

IT use for coordination of distributed work

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by

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Abstract

The aim of this thesis is to investigate the coordination of distributed work and how existing information technology (IT) can be used and developed to improve the different forms of coordination. We have characterized a number of dependencies and identified the coordination processes that could manage them. Additionally we recommend certain specific IT solutions that improve these processes. Our focus has been on the *usage* of IT applications rather than the technology itself. The usage of IT affects the whole organization and therefore also brings us to the area of organization and project structures. The study was done at Ericsson Microwave Systems (EMW) and was based on interviews and short ethnographic studies.

Acknowledgments

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1. Introduction

Distributed work is becoming more and more common in organizations today, and this requires a new kind of coordination. In the past, organizations divided work task amongst people in the same location. This required local coordination to manage the work tasks. Information technology (IT)¹ plays an important role in enabling coordination of distributed work. Our thesis studies the practice of distributed work when developing products at a department in Ericsson Microwave Systems (EMW). We try to understand the existing support in the organization for coordination of distributed work.

Informatics is an interdisciplinary discipline. When talking about Computer Supported Cooperative Work (CSCW) for coordination of distributed work, it is clear that the technical aspects of how the work is done will be investigated. However, it is equally important to look at the social aspects. Most of the theoretical background mainly comes from the area of CSCW, that takes into account both of these aspects.

Coordination is the central question of distributed work and is under focus in this study. Computer scientists often concentrate on facts, look for causality and fundamental laws. The belief is that everything can be measured. This is not enough when looking at how people work. Therefore we also take account of philosophical and social aspects. Any approach that does not include both of these point of views will not be able to discuss all the issues that arise in distributed work. We try to take a dialectic system approach to the problems and possibilities of distributed work². That is, we do not believe that neither a mechanical nor a romantic approach will grasp all the different perspectives and questions that need to be considered. It is important to try to see the whole picture.

The methods we use are qualitative interviews and short ethnographies, also called “quick and dirty” ethnography³. The interviews will give us a picture of how the organization is structured. The ethnographical studies in turn give an understanding of how the work is done and how it is to work in distributed groups.

¹ IT is a common and broad term and has different meanings in different situations. Our view on IT includes all the technical objects that are included in an information system (IS), actually most artifacts in general, like the computer, telephone, video, etc. It is the usage of these artifacts that is central to us.

² Dahlbom, B., and L. Mathiassen (1993) *Computers In Context. The philosophy and practice of systems design*, Cambridge: Blackwell.

³ Hughes, J., D. Randall, and D. Shapiro (1993) “From Ethnographic Record to System Design. Some experiences from the field”, in *Computer Supported Cooperative Work. An International Journal*, vol. 1, no. 3, pp.123-141.

Our observation show that it is hard to separate coordination of distributed work from coordination of traditional work. A lot of time is spent on coordination both locally and between the different locations. The organization supports distributed work by supplying different solutions and tools. However, these are not used to their full potential.

In order to improve the situation we propose various solutions; introduction of more standards, tools for coordination and the use of these general guidelines in order to reduce conflicts between different locations. We suggest two ideas on applications that could facilitate local coordination, information exchange and documentation.

Distributed work is characterized by a dynamic environment. New organizational forms and new ways of thinking about work are created. The different locations have to work very close together to support this work form and require that workers are flexible.

1.1. Background

One important trend in organizations today is that work is becoming more and more distributed. Many companies have been established in many different countries, thus being international companies. The fact that markets are becoming more competitive and more interdependent has made the conscious organization realize that being international is not enough. They have to be global, in the sense that they have to make use of all the internal resources of the company, think globally and act locally all in the same direction, as a whole. To keep up with competitors, companies must find more efficient ways to work and they have discovered the benefits of cooperation and wide networks. When projects can be distributed around the world it enables work to take place 24 hours a day. When one team finishes for the day the other can take over. Organizations being distributed require, however, more formal and stated forms of coordination, to be able to cooperate in effective ways.

Distributed work implies that work can be done regardless of geographical location. One can work anywhere with anyone. The necessary coordination between people that work together in a distributed way can be accomplished by managed distribution of work tasks, in order to know who does what. It can also be achieved through support for people to work simultaneously on the same task from different locations. Coordination is in any case essential for distributed work.

There has not been much research done in this new area and it is therefore of all the more interest to us. The studies done so far have looked at coordination from an organizational and a social point of view. We want to study the organization and what happens to it when working distributed, regarding IT and its use. That is to see how the technology is and can be used. The technological advances both in tele and data communications and in computers hardware and software have brought many possibilities and opportunities.

1.2. Objective and research question

The evolution of computer and communication technologies has enabled distributed work to become a reality. The coordination required for this is quite different from what has been regarded as normal work. We intend to explore how new IT use can improve coordination in distributed work.

The research question is as follows:

How is coordination practiced in distributed work and how can existing IT be used and developed to improve the different kinds of coordination?

1.3. Problem

To be able to answer our research question we have to deal with some problems.

- How is distributed work different from traditional work?
- How does the coordination work in practice?
- What kind of IT is used?
- What are the potentials of this support?
- Is there room for improvement and innovation?

2. Computer Supported Cooperative Work

The different research areas that will be presented here are all related to distributed work in some way. CSCW is, in our point of view, the common denominator. CSCW has all the aspects that are relevant for the study. However, related topics such as workflow management, language-action theory, Group Support Systems (GSS) and networking will be described in order to distinguish them as much as possible, even though we feel that they all relate to the same field of work, that is CSCW.

2.1. What is CSCW?

CSCW is an interdisciplinary field that looks at how groups work and seeks to discover how technology (especially computers) can support this work. The class of application created to support people that work together are often referred to as GroupWare or Group Support Systems.⁴

Group support systems (GSS) are concerned with enabling a group to interact and work independently of space and time. As shown in Figure 1, presented by Johansen⁵, there are different systems to support groups that work together regarding to locations and time.

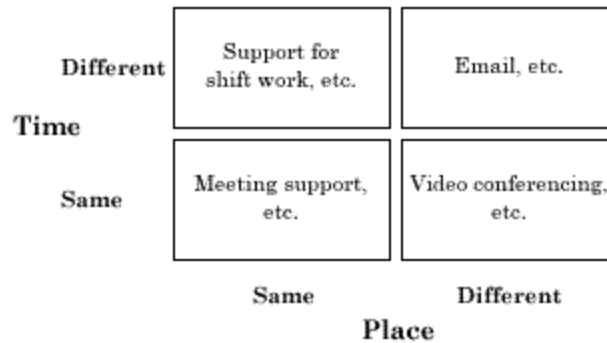


Figure 1: The different scenarios of GroupWare use.

⁴ Ellis, C., S. Gibbs, and G. Rein (1991) "Groupware, some issues and experiences", in *Communications of the ACM*, vol. 34, no. 1, pp. 39-58.

