Ubiquitous Commerce

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ABSTRACT
Ubiquitous computing offers many varied applications but will probably have its most significant impact on day-by-day living. "The most profound technologies are those that disappear," wrote Mark Weiser. "They weave themselves into the fabric of everyday life until they are indistinguishable from it." Over the past decade, researchers have sought to understand the ways ubiquitous technologies would affect different aspects of everyday activities including learning, entertainment, collaborative work and the home environment. But ultimately, new technologies will be used for conducting business. This workshop brings together researchers and practitioners interested in the uses as well as the implications of ubiquitous commerce.

Keywords
Ubiquitous computing, pervasive computing, electronic commerce, mobile commerce

WORKSHOP THEMES
The rapid proliferation of e-commerce technologies over the past decade has fundamentally transformed the way we conduct business. This trend is expected to accelerate in the coming years due to a number of different factors, including the introduction of new mobile and ubiquitous computing technologies; the wider recognition by business of the strategic advantages offered by the implementation of ubiquitous computing and communications infrastructures; the emergence of novel business models which become possible only through this technology; and last but not least the development of new economics that can be used to understand and value ubiquitous commerce activity. There are thus, several areas of contestation that must interact to produce the conditions for the successful implementation of ubiquitous commerce. Indeed, recent experience has shown that the concerns of these (traditionally distinct) areas are intimately interrelated and thus have to be co-developed in parallel. Moreover, researchers and practitioners from all fields need to be informed of the concerns and the priorities of each other so that they can include each others requirements in their models. We propose to hold this workshop to provide a forum for the expression of this collaborative ethic across disciplines.

To this end, we have identified both vertical and horizontal axes to describe the particular areas of interest that interact to shape ubiquitous commerces' future. At the horizontal axis we have:

- Technologies: Smart home, radio frequency identification, ubiquitous payments and value transfer, location and context awareness, agents.
- Legal: intellectual property protection, access to intellectual property, privacy protection, ownership of personal data.
- Social: effects on structures, emergent social practices, effects on roles within social organization units, identity and anonymity.
- Economics: pricing of ubiquitous services, valuation of goodwill and information goods, fair pricing for personal data and privacy.
- Business: ubiquitous business models, supply chain management and optimization, industrial design, process design, ubiquitous product development, customer relationship management.
- Experience design: appliances, architecture and building, ubiquitous commerce spaces.

At this vertical axis we have:

- Entertainment, infotainment, retailtainment and gaming.
- Tourism and experience recording.
- Ubiquitous assistance through valets and personal agents.
- Pervasive Retail.
- Remote shopping with smart home infrastructures.
- Health- and home-care.
- Industrial applications.
- Automotive telematics.

Ubiquitous commerce is intimately related to electronic and mobile commerce and it uses its infrastructures and developed expertise but it is characterized by two extra features: the electronic identification of physical products (consumer or otherwise) and the seamless provisioning of business and consumer services over ubiquitous computing infrastructures. Electronic tagging annotates physical artifacts with identification information, which can be used for tracking but also to associate particular characteristics or properties to the specific item. This facility provides for a rich information source that can be utilized either in supply chain applications or for enhancing the consumer experience (both applications are discussed in position papers in this workshop). Moreover, using ubiquitous computing infrastructures to deliver business services offers the opportunity for the development of novel customer-centric approaches that truly deliver the "anywhere, anytime" promise of electronic and mobile commerce (applications in customer relationship management and retailing are also discussed in position papers in this workshop).

WORKSHOP GOALS

Ubiquitous computing has been recognized as an inherently interdisciplinary research field, requiring the collaboration between several technical disciplines including but not restricted to computing, telecommunications, human computer interfaces and industrial design. In addition to these, ubiquitous commerce requires contributions from the product development, finance, business process management, standardization, law, consumer experience design and social science points of view, to produce useful results. However, researchers with the required expertise rarely have a common forum to exchange ideas and concerns and develop a research agenda and roadmap.

This workshop brings together researchers with diverse backgrounds to:

- Share understandings and experiences as well as recognize each other's concerns.
- Foster collaboration across research communities.
- Create effective channels of communication to transfer lessons learnt from one community to the other.
- Co-develop a roadmap for future research directions.

The workshop also aims to highlight the relevance of ubiquitous commerce to the already established electronic and mobile commerce research communities. In fact, ubiquitous commerce is seen as an evolutionary step towards a business environment where all activities are conducted electronically and where physical entities have an equivalent electronic counterpart.

WORKSHOP ACTIVITIES

This workshop brings together participants with technical, business and legal backgrounds as well as those with experience in consumer culture research and the social implications of changes brought about from new methods to conduct commerce. The workshop is organized around position statements and panel discussions so as to represent the multidisciplinary nature of the workshop.

Using experience gained via participation in several industrial ubiquitous commerce projects Elgar Fleisch and Christian Tellkamp develop a framework for the evaluation of ubiquitous commerce opportunities. Given the multiplicity of systems and solutions that may be developed on top of ubiquitous computing infrastructures a question which arises naturally is which ones would create value for the involved actors and how should they be structured to achieve that. Their solution is a set of challenges that must be met in order for a particular application to be appropriate for conducting business.

Matthias Lampe and Martin Strassner identify a limitation in existing corporate information systems, namely their lack of appropriate management of moveable assets. Indeed, they find that assets are not managed on a per item basis and information about location, situation and usage is either not accurate or lacking detail. The effect of this issue is that industrial operations may be delayed, inventories are used ineffectively or have to be maintained at much higher levels than necessary, which is particularly costly with higher value assets. They show how the use of RFID asset tagging can help eliminate many manual tasks, for example searching for assets, inspecting for damages or counting them, using a smart toolbox and smart inventory software application for tool management in aircraft maintenance.

Anatole Gershman looks at the possibilities for the implementation of novel customer relationship management applications opening up by the use of ubiquitous computing technologies. Arguably, networking physical objects and collecting large amounts of information is of little value if it is not used to improve existing or develop novel services. Indeed, the combination of a service channel, a sensor, and an actuator will change the way many business functions are perceived and performed. Finally, he identified three ingredients for a successful strategy in ubiquitous commerce:

- To be always on and connected to their customers.
- To be always aware of their customers real-time context (where the customers are, what they are doing, what is around them).
- To be always pro-active, taking advantage of the real-time opportunities to satisfy customer needs.

Olli Pitkänen focuses on the forthcoming legal challenges that will result from the deployment of ubiquitous commerce systems. Several issues stand out: if ubiquity will bring computer networks even into the most intimate places and walks of life, it is of essence that privacy will be in jeopardy at an unprecedented degree and its protection should be guaranteed using technical but also legal measures and mechanisms. Moreover, the novel rich

information streams collected by ubiquitous commerce systems will require that rights in information, that is, intellectual property rights, will be a central issue especially with regard to revenue sharing. Last but not least, ubiquitous commerce transactions will create new challenges to traditional contract law, while its fundamental concepts will need to be revised (especially where ubiquitous computing infrastructures will be relied on to make decisions on behalf of the consumer).

The position papers discussed thus far, take primarily the point of view of the business and how it can benefit from ubiquitous commerce. The last two papers of the workshop adopt the consumers' viewpoint and discuss implications for their day-to-day living. Steven Barile and Tony Salvador build on their work on frameworks that examines ecologies of consumption. In this position paper, they focus on transaction from both the consumer and the retailer perspectives and also consider the individual worker's point of view, in their attempt to identify useful and appropriate technological innovations that satisfy the transaction context. They follow an ethnographic methodology in their work, which is also informed by previous social research studies in this area. Cultural differences aside, the results they report are twofold: on the one hand they identify broad areas that have been overlooked as areas for innovation in retail and on the other they look at specific concepts that have found to be indicative of these broad areas.

Finally, in Panos Kourouthanassis and George Roussos attempt to explore some of the possible effects on the consumer experience due to the introduction of ubiquitous computing systems in grocery stores. They argue that ubiquitous computing technologies may potentially transform the function of particular activities in fundamental ways. Their starting point is their recent study on consumer behavior carried out during the trials of a prototype ubiquitous retail system for grocery shopping. They observe that novel shopping opportunities, enabled by ubiquitous computing infrastructures can provide a more entertaining and stress-free shopping trip compared to conventional shopping, and thus transform a utilitarian activity into an opportunity for entertainment.

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The Challenge of Identifying Value-Creating Ubiquitous Computing Applications

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ABSTRACT
Ubiquitous computing (UbiComp) applications involve large numbers of non-traditional networked computing devices which are often mobile and/or equipped with sensors to collect data. So far there is only limited knowledge on the impact of these technologies on business processes and how these applications can create value. In this paper we consider challenges for identifying value-creating UbiComp applications. For the individual challenges we provide examples from projects on industrial applications of UbiComp technologies in which we were involved. We conclude that companies can pursue two distinct strategies of dealing with these challenges, one aimed at incremental, the other one at more radical innovations.

