Developing Scenarios for Mobile CSCW

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Sammendrag/Abstract:

This paper presents a scenario-based approach to designing mobile applications. Based on empirical studies of consultants in a maritime classification company, a set of scenarios was developed. The scenarios are used for assessing current mobile platforms, as well as pointing to new design possibilities for the organisation concerned. Appraising some solutions for different scenarios, we found that the current trend of simply making the desktop smaller is not sufficient. Mobile computing and wireless networks cannot match the performance of unmoving technology. At the same time, work is usually organised according to the capability of the desktop. Thus, new metaphors and human-computer interaction techniques are needed to improve the design of mobile computing.

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1 Introduction

The objective of this paper is to *develop scenarios* for mobile CSCW, based on empirical studies of work in a maritime classification company, Det Norske Veritas (DNV). In order to achieve this, *mobile informatics* is set apart as a distinguished research area from informatics and IS. On the basis of the scenarios, we suggest a suite of new applications for mobile computing.

Mobile computing is currently reaching a first level of maturity. Industry interest is formidable and the adoption rate is likely to continue to increase (IEEE Internet Computing 1998, http://www.selectsurf.com/computers/hardware/mobile/).

Some popular platforms are emerging, for instance Windows CE; many of which simply denote a miniaturisation of the "desktop". This does not realise the full potential of mobile computing, since mobile work and IT use differ significantly from other settings. Traditional office-based metaphors, for instance "files and folders", references to stationary computer equipment, for instance "my computer" and spatial metaphors, such as "rooms", may not be suited for mobile work.

Mobile platforms generally have less bandwidth and processing power, whilst work itself is shaped by the performance of stationary computing. This maintains a capability gap between application requirements and the environment. It seems unfortunate, therefore, that the "desktop" has become the dominating design metaphor for mobile devices. This argument about the distinguished nature of mobile computing and IT-use is elaborated in section 2.

We believe that mobile computing design needs new metaphors and concepts. One possible approach to achieving this is the use of scenarios. Scenario-based techniques have received some attention recently, and they are usually used to explore future aspects of a phenomenon.

This paper describes and reflects on the use of scenarios as vehicles to transcend current constraints in mobile application design. This paper offers a framework for discerning relevant scenarios. It constitutes a novel contribution to designing HCI for mobile devices, and several essentially new applications are proposed for the example domain.

The next section argues that mobile informatics is indeed significantly different from stationary IT-use, and this argumentation feeds directly into developing the scenario framework in the following section. Section 3 discusses the findings from our empirical studies. Section 4 describes the rationale and framework for developing scenarios in the DNV case. It focuses on the working situations of mobile consultants at DNV. The scenarios are presented and aspects that should be brought to bear on mobile designs are elicited and analysed in section 5. Pointers to future research based on these contributions conclude the paper.

2 The spirit of mobile IT use

The problems investigated by this research are intractable and interesting aspects of mobile work. This does not mean that they are limited to specific organisational forms

or technologies, however. This section elaborates on some problems and possibilities of mobile IT use to clarify this perspective.

2.1 Organisation

This paper presents a research effort to explore the possibilities of seamless support for interactive multimedia. WithinIMIS, we collaborate, among others, with a Norwegian maritime classification company Det Norske Veritas (DNV). DNV, established in 1864, is organised as an independent, autonomous foundation. It has 4,400 employees and 300 offices in 100 countries. Employees come from 67 different nationalities. DNV is one of the world's leading maritime classification societies. The objective of their activities is to safeguard life, property and environment. They provides three types of services:

- *Classification*, which is to develop and maintain rules and standards for safe ships, offshore drilling and production units. DNV also verifies compliance with these rules during design, construction and operation.
- *Certification*. DNV is accredited to certify companies with respect to different standards, for example ISO 9000. The main difference from classification is that the certification is grounded in standards developed by organisations outside DNV, typically government agencies.
- *Advisory services*. DNV gives advisory services regarding technical solutions, training and safety, environment and quality management. It is within this section that we have started doing exploratory design for mobile computing.

