to become increasingly complex with more as well as new value network actors. This makes proper Service Level Agreements between actors increasingly important. The experts were uncertain about which actors will take which of the (new) roles in the value network. Most interviewees didn't expect innovation to come from telecom operators. The experts see a need for better regulation to stimulate the innovation and adoption processes of real innovative context aware services in open market environments.

## **MOBILIFE CASE EXAMPLE: THE CONTEXT WATCHER**

We shift in this section our focus towards an illustrative Mobilife example, i.e. the Context Watcher. The aim is to discuss and illustrate some of the obtained key challenges in the context of this concrete case.

### **Application description**

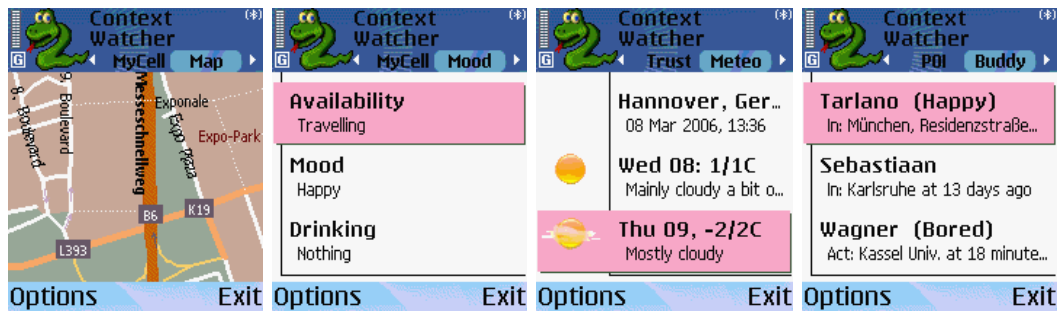
The Context Watcher is a mobile application based on both high and low-level context-awareness technology frameworks built in the MobiLife project. The Context Watcher has been developed in Python (a programming language) and runs on Nokia Series 60 mobile phones.

From end-user point of view, its aim is to enable users to automatically record, store, share and use context information in a way that makes their lives easier. To offer some practical examples: weather services can work automatically when location context is already known, users can unobtrusively check the whereabouts and well being of their friends or context tags can enable them to find photos of a specific situation quickly and effectively.

From the researcher or professional point of view, the Context Watcher also allows to gather real-life context data from a large user group (which can be used to develop and test reasoning algorithms and other related activities) and to create awareness in a large audience about the possibilities of context-aware computing in everyday life.

More in detail, the Context Watcher is able to record information about the users':

- location (based on GSM cell and optionally on GPS information);
- mood and other subjective pieces of context information (based on user input, e.g. availability or perception of safety);
- activities, meetings, and daily patterns (based on clustering and information fusion);
- body data (based on heart and foot sensors);
- weather (based on information from location-inferred remote weather context providers);
- visual data (pictures tagged with contextual data).



**Figure 1:** Examples of Context Watcher context information

This is possible due to the integrated usage of local and remote sources of information in a modular and distributed architecture. Local sources might be automatic (such as sensors) or manual (like a users' explicit input), while the remote ones range from systems that derive the postal address or the geographical location out of raw location data to public Web-based services like Flickr (for photo sharing) or Google Earth (for positioning on a global map).

As reported in (Koolwaaij et al., 2006), based on the configuration actually used, the application automatically connects to the local sensors available, e.g. via Bluetooth, and to the remote "context providers" over the 3G network. All gathered context information can be used 1) to adapt the behaviour of application running on the mobile phone (e.g., prioritizing the favourite applications depending on location cluster), 2) to serve as input for information services (maps, points of interest) and 3) to tag multimedia content recorded with the mobile device.

### **Business model challenges**

Going back to the challenges presented in the paper, we will now try to map some crucial issues onto the case at hand. However, we have to bear in mind that the Context Watcher design and development has not been driven by an already defined business case, but by the opportunity to investigate the underlying enabling technologies. Still, the development may also be viewed as being typical of 'web 2.0' (web as a platform), i.e. first trying to create something that appeals to users, than try to create scale and subsequently generate business interest.