The aim is to make cooperation and collaboration as easy as possible. The technology has evolved enormously since Johansen presented this matrix. Special mention can be given to the explosion of Internet use and evolution of information technology. Software applications like Lotus Notes, ClearCase and other tools have contributed a lot in the field of GroupWare. The possibilities and problems will be discussed further on in the paper.

Much of the work and theories that are used in CSCW and coordination theory are closely related to organization theory. Mintzberg⁶ and Morgan⁷ have both written about how organizations are run and how they work, how people interact, different organizational cultures and how people work in groups. A networked organization is defined by Morgan⁸ as the loosely-coupled organic network. This means that the involved organizations are dependent of each other because they share work tasks. This dependency creates a need for coordination. The coordination is realized through collaboration in networks. The interchange consists not only of knowledge, but also of a social, technical, logistic and administrative exchange.

Networking is a new term that is very important to consider when discussing distributed work. The fact is that distributed work might be more applicable for certain types of work. Examples of such work situations would be those; that are characterized by knowledge or service work as opposed to manufacturing, where employees are assumed to be empowered as opposed to controlled, where cooperative work is assumed to be the main form of work as opposed to individual work and where IT plays an important role.⁹ It is important to keep in mind that not all work nor all people are suited for distributed work.

2.2. Coordination theory

Coordination theory focuses on the interdisciplinary study of coordination. Thoughts on coordination originates from disciplines such as computer science, organization theory, transaction cost theory, operations research, economics, linguistics and psychology. Hence it is related to CSCW. The term coordination is very broad. Cooperation, collaboration and coordination have their own connotation but an important part of each of them

⁵ Johansen, R. (1988) *Groupware: Computer support for business teams*, New York: The Free Press.

⁶ Mintzberg, H. (1979) *The Structuring of Organizations*. Englewood Cliffs, NJ: Prentice-Hall.

⁷ Morgan, G. (1989) *Creative Organization Theory*, California: SAGE publications Ltd.

⁸ *ibid.*

⁹ Ljungberg, F. (1997) *Networking*, p 3-4, Ph.D. Thesis, Department of Informatics, University of Gothenburg, Sweden.

involves managing dependencies between activities, hence different forms of coordination¹⁰. Malone has come to a specific definition of coordination, as being “the process of managing dependencies among activities”¹¹. The goal is to characterize different kinds of dependencies and identify the coordination processes that can be used to manage them. These activities can be made by humans or objects like computers and machines. Progress should therefore be made by characterizing different kinds of dependencies and identifying the coordination processes that can be used to manage them. Coordination is often noticed when there is a breakdown, when something goes wrong. It is most noticeable when it is lacking.

There are different approaches to coordinating work, top-down or bottom-up. Top-down goal dependencies, is when people identify a goal together and decompose it in different parts in order to achieve that goal. The other approach is bottom-up goal identification, people working on different things realize that the parts can be seen as a whole and achieve a new or better goal.

Malone brings up the bidirection trend of IT. That is, depending on use and situation, IT can result in centralization or a decentralization of the organization. This now comes into the area of politics and power. When a change is done to the organization it is bound to affect how people work and different power or hierarchy structures. The fact that the organization structure can change either way implies that it is not the technology or technique per se that is important, it is rather by whom it is done and what the objectives and strategies are.

Coordinating is also a question of communication between people, this brings us to language-action theory. This theory deals specifically with the way people communicate. The language and conversation is structured in a strict manner. It is therefore possible to formalize communication. Winograd and Flores suggested this new foundation for IT design¹³. Their thoughts originated from speech act theory developed by Austin¹⁴ and later by Searle¹⁵. Winograd and Flores saw that certain speech acts create recurrent structures when they are related to others in conversations. When someone is requested to do something he only has three options, accept the request, negotiate (counter offer) or reject the request. There is also the possibility of misunderstanding and any

¹⁰ Malone, T.W. (1994) ”The Interdisciplinary Study of Coordination”, in *ACM Computer Surveys*, vol.26, no. 1, pp.87-119.

¹¹ *ibid.*

¹³ Winograd, T. and F. Flores (1986) *Understanding computers and cognition: A new foundation for design*, p.65. New Jersey: Ablex Publishing Corporation.

¹⁴ Austin, J. (1962) *How to Do Things with Words*. Cambridge, Massachusetts: Harvard University Press.

¹⁵ Searle, J.R. (1975) “A Taxonomy of illocutionary acts.”, in *Language, Mind and Knowledge* by K. Gunderson (Ed.), pp.344-369. Minneapolis: University of Minnesota Press.

of the parties interrupting the interaction at any point in time. A conversation or interaction therefore forms a recurrent structure called “conversation for action”¹⁶, see Figure 2.

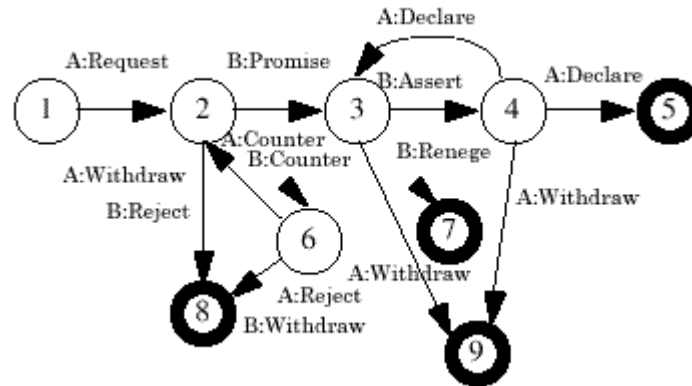


Figure 2: Conversation for action. The circles are states in the conversation, the bold circles are completion of the conversation, and the lines are speech acts.

Winograd and Flores argued that people continuously engaged in various conversations for actions and that this could be defined as commitments, which is one of the reasons people work. IT applications to support these conversation processes would therefore improve the performance of the organization. The result of their studies was the Coordinator¹⁷. The application enabled people to manage and negotiate commitments with each other electronically and was in turn elaborated into the “action workflow approach”.

The origin of Workflow management is in the automatization of office work.¹⁸ The goal was to rationalize all the work in order to make it more efficient and eventually to transform it to mechanical work performed by computers. The challenge was to implement Taylor’s ideas and principles in office work. It was believed that not only industrial work could be rationalized. Studies, however, revealed that most office work was much more complex than previously believed. Even the simplest secretarial work was very hard to conceptualize and rationalize. The figure presented by Winograd and Flores (Figure 2) can be simplified to illustrate the structure

¹⁶ Winograd, T. and F. Flores (1986) *Understanding computers and cognition: A new foundation for design*, p.65. New Jersey: Ablex Publishing Corporation.

¹⁷ Flores, F., M. Graves, B. Hartfield, and T. Winograd (1988) “Computer systems and the design of organizational interaction”, in *ACM Transactions on Office Information Systems*, vol. 6, no. 2, pp. 153-172.