Keywords
Business applications, innovation adoption, ubiquitous computing, value creation

INTRODUCTION
To date, there is no widely accepted definition of ubiquitous computing (UbiComp). One can probably say that applications based on UbiComp technologies involve large numbers of non-traditional networked computing devices which are often mobile and/or equipped with sensors to collect data [10].

This paper focuses on business applications. One of the main capabilities of UbiComp technologies in the context of business applications is their potential to reduce media breaks between the physical world and information systems [10]. This provides the opportunity for a more accurate, timely and detailed representation of the real world in information systems.

As UbiComp technologies start to become mature [11], commercial applications gradually become feasible [10]. There are already a number of UbiComp business applications which are in pilot phases or already available on the market. However, so far there is only limited knowledge on the impact of UbiComp technologies on business processes and how applications based on these technologies can create value for companies. Davies and Gellersen [6] mention economic concerns as one of the inhibitors for deploying ubiquitous systems.

We believe there is no general answer which UbiComp applications are value-creating. Companies that want to invest need to determine the value of a UbiComp application on a case by case basis. If companies have difficulties to identify promising applications, this can delay the adoption of these technologies.

LITERATURE REVIEW
In this section we look at selected research on evaluation and valuation. Findings from this research are used to derive the framework that we propose below.

The selection of an appropriate evaluation method, e.g. for a UbiComp application, depends on the application type. There are different taxonomies for classifying information technology applications (e.g. [9, 13]). According to Farbey et al. [9], the complexity of evaluation and the degree of risk and uncertainty is higher when e.g. an investment in an IT infrastructure is evaluated compared to an application for automating a process. However, at the same time, the potential benefits become higher. Often, the term intangible benefits is used to refer to benefits that are hard to quantify (either in monetary or non-monetary terms). As we use the term here, benefits are intangible if they can not be expressed in monetary terms. According to our understanding, value is created when the returns from an investment exceed the cost of capital (see e.g. [4]). Monetary evaluation – or valuation – can be conducted at different levels, ranging from market, firm, work group, business process to individual [5].

Chircu and Kauffman [3] suggest a limits-to-value framework for IT investments. The authors distinguish two types of barriers that make it difficult for companies to benefit from an investment in information technology. The initial sources of value (or value flows) may not be fully realizable due to valuation barriers that depend on the industry and organizational factors. This includes e.g. compatibility issues with current systems and organizational characteristics such as existing work processes. The potential value that remains after the

valuation barriers are taken into account may be further diminished by so called conversion barriers which include limited resources, knowledge or actual use of the system.

CHALLENGES FOR IDENTIFYING VALUE-CREATING UBICOMP APPLICATIONS

Our research question is as follows: What are the challenges in identifying value-creating UbiComp applications?

We propose four challenges which complicate the identification of value-creating UbiComp applications: the network challenge, the constraints challenge, the implementation challenge, and the valuation challenge.

The challenges were encountered in industrial projects on business applications of UbiComp technologies. Based on the literature review, we suggest a framework which incorporates the challenges. To provide evidence for the relevance of the individual challenges, we present examples from selected projects. The projects were conducted during an ongoing research initiative. Apart from the authors, the projects involved people from a number of companies and selected other researchers at different stages.

The framework proposed here uses ideas from the model presented by Chircu and Kauffman [3], although its intention is different. Our focus is on the challenges for identifying value-creating applications, both ex-ante and ex-post, whereas Chircu and Kauffman focus on the barriers that prevent the sources of value from being fully realized, independent from their visibility. The terminology we use is therefore different. Our framework furthermore incorporates findings from the research discussed above regarding the level of analysis, types of application and intangible benefits. Figure 1 provides an overview of the framework.

The projects listed below are used to illustrate the relevance of the individual challenges:

- For an industrial consortium, we developed an internet-based tool that allows users to estimate the financial impact of using RFID technology in the supply chain. The calculator considers pallet, case, and item level tracking.
- We are involved in a project with a software vendor and a number of other companies in which data from vending machines is integrated in an ERP system. The data is gathered by sensors and transferred via the GSM network. Among others, the project aims at improving product availability and decreasing maintenance cost by allowing timely and event-based refill and maintenance processes.
- For a car manufacturer, it was analysed whether RFID tags attached to certain spare parts could improve supply chain performance in the company's spare parts business. With the solution, the car manufacturer intends to improve the efficiency of handling incoming deliveries and to increase the accuracy of information on actual deliveries and inventory levels.
- For a pharmaceutical company, we examined a solution that monitors the compliance of patients with chronical illnesses in taking their prescribed medication. By increasing compliance of these patients, pharmaceutical companies hope to increase sales e.g. by reducing the churn rate. The solution uses Bluetooth and GSM technology for data communication. To illustrate the concept, a demonstrator was built as part of the project.
- A large European retailer tests different technologies in one of its supermarkets, among them RFID technology. In this test, RFID tags are used to track the movement of cases and pallets from the distribution center to the store and from the backroom of the store to the shop floor. Furthermore, a number of products are tagged at item level. This allows to track products also on the shelves. We already conducted site visits and are currently setting up a project to analyze the implications of using RFID tags within the supply chain for current processes and information systems.

In the following, the individual challenges are discussed.

UbiComp applications often involve more then one

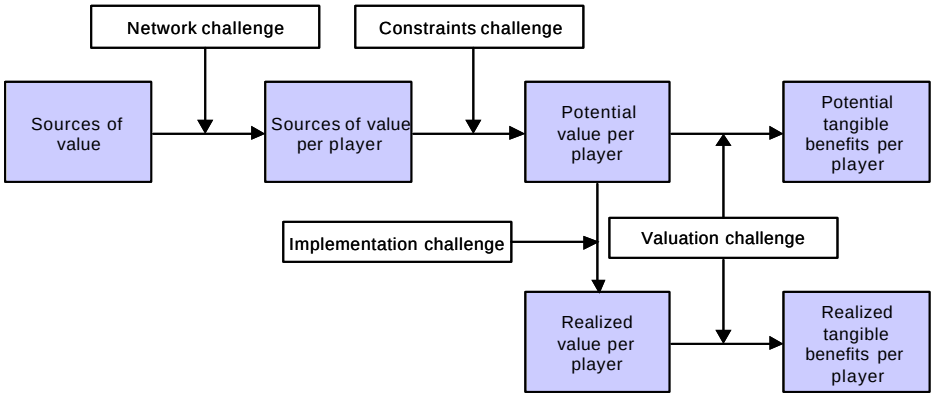

Fig. 1. From sources of value to tangible benefits per player: Challenges in identifying value-creating UbiComp applications

company. The network challenge refers to the issue that generally companies will not invest in an application unless they see a positive value for themselves. An analysis at the network level may indicate high sources of value. However, this is only a necessary, but not a sufficient criteria. Relevant is the level of the individual company. An example for the relevance of the network challenge is the introduction of RFID technology in retail supply chains. Retailers such as Wal-Mart expect to benefit from the use of RFID tags to track pallets and cases and are working on introducing the technology [2]. They thereby implicitly expect that their suppliers pay for – at least large parts of – the tags. If retailers had to pay for the tags, the results from our calculator indicate that their net present value from an investment can turn negative. Suppliers may initially not be willing to introduce RFID technology unless they expect their gains to exceed their cost. A solution needs to be found so that every player in the supply chain agrees to use RFID.

Constraints challenges are issues which inhibit that the entire sources of value can be realized. This can be existing systems, processes, etc. Constraints challenges are similar to valuation barriers introduced in Chircu and Kauffman's limits-to-value framework [3]. Specifically for Ubicomp applications, Davies and Gellersen [6] mention technical challenges as well as social and legal issues (e.g. privacy and data security). These aspects can become major constraints. Due to these challenges there is only a certain part of the value sources available to a player, which is called the potential value. In the project with the software vendor where data from vending machines is gathered remotely, we analyzed the potential value of detailed information on demand, product availability, machine status etc. for one specific vending machine operator. As we discovered, current processes prevent some of the value sources from being realizable. The company has defined fixed routes that specify which vending machines are refilled at what dates. Furthermore, there is already a system in place to manage product availability. Sales data for each slot in a vending machine is registered, and refill intervals and levels are defined based on this information. A main issue in defining a tour is minimizing the time personnel needs for getting from one vending machine to the next. There is no system in place that allows for dynamic routes to be defined based on product availability in certain vending machines. Such a system would have to take information from roughly ten thousand vending machines into account which are serviced by about 30 employees. These constraints currently inhibit the company from using the data in order to achieve higher product availability.

As the term already indicates, implementation challenges become relevant when a company starts to implement a solution. Limited resources, knowledge or low actual use of the system after the implementation is finished diminish the realized value. Implementation challenges are similar to the conversion barriers introduced by Chircu and Kauffman [3]. In the above mentioned project with a car manufacturer, the potentials of RFID technology for product tracking in the spare parts business look promising, but there are no standard solutions available so far. Introducing this technology still requires a company to invest resources to solve a number of generic issues, e.g. regarding the selection of appropriate tags, positioning of antennas, and integration into legacy systems. Experience from other pilots has shown that there is still a need for a lot of testing with RFID technology [1]. Companies that follow later may profit from this knowledge. Therefore, some players are reluctant to adopt early. Delays in implementing a solution reduce the potential value as (a) cash flows are delayed in time and (b) an initial competitive advantage may be lost.