We will begin this analysis from a technology perspective, as it has been deemed as one of the most critical resources aspects. It should be clear from the latter description of possible usages of context information that context-aware applications like Context Watcher can act as powerful enablers, or, in other words, as technology solutions that might be embedded into mobile phones or other mobile terminals to make other applications and services work.

As such, a context aware system like Context Watcher should not only be seen as a technological basis for directly offering a specific consumer service (with a revenue model based on e.g. monthly end user subscription fees), but may as well be marketed as a technology platform that enables mobile service developers and providers to efficiently develop innovative new context aware services (e.g. with a revenue model based on licensing).

With these alternative propositions, different organizational challenges emerge. When marketing Context Watcher as an open technology platform, having good connections with standardization parties, hardware manufacturers, telecom operators and mobile service developers is essential in order to become a central party in the value network of context aware services development. When, on the other hand, the Context Watcher technology is being used as a basis for developing and marketing a specific context aware ‘killer application’ aimed at consumers, one may have completely different goals like creating lock in effects, fastly building a huge customer base, using Context Watcher as proprietary technology to make life harder for potential competitors, etc.

From a product and service angle, it is no wonder that the experts interviewed talked about the uncertain business potential of context-aware applications. One has to look at them not only as autonomous products and services but also – or primarily – as a foundation or an enabler of other applications, including perhaps the most common ones like calendars, communication tools and media sharing services. The more than 100 regular Context Watcher users have been provided with a solution that extends their Flickr-based photo sharing with automatic tagging based on context data; furthermore, this fuelled also a sort of social experience as all of the Context Watcher users populated Flickr with similarly contextual-tagged pictures.

On the other hand, the success of similar distributed systems can not be taken for granted, given its dependence on complex and sometimes slow standardization processes, or at least the availability of open interfaces (an aspect well noted among our resource-related challenges). Flickr and Google Earth Web extensions of the Context Watcher work exactly because of these open interfaces, provided by the respective commercial entities, likely on the assumption that even third party independent development will bring some benefit also to them at the end, at least in terms of usage and visibility.

In this respect, we have to remind also an interviewee’s remark about the operators’ legacy of a closed model as an important barrier. The Context Watcher is in stark contrast with such a closed model: in a way, it could actually be seen as a typical case of a completely “off-portal” strategy and mechanism, referring to the mobile integrated offer of content, games and information services usually promoted on mobile operators’ portals. The application can be freely downloaded over the Internet, and a large number of terminals can run it. Not surprisingly, this completely “unbundled” offer is another barrier for the Context Watcher’s wide adoption though. Users have to find a suitable commercial offer for data costs on their own, which is something not always easily available, or not all around Europe – not to mention that when travelling users have to pay roaming charges, with prices that can go up to 10 euros for a megabyte. Flat rate subscriptions models are essential here, as they are actually provided by some operators – even if they are usually valid in the home country limits.

For sure, users’ time and money is limited, as one interviewee remarked that context-aware services will have to face fierce competition to gain their place in the market. Other reported risks and challenges like information overload,

configuration difficulties and privacy concerns appear relevant for the Context Watcher as for context-awareness applications in general. Once launched to the general public, outside the environment of researchers and professionals, it would be quite easy to find out that for some people even installing an application on their phone is too difficult, or that the overall idea of sharing information with some of their contacts is not welcome. Yet some or most of these setbacks might fade away in the face of the actual application usage, as shown also by the users' trial performed during the last phase of MobiLife. Some of the social facets of the application have been especially appreciated there, like the enhanced communication with your buddies and media sharing. Worries about privacy, and resistance to sharing, should not be considered as definitive hurdles. Even if some of the interviewees point to the fears that for example privacy concerns may generate. As one researcher working on the development of the Context Watcher put it: "we try to move people 'from privacy scares to context shares'. People involved in the trial said that in the end they were sharing much more context information than they had expected beforehand, just because it's fun".

"[These] developments are underestimated from a long-term perspective, overestimated from a short-term perspective", said one interviewed expert; for all the possible current difficulties to make the Context Watcher a viable business in the short term, similar statements sustain the expectations of promising outcomes and call for a dedicated work on the specific business modelling challenges of this initiative.

