

Mobile Informatics

Innovation of IT Use in Mobile Settings: IRIS'21 Workshop Report Steinar Kristoffersen, Fredrik Ljungberg

Introduction

In this paper, we report from the workshop "Mobile Informatics: Innovation of IT use in mobile settings," arranged in conjunction with the IRIS'21 conference in Sæby, Denmark.¹ We suggested *Mobile Informatics* as a field concerned with exploring new and innovative ways of using IT in mobile settings. By organizing the workshop, we attempted to introduce footholds for Mobile Informatics within the IRIS community. In particular, we wanted to explore the basis for such a field and elicit relevant issues for future research. The workshop was supported by the Swedish Information Technology Research Institute (SITI).

Before describing the workshop and its results, let us briefly introduce the IRIS community.

IRIS

The IRIS conference is the annual conference of the IRIS association (<http://www.viktoria.informatics.gu.se/>), which is the organization of Information Systems and Informatics researchers in Scandinavia. The association, hosted by the Viktoria Institute in Gothenburg, was established last year in order to strengthen the cooperation between researchers in the IRIS community.

One main objective of the IRIS conference is to be a stimulating and open arena for intellectual discussions and the exchange of ideas. Doctoral students are, and have always been, one

important target group for the conference.

The IRIS conference alternates between the Scandinavian countries. This year's conference was the 21st since the start in 1978. The Information Systems group at the Computer Science department of Aalborg University organized it. The conference hosted 120 people mainly from Scandinavia, but also from the UK, US, Germany, etc.

There were three keynote speakers at this year's conference: *Peter Checkland*, Lancaster University, UK; *Ojelanki Ngwenyama*, Virginia Commonwealth University, USA; and, *Ali Farhoomand*, University of Hong Kong, China. The talk by Checkland concerned two fundamental items: "information systems" and "information systems research." The topic of Ngwenyama was "the political economy of the new global information society," while Farhoomand was concerned with "teaching cases."

The working groups of IRIS are very important. The working groups comprise approximately ten people each, offering. They offer a discussion forum for the papers, with the objective of improving argumentation and ideas. The conference also involves some formal presentations and workshops. The four workshops of the conference were:

- *InfraGlobe*: The Dynamics of Complex Infrastructures in Global Organizations. Organizers: The Internet project (<http://internet.informatics.gu.se>).

- *Why use the case method for teaching?* Organizer: Ali Farhoomand, The University of Hong Kong, China.
- *Organizing research as collaboration with industry*. Organizer: Peter A. Nielsen, Aalborg University, Denmark.
- *Mobile Informatics: Innovation of IT-use in a mobile setting*. Organizer: Steinar Kristoffersen, Norwegian Computing Centre, Norway; and Fredrik Ljungberg, Viktoria Institute, Sweden.

The remainder of this paper describes the workshop on Mobile Informatics.

The Workshop

About 40 people attended the workshop. The first item on the agenda was an introduction by us, the organizers. We gave a background of Mobile Informatics and introduced a conceptual framework. Next were "guru talks" by three distinguished researchers of the IRIS community: *Finn Kensig* at Roskilde university, Denmark; *Bo Dahlbom*, Gothenburg university and Viktoria institute, Sweden; and *Kari Kuutti*, University of Oulu, Finland. The gurus were asked to express their views on Mobile Informatics, and in particular, the conceptual framework outlined. The objective was to complement the categorizations made on the basis of our field studies with a broader set of concerns. It was also important to involve the participants in this debate. We therefore devoted considerable time for discussions, and participants were invited to give their own views on the subject. Finally, the workshop concluded with a summary and comments by Joan Greenbaum.

¹. IRIS is an abbreviation of "the information systems seminar in Scandinavia."

Let us now describe in more detail the conceptual framework of Mobile Informatics that we outlined.

Background

Mobile computing consistently fails to live up to expectations. Early adopters complain about the size and resolution of displays, awkward input devices and limited bandwidth (Dix and Beale 1996). There is every reason to assume that complaints will be exacerbated in step with users expecting increasingly powerful, synchronous and graphic applications. Many enthusiasts respond to this challenge by suggesting that new mobile technologies will be sufficiently powerful to meet the new needs of users. We assert, however, that expectations and requirements of the user community will proportionally increase by new advances in computing technology. The ante will, in a sense, be upped once more.

This workshop offered an initial exploration of this area. It represents a fascinating challenge given that today's mobile devices are immensely more powerful than the desktop computers of yesteryear, but at the same time they are a far cry from what users want today. We believe this challenge is fundamentally conceptual, rather than technical; *today's mobile computing paradigm simply does not meet the users' needs!*

We have launched a research program that aims to develop the conceptual foundations for mobile IT use and CSCW more thoroughly. The research program is partly sponsored by the Swedish Information Technology research Institute, SITI. The workshop presented the results of our work thus far. It also invited prominent researchers partaking in Europe's longest running IS conference to comment upon our ideas.