Valuation challenges refer to the problem of determining the tangible benefits from a project. Valuation challenges are present at two distinct points in time. Ex ante, which means before a decision to go ahead with an investment is made, and ex post, i.e. after the solution is implemented. In our project with the pharmaceutical company, the system would have required the co-operation of doctors, pharmacists, and patients. Their willingness to co-operate was hard to judge, and we were not able to determine ex ante with reasonable accuracy (a) whether a monitoring solution would be able to increase compliance and (b) what value would hereby be created, e.g. by reducing the churn rate. The potential benefits of the application thus remained intangible.

It can also be difficult to determine ex post whether a solution is value-creating. Some UbiComp applications (e.g. the use of RFID technology for tracking products in a supply chain) focus on increasing the efficiency of gathering data (e.g. by automating the delivery verification process) or avoiding the negative impact of inaccurate or imprecise data (e.g. on product availability). A common approach is to conduct a pilot project to see whether the potential benefits are really achievable. However, processes in a pilot can often not entirely reflect actual processes. In the demo store set up by the large European retailer mentioned above, the work routines are somewhat artificial (e.g. cases are manually tagged before shipment from the distribution center). This makes it difficult to measure e.g. whether RFID technology really increases labor efficiency.

CONCLUSIONS

In this paper we have presented four challenges in identifying promising business applications of UbiComp technologies: the network, the constraints, the implementation, and the valuation challenge. These challenges are not unique for Ubicomp applications. However, some of the challenges – the network challenge, the constraints challenge, and the ex post valuation challenge – are from our point of view of specific relevance for UbiComp applications.

The network challenge occurs when more than one company is involved in an application. This is frequently the case with business applications of UbiComp technologies. The question of appropriate business models is far from being solved for a lot of scenarios [6]. Further examples of complex scenarios involving UbiComp technologies where the business model might not be obvious can e.g. be found in Fano and Gershman [8] and Tarasewich and Warkentin [12].

The constraints challenge deals with the limitations in achieving the value sources due to e.g. compatibility issues with existing processes or systems. One of the main challenges for UbiComp applications is putting the information that can be gathered into use. New kinds of application logic may be needed in order to benefit from the additional data. For example, what needs to be changed in an ERP systems when a company wants to benefit from the ability to track each individual product as it moves through the supply chain?

The ex post valuation challenge refers to the problem of measuring the value that is supposed to be created by an application. Even when benefits may be tangible ex ante, they can be difficult to observe and may only show when the performance before and after the solution was implemented is compared over a longer time period. For new technologies such as UbiComp technologies, it might take some time to prove that tangible results are delivered.

The fact that it is challenging to identify value-creating UbiComp applications has certain implications for the adoption of UbiComp applications. The previous comments seem to suggest a strategy of focusing on incremental improvements and quick wins. Companies may decide to go ahead with applications based on UbiComp technologies which only involve a few players. They may initially focus on applications which do not require extensive changes to existing systems and which are consistent with existing processes. Furthermore, companies may prefer applications with tangible benefits that can easily be observed after implementation. However, there might be an alternative to this strategy. Up to a certain degree a company may be able to improve its evaluation process. A good understanding of the challenges can lead to a higher chance of correctly identifying value-creating applications that are radical in nature rather than provide incremental benefits. Knowledge seems to play an important role for this strategy to work. Depth of knowledge – as well as company size – has a positive impact on the adoption of radical innovations [7]. Companies that want to pursue this strategy may e.g. engage in industry initiatives, collaborate with other companies, develop internal resources, conduct extensive pilots, and seek close contact with academic institutions.

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The Potential of RFID for Moveable Asset Management

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ABSTRACT
Moveable asset management is still not appropriately supported by existing IT systems. Items are not managed individually, information about location, status and usage is not accurate or lacking. This can cause delays in industrial operations, inefficient use or excess inventory of costly assets. We propose RFID technology as the key to link the necessary data directly with the physical assets. Assets become able to manage themselves, which eliminates many manually tasks, like searching for assets, inspecting for damages or counting them. The article demonstrates the potential of RFID based asset management solutions using the example of tool management in aircraft maintenance. The example includes the smart toolbox and smart tool inventory application as an implemented solution.

Keywords
aircraft maintenance, asset management, RFID, smart assets, Ubiquitous Computing

INTRODUCTION
The management of moveable assets is still a major challenge in the industrial environment. Examples for such assets are vehicles, containers, or tools. The goal of moveable asset management is to make assets available when needed and ensure their efficient use. For this reason asset management encompasses activities like locating assets, tracking their usage and ensuring their maintenance. From our daily life we might have experience about how much time we are spending on searching for personal belongings. This problem is much more complex for companies that are dependent on many different kinds of assets that are often used on a shared basis. Workers are wasting much time in searching for assets, which results in increased process costs. For example, if the right container is not available, parts for the assembly cannot be transported to the line and production schedules might be delayed. Improper maintained tools can cause damage or even lead to accidents.

Existing standard business software, like ERP-systems, increasingly tend to support asset management. Good asset management systems should be able to

- manage assets individually,
- allow to locate the right assets,
- provide information about the current physical status (quality) of an asset, and
- keep an information history of an asset.

Typical drawbacks of today's asset management systems are the failure to appropriately support these tasks and a missing direct integration of physical assets with the IT-system. They only manage the number of assets in stock and cannot manage items individually, and they are not designed to store enough related data with an asset, for example, usage data or status information. This results in manual data capturing, which is expensive and error prone.

In this paper we want to show that Radio Frequency Identification (RFID) technology [1] bears the potential to overcome these drawbacks. To demonstrate how RFID can improve the management of moveable assets (see Section 2) we developed two demonstrators for the tool management in the business of aircraft maintenance. (see Section 3). We use demonstrators to show the potential of RFID technology. Examples for institutions that are performing and presenting research in this way are Accenture [2], IBM [3], TeCo [4] and the M-Lab [5]. Section 4 closes with a summary about the benefits and challenges in the adoption. It also provides a prospective how the impact of Ubiquitous Computing technology on moveable asset management may develop in the future.

RFID ENHANCED ASSET MANAGEMENT
RFID is one of the major technologies that are frequently discussed in the area of Ubiquitous Computing. As shown in Fig. 1, this technology can be seen as the next evolutionary step in automatic identification (Auto-ID) technology. It integrates the digital and the physical world by seamlessly connecting objects in the physical world with their representations in information systems [6]. The avoidance of media breaks bears the potential to improve the efficiency of business processes through automation that leads to reduced cost since less human intervention is required, human errors are eliminated and laborious manual

data gathering is avoided. More efficient processes and new services will be the result [7].

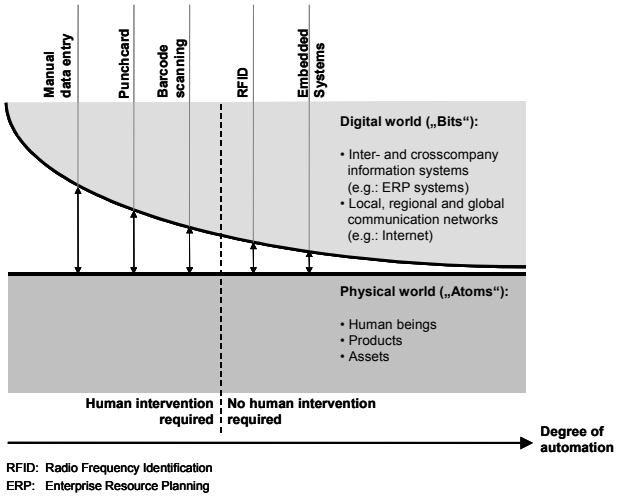

Fig. 1. The media break between the physical and the digital world [8]

According to the definition of smart objects [9], smart assets have a unique ID, may use sensors, have a memory and are able to communicate. Using these features they are able to meet the requirements for good asset management systems that were stated in the previous section. An attached RFID chip makes it is possible to identify and manage smart assets individually. With an infrastructure of reading devices in place they can be tracked and localized. Sensor enhanced RFID devices enable them to monitor their physical context (awareness) such as temperature or moisture. The memory of smart assets can be used to store history information that can be requested later (e.g. about usage). As a result most tasks in asset management, like identification, tracking, monitoring can be done automatically. From a users point of view the smart assets seem to manage themselves. Decisions that affect the asset can be made on the object itself. Information technology that indeed is empowered by a ubiquitous computing infrastructure is directly linked to the movable assets.