¹⁸ Ljungberg, J. (1996) *Workflow management. State of the art*, Swedish Institute for Systems Development (SISU), Stockholm, Report 96:21.

of workflow (Figure 3). Once the principle is accepted, almost all work or interaction can be seen in this way, and is therefore easy to conceptualize.

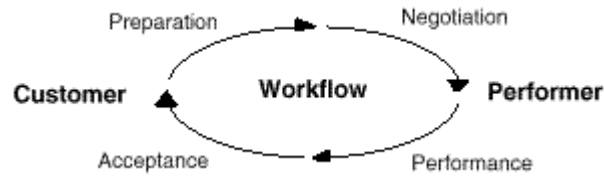


Figure 3: Structure of a basic workflow loop.

Not all situations fit this structure but it can be seen as a model, and all models are conceptualizations of reality. The main actors in this model of workflow are the customer and the performer. Situations can occur where these are the one and same person, in that case it makes the model superfluous.

Coordination theory can help to design computer and communication tools that enable people to work together more effectively and creating more flexible and satisfying ways of organizing collective human (and non-human) activity. Malone brings up all the relevant aspects on coordination needed for our study and therefore we have opted to follow his theories.

3. Method

In order to answer our question, how coordination in distributed work is practiced and how existing IT can be used and developed to improve and support the different kinds of coordination, and give a meaningful result to our study we needed to define a method. Much of the literature on research methods refers to quantitative and qualitative methods¹⁹. We chose to use qualitative methods. In order to see how people work together we had to understand their working environment. That is their working habits, routines and way of doing things. We would also have to get a clear picture about how the groups are organized, formally and informally. Quantitative methods would give us general views how the work is done. Methods for data collection like questionnaires, surveys, general leading interviews would, in our opinion, be based on biases and perceptions of reality that would not contribute to our understanding of how the work is done. If we did not understand the work situation we would have no opportunity or possibility to try to support it with help of IT and our ideas. Seeing that we wanted to support the work done by groups that are distributed, we found it natural to study a specific group that works like this. We felt that if we managed to understand a specific group's needs and furnish them with a good solution to support their collaboration and cooperation, we could probably identify more general implications. That is going from a small, individual perspective to a more general. The quantitative methods do the opposite, they try to understand the general view and apply it to specific situations. The qualitative methods for gathering data, like interviews, group interviews, observation and ethnography would, in our opinion, give us a deeper understanding of how the individuals are and work as a group. This would help us understand the working situation and the possibilities to support the collaboration and coordination between people.

3.1. Ethnography

One way of understanding a work situation is to observe how people work, what they do and why they do it. This is the fundament of ethnography. When trying to understand and improve a situation, models, interviews and organization charts are of no help if one does not look at how the work actually is done. The main critique to other approaches, as for example Business Process Reengineering, BPR, is that there is no interest or focus in how the work actually is done, but rather on how it is supposed to be done.

¹⁹ Smith, M.E., R. Thorpe, and A. Lowe (1991) *Management Research, An Introduction*, p.73, London: SAGE publications Ltd.

There are different ways of approaching an ethnographic study. One can attempt to become an invisible observer and try to keep one's presence as inconspicuous as possible. The other approach is to attempt to perform the work in question and become a user. The latter requires time and skills in the area of work that is under study, therefore, the first is often used. The critique given to this is that one's presence always affects the persons that are studied. However, people have to do their job and soon forget the observer's presence. This is especially true once a trustful relationship has been established. When the study subjects realize that the meaning of the study is not to take their jobs, but rather improve their working situation, they usually accept the presence of an observer.

Ethnography has a long tradition as a research method within anthropology and sociology, e.g. the study of foreign cultures and national communities respectively. Ethnography focuses on people and the way they interact and perform different tasks. When one tries to focus on the way things actually are done this is a good method. The connection from anthropology to CSCW and IT is becoming more and more popular.²⁰ The fact is that there is a very close connection to these ethnographical studies and the work done in participatory design and the Scandinavian School²¹. The Scandinavian School focused on the workers and their needs, how they worked and how computers and information systems could help them. These ideas originated in the early 70's. It was believed that if users could be involved in the development of information systems, the result would be better and more widely accepted. The step from participatory design and the Scandinavian School to ethnography is not very far.

The strength of ethnography is that it gives a perception of reality and of the organization that is more than just an organizational chart and formal descriptions of work tasks. Seeing that people have personal biases and the companies other biases, ethnographers do not content themselves with what people say they do. They observe what is done and how it is done. One of the problems of the traditional ethnographic tool, the pen and the paper, happens to be one of the major problems of ethnography as well. They are both very time consuming. For this reason, a study is usually regarded as finished when it begins to contain distinctive patterns. After that time whatever occurs is simply not considered worth the resources needed.

As much of the work in organizations, and in IT-development in general, the main problem is time. However, even if resources are limited already at the very beginning of a systems development project, it might be

²⁰ Hughes, J., D. Randall, and D. Shapiro (1993) "From Ethnographic Record to System Design. Some experiences from the field", in *Computer Supported Cooperative Work. An International Journal*, vol. 1, no. 3, pp.123-141.

possible to make an ethnographical study. There is a short version of ethnographical studies, “quick and dirty” ethnography. This method has the same principles as ordinary ethnographic studies but concentrates the study to a short period of time. From a period of originally several months to a year the study period is reduced to a few days or weeks. It is this form, “quick and dirty” ethnography that we have opted for. The consequences of this is that the study could be deeper and more detailed if it were longer. It is, therefore, possible that information that could be relevant for the study might have been overlooked. However, we feel that we can extract most of the essential information with a “quick and dirty” ethnographical study.

3.2. Qualitative interview

As described earlier we have chosen qualitative interviews, as opposed to quantitative, in order to get a clear picture of the specific group’s situation, problems and needs. Seeing that we were not familiar with the specific working situation of the group at EMW, it would have been very hard to make a meaningful questionnaire or other form of quantitative interviews. Open ended interviews allowed us to direct the conversation in the desired direction but also gave the interviewee large room for bringing in what he felt was important. Essential things that might not have come to our minds to ask, was much more likely to come up in this kind of discussion. The purpose of the interview was to understand the meaning interviewees attach to issues and situations in contexts that are not structured in advance by the researcher’s assumptions, and to uncover new clues.²²

A criticism of these types of interviews is that people are simply not aware of their own motives and can therefore not give truthful description of how they work. We feel that there is some truth to this. Either that the most common things, that are done mainly by routine are forgotten or not perceived by the person in question and hence you need to be an outside observer to perceive it. This is one reason why we chose to complement the interviews with ethnographical studies. It gave us an opportunity to actually observe the group in their work environment and their day to day tasks. We hoped that this would give a holistic view of how the group works in a distributed and local environment.