## **DISCUSSION AND CONCLUSIONS**

The interviewed experts mentioned many challenges in designing business models for context-aware mobile services. Probably the most difficult challenge in the user/customer and the service/product business model components is found in the uncertainty about the added value of context awareness and personalization for specific user segments. This makes it very hard to define valuable context-aware propositions, which is critical to any viable business model. Although the importance of privacy is not disputed, measures have to be designed as not to hinder ease of use. Another important challenge is seen in creating trust, e.g. related to providing personal information.

In the earnings logic component, users' willingness to pay is considered limited. Advertising is considered a significant (new) revenue source. Some experts advocate the use of multiple revenue models simultaneously, i.e. the subscription model, the transaction model and the advertising based model.

Regarding the resources component, the main challenge is that although technology will drive context aware services, advances in technology are still needed to enable these services. Also challenging are the integration of different technology platforms, the use of open standards and where to locate the intelligence for personalization (centralized personalization versus terminal based personalization).

The supplier/actors component will face increasingly complex value networks, and proper Service Level Agreements will gain importance. The role of telecom

operators is unclear; especially their innovative power is questioned by the experts. Still, operators will play an important role as they have access to valuable context information as well have customer billing relations.

Challenges for context-aware business models have been assigned to the business model components. Still, many challenges span more than one component, or exert an important influence over other components. This could already be seen in the user/customer and product/service component, where value propositions (service component) have to address the needs of specific user segments (user component). Introduction of an advertising based revenue model has consequences for the value network, as it extends the network with advertisers.

Some interesting cultural differences can be seen with regard to the privacy challenge. The Finish experts place a much stronger emphasis on privacy issues there than their Italian counterparts.

The challenges that we found in the expert interviews are in agreement with what we found in the literature (as described in the introduction). Still, our analysis shows that some challenges are considered more important than others. Also the impact of the challenges on the business model can be better understood from assigning them to one or more business model components.

The business models considered here are geared towards the provisioning of context-aware services to customers as independent services. Other benefits for providers, other than direct profit, may come from reduced churn or from increased sales of other products with which the service is bundled as a differentiating add-on.

As in any expert study, the results presented in this paper should be interpreted with care as they are based on the subjective perceptions of our respondents. This is especially the case here as we interviewed only a limited number of interviewees. In addition, they were based in three countries only, although Finland, Holland and Italy might be conceived indeed as rather differing countries. There is also a bias towards Finnish respondents in our sample.

The reliability of our results could be improved by making distinctions between the backgrounds of the interviewees. Furthermore, with a larger number of respondents we could attempt to make correlations between the opinions of the experts on the various challenges, e.g., using factor analysis.

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**Appendix 1:** Business model challenges for context aware services obtained from the interviews; findings are categorized by type of interviewer. The issues regarded more important are bolded.