On top of the more efficient asset management, additional services around asset management can be created by using this infrastructure [10]: The ability to manage moveable assets anywhere and anytime facilitates the outsourcing of asset management to logistics service providers. Accurate information about usage enables pay per use-models that also support this trend. Providing information about status and location of assets can also be seen as independent services (e.g. track & trace).

The following examples show how some companies are using RFID to enhance asset management:

- Scottish Courage had to face 3-5 % shrinkage of their aluminum kegs per year. To solve this problem the brewery decided to use the RFID-technology to individually identify their kegs and to track to what customers they are lend out. The system enabled the brewery to get their asset back or claim for refund. Later the brewery decided to outsource the management of their beer kegs to the company Trenstar, who adopted the system and introduced a pay per use model to bill for their service.
- A gas dealer attached RFID tags to his gas bottles that store the basic weight, the type of gas and the filling date. As empty gas bottles have different weights, knowing the base weight of a gas bottle makes it easy to determine exactly how many gas needs to be refilled.
- Nortel Networks uses expensive test equipment, which needs to be accessed by many engineers. To avoid searching for the equipment, Nortel implemented a RFID based local positioning solution. Since Nortel has introduced the system most devices can be found in less than five minutes.

SMART SOLUTIONS FOR AIRCRAFT MAINTENANCE

For the execution of MRO (Maintenance, Repair and Overhaul) of aircrafts, many requirements by law regarding quality, safety and documentation exist, which leads to extensively standardized processes within the industry. The presented problems are therefore similar throughout the aircraft maintenance industry. The solutions that are presented in Section 3.2 are based on the concept of RFID enabled smart assets and were developed by the M-Lab in cooperation with a major company from the aircraft industry and SAP SI.

Challenges in the Tool Management

Each mechanic in the aircraft maintenance company has a personal toolbox that contains the most often used tools. The mechanic is personally liable for the tools, for example, in case of loss he or she needs to pay for the tools. The mechanic is also liable for any damage that is caused by a tool, which was forgotten in an airplane after a maintenance task. The following processes could be identified as labor intensive and cumbersome tasks for the mechanics:

- *Marking.* Tools are marked by engraving the ID of the toolbox. This task is done manually and can take up to two days. Since the marking fades it needs to be replaced every two years.
- *Routine completeness check.* The completeness and correctness of the toolbox must be checked after each maintenance task. This means the mechanic has to check whether all tools are in the box and no tools were exchanged with colleagues.
- *Base completeness check.* Each mechanic has to perform weekly cross checks of his toolbox together with a colleague, which can take several hours. A tool list acts as a written protocol to facilitate the check and needs to be signed after completion.
- *Lookup.* If a tool is missing after a maintenance task the aircraft in question needs to be searched until

the tool is found. In the worst case this can lead to a delayed delivery of the aircraft to the customer.

Special tools can be checked out from a central tool inventory. The tools are stored in automated shelves and a service operator is taking requests for tools. Every mechanic can have up to 10 tools checked out the same time. To ensure this limit a tool is handed out only in exchange for a metal token that has the personal identification number of the mechanic inscribed. The following three processes describe the tasks of the operator:

- *Checkout*. If a mechanic requests a tool it is handed out to the mechanic in exchange for a metal token. If the tool is not on its shelf position the operator should find a metallic token instead which shows who has lent out the tool.
- *Return*. In exchange for the returned tools the mechanic gets the metal tokens back. The operator receives the tool and puts it back into its shelf position. Often tools are returned late and not available to other mechanics since there is no tracking information available.
- *Lookup.* Sometimes mechanics wants to know what tools they have checked out. In this case, the service operator must search for the tokens. which can take up to three hours.

Concluding, the weaknesses in these processes are based on missing documentation of checkouts and human errors. This leads to searching for tools that are checked out, misplaced tokens, exchanged tools, forgotten completeness checks and time consuming tool marking. The smart toolbox and the smart tool inventory that are described in the following sections address these weaknesses.

The Smart Toolbox

The Smart Toolbox was introduced in [11] in the context of the Smart Box Concept. We implemented the Smart Toolbox (see Fig. 2) to demonstrate the concept of automatic and unobtrusive content monitor using RFID technology. RFID tags are attached to all tools and the boxes are equipped with RFID readers and antennas. The identification of the toolbox in addition to the identification of the tool is written on each RFID tag, this means, the toolbox can uniquely identify all tools that are in the toolbox and automatically perform the routine and base completeness check. To check for completeness, this is done by comparing all IDs on the tools with a list of IDs of tools that are belonging to the box. By comparing all IDs on the tools with its own identification the toolbox can automatically check for correctness.

The state of the toolbox is visualized (see Fig. 2) in two ways corresponding to the two conditions: (a) Missing tools are shown by empty spaces, and (b) tools that belong to a different toolbox are highlighted with a special indicator. The mechanic easily recognizes if a tool was forgotten and can take the appropriate actions right after he finishes a maintenance task avoiding or reducing the lookup process.

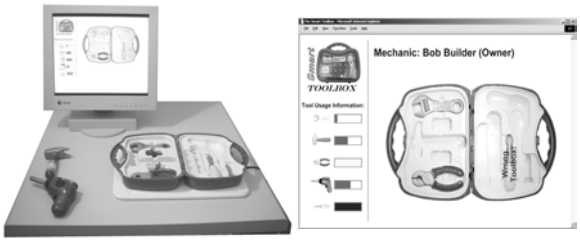

Fig. 2. Setup and screenshot of the Smart Toolbox demo

The way the mechanic handles the tools does not change by introducing the smart toolbox. The automatic monitoring happens unobtrusively relieving the mechanic of annoying checking procedures. In addition, the smart toolbox identifies the mechanic who interacts with the box by detecting the RFID badge of the mechanic. If he is not the owner of the box a warning will be displayed to help avoid mixing up of tools in advance. Another additional benefit is the usage history of the tools that is inferred by keeping the times a mechanic takes out a tool and puts it back in. The time until the next maintenance or exchange of a tool can be visualized by combining the usage history with the expected lifetime or maintenance frequency of a tool. This usage history also allows optimizing the content of the toolbox, this means, tools that are used infrequently can be removed from the toolbox and placed in the tool inventory.

Instead of manually marking the tools the toolbox can initially write its identification on all tools in the box. However, this requires RFID tags attached to the tools. This is done ideally during the manufacturing process of the tools.

A real world implementation of the smart toolbox faces the following challenges: (a) Most of the tools are made out of metal, which require specialized RFID hardware (e.g. low frequency systems or ferrit coated tags), (b) the toolbox itself is made out of metal, which can be solved by placing RFID antennas in each drawer of the toolbox, and (c) some of the tools have a small size, which make it difficult to attach a RFID tag.

The Smart Tool Inventory

Similar to the smart toolbox, RFID tags are attached to all tools in the inventory and a RFID reader and antenna is placed in the checkout counter (see No. 1 in Fig. 3). The RFID hardware allows to uniquely identify tools that are placed on the checkout counter. In addition to the tools, each mechanic can be identified using the security badge, which also uses a RFID chip.

The implementation consists of two parts, (a) the RFID client that handles the identification of the tools and mechanics, and manages the checkout and return, and (b) the web application that allows the service operator to access information about the checkout state of tools. This means, the lookup process can be performed in seconds.

The RFID client is connected via the intranet to the tool management system. The tool management system is part of an SAP R/3 system and the connection is done using the Business Connector interface of the SAP system. The data to and from the client is sent using XML messages.

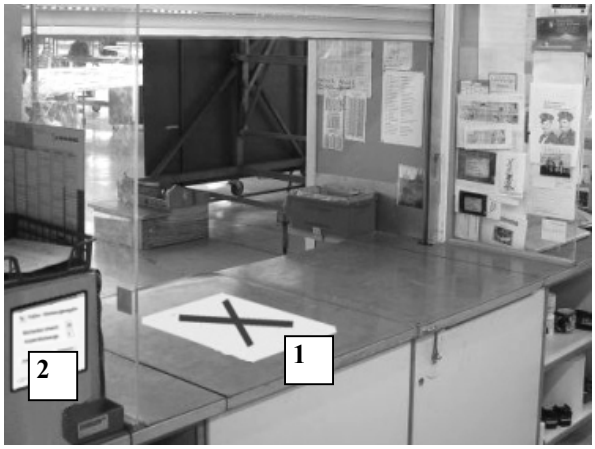

Fig. 3. Smart Tool Inventory setting with RFID reader and antenna (No. 1) and display (No. 2)

The checkout and return processes do not get more complex using the smart tool inventory application. In contrary, since the metal tokens can be omitted the process is optimized. No explicit user interaction with the system by the service operator is needed, since the tools trigger all processes: If a tool is placed on the counter, its ID is checked in the tool management system. If the tool is currently checked out a return process is initiated and the identified tools are marked as returned in the system, otherwise a checkout process is initiated where the tools are marked as checked out by the identified mechanic. To avoid missing tools due to RFID errors, a visual feedback about the process is given to the service operator (see No. 2 in Fig. 3). In addition to the current state of a tool the history of checkout and return processes is stored. This allows detailed statistics of tool usage and can lead to an optimized tool inventory.