²¹ Ehn, P. (1992) “Scandinavian Design: On Participation and Skill”, in *Usability. Turning technologies into tools*, edited by P. Adler and T. Winograd, pp. 96-132, New York: Oxford University Press.

3.3. Process

We intended to do our study in five steps, starting with a literature survey, followed by choosing the study object, understanding the work situation, analyzing the collected data and finally giving suggestions on improvements.

3.3.1. Literature survey

Most of the research in relevant theory and other similar academic work was done in advance, since the topic has interested us for a long time. We gained a deeper understanding of the topic that helped us to understand and define what we wanted to do and what theories could be applicable. It was also important to get a picture of what had been done in this area, especially since we wanted to give EMW suggestions on improvements. Our main source was the University library and the Internet.

3.3.2. Choosing the study group

Once we got a deeper understanding of what we wanted to achieve it was time to choose a study object. We sought an international company that were networked and used IT to support its work. The reason why it should be an international or large company is that we wanted to observe the coordination of work among geographically separated people. The group should be composed of persons, who are working distributed in a project. It was critical that these workers were geographically separated and use IT as their main tool for coordination.

We came to study members from two units at the division for Mobile Telephony at EMW, located in Mölndal. We followed two persons in each group. The four people studied are civil engineers and work with technical development in projects together with persons in Kista and Nürnberg. The connection was made through Fredrik Ljungberg, research-worker at the Viktoria Institute²³ and Staffan Brodén, assistant IT-manager at EMW.

²² Smith, M.E., R. Thorpe, and A. Lowe (1991) *Management Research, An Introduction*, p.73, London: SAGE publications Ltd.

²³ *The Viktoria Institute* is a non-profit research company in Gothenburg, which works closely with the Institution of Informatics, University of Gothenburg.

3.3.3. Understanding the work situation

At this point in our study we were provided with an office and came to sit amongst the groups we were to study. This gave us a better understanding on how the company is organized and easy access to our study group. We interviewed all four study subjects, one at a time. With these qualitative interviews we tried to understand both how the organization is formed as well as how they worked in different project groups. The interviews also gave us an introduction to how the individuals work together and how they perceive the coordination between the project groups and divisions. This was done by only setting an overall agenda (see Appendix A) and then letting the person who was interviewed lead the discussion. This gave room for an open and flexible conversation. We felt that it was important that the person interviewed was in a familiar environment in order to feel secure, so we made the interviews at their department at EMW. The interviews took approximately two hours each and were taped.

In order to get a deeper understanding of the work situation we proceeded with the ethnographical study. There are different ways to do this. The first is to try to be "invisible", disturb as little as possible. Another approach is to be more active. We took the more inactive, observing roll, because of the short study there were not much time to get into the work situation in order to find tasks for us. We were interested in how the work was done and how persons actually acted in their working situations. One of the difficulties with ethnography is to gain the subjects' confidence and trust. We felt that this problem was not very pronounced, as we were clearly there only to support these people. There was also no pressure from management or anyone in the organization that our results would be implemented. The fact that the person under study fulfills the requirements of networking (i.e., empowered, service work and where IT plays an important role) also diminished this problem. This was one reason why we chose to study just this group that is they are open for new ideas to improve their work and working situation.

The ethnographic study took place after we had formed a picture of how the organization is built, which was done mainly from the interviews. We followed two persons each, for two days. It was the same four persons that we had interviewed earlier. Two of them were followed for two days in a row and the other two at two separated days. All in all we got eight days of ethnographical studies. We were there when they came in the morning and did not leave until they did. We observed how they worked, what they did, how and why they did it, who they were talking to and interacting with and what tools they used while doing this. We got a good picture of how

the work was done and could separate the more general and common tasks from the more rare. It also gave us a picture of how their personal networks looked like. That is, who they most frequently interact with.

3.3.4. Describing and analyzing the collected data

The analysis and the writing of the paper were also done at EMW. This was mainly to facilitate further contact and give a better insight of how the organization works, both formally and, more important, informally. This also gave us the opportunity to complete our data if we felt something was missing, because of the easy access to the study group.

We started with writing down all our collected data, i.e. the interview material and the notes from the ethnographic studies. We then continued with going through this material carefully, we read it several times and had many discussions about what was relevant information and what was not. This phase resulted in the description of the current work situation, described in the next section. It gave us the background and information to analyze the work situation. Our suggestions on improvements were based on the results and the analysis.

3.3.5. Suggestions on improvements

After analyzing the data from the ethnographic studies and interviews we had gained a deeper understanding of how the distributed work was supported in the studied groups. This led to a number of ideas that we developed on how existing IT could be used to improve coordination of distributed work that hopefully can be useful to EMW. We also tried to give a general picture of what happens when working distributed. What opportunities and needs will occur and what is important to think about? The suggestions were presented to the department for Radio and Signal Processing at EMW.

4. Case study

The material in this section is based on interviews and ethnographical studies. We have divided the material in four parts. First we will describe the work settings. The second part is about how the coordination of work is done. Thirdly, we will describe the problems experienced by the four persons we interviewed and studied. In the last part of this section we will present the studied person's ideas of how to improve the coordination of their work.

4.1. Work settings

To give a background to how the work is performed, we will in this section describe the organization and how the work is structured. We will also describe management, the studied persons and the tools used.

4.1.1. The organization

Ericsson is a world leading supplier of equipment for telecommunication systems and related terminals. The company produces advanced systems and products for wired and mobile telecommunications in both public and private networks, for delivery to customers in more than 130 countries.

Ericsson Microwave Systems (EMW), is Ericsson's core company for microwave communications and defense electronics, as well as the research and development (R&D) center for microwave technology and high-speed electronics. EMW's head office is situated in Mölndal outside Gothenburg, Sweden.

There is a division in EMW named Mobile Telephony Products. They develop radio base stations and the next generation of GSM base stations. The actual building of the division is located at a distance from the rest of the buildings of EMW. The division is located on two floors in this building and there are three departments. One of them, the department for Radio and Signal Processing, develop products for a base station that is going to be a part of a test net in Stockholm. This is done in cooperation with other Ericsson companies, Ericsson Radio Systems (ERA), in Kista and Ericsson Eurolab Deutchland (EED), in Nürnberg. The department in turn consists of four sections, the workers we followed, Ann-Marie, Bo, Anders and Per, work in two of these sections, see Figure 4. It was in these two sections, the section for System Development and the section for Digital Design, our study was made.