DNV guidelines, products and services are offered to customers by geographical divisions. The consultants thus meet customers regularly at their sites, sometimes quite far away from the Home Base Unit (HBU). Mobile work is simply necessary for a global company whose business is mainly location-dependent. After all, ships and oilrigs cannot be inspected "long distance".

2.2 Use situations

It is important to be aware of the mission-critical nature of mobile IT-use. When people leave their home base to work remotely, for instance at a customer's site, it is because they have to. It may be that the objects of their work are not accessible from home, for instance as when certifying maritime installations. It could also be the case that the work product needs to be tailored to specific requirements and demands within the user's physical organisation. This is the case for DNV advisory services. The crucial observation is that in many cases, if the mediating technology fails to work properly, it is often not possible to do any work, and, additionally, such breakdowns often alienate working partners and customers.

Mobile applications are often described as providing a transparent "place" of work; mobile work can be performed regardless of location. Interestingly, mobile work often means not disregarding place, but rather the complex encounter of multifarious new places and faces. Offering support for communication and work with reference to such particulars is therefore likely to be more beneficial than the inverse.

Several other problems may be experienced in mobile work (Kristoffersen and Ljungberg 1998; Kristoffersen and Ljungberg 1998). We found, e.g., that planning is

often impossible, since work is mobile for the very reason that not all constraints and possibilities can be discerned in advance. If they were, the need for mobility would be severely reduced.
This brief analysis also suggests that mobile work also renders virtually useless some of the mechanisms usually used for navigating in ones local habitat (Wynn 1984). Without visual and practical contact with the office environment, it becomes more “unknown”. Most people have probably tried to direct someone through the telephone, to find a paper in ones office; usually it is not an easy task to achieve. Most people will, however, be able to find the same paper almost as soon as they cross the doorstep of their office. The physical environment of work facilitates access to objects as well as logical arrangements, the flow of work, important resources and people.

2.3 Technology

Mobile work is of course linked to the technology by which it is mediated. In a global, fast-paced organisation, distributed work cannot take place without communication technologies. Many traditional organisations, on the other hand exhibit the same idiosyncrasies, albeit perhaps in less pure forms.
For the problem of this paper specifically, we depart from state-of-the-art mobile computing, such as a Windows-based palmtop or laptop computer, a combination of pen and keyboard input and remote access to home base units via modem.
For mobile technologies, it is a weighty argument that in almost any mobile environment, connections are going to be unpredictably unreliable. Buildings and weather may cause interference, and parts may get lost or turn out to be incompatible with the remote network.
A related problem is that mobile information- and communication technologies often have sub-optimal performance. This is not a judgement of inferiority as such, simply an assertion that most organisations optimise work processes with reference to state-of-the-art desktop applications, just as software vendors maximise the functionality of software to the best processors available. One example from the DNV case is that even powerful laptops cannot practically replicate the complete customer-databases, although these machines today are more powerful than the ones used to install the databases at HBU originally. Even if mobile devices become more powerful and wireless networks increase their capacity, there is little evidence that they will surpass the trajectory of increasing power within the fixed computing environment.
Mobile technologies usually offer exactly the same addressing schemes and directory services as desktop technologies do, but in this new context that may just be too weak. The reason is exactly the point made previously, that mobile activities are location-dependent by nature. Using the mobile phone as an example, would it not be convenient to be able to call the car in front?

2.4 Mobile computing research

The current body of research in mobile computing is vast and diverse, and the majority is concerned with resolving technical issues in communication and data processing (MobiCom 1997). However relevant, this research will not be drawn upon in the remainder of this paper, which focuses on application categories and functionality that is pertaining to a particular case.