The implementation of the smart tool inventory faces the following challenges: (a) Most of the tools are made out of metal, which can be solved using specialized RFID hardware, (b) the RFID tags need to be attached to the tools. As in the previous smart toolbox application, this should be done during the manufacturing process of the tools.

CONCLUSION

In this paper we have shown that RFID technology has a high potential to improve moveable asset management in several ways based on automatic and unique identification. The following benefits are the result of avoidance of media breaks by automating or reducing manual tasks: (a) identification of the right assets (b) locating of assets (c) monitoring the quality or state of assets, and (d) keeping the history of assets.

There are still several challenges to overcome when using RFID to enable smart assets. First the technology has some major drawbacks as long as it is used in metallic environments. These problems can be solve using specialized RFID systems, however engineering know how is needed in addition to IT know how. Second there is a lack of standards in product identification. A concept for a ubiquitous Auto-ID infrastructure is currently developed by the Auto-ID center at MIT. Third, traditional ERP-systems are not ready to manage all those assets individually. ERP-vendors like SAP are also supporting the Auto-ID center and working on smart items infrastructures.

In addition to the improved asset management, innovative services can be created by using this infrastructure: (a) outsourcing of asset management to logistics service providers, (b) pay per use-models, or (c) real-time information about status and location. More research needs to be done in refining the solutions and developing scenarios that are using Ubiquitous Computing technologies beyond RFID. In order to fully implement the vision of smart assets sensor technology can be incorporated.

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Customer Service with Eyes

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INTRODUCTION

Camera phones are the latest ubiquitous gadgets rapidly growing in popularity in Japan and Korea where they represent over 80% of all new cell phones sales. IDC estimates there will be 300 million camera phones worldwide by 2007. Users can instantly and inexpensively send and receive snapshots taken with these cameras. We believe that these are not isolated gadgets, but an important component of the new emerging infrastructure with significant consequences for many business processes. In this paper, we examine its impact on customer interaction, customer service, and more specifically how it will affect call centers and the roles of call center agents.

Every new infrastructure forces businesses to adapt their strategies and business processes. Those who adapt faster and better, gain significant competitive advantages. Call centers are a prime example of businesses having to adapt their processes to accommodate the adoption of a new technological infrastructure. The introduction of automatic telephone switches made call centers possible. In 1956, Pan Am introduced one of the first 24/7 call centers, giving customers a local phone number in every market. In 1967, ATT's introduction of toll-free "800" numbers opened a flood gate for phone-based customer services. Today over 70% of customer interactions are handled by telecommunications channels. Call centers have become standard practice as an effective business tool and as a convenience expected by consumers.

More recent technological advances such as telephony/computer integration, voice recognition and the World Wide Web precipitated a new wave of changes in the operation of call centers and in the business processes that rely on them. The precipitous drop in telecommunications costs made offshore call centers economical. Businesses are actively trying to reduce customer service costs by channeling more and more interactions to the Web and to the automated voice response systems. Customers also expect more from vendors - online product manuals, updates, account status, shipment tracking, etc. Businesses have to be ever more creative in their use of IT infrastructure to satisfy the rising expectations of their customers while maintaining profit margins.

Looking ahead, we see a new wave of infrastructural changes that includes pervasive broadband wireless connectivity and a growing range of connected sensors such as cameras, microphones, position readers, auto-ID tags, etc. An early example of this trend is the camera phone. We believe that it will change the way people interact with businesses. Until now, in a typical interaction with a call center, people used the telephone to say something to a business. As people grow accustomed to using camera phones to show things to each other, inevitably they will want to use them to show something to a business. It is also likely that they will expect businesses to show things to them. We believe that this change is momentous - in a very real sense, businesses through their call centers will gain millions of eyes into the world of their customers, but they will also need much greater intelligence to provide intelligent responses to vastly increased amounts of information they will be receiving. In the remainder of the paper we provide an overview of the functions that may be served by cameraphones in interactions with call centers, the new roles that call center agents may need to fill, and the challenges of indexing media provided to a call center..

MEDIA IN CALL CENTER INTERACTIONS

The following examples illustrate the new aspects of customer interaction and highlight both the opportunities and the challenges of the new capabilities:

Pointing/Identification

Instead of trying to describe an object using words, consumers will simply use the camera phone to send a snapshot of the object customer service. This works especially well when one tries to convey the style of furniture or a house. An expert at the call center can gain a much better understanding of the customer's need or intention and provide a better service. At the same time, it will require an expert to correctly identify the style of furniture from the snapshot thus raising the required level of qualification of the call center personnel.

Context Capture

A customer can use the camera phone to take a picture of the environment in which the desired product is used - a yard, a room, an office, a workshop, a half finished project, etc. This can help the service provider select the most

appropriate product for the customer as well as to suggest other products that might be useful.

Technical Support/Training

A series of snapshots or a short video can be used to capture how a user is performing a procedure. A service provider can then use it to correct or train the customer.

Customer Insight

Businesses use surveys and focus groups to glean how their customers use their products. Media-rich customer support interactions will very likely provide real-life data and images that will be more reliable than traditional surveys. They will show how the customers are using the product, what they are trying to do, what other products they use, etc.

Verification/Documentation

Consumers may use camera phones to document that a repair was performed for insurance purposes, or that they actually possess what they seek to insure. They may verify that they are ordering the correct parts by sending pictures of the device into which the parts will be placed. Businesses, similarly, may send pictures to consumers to verify that a product ordered is the correct product.

In the future, 911 and other emergency call centers may be flooded with snapshots of alleged perpetrators, suspicious characters, damaged property, etc. All of this information will undoubtedly contain valuable leads, but their timely extraction may be very costly.

EVOLUTIONARY ROLES

The greatest challenge for media-rich business interactions is the timely intelligent interpretation of images, video, audio and other sensory inputs as well as their indexing for future use. Typically, this requires humans. At a time when businesses are trying to automate as many interactions as possible and offload customers to self-service web sites, new technologies such as camera phones that draw humans back into the loop are a cause for concern. At the broadest level there are three agent roles that are likely to gain significance as media is incorporated into call centers:

Agent as media interpreter

Perhaps most obviously, as media arrives at a call center, a key task will be to interpret the media. What is depicted in the media? This is partly a question of indexing the media - an issue we discuss below. But beyond indexing, the question is how it relates to a given case. Agents will have to answer questions including:

- Diagnosis: What functional questions are raised? While media may be indexed at a certain level, it will often likely be at a level unrelated to the business processes of the organization. For example, a caller may preindex a picture as a car, but it may be up to the agent to further annotate the car as being involved in a hit and run, and yet another to declare it a total loss from an insurance perspective.
- Relevancy: For which cases is this media relevant? Once interpreted or "diagnosed", the media will need to be related to particular cases and associated with broader trends.
- Routing: To whom should this media be routed? Just as an operator today routes calls to the appropriate person, they may soon be routing media. In many cases media interpretation may simply be a question of determining who should view it.

Agent as Producer

When making movies, most footage winds up on the cutting room floor. Call centers will likely find that most media they receive either from people or from surveillance cameras needs to be edited and annotated to be useful.

For example, while a witness to a mugging might submit a picture of a mugger, the 911 agent may have access to numerous security cameras in the environment. A key task for the 911 operator will be to identify environmental cameras likely to be relevant. The feeds will then be reviewed and filtered down to the few useful cameras from the far larger set of available ones. Ultimately the task is, in effect, one of editing and "producing" the media associated with a case. To continue the 911 example, the 911 operator, after reviewing images sent in by witnesses and accessing nearby security cameras, may select, annotate, and forward to the assigned officers only the most useful media.

Agent as collaborator

The rise of the camera phone is arguably indicative of the broader trend of consumers using increasingly powerful collaboration tools such as video conferencing, instant messaging, and soon, multimedia messaging. For computer technology support it is common for a call center agent to, in effect, collaborate with a user in solving a problem. In many cases the call center agent has direct visibility into the caller's computer, account, or can reproduce a problem locally. Technologies such as the camera phone promise to provide the same kind of visibility for a broader range of environments, enabling collaborative approaches for a wide set of tasks.

MEDIA INDEXING

Not every picture a person takes necessarily leads to an immediate interaction with a human. A likely common use for consumer media is gathering examples of a problem that will be discussed later in a single interaction. For example, photographing locations for roof leaks during a storm, a suspicious person repeatedly loitering in front of a building, deteriorating conditions on a street corner, are all instances of images that may be captured over time and preserved as a collection for future use. Other examples when immediate action may not be possible or appropriate include insurance claims verification, marketing information and crime reports. In all such cases, media-rich reports need to be indexed and classified for further

processing with other materials. There are several approaches we can take to address the problem of the increased need for human indexing of rich media.