Mobile Computing and its Use

The workshop was planned from the premise that mobile work and IT use is significantly different from stationary computing. Some of the literature in mobile computing offers helpful indi-

cations of what the new research agenda might entail. However, many projects have focused mainly on the *technical* aspects of mobile IT. To mention but a few: small keyboards, limited battery life, unreliable network connections, varying channel coding and characteristics, volatile access points, risk of data loss, portability and location discovery (e.g., Bhagwat and Tripathi 1994, Dearle 1998, Francis 1997; Imielinski and Badrinath 1994; Satyanarayanan 1996). Nevertheless, it is often acknowledged that not all problems and solutions can be found within the technical domain only. For example, consider printing a document in a mobile work situation. Besides technical issues, such as device drivers, this involves issues like:

- Culture, e.g., is it okay to require printing facilities at the customer's site?
- Practical concerns, e.g., how many printer and network drivers is it necessary to bring along, not to mention cables and adapters?
- Security, e.g., can a confidential document be taken, inadvertently, from the printing tray?
- Task, e.g., will the paper copy have sufficiently high resolution and precise colors?

In some cases, the solution might not be to improve printing, but instead to facilitate sending a facsimile to the closest fax machine (Francis 1997). We maintain the design of new IT support for mobile settings has to take into consideration a variety of aspects of the overall "use situation".

Mobile Informatics

Mobile Informatics is an attempt to establish an applied research field concerned with new applications for mobile settings. The objective is to explore, design and evaluate innovative ways of *using* IT in mobile work and leisure activities, thus not only focusing on the technical aspects.

The development of mobile technology, such as architectures and protocols, has been impressive. However, the attempts to realize mobile comput-

ing as innovative application have often failed. Thus, the actual use of IT in mobile settings does not live up to the promise of the R&D in the engineering disciplines. The slow transfer to real use situations is a serious problem, especially because the gap between technological innovations and real use situations in many cases is a gap between engineering companies and their customers.

From this discussion it follows that exploring the possibilities of new and innovative concepts of how IT could be used in mobile settings is both timely and important. This is the case for Mobile Informatics.

A Reference Model for Mobile Informatics

Mobile Informatics implies a focus on the activity within which people are engaged. Here we can differentiate between highly and slightly mobile work.² Capturing the range of mobile workers, on the other hand, we could distinguish between local, regional and global mobility. Both categorizations are meaningful in the context of the cases that we are currently working on (Kristoffersen *et al.* 1998; Kristoffersen and Ljungberg 1998a; Kristoffersen and Ljungberg 1998b).

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). There is 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.

In the next section we outline the basic model of Mobile Informatics presented at the workshop. The model played an important role in the workshop, both in the discussions and the "guru talks."

2. It should be noted that we are not interested in "work" only, but in mobile activities in general.

Core Concepts

The reference model for Mobile Informatics builds on fieldwork and discussions. Its core concepts are:

- *Modality*, which is a characterization of the physical relocation patterns of the mobile worker/mediating technology.
- *Technology*, which can to varying degrees be adapted to mobile work.
- *Service*, which is the set of intended operations offered by the functionality of the mediating technology.
- *Mobile session*, which consists of changing modalities and services.

A *mobile setting* comprises at least one mobile session. The following figure summarizes the model in relaxed UML (Unified Modeling Language) notation:

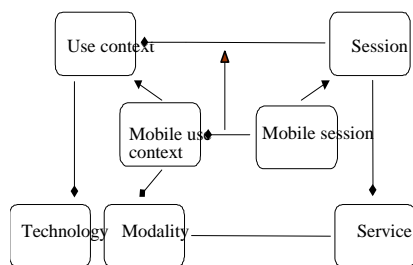


Figure 1: A reference model for Mobile Informatics

We have, briefly, identified and described three important *modalities* of mobile work:

- *Visiting* is working in different places for a significant period of time.
- *Travelling* is working while travelling in a vehicle, such as an airplane or a train.
- *Wandering* is working while being locally mobile.

Certainly, these are only ideal types; nevertheless they represent a useful conceptual topology which distinguishes mobile work from stationary

work and contributes to developing a new research agenda for Mobile Informatics. The following figure illustrates the changing modalities of mobile work:

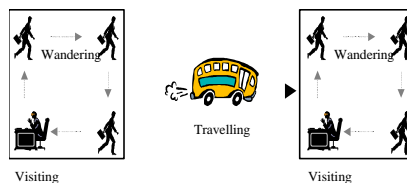


Figure 2: Modalities of mobile work

Services and modality constitute central components of a mobile session, which due to its mobility is far more contingent and dynamic than mobile work. Thus, it points in the direction of *new items for a Mobile Informatics research agenda* when these dimensions are combined, such as in the following figure:

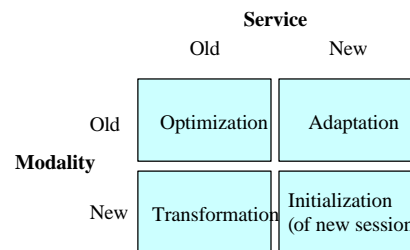


Figure 3: Changing services and modalities

Building on the framework outlined above, the following items for a mobile computing research agenda can be outlined: initialization, transformation, adaptation, and optimization.