Some examples can be found of literature that deals with the requirements for mobile workers on an application-level, e.g. (Dix and Beale 1996). In this volume, Mitchell discusses aspects of CSCW (Computer Supported Co-operative Work) for the mobile teleworker. He points to three ways in which mobile technologies have affected mobile workers:

1. They can go straight to where the customer is, without articulating work through a central office (HBU), and
2. they can return home from work directly, without reporting back to HBU.
3. they can, and may have to, deal with contingencies and new requirements in the 'field'.

Focusing on the problems of retrieval and synchronisation, Dix and Beale discuss how pre-planning, caching and updating can be realised for mobile applications. Interestingly, they also assert that the primary barriers to teleworking seem to be manegerial and social, rather than purely technical (Dix and Beale 1996b). This implies that mobile computing should be considered in a use perspective as well as technical achivements.

Dearle (1998) denotes mobile IT as a whole new computational paradigm, in which processes migrate with users. Separating this paradigm from stationary computing, Dearle identifies the needs of this paradigm to provide mobility of views, processes, channels, code and state. He does not link these technical requirements with the particular needs of the users in the wider context of mobile work, however. In order to start dealing with these aspects of mobile computing, we introduce a research agenda called *Mobile Informatics.*

2.5 What is "Mobile Informatics"

This paper builds on an argument that mobile work and IT-use is significantly different from its stationary complement. Existing literature go some of the way in proving this point.

Some of the technical literature in this area concentrates on various types of mobility, such as user-, terminal-, and application-mobility (Thanh 1997). Another useful concept is session-mobility, which denotes the capability of migrating potentially active conference-objects around the network (Kristoffersen 1997).

Alternatively, one could focus on the people engaging in mobile activities, and differentiate between highly or slightly mobile and stationary work. This topology captures the intensity of mobility within the work. Capturing the range of mobile workers, on the other hand, on could distinguish between local, regional and global mobility. Both categorisations are meaningful in the context of the DNV case.

There is, however, more to mobility than simply moving. Its is often useful to distinguish between work that is mobile by nature, and the technology which may (or may not) support it; mobile media. There are different reasons for mobility as well, so travelling for business or pleasure belongs to a different category from transportation (of goods, or simply applying a "state-transition" perspective on mobility as getting from one place to the other). In this larger picture, we also wish to include nomadic use of stationary technology, which sometimes, but not necessarily, entails using mobile technology.

Based on the preceding discussion we propose the terms Mobile Informatics to denote information- and communication aspects of IT-use in mobile work.

2.6 Scenarios for Mobile Informatics

Generally, we see scenarios as a useful tool for outlining problem spaces, which are present, but sometimes undetected, and for exploring new solution spaces in a radical fashion. Scenarios are becoming an established way of anticipating and describing future use of computer systems.

Bardram describes how collaborative scenarios were used in the re-design of a Hospital Information System in Danish healthcare (Bardram 1998). They were used to support the creative, non- reductionable aspects of design. Based on a definition of a scenario as a concrete description of activities that the user engages in when performing a specific task, Bardram claims two benefits of scenarios: First, they are vehicles for supporting the creative meeting between users and designers. Second, they indicate the usefulness of a system on the background of work practices within the organisation.

The greatest difference between scenario-based design and traditional specification is that scenarios tend to be concrete, whilst functional specifications, e.g., tend to be abstract. Certainly there is no mutually exclusive relationship between the two, one main issue in using scenarios is how to translate the verbose, concrete description of a scenario into a precise, logical design (Carrol et al. 1994). In this paper, this will not be attempted resolved explicitely.

One potential weakness of scenario-based techniques for the design of interactive systems is that the user is not usually given the opportunity to interact with the scenarios (van Harmelen 1989). In our case, this will be sought resolved by exposing user representatives to the scenarios and engaging them in the validation and design process.