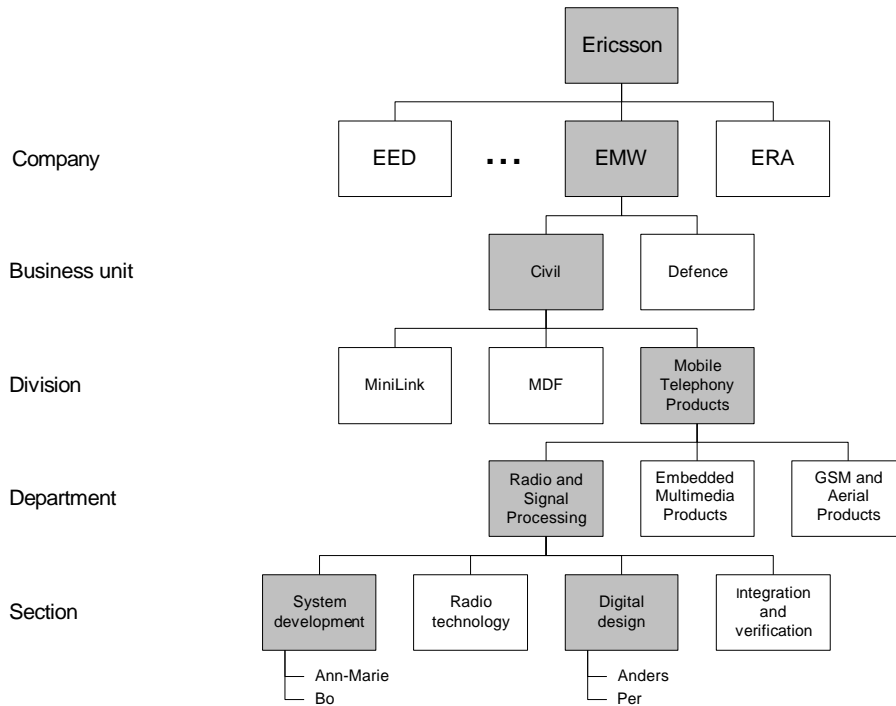


Figure 4: Organization structure. The shaded boxes show the path to the sections were our study was made.

The section for Digital Design, consists of approximately 20 people who develop products for radio base stations. They work with, among other things, digital construction, programming and digital card construction. Anders and Per, two of the subjects, work in this section.

In the section for System Development they are about 20 people too. The section is responsible for system development of radio base functions for digital mobile telephony. System construction, system studies in and construction models for base stations, are part of their work. Ann-Marie and Bo work in this section.

4.1.2. The projects

Almost all work at the sections is done in project form. These projects are mainly run by ERA in Kista. The projects are divided into sub-projects that are mutually related to each other. The main project, of the sections

we studied, with, is called WERA and is a test system for the next generation of mobile telephony. The project will lead to a new base station that will be a part of a test net in Stockholm (Stockholm Test Network, STN). This is done in order to set up a real test environment and is run by ERA.

European Telecommunications Standards Institute (ETSI) has recently set the new standard for the next generation of mobile telephony (in Paris, 29 of January 1998). It basically followed the concepts of the WERA project, but there were some compromises to other alternatives. This has resulted in another project, Wictoria, which will result in the commercial products based on the new standards. Wictoria is the next major project and will also be run by ERA.

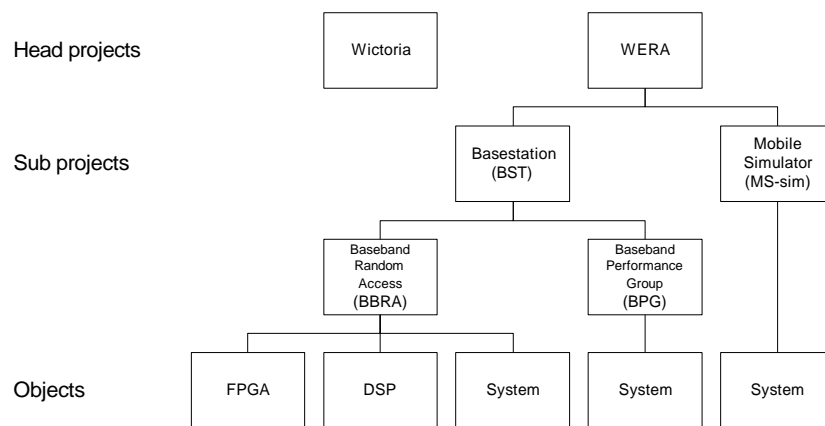


Figure 5: Project structure

The persons we followed work mainly in WERA. WERA consists of several sub projects, spread around the world and not only in Ericsson companies. Basestation (BST) is one of WERA's sub projects. The four people we studied work in one sub project called Base Band Random Access (BBRA) and another called Baseband Performance Group (BPG), see Figure 5. BBRA has two objects, FPGA (called "hardware") and DSP (called "software"). Mobile Simulator, MS-sim, is another sub project in WERA that two of the persons we followed also work in. In almost every sub project there is an object called System. One of the subjects is involved in several System objects, another is involved in two.

4.1.3. Management

The department for Radio and Signal Processing acts more as a consultant to another Ericsson company than a part of EMW. ERA buys its services for different projects. The department looks at themselves as "internal consultants", they work with an Ericsson company, but it is not the Ericsson company they belong to. They are formally employees at EMW (that is not a consultant company), but they work mainly in different projects for ERA. This leads to a conflict of identity for many persons in the department. This issue is often discussed and the management helps them to realize that they are an important part of EMW. One of the studied persons says that this is not that important for him, but that he can feel the dislike from his colleagues. Another feels that he belongs to ERA, he sees no direct connection to EMW. Another consequence of the role as consultants is that EMW does not get any credit for the work done at the department for Radio and Signal Processing. It is ERA that puts the parts together and has a product to show.

There are many levels in the organization, both at EMW and in the projects run by ERA. This demands management, and there are leaders at every level, both in the organization and in the projects. There is at least one manager for every box in the figures (organization and project structures above).

The managers in the organization are responsible for the staff in their "box". It is they who allocate time to the different projects and decides who will work in which project. They also manage ordinary personnel questions, like competence development, vacation planning and similar issues.

The projects, in turn, have their own managers. They are project leaders or object leaders, depending on what level the sub project is. Just as in the organization there are managers at every level. The project leaders are responsible for time planning and things that concern the project. Allocation of projects occurs after consultation with the unit manager. The allocation of resources (human and financial) in the projects is mainly the responsibility of the project leader, but it is common to report eventual delays and so on to the unit manager. There is not much conflict with this though, seeing that the unit managers and the project leaders meet regularly.

Most of the workers see their unit manager as their "boss" and often go to them when problems occur. This is sometimes done even if they are supposed to go to the project leader. The project leader is mainly seen as a co-worker, this could be one reason why most reporting is done to the unit manager. The groups in the objects, on the other hand, are often small. The object leaders in these groups work closely to the others in the object and here it is natural that the leaders take care of the problems that occur.