User/customer	Product/service	Earnings logic	Resources	Roles / Actors / Organization
<p><b>Finland; practitioner</b></p> <ul style="list-style-type: none"> <li>• Changing role of customers, are they ready for that [i.e. active involvement in content creation, providing information]?</li> <li>• User should be in control.</li> <li>• Personalization makes the use more comfortable and thus encourages consumers to use services.</li> <li>• Regulation, privacy gives the boundaries.</li> <li>• People have a threshold to give out a lot of information for personalization to some indefinite place. People rather personalize devices/terminals that are in one's own control.</li> <li>• We can give a lot of things to somebody to take care of. But somewhere there is a limit. And the limit is different in different cultures, contexts, situations.</li> <li>• People do not have patience to input their information or choose from menus – the process is too heavy. That's why I believe in automatic personalization.</li> <li>• Users are not going to recognize the group dimension as a novelty in itself.</li> <li>• Group-aware and context-aware communication may fuel the information overload.</li> <li>• Context awareness functionality is not only interesting for the consumer market but also in a business context.</li> </ul>	<p><b>Finland; practitioner</b></p> <ul style="list-style-type: none"> <li>• Internet is too dangerous – in spite of different firewalls, not suitable for the mobile phone.</li> <li>• Personalization is essential in mobile services with small displays, needed in all mobile services</li> <li>• Consumer gets a picture that he has full freedom of choice – can do whatever he wants. But still somebody has made the choice for you: here you have fish and meat options, which one do you take.</li> <li>• Make two versions of the service rather than try to take everything into account.</li> <li>• Personalization has to be scalable.</li> <li>• The real value lies in the application, not in the technology itself.</li> <li>• Context awareness may be seen as an enabling technology for new forms of marketing.</li> </ul>	<p><b>Finland; practitioner</b></p> <ul style="list-style-type: none"> <li>• <b>Advertisement significant revenue source</b></li> <li>• <b>Users expect free mobile services (users are used to free internet services)</b></li> <li>• We will see more focused and personalized advertising forms (“Changing use of advertising: possibility to better targeting, paying for customers if they listen/watch advertisements”)</li> <li>• Advanced technology for automatic personalization. The management - who will pay for it?</li> <li>• Price erosion driven by a more open business environment.</li> <li>• Where is the money?</li> </ul> <p><b>Finland; academic</b></p> <ul style="list-style-type: none"> <li>• <b>Advertisement significant revenue source</b></li> </ul>	<p><b>Finland; practitioner</b></p> <ul style="list-style-type: none"> <li>• Personalization is not a problem from technology point of view.</li> <li>• [Multimodality] usually these topics are too difficult.</li> <li>• <b>Technological constraints: still a lot of implementation issues, e.g. identity and trust management.</b></li> </ul> <p><b>Finland; academic</b></p> <ul style="list-style-type: none"> <li>• Very complicated technical provisioning chain.</li> <li>• Main part of personalization will be done in terminal / device.</li> <li>• The usability, “response time”, management and trust can be more easy and trustworthy solved by personalized terminal.</li> <li>• Centralized personalization will be a stronger phenomenon. It's a megatrend.</li> <li>• Who is doing it and</li> </ul>	<p><b>Finland; practitioner</b></p> <ul style="list-style-type: none"> <li>• Japan and China, centralized power to operators</li> <li>• Global players are strong</li> <li>• There is a risk that the operators can not bundle the new services</li> <li>• Personalization provider: possible according to law?</li> <li>• Privacy and trust provider extremely crucial</li> <li>• Aggregator role: aggregate and coordinate things.</li> <li>• [Personalization as a specific business?] Could be. Maybe I believe more in the aggregation models of eBay and Amazon, where they are statistically profiling different categories. It is not commercial as such and has a strong personalization.</li> <li>• It is not clear who is going to build group-aware services and provide them.</li> <li>• Operators and MVNO might consider covering the role or provider of these group-awareness capabilities.</li> <li>• Operator can be seen as important context information providers (however, also a lot of</li> </ul>