The selection of scenarios from a wide space of possibilities is another important issue that needs to be taken into consideration. Young and Barnard (1991) propose to distinguish between *signature tasks*, which have been deliberatively chosen to match the capabilities of the target domain, and *paradigm tasks*, which have been thoroughly analysed and understood on those terms. Rather than relying on the maturity of the analysis for selecting paradigm scenarios, this paper proposes a selection based on the findings from preliminary empirical studies.

The main rationale for using scenarios in Mobile Informatics is to resolve the dilemma of the "desktop metaphor" in mobile computing: small machines and wireless networks are always slower, but the organisation of work is usually adapted to superior performance. This is not a negative performance gap, as such, since most mobile devices have ample processing power. We chose to think of this as a positive design gap; Current design metaphors unable applications that fulfil the potential of Mobile Informatics, because they have not taken the particular requirements of mobile work and IT-use seriously. Mobile applications are all too often designed as miniature desktop systems. Thus, neither organisation nor technology is optimal for mobile work.

3 Empirical findings

Developing and discussing scenarios is a particularly fruitful approach for exploring the space of problems and solutions for a project (Schwartz 1992; Wired 1997). This project's current objective is to investigate the possibilities of supporting DNV mobile consultants in their work. One important part of this endeavour is to implement and

evaluate prototypes for mobile work. Technical contributions should build on a clear understanding of the existing application domain and its users. Preliminary studies have been carried out within the IMIS-DNV project, and a more focused, deep effort is planned to design and evaluate a production system.

There is, currently, a need to narrow the scope of the project. Design is about envisaging future IT-use. The scenarios are part of this process, as instruments for finding out what the project's prototypes should try to achieve, how and for whom. This section of the paper explains the scenario framework, and relates its components to findings from the preliminary empirical investigations. The scenarios are intended to cover realistic, yet potentially futuristic technological possibilities. On the process level, they explore several different organisations and cultures of work, since technological and institutional changes tend to be related. DNV is a large enterprise that influences as well as adapts to trends in society and working life, thus, we have also attempted to include a wider set of issues, such as an increasingly mobile lifestyle, flexible institutions, globalisation and a networked organisation of work.

We have tried to determine which dimensions of the potential space of problems and solutions that are most important, on the basis of fieldwork.

The empirical study comprises interviews with five respondents and one day of observing a consultant at work with a customer. We have focused on job situations, in the sense of activities that are found in all the transcripts and are recurring.

Some job situations are described in more detail below. The purpose is to provide examples to illustrate the different scenarios, and to ground our suggestions in real-life activities.

Four typical job situations emerge from the present empirical material: 1) Contacting co-workers, 2) Scheduling, 3) Document handling and 4) Information management.

3.1 Contacting co-workers

This situation occurs whenever consultants need an answer from other people, or they have to inform another person about relevant issues. It can be carried out in a number of different modes. Contacts may be synchronous or asynchronous. Technology often plays a mediating role. Contacts may be single or multiple. Single contacts occur when e.g. a mobile worker contacts a secretary to inquire about messages, while multiple contacts may be of the broadcasting type: "does anyone know how to deal with this problem?"

The type of information exchanged may vary from brief exchanges of plain text/voice to complicated drawings, etc. Different types of information have different degrees of urgency. Contacts may be directed externally towards customers, suppliers, etc, or internally to DNV co-workers. Accessibility is another key issue. People travel, work part-time and are away in meetings—all of which influence the ways in which they may be contacted.

The need for information for mobile workers can only partially be planned. Necessary files, such as plans, agendas, presentations, etc., may be downloaded on a laptop before travelling. However, people forget and they may discover too late that an important file is missing. Moreover, the remote situation's requirements can only be fully revealed upon arrival. Thus, the need for information may be highly unpredictable: "you never know when you will need that particular piece of information".

3.2 Scheduling meetings

Configuring new situations is an integral part of mobile work. It is more complicated to schedule a meeting when the group is not co-located and the process of developing scenarios should take these issues into consideration.
To schedule a meeting requires negotiations between the people who are involved. It often involves rescheduling of people's appointment as well as negotiated sharing of resources such as equipment and meeting rooms.
The scheduling task increases in complexity with number of persons involved. Negotiations require simple and rapidfeedback and may sometimes require lengthy rescheduling.