4.1.4. The group studied

The group that we interviewed and followed in our ethnographic study consisted of Ann-Marie, Bo, Anders and Per. Ann-Marie and Bo work together in the BPG and MS-sim sub projects. They have neighboring offices on the second floor in the building. Anders and Per work together in the BBRA sub project and they are located on the first floor. All four persons also work together with others in different projects and it is often the case that one is involved in several sub projects at the same time. The reason this group was chosen was because the department for Radio and Signal Processing recently changed the way of work. Research and development used to be divided into different areas or products. Work was done locally on one product. Now the department works together with other R&D in Kista and Nürnberg on the same product.

The individual can, to a large extent, influence their work specifications. At the beginning of the WERA project all work specifications were unspecified and had to be divided. The work specifications have become much clearer after hand. The work in WERA consists of different phases; system design, implementation and verification. The different phases require different coordination with different people and involve different work tasks.

Ann-Marie is a system designer, she deals with algorithms and vector simulation. Ann-Marie is mainly involved with the BPG sub project, but is partly working in the MS-sim sub project as well. There are also other groups that she has contact with, mainly with the section for Digital Design and the section for Integration and Verification. She works alone in her office, it is a typical room like the others. It has a desk, computer, telephone, white board, shelf, radio, plants and all the kind of personal belongings one might have in an office.

Bo is a system engineer and works with algorithm development. He works in several projects, mainly in their System objects. The sub projects he works in are BPG, MS-sim, amongst others. He also has contact with people in other sub projects that work with system development, system design, hardware and verification. He shares office with Justus, he is almost always present and they work a lot together even though they do not work in the same projects.

Anders is a designer in digital design and also an object leader for FPGA, which is the hardware object in the sub project BBRA. He is also engaged in the early stage of the Wictoria project. Anders shares office with Urban, who was not present during the study since he was working in Kista those two days.

Per is a system designer and works with programming and system design, implementation and verification. He works in the “software” part of BBRA, DSP. He shares room with Bosse, whom he also works with in the DSP object.

4.1.5. Tools

Many different tools are used in the every day work. The main tools are the telephone and the computer. There are computer applications for construction, writing and programming. These computer applications are not studied, as they do not contribute to the coordination of distributed work. The main cooperation with the different groups is exchange of documents and programming codes. The applications that are further looked at are the ones for sharing information and coordinate work. The different applications that most of the work for product development is done in are, amongst others, COSSAP, Matlab, Synopsis and Mentor. Applications for programming and documentation are, for example, Framemaker, Emacs and Xemacs. These do not contribute to the coordination of distributed work and are therefore not studied.

To enable distributed work the groups in Mölndal, Kista and Nürnberg share similar computer environment. They all have UNIX accounts and can logon from any computer, regardless geographical location, and work from there. This comes in handy when traveling between the locations as many do. All groups can also logon to each other’s networks, so that they here in Mölndal can change, for example, the files owned by Nürnberg. Nowadays much of the updating of files is automated, before they here in Mölndal logged into Nürnberg’s computer net at least once a day. Slow connections made this a very time consuming task.

On the following two pages we describe the tools identified for coordination of work. They are categorized regarding to their use, i.e. tools for communication, tools for information retrieval and exchange and tools for planning and informing.

Communication tools	
<u>Tool</u>	<u>Use</u>
Electronic mail programs	There are a lot of different electronic mail programs and there is no standard between the Ericsson companies. The programs used at various parts of Ericsson are very different, the range is from OpenMail, Emacs, Xemacs, and Netscape. This can lead to some format problems.
Telephone	Most telephones have loud speaker and a display to show the number that is calling. It also has a secrecy button that is used in telephone meetings. There is a function for entering codes to tell where you are when not answering, to lunch, on a meeting, back at 3, etc. This function is used by some but not everyone and not at all times.
Faxmachine	There is on every floor, it is sometimes used during telephone meetings if information needs fast sharing.
Section cellular	There is a cellular telephone that is available in every department and can be borrowed. It is used when going to Kista and when out of the office.
Post-it notes	Post-its are widely used. They are sticked to computer screens, telephones, doors, whiteboards, etc. They are also used to pass information to each other.

Tools for information retrieval	
<u>Tool</u>	<u>Use</u>
Netscape Navigator	Netscape is the web browser in use.
Ericsson's intranet	All information about the project is published on the intranet, and is administrated by Kista, with links to reports etc. Anders, e.g., uses these pages to check time plans, names and positions in the project. There is a page called "WERA today" that he uses if he knows what he is looking for. Per, on the other hand, does not use the intranet very much as it is hard to find the information looked for. However, there is a personnel directory that is very practical which he uses, especially when contacting people in Kista.
Hardware alert	A web-based error handling system, used in FPGA- projects. Any kind of trouble that concerns development and construction of the cards can be reported here. The issues are handled at telephone meetings with all the object leaders for FPGA sub projects. The meetings are held twice a week, and Anders is one of the object leaders. The issue might lead to a trouble report in TR-tool (see below) if it is considered a serious problem.
TR-tool	An application for handling trouble reports. Someone in the project registers the error, every location has an expert in the project who handles the report and directs it to the right person. The report can not be erased, but can be set to different levels of priority and status. Anders reads TR-tool every morning.
Tele	An electronic telephone book that includes all EMW's employees. It is easy to search in and is widely used.

Information exchange tools	
<u>Tool</u>	<u>Use</u>
ClearCase	A revision handling system, that gives a graphical view (tree structure) of document files and all its different versions, it organizes the files in use in “models”. The graphics also show how the computers handle the updates, which direction the synchronization of files is done. The system is synchronized regularly, this enables everyone to have the latest versions of all the files. The owner of a model is the only one that is able to make changes in it, however, all the others can open it. The responsibility is not personal, rather per unit or geographical location. All deliveries to customers are done here, by changing the label on the files to deliver.
ClearCase Environment	Helps visualize the structure of the work with the files. Which documents to work with and versions of documents is defined here. Different views are used depending on what part of the product is to be developed. This way all related documents can be in the same view, i.e. the ones needed for a specific product or sub project. It is also possible to see who is working in which views in ClearCase Environment and if the files are checked in or out or are reserved.
ClearCase Diff	A function in ClearCase where two different versions of a document can be compared. The changes are highlighted and different styles and colors can be set to define the kind of changes and who made them.
PRIM	A document archive, it also contains product administration, overviews and product documentation. PRIM is also a register for product number and registration notation.
GASK2	A document archive.
Delta	A system to get version numbers of documents. Delta, as well as PRIM and GASK2 are used to search and retrieve documents.
FTP	An application for transferring files that is not widely used at the department. The files are usually attached to e-mails if they need to be send, when the files are not in ClearCase. FTP is used as an emergency solution.
Newsgroups	There are newsgroups in EMW that discusses various issues. Some of our subjects read it sometimes, but not regularly.