AUTOMATED INDEXING

There are millions of cameras in our physical environment, from security cameras to ATM cameras to name a few. Most of what these unmanned cameras capture is completely unimportant. The difficulty, of course, is identifying points of significance. Fortunately, many events of significance are accompanied by actions that trigger additional sensors. For example, users of ATM machines swipe their cards and thus identify themselves. The transactions they conduct can also be a source of indexing. Visitors to a building ring the bell of building and talk through the intercom. These interactions can also be captured and added to the index.

INDEXING AT THE POINT OF CAPTURE

As suggested earlier, camera phones are different from security cameras - they are manned. They capture media when a person finds something of significance. The person taking the picture can orally pre-index it as being a vehicle, person, or physical setting (e.g. a street corner). While this is not an exhaustive index, it can be very helpful when combined with automatically captured features such as the identity of the person capturing the image, the time and date, and the coordinates of the physical location.

OFFSHORE OUTSOURCING

The fact that media is easy to transmit makes it a prime candidate for offshore interpretation using inexpensive labor. Images, depending on the application and accuracy requirements, may be able to be classified as quickly as one per second by a trained analyst. This can even be done in real time. Robustness and consistency can be achieved through redundancy by sending the same picture to several operators. Security can also be achieved by sending pictures from different sources to different processing centers in a randomized fashion.

CONCLUSION

Pervasive computing creates a new level of ubiquitous infrastructure enabling broadband wired and wireless connection among countless sensors and "smart" objects. The camera phone is one of the first manifestations of this emerging infrastructure and, as we tried to argue in this short paper, it presents both interesting opportunities and formidable challenges to businesses. It is an opportunity because it creates a media-rich channel of communication between companies and their customers. It is a formidable challenge because this channel does not simply reduce the cost of doing today's business. It demands new ways of interacting with one's customers and will require a substantial redesign of customer service processes and systems.

Legal Challenges to Ubicommerce

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ABSTRACT
This position paper aims at discussing future legal challenges to ubiquitous commerce and related research topics. Ubiquity will bring computer networks even into the most intimate places and walks of life. Therefore privacy protection is one of the most important legal areas to be considered. Also, ubiquitous commerce is heavily based on information. Thus rights in information, that is, intellectual property rights, will be central. Traditional contract law is also facing significant challenges while its fundamental concepts need to be revised.

Keywords
Ubiquitous computing (*ubicomp*), ubiquitous commerce (*ubicommerce*), intellectual property rights (IPR), privacy, contracts

INTRODUCTION

To assess legal challenges related to certain technologies, it is essential to understand the key characteristics of those technologies. However, the technologies are nothing but enablers. Therefore we must consider the societal implications they may have. Only then, we are able to discuss the legal effects. In the case of ubiquitous commerce, we first need to understand, what kind of technology enables ubicommerce. Then we should try to estimate its societal effects and attempt to see the legal challenges related to them.

By *legal challenges* I mean difficulties in legal reasoning or somehow unsatisfying outcome of the legal process. It should be noted that in general legal structures are intended – among other purposes – to facilitate business: they diminish risks, encourage trust formation, and thus enable business methods. In a novel business environment, however, existing legal structures may become outdated, contradictory, or difficult to apply to new and complex situation even when sound rules exist and can be found. This increases the transaction costs, and slows down the development of value networks and the market in general. At worst, companies become vulnerable to risks that could be avoided or contained if the legal challenges were better understood. [7] The poor understanding of legal challenges may also lead governments or standards bodies to regulate markets in an unsatisfactory way and even to create obstacles to services that might be important and useful both for users and the society at large.

UBICOMMERCE TECHNOLOGIES

In the following, I will not try to describe the technologies that are needed to build ubicommerce. Instead, I will point out a couple of technical issues that will be essential to ubicommerce and that – based on my view and our previous studies [6, 7, 8] – will affect mostly on legal challenges.

The technologies that enable ubiquitous computing extend the reach of computation and information beyond the traditional framework of a computer application running on a fixed set of machines. The extension may be physical, breaking the ties of the desktop, wired computer. Alternatively, the extension may be in scope, providing information services to the public in a form that does not require technical expertise. Ubiquitous computing is the trend towards increasingly pervasive, connected computing devices in the environment, a trend being brought about by a convergence of advanced electronic - and particularly, wireless - technologies and the Internet. Ubiquitous computing devices are very small or even invisible devices. They are often mobile but they can also be embedded in almost any kind of artifacts, like vehicles, household goods, clothes and entertainment equipment. The common denominator of many ubiquitous devices is the ability to communicate through increasingly interconnected networks. [e.g. 4]

Ubiquitous computing is arriving slowly but surely. By its nature, it is hidden and spreads stealthily. Users do not become aware of the fact that e.g. most household appliances already include embedded information technology. Therefore this significant change does not take place overnight, but little by little and secretly. It is using kind of a bottom-up model: when gradually more and more appliances are equipped with embedded information technology, it is possible to say that we have entered the ubicomp era, although it is hard to recognize from a distance. Probably, ubicomp will not come into view

everywhere. For example, vehicles already include a lot of information technology. The break pedal and the breaks are no longer connected mechanically, but through a computer, which may decide to decrease the breaking force to avoid locking even if the driver presses the pedal as much as she can. Yet, using the breaks feels quite the same as earlier: although computer has got into power, it remains hidden and the user does not see much difference.

Ubiquitous computing will probably change our world much more than just mobile computing is changing. For example, one can always turn off the mobile phone or the handheld computer, if she or he wants to remain the privacy and does not want to be reachable. Instead, ubiquitous devices cannot be turned off. They are hidden and they can always transmit information that the users cannot control.

Ubiquitous commerce is hardly possible without context-aware applications. Context includes all the physical and social circumstances and facts that surround a particular situation or event. If a system is aware of the context, it may adapt its behavior accordingly. Typically, context includes facts like location and proximity, user and device identity, time, history, and activity. [3] It seems that location information will be one of the most important pieces of context information. While computer networks in general have significantly released people from the boundaries of the physical world, ubiquitous computing can in turn make use of locations and gain added value of their inherent characteristics and constraints. In general, context-awareness will be very useful for ubicommerce. First, ubiquity necessarily brings forth many kinds of devices. Applications cannot operate if they are not aware of the operating context and able to adjust themselves to different computing environments. Second, 'ubiquitous' refers to applications that are used in numerous circumstances. It is unlikely that any static solution unaware of conditions would succeed. Third, context-awareness introduces lots of new business-models and opportunities. For example, a service that takes into account the social situation in which the user is acting has much better chances to please the user than a service that is not able to adapt to the situation. Therefore, context-awareness will be one of the key-enablers for ubiquitous commerce to succeed.

Context-awareness requires that the system is equipped with sensors and other devices that collect data on the environment, the user and other actors. We soon realize that is a technical necessity that a ubiquitous commerce system collects personal information and probably transfers it to others.

Ubiquitous commerce will be heavily based on communication and transferring information. Information will be one of the essential merchandises. Also, services that, for example, add value to customers' own information or enable customers to improve information form another significant part of ubicommerce. Therefore technologies that enable the creation, the transfer, the modification, the fetching, the collection, and the storage of information in ubiquitous devices will be most important.

It will be necessary to manipulate information based on several reasons. They will include device features, user profiles, context information, and content's own characteristics as well as service properties. In particular, the characteristics of the wireless link between the ubiquitous device and other computers should be taken into account in content adaptation.

LEGAL CHALLENGES

Let us briefly discuss the examples of various legal challenges that will appear when companies enter into ubiquitous commerce. They can be grouped according to legal areas.

Intellectual Property Rights

Intellectual property rights (IPR), including copyright, patent, database protection, and so on, form the legal basis of business models that are build on selling information or providing information-based services. Especially, copyright issues at large are important to those who want to get return from information. Other actors, like device manufacturers and service providers, can find business opportunities by enabling copyright protection.

However, intellectual property rights do not necessarily protect all the information. The legal rules are often rather old and they have come into being in a quite different world. In ubicommerce, it might be quite different, what needs to be protected than it used to be in the pre-computer world.

Privacy

Large part of the information managed in ubicommerce is private by its nature. People do not want to see information on e.g. their location, behavior, habits, interests, transactions, finance, social situations, and health spreading around. Therefore, the ubicommerce systems must support privacy and confidentiality. On the other hand, many companies and public agencies would be very interested in accessing those data. For example, a commercial company would be able to direct marketing quite accurately to right individuals if it knew that much about their habits and health as an ubicommerce system can easily know. Some customers might be willing to benefit from the situation while others are so concerned about their privacy that they would not dream of letting this information to be utilized.

In the European Union, the data protection directive has set quite strict rules, but in the USA, for example, the discussion about privacy protection has not led to comparable statutes so far. It remains to be seen which approach ultimately proves to be more attractive: although privacy is extremely important and must be protected, too strict privacy protection may lead to the unintended result

that some useful services are simply not developed in the first place.