3.3 Document handling

Producing documents and transmitting them is a characteristic activity of knowledge based work. Depending on the type of document and the production process, the need for equipment and connections vary.
The task may vary in degree of urgency. Documents may be aimed at both internal and external receivers, and the types of documents may range from simple text-based memos to possibly large and/or complex graphical or multimedia presentations. Similarly, the reliability of the information may vary, depending upon e.g. whether handbooks are updated.

3.4 Information management

This job situation differs from the first situation in the sense that one distributes information to a group of persons, not only to a specific co-worker. To gather information in this con-text means to search for information in archives, databases, regulations etc. without the involvement of another person.
On the distribution side, the size of the group is of importance. To reach a large group may require access to directories. Furthermore, the stability of the group points to the need for meticulously updated directories in case of changes, and for easy re-establishing of group membership. The need forfeedback may also be important, for instance when the distributed information calls for hearings, or concerns changes of dates and time for specific events. As in previous situations, the distributed information may be directed internally and externally as well as mixed, which calls for security considerations.

4 Developing scenarios

The scenarios can be categorised according to the organisation of information resources (databases as well as people), the infrastructure and the fundamental modus of work. This topology constitutes a framework for developing scenarios for mobile computer supported co-operative work. It is important to be aware that, although this framework is empirically informed, its combined elements will only partially represent actual work situations. Creating scenarios is a matter of design rather than reporting.
The following figure shows the relationship betweenkey aspects of working situations

at DNV (presented above) and these three dimensions.

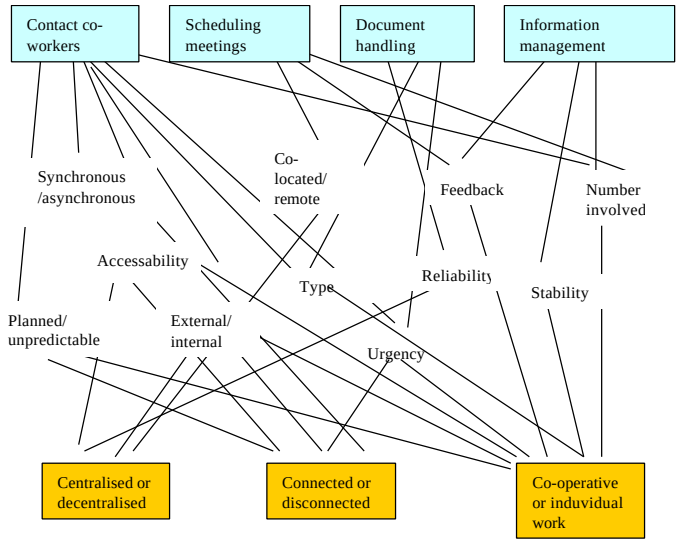

Figure 1: The empirical argument
These following sections describe the selected dimensions in more detail:

4.1 Centralised or decentralised information resources

At one end of this dimension, information resources such as databases and co-workers pertaining to a mobile situation can be found in one “authoritative” location, the HBU. At the other extreme, these resources are completely decentralised and under the control of its local owners.

4.2 Connected or disconnected

This dimension represents the available infrastructure: Whether the mobile consultant can connect synchronously to the information resources, or updates have to take place asynchronously. In most cases of synchronously connected infrastructures, the supporting systems will have to handle graceful degradation toward asynchronous connectivity, since a mobile environment cannot guarantee permanent connection.

4.3 Co-operative work or individual work

At one end of this dimension, we can conceive an organisation of the enterprise that encourages mobile associates to work more independently, i.e. as autonomous agents toward customers. On the other extreme, co-operative working arrangements involving several other people within DNV (or even from the ‘outside’) could be the preferred mode of operations.
The following figure graphically represents this potential space of DNV mobile applications.