<ul style="list-style-type: none"> <li>• <b>Trust and privacy the most essential theme.</b></li> <li>• Users not familiar with things related to trust and privacy, may create irrational fears and slow adoption.</li> <li>• Users' willingness to continuously adopt new services.</li> <li>• Users' time and money is limited and context services will have to cut their own slice of those.</li> </ul> <p><b>Finland; academic</b></p> <ul style="list-style-type: none"> <li>• Markets are very heterogeneous, have their own characteristics: <ul style="list-style-type: none"> <li>- In Japan users benefit entertainment/games,</li> <li>- In US the content</li> <li>- In Europe enterprises look for benefits</li> <li>- In India and China poor users</li> </ul> </li> <li>• Perspective in games, experiences, communities.</li> <li>• We don't buy if we don't know the service provider</li> <li>• Personalization used to manage the complexity. That could be motivated</li> <li>• The crowd (target) will be diverging to smaller groups than ever, communities will emerge, the personalization is needed to manage the complexity</li> <li>• Personalization is fun but if it requires some more effort, people are not able to do it.</li> <li>• Individuality is important, if that has any economic value is another question.</li> <li>• Is it then not irritating if I want to act differently next time and the machine keeps</li> </ul>	<p><b>Finland; academic</b></p> <ul style="list-style-type: none"> <li>• Music, broadcasting will be used through mobile phones.</li> <li>• Knowledge about customers.</li> <li>• Personalization is important, it is one of the topics that differentiate mobile environment from the Internet-world. Locality combined with personalization.</li> <li>• Personalization is competitive advantage but service/application specific, or added value to terminal.</li> <li>• Personalization would need to be domain specific.</li> <li>• Develop group-aware products/services that take effective and distinctive advantage of context-awareness capabilities.</li> <li>• Context awareness is in itself a nice technology, but the question is what is the real business potential.</li> <li>• Earning trust: trusted players needed to whom you are willing to give your information</li> <li>• Trend of packaged</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Users expect free mobile services (users are used to free internet services)</b></li> <li>• Real need for better earnings logic in the value network.</li> <li>• Find a way to exploit the possibilities created by technologies like sensors, such as in the case of intelligent clothes.</li> </ul> <p><b>Italy; practitioner</b></p> <ul style="list-style-type: none"> <li>• Three alternatives: "The three models (subscription-based, transaction-based and advertising-based) are all relevant and will co-exist also in the future"</li> <li>• <b>Advertisement significant revenue source</b></li> </ul> <p><b>Italy; academic</b></p> <ul style="list-style-type: none"> <li>• The advertising role will be minimal. In the case of a bigger liberalization the subscription model will be the most important. In the other case content consumption may be more important; either</li> </ul>	<p>where? Decentralised system means specific servers, which include context and personalization related services.</p> <ul style="list-style-type: none"> <li>• Multimodality is important issues. As researcher we are a little bit lost with it.</li> <li>• Patent and DRM solutions should be in place to make these service work.</li> <li>• <b>Standardization and open interfaces are essential for effective and fast development.</b></li> <li>• Interesting content has to be available – provided that property rights issues are managed.</li> </ul> <p><b>Italy; practitioner</b></p> <ul style="list-style-type: none"> <li>• It is not a technology problem than one of accessibility.</li> <li>• Personalization technology is especially important in the perspective of the interaction between multiple devices.</li> </ul> <p><b>Italy; academic</b></p>	<p>context aware services could be handled locally on the terminal).</p> <ul style="list-style-type: none"> <li>• Threats are harder to control in open business environment.</li> <li>• Rules of the game how to act in the network must be in place and controlled.</li> <li>• The power of operators: if they don't like new technological developments they may hinder/slow them down.</li> </ul> <p><b>Finland; academic</b></p> <ul style="list-style-type: none"> <li>• Europe – concentration of businesses to a few players will continue</li> <li>• Managing the complexity of context-aware services</li> <li>• Small companies will take care of roles that the large ones are not interested in</li> <li>• Operators have a chance for providing trust and billing related service</li> <li>• Billing, money and trust are related. Two contradictory forces; mobile access and credit card company.</li> <li>• Portals will become common also in mobiles, who is going to provide it?</li> <li>• I don't believe anybody could run personalization as a business. Unless it would be completely global</li> <li>• New players to the value net,</li> </ul>