Contracts

Contracts affect everybody in ubicommerce. Each commercial transaction is typically a contract. On the other hand, as laws are often outdated and cannot be revised quickly enough, legal problems must be solved in contracts. For example, if outdated copyright law is inadequate in a certain situation, it can be overridden by a contract. Yet, transaction costs increase rapidly, if everything must be agreed on. Also, many rules in contract law are outdated. It will be very difficult to construe concepts like *offer*, *acceptance*, and *consideration* when software agents in tiny computers negotiate with each other through a network. Or even if the human beings themselves are bargaining using an ubicommerce system, some fundamentals of the contract law may need revision: for example, it can be very difficult to find out who are the other parties in a certain transaction, because they can be far, moving and using unreliable and changing connections. Therefore challenges in contract law will affect everyone.

Other Legal Areas

There are a number of other legal areas that will be affected by ubicommerce technologies. For example, labor law affects professionals if ubicommerce changes their working conditions. In many countries, labor laws are badly outdated. They are hard to apply in situations where working hours, company or group formation and other conditions are extremely flexible.

Tax laws face similar challenges to labor law. Traditional tax laws are hard to apply in new kind of transactions on ubicommerce. It is also unclear which fiscal entity has jurisdiction to tax certain transaction.

International Law: ubicommerce by its nature ignores borders. Transactions can easily be completed between parties anywhere in the world. If the service is provided globally or if a customer travels abroad while using the service, international aspects become vital. Although some laws are harmonized, many laws are, and necessarily will remain different reflecting cultural and local distinctions. The legal area called International Law will be challenged to find solutions to problems e.g. in choosing the right jurisdiction.

CONCLUSIONS AND FUTURE WORK

It depends profoundly on the viewpoint, which legal challenges are considered the most important. In the previous studies, we have concluded that the legal areas including most challenges on the Mobile web will be *intellectual property rights*, *privacy*, and *contracts* [8]. I have no reason to doubt that they are the most challenging legal areas in ubiquitous commerce also.

In relation to ubicommerce, privacy will be extremely important area. Mobility, context-awareness and, ubiquity will bring computer networks even into the most intimate places and walks of life. Context-awareness becomes most beneficial, if context-information can be used on the fixed network side of the wireless link. However, the user does not necessarily trust the access provider and does not want disclose context information that may impart private matters. Challenges to privacy are much greater on ubicommerce than ever before.

Intellectual property rights, particularly copyright, will also be a legal area where a number of challenges come up. Especially issues related to content adaptation will be significantly more challenging than ever before. In addition to legal protection, the future information products will be increasingly protected by digital rights management (DRM) systems and other technical measures. On the other hand, to provide high quality service, it should be possible to flexibly distribute content and adapt it on the basis of context. There will be remarkable challenges to fit these different aspects together.

There will be major challenges related to contracts. First, on mobile networks, it is not always easy to find out who the contracting parties are. Second, it will be sometimes difficult to state what the subject of a contract is. It can also be complicated to determine when the parties have committed to the contract. Moreover, on a mobile network it can be troublesome to decide which the governing law is and which authorities have jurisdiction over disputes. A fundamental reason for the contractual challenges is the structure of the future networks that will supposedly be quite fragmented.

There will be noteworthy challenges in other legal areas too. For example, international law in general will be important, because of globalization and moving users. Labor law will face challenges because of changing work. Tax laws meet challenges because of new kinds of transactions, resources, and incomes as well as moving users, globalization, and changing work. Nevertheless, those other areas do not seem to bring forth as crucial challenges as the first three.

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Developing the User Experience in Ubiquitous Commerce

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ABSTRACT
In this position paper we attempt to explore some of the possible effects on the consumer experience due to the introduction of ubiquitous computing systems in retail. We argue that ubicomp technologies may potentially transform the role of particular activities in fundamental ways. Our starting point is a recent study on consumer behavior carried out during the trials of a prototype ubiquitous retail system for grocery shopping. We have observed that novel shopping opportunities, enabled by ubicomp infrastructures can provide a more entertaining and stress-free shopping trip compared to conventional shopping, and thus transform a utilitarian activity into an opportunity for entertainment. We discuss how this shift affects consumer experience design.

Keywords
User experience design, ubiquitous commerce

RATIONALE
During the annual ECR Europe Conference which took place in Glasgow (2001), the Coca Cola Research Group presented its vision on how traditional supermarkets will operate in the near future. In effect, this presentation revealed that several trends will demand a revolution in nowadays food retailers' core business processes. Indeed, competition in the fast moving consumer goods (FMCG) sector is growing and evolving forcing retailers to continuously lower their profit margins. At the same time, the socio-demographic changes in nowadays consumer market (such as increased number of dual-income, single-parent and technology-familiar households) have significantly altered shoppers' expectations, demands and spending patterns during their traditional shopping experience (Kim, 2002). A recent survey identified that the "traditional family" has declined dramatically (Carter et al, 2003). In effect, it is estimated that by the year 2021 the average household size will comprise of 2.21 members (compared to an average of 2.7 on 1981) while there will be an increase of 30% of one person households (and a subsequent decrease of 33% for married couples). Moreover, the share of total retail expenditure accounting to groceries and food will decrease to 40% by 2004 compared to 50% in 1984. The presentation concluded with the remark that forging stronger consumer relationships and establishing consumer retention will become increasingly important thus, the selection of the appropriate consumer relationship strategy will be the fundamental building block for the successful economic future of tomorrow's food retailers.

This observation becomes more important if we take into account that the overall consumer shopping experience is affected by a number of store-related factors which include - but are not limited to - ambience (temperature, scent, music and so on) (e.g. Baker et al, 1986), service quality within the store (e.g. Aylott et al, 1998), store image (e.g. Levy et al, 2001) and situational elements (such as crowding, time and budget availability by the consumers and so on) (e.g. Donovan et al, 1982). All these lead to consumer dissatisfaction mainly through the form of increased levels of stress for the supermarket shopper (Aylott et al, 1998) and may result to create a new form of supermarket shopper: apathetic shoppers; people who have no interest in, or actively dislike, shopping and appear to endure rather than enjoy the whole experience (Reid et al, 1996).

The heart of the matter is that the traditional levers of price, selection and location – although still important - are no longer sufficient in order to achieve competitive differentiation. As a result, retailers should concentrate on enhancing the end-to-end shopping experience aiming to win customer loyalty by inventing innovative ways of satisfying customer needs. According to retail management theory, a shopping experience can be driven toward the maximization of efficiency or toward entertainment (Lewison, 1997, p. 138). It is therefore imperative that the retail value chain stakeholders should jointly discover the actual consumer needs and implement new shopping experiences.

The rapid evolution of new technologies presented both opportunities and risks for those retailers thriving to innovate. It should be emphasized that traditionally, the retail sector is very technology oriented, constantly experimenting with new technologies promising to streamline and optimize core operations within the store or the warehouse and communication within the entire value chain. Indicative examples include the introduction of Electronic Data Interchange (EDI) to standardize the ordering process between the supplier and the retailer, and the introduction of barcode scanning at check-out. Still, decades after the introduction of sophisticated information

systems in production and logistics control, significant inefficiencies remain in modern retail supply chains affecting retail operations efficiency (ECR Europe, 2001). Upstream inefficiencies refer to ineffective information sharing among retail stakeholders resulting to high inventory levels (mainly anticipatory), high out-of-stock conditions, high returns rate, and long lead times amongst others. Downstream inefficiencies refer to limited supply chain visibility resulting to low demand forecast accuracy, inaccurate promotion planning, and low on-shelf availability. Nowadays, the latest developments in wireless network infrastructure (mainly deriving from the wide deployment of Wireless LANs and the forthcoming 3G networks), interactive TV, mobile and wireless devices and automatic data capturing techniques (namely Radio Frequency Identification - RFID) lay the foundation for the deployment of ubiquitous commerce information systems; integrated environments capable to enhance the total shopping experience in such a way that the shopper is feeling understood, supported, and consequently, delighted.

CONCEPTUAL SCENARIOS

Ubiquitous commerce should not be limited on embedding technology in the retail arena. On the contrary, it should be a major business undertaking focused to and driven by the customer. It is all about delivering innovation through enhanced shopping experiences. Ubiquitous commerce can be foreseen as the natural evolution of multi-channel retailing, namely reaching the consumer through alternate channels. In the supermarket environment, the shopper can pick up a wirelessly connected shopping cart equipped with a display device and an RFID sensor capable to scan the contents of the cart. She uses her loyalty card to log in the system, which welcomes her and presents her the shopping list she uploaded prior to her visit to the store. She can then start navigating within the store as usual, picking up products and placing them inside the shopping cart. Each time a product is placed in the cart, the display device shows its description, detailed information, price, and updates the total cost of the cart's contents. At the same time, the product is erased from the reminding shopping list. Moreover, at any time she can request for additional information about a product (e.g. nutritional value, ingredients and so on), get informed about the promotional activities running in the supermarket (fully personalized based on the shoppers' profile and past consumption patterns), and request for navigation assistance within the store. Finally, during check-out the system transmits the list of purchased products along with the total amount to the cashier which issues the receipt.