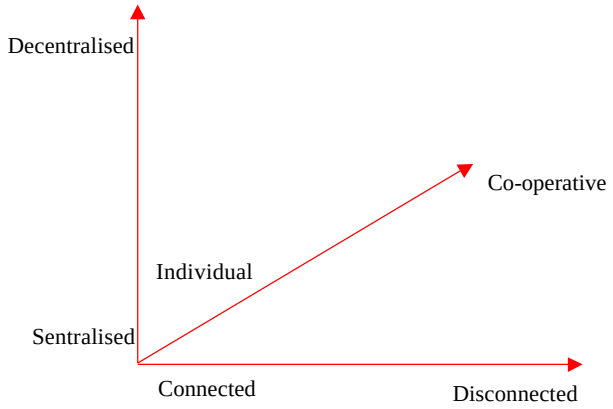

Figure 2: The scenario framework

This framework provides eight reference points in a three-dimensional space of mobile situations (in between which there are obviously continuous transitions of situation types). In the remainder of this paper we elaborate these eight scenarios, and elicit design alternatives for each.

5 Scenarios for mobile CSCW

The following table summarises the scenario proposals coming out of the framework suggested above:

Name	Information resources	Network	Mode of operations
Satellite	Centralised	Connected	Co-operative
Operator	Centralised	Connected	Individual
Fighter pilot	Centralised	Disconnected	Co-operative
Consultant	Centralised	Disconnected	Individual
CyberGroup	Decentralised	Connected	Co-operative
Sharing	Decentralised	Connected	Individual
Networking	Decentralised	Disconnected	Co-operative
Market	Decentralised	Disconnected	Individual

Table 1: List of scenarios

5.1 Satellite

In the satellite scenario, the group of people working together are mainly preparing and working towards the customer from HBU. When mobile consultants go out to work at customers' sites, the remaining members of the group at HBU provide real-time support.

This scenario combines a centralised organisation of information resources with a perspective of the work as mainly co-operative. We also assume that the mobile DNV associate can access the common information resources synchronously, albeit with a minimal risk of loosing the connection temporarily.

In this scenario, the physical headquarters at Høvik (HBU) exists exactly like today and the consultants are employed by DNV, thus they have their permanent workspaces at HBU. Mobile associates, as a rule, spend some time every day at HHQ. All technical

documentation and databases are stored at HHQ, and can be accessed either by librarians or, electronically, from a trusted access point. Very few people have their own private offices, however, most associates are organised in teams working toward defined segments of the market, and they usually share an open work space. Some prefer cubicles; others do their work around larger tables.

Within the group, people specialise in different areas of customers' business, such as management, software development, production, etc., or they have different competencies relating to methodologies and products offered by DNV. Finally, some are mainly advisors, some are assessors and auditors, and some do project management, documentation and implementation on behalf of the customer.

The following is a description of a work situation as it could have been observed in the Satellite scenario. It involves a consultant, Albert, working with a customer called AkSoft to improve their quality management system.

Albert, arrives at AkSoft's offices, and together with the CEO, the software quality manager several senior engineers, they gather in a meeting room to continue planning for the Assessment phase of an ongoing certification. Albert's presentation of CMM and BOOTSTRAP is well conducted, and the pros and cons of each methodology are well presented. When the CEO tells Albert that TickIT needs to be considered as well, the meeting grinds to a halt.

Albert does not know TickIT. The preparations could all have been a waste of time, unless something can be done to bring TickIT reasonably well (and fast) into the discussion.

DNV has developed templates for this sort of evaluation and planning presentations, but they have to be adapted to the circumstances by a person that knows the topic well. Therefore, Albert has to get in touch with members of the group that know TickIT, because he needs their help in adapting the presentation.