Tools for planning and informing	
<u>Tool</u>	<u>Use</u>
Calendars	There are several calendars in use. It is common to have at least two, one electronic and one paper calendar. Some of the workers have two paper calendars, one agenda and one that is lying on the desk. Updating must be done in all of them if they shall be up to date.
Whiteboards in the offices	In almost every room there is a big whiteboard on the wall. It is used for project and technical information. When discussing technical issues it is often used to illustrate ones point and to clarify.
Small whiteboards outside the rooms	Outside the rooms there are small whiteboards with a pen attached to it. They are supposed to be used to tell where you are if not in the office. Some persons use this frequently, while others do not. This is a rather new system.
Common whiteboards	There is a common whiteboard outside the reception. Information about where the managers are is supposed to be noted here. There are also whiteboards with information about the projects and the presence of the others working at the department. These are positioned in the corridors and were not used or updated once during the time we did our study (three months).

4.2. Observations

The organization is well aware of the need for coordination of work and tries to support it as much as possible. The sections have documented the way coordination should be achieved and the section's different contact bases. The document also identifies the different kinds of groups the sections need to cooperate with and how this could be done.

A lot of work is based on communication. It is important to be informed of what is happening and inform others of what you do. This is done in many different ways, formal and informal meetings, e-mail, intranet, telephone and other computer tools. Under our study we tried to identify the different ways the workers coordinate their work and we distinguished some forms of coordination.

- Local coordination - The coordination of everyday work between workers in one location, that is present in most organizational forms.
- Distributed coordination - The form of coordination required between the different geographical locations in order to perform the work tasks.
- Coordination within projects - The communication processes to coordinate work within a project group.
- Coordination between projects - Different projects that are dependent of each other, have to coordinate their assignments to know how they affect each other.

The coordination tools that we listed earlier can be categorized into these different forms. There are meetings to support all of these types of coordination, therefore, meetings will be brought up in a separate section.

Before we get into the details we would like to highlight the importance of e-mail. E-mail tools are mostly used to coordinate work that is distributed both within and between the projects. However, it can be used to coordinate local work as well. The most common thing that is done when arriving at the office is to unlock the computer and open the e-mail program. This is as natural as it is to take off your coat, it helps people plan their day. A new e-mail about a meeting can change the structure of a future workday. The e-mail programs are frequently used during all of the day. The computer is not only used as a working tool, but also as a communication tool. It is a central artifact that both consciously and unconsciously affects the way of work.

4.2.1. Local coordination

We saw that most of the communication between co-workers at the same place is informal, whilst the communication with others that are in other locations is more formal. We are here going to exemplify ways in which local coordination takes place.

The fact that there are two floors in the building is important and has an impact on the way our subjects choose to communicate. In order to talk to someone who is on the same floor, it is most common to take a stroll over to the person's office to see if he is there. However, when it is someone on the other floor, it is more common to telephone or e-mail.

There is one printer per floor, which means that you have to go and get your printouts. This is very good because on the way to the printer people run into each other. Errands are then made. Informal meetings take place and people are more aware where others are and what they are doing. Often they go around the halls to look for a person, but do not always find them. Instead they run in to other persons that can be asked and give a little information.

Seeing that a lot of people move around makes it sometimes hard to know where everyone is. A lot of time is spent looking for people and trying to find out what they have done and are going to do. The methods of locating persons can be far fetched. People can take qualitative guesses of where the person is or who to contact that might know where he is. Sometimes a person is found by accident whilst running in to or talking to someone else. If someone is not found, there sometimes is an alternative way to solve the problem. Things can be postponed or altered. The following quote shows how work is affected by others and can be changed.

Per: "Have you been talking to anyone higher about this?"

Torbjörn: "We can go to Anders and talk to him now."

P and T go to see Anders, but a sign on his door says that he is in Kista.

P and T stand in the hall and have a technical discussion.

P: "Our group can set the threshold ourselves, as long as everyone knows."

T: "Yes, you can."

P: "Are you here on Thursday so we can talk to Anders then?"

T: "Yes, I am."

The way of coordinating and keeping track of information can be very informal. Critical information can be written on a small post-it note. It might then be placed on someone's desk without him knowing.

Persons that work closely together physically sometimes prefer talking to someone familiar rather than someone else even though it would be much better to do so. This is the case despite of the small problems mentioned earlier with two floors. This is because knowledge and experience is shared with their local colleagues even though they are not working in the same project. In this respect, Kista is regarded to have an advantage seeing that they are bigger and have more employees. It is easier for them to work with each other since they all are at the same place and can share all the collective expertise.

4.2.2. Distributed coordination

There is also the situation where our subjects work together with people at a different location. This can be persons in the same project or people who work with similar tasks in other projects. For example, the unit and project leaders often talk to other project leaders to keep themselves updated. Much of the work is lead by project leaders that are located in Kista. Apart from the regular telephone meetings to coordinate work and solve different problems, it is very easy to go to Kista. This can be decided very fast in a dynamically way. There is some procedures to go through as booking a train or plane ticket, filling in the travel report form and so on, but this is not seen as a problem.

Apart from the main communication medium, the e-mail, there is also the paper mail. This is often taken when one happens to pass by the mailboxes. As mentioned earlier e-mail is used extensively. The telephone is also used. There are also periods and situations when e-mail is more used and other when the telephone is preferred. Directly after delivery of products there are many telephone calls to report errors or ask questions. If the response is not urgent e-mail is often used.

Once a relation is established with a person, further collaboration is facilitated, despite of geographical location. It is this initial contact that has to be made.

4.2.3. Coordination within projects

There are differences in the coordination *between* the project groups and the coordination *within* the group. In the BBRA sub project there is an informal way of working, they all sit in the same building and there is direct communication. In the BPG sub project they try to work as one group, even if they are located at different places. The three locations (Kista, Mölndal and Nürnberg) have been working isolated even if they share the same database. In the BPG sub project there is a telephone meeting once a week, they also meet in person every two or three months. The groups have had a lot of meetings and social activities to get to know each other. This has been working well although there are some cultural differences.

A specific case of coordination is when two people that work in the same project also share the same office. They plan their work in different ways than those who are not in the same location. They frequently discuss problems and work closely together.

ClearCase is the main tool used to share documents in the projects. ClearCase gives a good view of how the document has evolved over time. However, there is also need for documentation to explain the work done for future use. This is often the part of the project that takes time. Everyone knows that it is important and that there should be more and better documentation, but there is often no time to allocate for documentation. This is especially the case when the project is late or other projects are taking ones time. The fact that there often is no documentation makes it hard for someone else to get started with taking over someone else's work. However, when the person is available locally or by telephone this is not much of a problem.

4.2.4. Coordination between projects

Most of the work is coordinated at the start of a project. When the projects have gotten started and are running there is not as much need for working together with the other places as in the beginning. Most of the work is then already divided and distributed. At this point the project groups can give their different parts their own priority. However, it happens that similar problems occur in the different places and this is not identified until later and therefore creates some double work. When this becomes apparent, by being brought up in a telephone conference or e-mail, a general or one solution is chosen.