Moreover, in her household the shopper is fully supported by the ubiquitous commerce system, which is able to continuously monitor the home inventory and generate "out-of-stock" alerts when a product needs replenishment. The shopper can receive in her mobile phone (or other wireless device) the automatically generated alerts (accompanies with personalized promotion messages) and proceed, should she desires, to replenishment orders.

DEPLOYMENT CASE STUDY

The common strand in both scenarios is that technology plays a key role in the development of ubiquitous commerce systems. Nevertheless, ubiquitous computing researchers argue that the successful deployment, and consequently adoption, of such systems highly depends on their perceived value by their actual users (Davies et al, 2002). If the end users of ubiquitous commerce systems fail to identify the value offered to them they will simply not use them. Our experience in ubiquitous commerce systems derives from our involvement with MyGROCER, an EU-funded research project spanning two years (2001-2002) aiming at designing, developing, and testing innovative shopping schemes in supermarket environments taking into account leading edge technologies (namely RFID and wireless interconnectivity).

The MyGROCER concept followed the two scenarios described above. Our intention was to develop an integrated environment capable to support the shoppers throughout their entire supermarket visit as well as support them within their household in terms of monitoring the home inventory, receiving out-of-stock alerts and so on. From the beginning of the design phase we tried to incorporate the shoppers' actual requirements for such a system. Indeed, supermarket shoppers represent a target group that can't be easily profiled. In particular, they represent people with diversity in age, culture, values, familiarity with technology and so on. Therefore, the selection of the appropriate technology solutions would greatly influence the level of acceptance for MyGROCER. For the supermarket environment, we decided to implement a prototype shopping cart capable to automatically scan supermarket products while at the same time provide valuable information to the shopper through a display device thus, create a fully interactive shopping trip. Regarding the smart-home concept, we implemented a home server capable to store instances of the home inventory and at specific time frames (predefined by the shopper) transmit the current inventory level to the retailer's server through the Internet (using DSL, ISDN or a simple V90 modem). The server communicated through RS-232 with two RF-Readers which the shoppers used to register products "in" and "out" of the household. The shoppers could have access to their "home inventory" and "missing products" lists using the Internet or their WAP-enabled mobile phone. A detailed technical discussion of MyGROCER is included in Kourouthanassis et al, 2003 and Roussos et al, 2003.

We performed a two-phase evaluation of MyGROCER in order to ensure that the system incorporates the shoppers' perceptions and specific requirements, identify potential barriers of acceptance in all levels (social, legal, family, etc) and take timely corrective action should it was

required. MyGROCER received substantial interest and appealed to most respondents. In effect, most of the participants expressed the opinion that MyGROCER will constitute the "shopping of the future". The perceived benefits of MyGROCER on the participants' "traditional shopping experience" referred to conducting shopping faster, easier, and at better value for money. Elements that proved to be appreciated by the participants included the ability to constantly monitoring the contents and total cost of the products within their shopping cart (including an accurate description of each scanned product), the ability to compare the value of similar products simply by scanning them and receive personalized promotions during their shopping trip, the accurate in-store navigation system and the ability to bypass queues (smart check-out) and reduce waiting time. Nevertheless, the majority suggested that the system should empower the shoppers to select the level of personalization that the system offers including an option of anonymous usage in order to provide just an enhanced in-store shopping facility. Conclusively, protection of their privacy and personal data was of paramount importance to the survey participants. These observations led us to the redesign of MyGROCER in several ways, these changes wgere reflected in the deployed system.

The second evaluation of MyGROCER spanned over a two-week in-field trial during September and October 2002 (Athens, Greece - ATLANTIC supermarket). The aim of the trial was to understand how the new shopping method influences the shopping experience compared against the traditional supermarket environment. Members of the supermarket loyalty club were selected to participate to the study in order to prevent privacy issues from arising. For the trial a full aisle was modified, a representative sample of products was selected and equipped with RFID tags and wireless networking infrastructure was installed. The survey participants were demonstrated the functionality of the system, used it to conduct part of their shopping and filled a questionnaire comparing their experience using the system against traditional shopping.

MyGROCER services appeared to be highly appreciated by the survey participants. In effect, elimination of queues and continuous monitoring of the total shopping cart value appeared to be the most highly appreciated services while item price monitoring, in-store navigation and on-screen monitoring of the products they purchased were second runners. Moreover, participants expressed their perceptions of different aspects of the system including usefulness, usability, trust, intention to use and service quality. The majority regarded the new shopping method as a useful addition to current supermarket shopping options, expressed the view that it significantly improves the shopping experience and found the system to be user friendly and intuitive to use. Having resolved the issues of fair use of personal information by selecting members of the loyalty club no other significant issues relating to trust were raised and, in fact, a significant number of the participants stated that they would trust the system to do their shopping and that they would trust it more than another computer assisted shopping method such as the Internet or self-scanning in-store mechanisms.

The most interesting results related to the effects on the conventional shopping experience of the participants. The most striking response was that the new shopping scheme resulted to an entertaining (and even exciting for some participants) shopping trip. In addition, the participants stated that the use of the system reduces their stress level and sense of time pressure while shopping. It should be emphasized that the survey participants expressed their willingness to adopt and use the system even in its prototype form. However, several concerns were raised particularly regarding the use of the system by older or not familiar with technology people.

CONCLUSIONS AND DISCUSSION

Ubiquitous commerce is no longer a vision, but over the past few years it is gradually becoming a reality. This can be mainly attributed to the recent technological advances, which made the deployment of pilot initiatives technically and economically viable. In effect, 62 of leading retailers in North America and Europe have expressed their plans to deploy new IT-enabled convenience schemes for consumers (such as info-kiosks, RFID enabled check-outs, navigation assistance and so on) within the next 3-5 years according to a survey performed by IBM and the National Retail Foundation (IBM Institute for Business Value, 2003). It should be emphasized that over the past few months we have already observed an increasing number of retailers willing to embed innovative technological solutions and shopping schemes into their store environment. Price Chopper is planning to deploy self-service info-kiosks providing access to accurate product information; Wal-Mart is working with its top 100 suppliers to deploy new RFID tags for tracking crates and pallets in the supply chain beginning in January 2005; Marks & Spencer will install new self-checkout schemes in eight additional stores following a successful three-store pilot.

The benefits deriving from the deployment of ubiquitous commerce systems are apparent. Retailers will have a tool that enables them to "work with their consumers" making them an indistinguishable part of their operations and reaching them in a way that they become a real stakeholder, part of their vision for an optimized value chain. The direct benefits for the retail value chain deriving from the incorporation of leading edge technologies in the retail value chain include among others:

- Real-time information provision regarding the products' lifecycle within the value chain optimizing the forecasting process of future demand.
- Real-time information provision regarding the shopper's consumption behavior providing the ability to identify and model shoppers' emerging needs.

- Introduction of personalized marketing/promotional programs including accurate monitoring of promotions effectiveness.
- Elimination of out-of-shelf /out-of-stock conditions.
- Elimination of thefts within the store.

However, the most important benefit deriving from the deployment of ubiquitous commerce systems is the creation of new shopping experiences and consequently, enthusiasm for the consumers. This is particularly true especially in our era where recent advances in manufacturing, distribution and information technologies combined with the urbanization of modern society have created the so-called new consumer who is more knowledgeable about comparable product costs and price; more changeable in retail and brand preferences; showing little loyalty; self-sufficient, yet demanding more information; who holds high expectations of service and personal attention; and is driven by three new currencies: time, value, and information.

Although there are still several challenges to the wider deployment of such integrated shopping schemes - especially those relating to issues of personal identity, security and privacy but also standardization and engineering - the results of our prototype implementation indicate that consumers would accept the introduction of innovative information systems when they become commercially available. Our research revealed that the issue of trust and privacy is extremely important considering the fact that we constantly need information regarding the consumers' current location in-store, past consumption patterns, household information, demographic data and so on in order to provide fully personalized services. An initial critical appraisal of this situation would indicate that application designers must make some compromises on the extent they offer personalized services. Traditionally, data protection legislation in most EU countries prohibits the capture and storage of any person-related data and only allows exceptions for clearly defined purposes after which the data must be destroyed. In our case, we allowed consumers to deactivate the provision of personalized services and at the same time participate to the system without providing their full set of personal information. However, this is not the solution to the general problem of trust and privacy. We expect that users will eventually be willing to adopt such applications only if they perceive that they are getting better shopping experiences in return for letting go some of their privacy.

Finally, the full involvement of the end-users during the design and development of the ubiquitous commerce system ensures the adoption and actual use of it after its commercialization. Our experience from MyGROCER revealed that the production of mock-up demos (in the form of concept sketches and non-functional interface screenshots of selected system functionality) and their exposure to real supermarket shoppers helped us identify potential barriers of acceptance and provided us with the necessary feedback to redesign the system according to the actual user needs and expectations.

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