Initialization

Main objective: Develop models and systematic support for establishing sessions in a mobile setting.

Some selected research problems:

- *Browse, inspect and select services.* We can assume that the availability of services from a mobile terminal will vary with geographical re-location.

- *Browse, inspect and select resources* such as documents, people, procedures, etc., from within a service. It is integral to establishing sessions, especially involving other people in a synchronous setting, to be aware of who is available and what they are able/capable of contributing.
- *Negotiate access, quality and pricing.* In a situation where mobile communications are more expensive than those offered by a stationary infrastructure, whilst at the same time furnishing limited performance and bandwidth, it becomes important to support the necessary tradeoffs between cost in time, money and quality.
- *Programming sessions.* In a mobile setting, users cannot be expected to be fully interactive, since mobility itself imposes demands on attention and mobile work is likely to be directed towards physical objects – otherwise, why go mobile in the first place?

Transformation

Main objective: Develop models and systematic support for sustaining services between modalities in a mobile setting.

Introducing the notion of changing modalities enhances the Mobile Informatics research agenda with an interest in how people can change between modalities whilst remaining connected to current services.

Some selected research problems:

- Decomposition of services into atomic, re-locatable units.
- Maintaining application state across modalities.
- Maintaining participation across modalities, in case of collaborative applications.
- Re-location and adaptation of service units in new modalities (see “Adaptation” below).

As this list shows, some of the research problems that can be described as transformation from the originating terminal’s perspective, are likely to be perceived as adaptation problems on the side of the receiving terminal.

Adaptation

Main objective: Develop models and systematic support for seamless use of new services within modalities in a mobile setting.

Here the focus is on how new services (for which the current modality may not be suited) can be adapted to function in an effective manner.

- Negotiating access and performance profiles for users entering a new modality.
- Changing data from new services to make available programs interpret and refine such elements in a satisfactory manner.
- Adapting programs to deal with new types of data.
- Aggregation of service units into fully functioning services for the current modality.

Optimization

Main objective: Develop models and systematic support for improved performance of sessions in a mobile setting.

This item on the agenda is already well covered in the mobile computing area. There seems to be a tendency, however, of assuming that mobile technology will be almost as reliable as its fixed counterpart. We believe that more work is needed on how to complete business-critical tasks using mobile systems in case of unanticipated technological breakdowns.

Other important research areas are, among others, HCI issues in the mobile context. For example, the mobile context imposes new requirements on techniques of interaction and visualization.

New Applications

We aim to combine empirical studies with the conceptual framework of the model to produce innovative, mobile-aware applications (see, Ljungberg *et al.* 1998). By technical experimentation and empirical evaluation, such applications can inform re-design and improvement of the model, and, thus, the research agenda.

Below, we outline some application ideas for extended mobile computing research.

MOTILE (MOBILE Tactile Input for a Lightweight Environment): This application should offer the possibility of simple, tactile input for mobile devices. It can be conceived as a virtual keyboard, operated only with three buttons, and relying on the shared functionality of the network and target applications for advanced operations. A small prototype has already been developed.

SEA (Secure Easy Access): This application should offer secure and easy user registration, directory services and authentication from remote environments that have not been prepared in advance, e.g., using web-based protocols.

MIC (Multimedia Interaction Console): Managing the interaction itself is an integral and potentially heavy-weight task for users of collaborative multimedia applications. This task is made genuinely more difficult in a mobile setting when the user may have to move between different environments. This application should offer a general console for operating and adapting mobile multimedia applications.

BEE (Best Effort Engine) Server: Since mobile environments cannot guarantee access or performance, whilst at the same time mainly hosting business-critical applications, we propose an application that performs rule-based scans of the user's local environment, in order to offer a distributed cache that can be accessed whenever the mobile system can get hold of it. The underlying idea is for no mobile host to ever run below its maximum capacity. The available storage space and processing power should be opportunistically used to anticipate problems following a breakdown in infrastructure or functionality.

Finally, one important rationale when selecting and outlining the four application ideas for development and testing in an experimental infrastructure is that, conceivably, they can also be

offered as general components for further use in application development.

Comments from Participants

The following section describes some comments and questions made by the participants. It is offered as a fictive dialogue between one of them (Q) and one of use (A):

Q: It seems that the Model implicitly assumes that the mobile workers need, or at least have a home base?