In similar situations previously, Albert has used the customer's computer network to access the DNV Extranet Server on which dedicated software made it possible to run any application as an applet within a web-page. With a little help over the mobile phone, from the relevant DNV associates, he has usually been able to tailor the presentation and learn enough about the case or method to do the job. Assistance-on-demand is one of the core support systems for DNVQA associates, since their work is too complex and too mobile for all of them to know everything always.

Unfortunately, because of security concerns, AkSoft are not on the Internet, so Albert cannot access the full set of DNV applications. This does not mean that he is unconnected, however.

Albert connects through the GSM net, inserting a PCMCIA card into his Personal Digital Assistant (PDA) and phoning up HBU with his mobile phone. He invokes an "awareness client" which uses a combination of voluntarily (but automatically) compiled activity logs and "active badges" to find out what people in his group are doing at the time. Fortunately, he localises two associates with the pertaining competencies, Beatrice, who is the maritime software expert in the group, and Charlotte, who is a TickIT assessor. The awareness client summons Beatrice and Charlotte to a teleconference using the simple conference application (SCA). SCA seamlessly adapts to various performance levels, and Beatrice and Charlotte can participate from their workstations, even if Albert is only on a PDA.

The PDA cannot run the presentation manager used by DNV, and it is not likely that it could have stored and processed the complete template specifications anyway, because

of their size. It also cannot run the tools necessary to adapt the template to a specific customer. On the other hand, it is well suited to mediate the tailored version, since that is likely to be smaller. Thus, Albert asks Beatrice and Charlotte to prepare the presentation, on their workstations. It is quite a complicated procedure, since Albert has the knowledge of the project, whilst Beatrice is the expert for the market segment and Charlotte is the TickIT assessor, and the output is, necessarily, a co-operative product.
It could have taken too much time to do this during the meeting with the customer representatives. However, SPI is (at least) just as much about organisational learning as process specifications, Albert connects the audio output to the loudspeakers in the room and displays the screen of his PDA onto the whiteboard using the overhead projector.
The work proceeds smoothly and after a while the presentation of TickIT assessments, specific to the needs of AkSoft, are finished.
Now, the next, albeit slightly less critical problem, is that the new presentation should be printed to slides and paper. The PDA cannot print directly to any printer, since it would be impossible to anticipate and bring within the drivers and cables necessary for any platforms the customers might have.
Fortunately, there is a PC on the AkSoft LAN and Albert connects to it using his PDA connection toolkit. He uses Mobile File Transfer from the PDA and downloads the finished slides onto the PC, in PDF format, which can be printed literally everywhere. The AkSoft PC does not carry an Acrobat Reader, but Albert always has one in a suite of useful CP tools stored on his PDA.
Printing and distributing the slides takes only a few minutes, and soon the meeting proceeds to discuss the TickIT approach, compared to CMM and BOOTSTRAP. Since the AkSoft participants at the meeting peripherally participated in the co-operative effort to compile an AkSoft specific presentation of TickIT, it does not take long, however, to reach a conclusion.
This scenario shows the richness of the scenario approach, and many implications for mobile CSCW design can immediately be drawn from it.
The co-operative, centralised and permanently connected organisation of work would typically benefit from flexible, synchronous CSCW. This scenario, moreover, indicates the need for software solutions that take into account the unstable connections and limited bandwidth of mobile computing.
Rather than describing each scenario in full detail, the remainder of this section briefly presents scenarios 2-7 and points to preliminary design implications.

5.2 Operator

This scenario involves individual work as the prevalent mode of operation. Resolving a need for assistance with common, shared information resources, the mobile consultants have to remotely access and update items at HBU databases.
The most important difference between this scenario and the satellite is that the consultant would have to rely on common (and authorised) information resources, rather than interacting with colleagues.
Many organisational memory approaches today are aligned with this scenario, in which consultants remotely access and update information (without co-operation) through a shared information space.