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<p>telling you are not part of this group.</p> <ul style="list-style-type: none"> <li>• Privacy issues involved. But if there are certain benefits consumers give up some privacy.</li> <li>• Users are not going to recognize the group dimension as a novelty in itself.</li> <li>• The customer base has to be carefully segmented as group information sharing will appeal mostly to well defined targets, such as the youngsters or specific professional communities.</li> <li>• It is a question about privacy - if you want to tell someone when you are free and when busy. People do not want to that anyone can get hold on you. These things are problematic in the future.</li> <li>• People trust authorities in Finland and there are huge registers about people.</li> <li>• <b>In mBusiness, privacy and trust are in the core.</b></li> <li>• Mechanisms should be easy so the user can understand.</li> <li>• Convenience vs threats.</li> <li>• In Western countries written text is preferred but e.g. in Japan pictures.</li> <li>• Special needs of e.g. elderly people (can't see small fonts etc).</li> <li>• <b>Users are not ready to adopt mobile services that are too difficult to use, especially if they are delivered via their mobile phones.</b></li> <li>• Sometimes people want to be idle, not always busy/moving/connected.</li> </ul> <p><b>Italy; practitioner</b></p> <ul style="list-style-type: none"> <li>• The customer base has to be carefully</li> </ul>	<p>offer.</p> <ul style="list-style-type: none"> <li>• PCs are full of problems, if all devices would be like game device, they are multimodal, and then I would accept only one device.</li> <li>• If the device includes everything it is a poor device (e.g. washing machine and oven merged).</li> <li>• Do better than Internet-based services, which offer already plenty of information about everything.</li> </ul> <p><b>Italy; practitioner</b></p> <ul style="list-style-type: none"> <li>• Market position is determined by what the company is good at: design and implement digital applications on interactive media characterized by a high degree of user personalization</li> <li>• Despite the fact that group-awareness is a long debated and researched theme in the industry, there is still a lack of convincing products/services on the market.</li> </ul> <p><b>Italy; academic</b></p> <ul style="list-style-type: none"> <li>• Personalization is</li> </ul>	<p>subscription based or transaction based</p> <p><b>Netherlands; practitioner</b></p> <ul style="list-style-type: none"> <li>• Without open innovation/business environments difficult for start-ups to develop profitable services</li> </ul> <p><b>Netherlands; academic</b></p> <ul style="list-style-type: none"> <li>• I don't know which player will really profit from mobile data services. Content providers and device manufacturers make a good chance</li> </ul>	<ul style="list-style-type: none"> <li>• <b>Standardization and open interfaces are essential for effective and fast development.</b></li> </ul> <p><b>Netherlands; practitioner</b></p> <ul style="list-style-type: none"> <li>• Better personal identification technology / solutions needed for offering context aware services.</li> <li>• We also 'simply' need better terminal screens and terminal power sources besides all high tech context aware technology.</li> </ul> <p><b>Netherlands; academic</b></p> <ul style="list-style-type: none"> <li>• Presence awareness may be very useful for supporting communication and context aware services. In order to offer such services, intelligent rule engines need to be developed.</li> <li>• Intelligent rules engines need to be developed to make an enabler like group-awareness work</li> </ul>	<p>new kinds of integrators.</p> <ul style="list-style-type: none"> <li>• Increasing amount of intermediaries, increases complexity.</li> <li>• Europe industry lagging behind as others (e.g. some Asian countries) are faster and more capable to lead here.</li> </ul> <p><b>Italy; practitioner</b></p> <ul style="list-style-type: none"> <li>• Billing is natural role for operator.</li> <li>• Operators' legacy of a closed model is an important barrier.</li> </ul> <p><b>Italy; academic</b></p> <ul style="list-style-type: none"> <li>• Current actors extend their operations to cover new roles</li> <li>• Liberalization might decrease the control over the value chain and helps in liberating new market forces.</li> </ul> <p><b>Netherlands; practitioner</b></p> <ul style="list-style-type: none"> <li>• Open business environments needed for innovation</li> </ul> <p><b>Netherlands; academic</b></p> <ul style="list-style-type: none"> <li>• New/changing roles will appear and who will fulfil them?</li> <li>• Every actor should find it's own niche and design of proper SLA's with other parties in the network</li> <li>• Opportunities for start-ups</li> <li>• Micropayment providers</li> </ul>
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<p>segmented as group information sharing will appeal mostly to well defined targets, such as the youngsters or specific professional communities.</p> <ul style="list-style-type: none"> <li>• Privacy dimension is important but may be overestimated.</li> <li>• Importance depends on specific usage, you could have excesses here.</li> <li>• Legislation and enforcement: efficient sanctions in place?</li> <li>• Authorities and politician should create common rules.</li> <li>• Of course we have the digital divide dimension: people with different abilities or special needs. In this case is important.</li> </ul> <p><b>Italy; academic</b></p> <ul style="list-style-type: none"> <li>• Not that crucial maybe. Principle should be 'the good enough'</li> </ul> <p><b>Netherlands; academic</b></p> <ul style="list-style-type: none"> <li>• P2P communications important.</li> </ul>	<p>definitely one of mobile strong distinctive features. But you don't have to stretch it at the maximum level.</p> <ul style="list-style-type: none"> <li>• It is very difficult to think about context-aware applications with business potential</li> </ul> <p><b>Netherlands; academic</b></p> <ul style="list-style-type: none"> <li>• No common solution that could be replicated, focus on pure technological innovation is waste of money.</li> </ul>			
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