A: We do not think that it does. Mobile work seems to be characterized by frequent modality *changes*, and that is what the model describes without reference to a distinguished "home base". One can be *visiting* new sites continually, without ever going back "home". On the other hand, this model is only a vehicle to reflect upon studies of mobile work in specific instances. We have used it to reflect upon cases in which a "home base" did indeed exist. Therefore, the implicit assumption of an existing "home base" stems maybe from our application of the model rather than the model itself. People should not allow any model of this kind to *replace* empirical studies or reflection, but rather apply it as an analytical tool.

Q: Does this modeling effort only apply to mobile work? What about leisure, family and games?

A: This question can pretty much be answered in a similar fashion to the previous one. There are no references in the model to "work" as such. We have only applied it to organization of *work*, but that should not be considered an implicit constraint of the model, only of the specific cases for which it has, *thus far*, been applied.

Q: Have you considered amending the model to cover Virtual mobility as well?

A: Not really. We use it, among other things, to distinguish Mobile Informatics from Virtual mobility. This may not be the best solution. On the other hand, the issue is interesting and would be interesting to explore in more detail.

Q: Why have you not included typical dimensions from task-analysis, such as

- *collaboration, communication and co-ordination;*
- *individual versus co-operative work;*
- *synchronous versus asynchronous communication?*

A: We are currently exploring these dimensions in another context (Kristoffersen *et al.* 1998). They have been part of the model in early stages, and were removed because they were not essential for its purpose, which is to distinguish and define *Mobile Informatics*.

Q: This model seems to help preserve mobility, do we not often want to eliminate to need to travel? What is so special about mobility, anyway?

A: This model is empirically grounded. It “preserves” mobility in cases where people are mobile, because people are usually mobile for very good organizational and personal reasons. Further field studies may modify the model, but we do not see mobility as “good” or “bad”. It simply seems to be becoming a very prevalent part of our lives in business and elsewhere.

Q: Since this model is only based on a limited number of case studies, can you really guarantee its generality?

A: This is a common problem. The model can only be brought forward by testing and modification based on further empirical studies and design projects.

Q: You talk about “stationary bias” as it was always a negative property of mobile information systems. Is it not sometimes very desirable to have that on a mobile platform?

A: Only when you want your mobile computer to be a stationary computer (Kristoffersen & Ljungberg 1998b).

“guru talks”

The “guru talks” were given by Finn Kensing, Kari Kuutti, and Bo Dahlbom.

Finn Kensing

The comments by Finn were very much concerned with notion of *use context* in the conceptual model of Mobile Informatics. Finn argued that use context, at least, involves the technological context, the design project context, the work practice, corporate strategy, different interests, etc. He also maintained the importance of “grounding” a model of Mobile Informatics in extensive studies of mobile work. This in turn would enable a more concrete explanation of the concepts used to characterize and distinguish Mobile Informatics.

Kari Kuutti

Kari’s talk was about how mobility would possibly change infrastructure, service, and interface. He argued that mobility will make a difference, i.e., that the nature of infrastructure, service, and interface, actually will be changed. Kari characterized the R&D on infrastructure and mobility as very much “technology push.” He continued by discussing the “good opportunities” for work studies to inform the design of mobile services, and HCI research to inform the design of interfaces for mobile devices. Kari ended his talk by describing some Mobile Informatics projects at the University of Oulu.

Bo Dahlbom

Bo started his talk by arguing that historically, the IRIS community has been oriented towards discussing whether new technology is good or bad. The UTOPIA project, he argued, was very much about the appropriateness of the PC. So, “is the mobile technology good or bad?” he continued. The reason why asking such a question is “simply because it is such a powerful technology”. Bo continued by maintaining the importance of Mobile Informatics. The reason why, he argued, is that society is becoming increasingly a matter of “moving” and “talking”. However, he was not so convinced that the reference model of Mobile Informatics presented here was the most appropriate one. He liked the three kinds of modalities, but not the model as such. One reason why is that the model assumes that people have a workplace, but “why if they have not?” Against this background,

Bo made the suggestion “don’t stay too close to the situation today”. Especially he warned us about assuming that there will, in the future, be such things as organizations and offices.

After the “guru talks”, there were some time for presentations by the workshop participants. The only formal presentation was done by Jorma Kajava at the university of Oulu, Finland. The talk by Jorma addressed the potential of artificial intelligence in mobile computing.

Further Work

Following up this successful workshop within the context of a traditional Scandinavian IS conference, our next move, of which this brief discussion is one important step, will be to take the ideas to an international stage. Anyone interested in thus partaking in further developing the reference model for Mobile Informatics are encouraged to contact us at: mobile-informatics@nr.no, or check out our web-site at

<http://viktorija.informatics.gu.se/groups/mi/Start.html>.

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