5.3 Fighter pilot

Similarly to a fighter pilot, the mobile consultant of this scenario prepares for work in a co-operative mode at HBU, before going out to the customer. Whilst in the field, since a mobile connection cannot be assumed, people are on their own, until they return to HBU and can be debriefed for the benefit of the group.
The orientation of this scenario towards co-operative work needs to be realised in sessions before and after the mobile work takes place.
For the "debriefing" meetings, synchronous and co-located meeting support systems would certainly be useful.

5.4 Consultant

This scenario is very close to the common organisation of work at DNV today. Information resources are found at HBU, each consultant prepares individually and cannot connect again during the working session at the customer's site. The endeavour is mainly individual and other people are likely to be educated about the case only if they ask.
The most important difference between this scenario and the second is that relevant resources are not available when mobile.
Properly replicated databases, with an intelligent pre-fetching and synchronisation scheme is one viable design alternative for this scenario.

5.5 CyberGroup

In the CyberGroup scenario, information is distributed amongst the mobile consultants, and most people are working elsewhere. Thus, HBU's size is reduced and its role is mainly to facilitate the virtual groups. People within these tightly coupled groups depend on each other's support, and therefore they are continuously connected. Information is under local control, and is placed into a context through negotiation and mutual support.
The distributed nature of information and human resources is a significant characteristic of this scenario. It is oriented towards co-operative work, however, and technology is needed to ensure the potential of information sharing and collaboration in the field. Since members of the cybergroup need continuous connection with co-workers, whilst also interacting with customers, the mobile application should be based on principles of ubiquitous computing.

5.6 Sharing

This scenario is similar to the previous one, except that work is mainly individual. Thus, information will have to be accessed in a traditional database fashion, eventually with only a limited set of automatic constraints imposed by the owner. It is similar to the Operator scenario with information resources distributed, rather than centralised. Albert's presentation at AkSoft could, in this scenario, only be "saved" if it was possible for him to locate and negotiate access to necessary programs and templates in the distributed space of resources.

Mobile agents that search and retrieve information on behalf of users could be considered for this scenario. Since work, in this case, is mainly individual, agents should also be able to negotiate access

5.7 Networking

Networking is decentralised and disconnected during mobile sessions. In this scenario, mobile DNV consultants rely on formal and informal personal networks of contacts to provide assistance, before and after sessions. One can imagine that such networks will consist of external consultants as well as DNV associates, loosely coupled together by their ability to provide mutual support. In the network, people know each other's abilities.
Since a mobile connection cannot be assumed in the field, this scenario relies on technological support to do informal networking between and after sessions. Perhaps a media space type application could provide a useful medium for maintaining informal connections in the network.

5.8 Market

In this final scenario, human and technical resources are distributed unevenly among very loosely coupled consultants, without participation in a co-operative network. Technical connectivity (between) sessions would have to be improvised, and it is not unlikely forthis scenario that information is bought and sold between people who do stand-alone projects for DNV.
One application category that should be considered for this scenario is electronic commerce, which would enable agents in the market to trade business and information regarding DNV advisory services.

6 Conclusions

This paper suggests a novel approach to designing applications and user interfaces for mobile applications. Based on a brief empirical investigation, scenarios spanning a relevant space of problems and solutions were proposed and discussed. The analysis indicates that new metaphors and technical capabilities are needed to exceed the "mobile desktop". In this first examination, a range of applications from ubiquitous computing to electronic commerce isproposed, all of which represent new perspectives on mobile work for the organisation involved.
The primary usage of the results reported in this paper is to inform and inspire design considerations within the IMIS-DNV project. On a more general level, however, the scenario framework described below is offered as an instrument for developing and reflecting on similar scenarios for other projects involving mobile computer-supported co-operative work.

7 Future research

This paper introduced scenarios as a design tool, to inspire a discussion about current

and future concerns of mobile informatics. Within the IMIS projects we are currently adapting and evaluating traditional office support systems in a mobile environment. In the next step, "mobile-aware" applications will be designed according to selected scenarios.

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