Not all the work done in one project group is always taken in account in the work in another group. For instance the work done in the BTS sub project definitely affects the work in the MS-sim sub project and it is

also the case that much of the work done in BTS could be reused in MS-sim. Another example is the work with TX- and RX- modules. Nürnberg develops TX- modules, whilst Kista develops RX-modules. Both need the others module for testing, but instead of using each other's modules they make their own. One reason for the parallel way of work has been lack of time. The thought is that the work shall be more coordinated in the next project, Wictoria.

People may work in several projects at a time and a lot of the projects affect each other. The work in one project might be crucial for the work and result of another project. It is also the case that if one project is delayed it requires more work from persons that should work on another project at that time. This can create complications for the project leader that is not aware of the status on other projects and who is involved in them. The part below from a project meeting shows several problems due to the project. Nothing in the project has been done, it is low prioritized by the members in the project. Another problem is that the project leader is located in Kista, while the others are located in Mölndal.

Project telephone meeting.

Bo, Justus, Anders and Sven are in one room in Mölndal. Telephone person (T) is in Kista.

T: "Have you got the time plan?"

S: "Yes, but we haven't read it."

T: "OK. We can go through it together."

Comment: The connection is broken. They telephone again.

T: "OK. We'll start going through the time schedule."

A: "I don't have time to do this document (first thing on schedule)."

T: "OK. Bo, can you take over?"

B: "Well, I see that it has to be finished before the end of the month, so I guess I can, but I don't know much about it."

T: "Should we do a workshop to find out what functions are needed?"

A: "Well, that's not the hard part."

T: "It is a quite hurrying function now."

B&A: "Yes indeed."

T: "How long time can it take?"

A: "About two weeks."

S: "That means the 34th if we don't want to go into April."

T: "Well, let's say the 3rd of April as a deadline, and I'll put your name down."

B: "OK. It's only a paper."

T: "Is it a realistic date?"

J: "We need to know exactly what they want."

T: "Maybe we need a meeting with everybody. How long are you on the project?"

S: "I haven't discussed it with AF yet."

Comment: AF is the organizational manager.

T: "Anders, what about your document, have you started?"

A: "No. So it won't be finished before the week of the 9th of April."

T: "How long is Bo in the game?"

B: "That's not decided."

A: "There is no decision on S3."

T: "Who will be responsible for it?"

B: "I don't know."

T: "We can just get a hold of the right people."

J: "Product management should be there too."

A: "If the guys from BBRA are present it is easier for them to accept the decision."

J: "It is a big potential job for Digital design. When can we do it? After Easter."

T: "Won't MS-controller be late then?"

B: "We can send out a PM or something."

Comment: Another telephone rings, no one answers.

T: "How are the plans for the Easter holidays?"

J: "Me and Bo are away week 16."

A: "The R4 project has been delayed, that means that me and Justus are nearly indisponible in April."

T: "What do you have to do with R4?"

A: "We have to talk with ATJ about allocating work. As it is today we can't say much about S3."

J: "We prioritize S1, S2, R4 and S3 here. On the other hand we have found out that it is not that much work with R4."

T: "Could you try to see how much time your work with R4 will take?"

B&J&A: "Yes."

J: "We can talk about it next week."

T: "OK, good. Well, not good, but OK."

J: "Anders and I can send you a plan on Monday so we don't need to have a meeting."

S: "Who promised that we should include GPS?"

T: "I discussed it with Thomas, OK. Bye."

This project meeting shows that there is an influence on one project if others are delayed. Things are not done in time and someone has to prioritize what has to be done and what should be left for a later stage. It is also the case that different projects are very closely related to each other. As we have seen people work in different projects, some in parallel with others. All projects need to carry their own costs so people have to report how much time they spend on each project each week.

4.2.5. Coordination through meetings

Distributed work is handled with a lot of communication and sometimes physically meeting with the other members of the project. These meetings can be planned in advance or occur in a dynamically unplanned way. Meetings are held regularly. This is how most of the coordination between and within the projects is done. The section (organization) meetings keep the people in the local group informed on what is happening in the different projects and locally.

The sub projects meetings are an example of local coordination. They are held about once a week, where the project leader reports what happened on the project meetings at higher levels. The work is also organized and distributed. Different status and responsibilities are discussed.

The section meetings are also an example of local coordination, but between projects. They are held once a week, on Mondays. Seeing that people work in different projects, it gives a general overview of what is happening and how the different projects are doing. General issues are also discussed.

When it comes to distributed coordination, telephone meetings are widely used. One of the subjects thinks that telephone meetings are not the best solution. They have low efficiency, mainly because of bad discipline, people are late, are not prepared, use their own whiteboard while explaining and talk at the same time. The other subjects think that the telephone meetings work well and fulfill their requirements.

Project meetings are normally telephone meetings and are held once a week. This keeps all the members of the project up to date on what is happening. The project leaders handle these meetings. They are structured differently. The telephone meetings we have described in this section are all different in some way.

The following conference (in the quote below) consists of about 10 people from the three offices, that work together in a sub project. Here is a recapitulation of what has been done in the past week, the situation report and what is expected to be done in the following week. Specific problems and issues that might be of interest to everyone are also brought up.

Bo and Ann-Marie are in her office. The telephone meeting starts a few minutes late. Two out of the three from Nürnberg are in Kista. The connection is lost. Another attempt is done, the connection is up again. All parties are present. The connection is lost again.

Ann-Marie: "They might not have noticed that we lost the connection. They just think that we are being quiet."

Comment: There is a button that normally is pressed for privacy so that one can talk with someone in the same room without the others hearing or getting disturbed.

A-M: "I'll send him an e-mail."

The connection is made again.

Mattias: "So how much of my speech did you hear?"

Nürnberg and Mölndal: "Nothing."

M: "OK. I started with some general information. I am going on vacation in two weeks. So that meeting is canceled, but the status report should be sent to Lars. Ann-Marie and Bo, when do you arrive?"

Comment: They are going to Kista tomorrow.

B: "About 10 am."

M: "OK, after lunch we will see what needs to be discussed further. Let's start with the status reports."

Comment: First person talks very softly and can not be heard. Both Bo and Ann-Marie complain but not so the others can hear. Most people apart from Bo and Henrik have already sent e-mails for the status report. These will be put together with the rest of what is said in the meeting. The discussion in the meeting continues.

B to A-M: "What is the problem?"

A-M: "I don't know."

This shows that everyone is not aware of the presence or non presence of people in telephone meetings. Seeing that people try to be as quiet as possible to not disturb, the others are not aware of them if they happen to lose the connection. When two persons are in the same location there are conversations between them that the rest of the group does not hear. This does not occur in a normal meeting. They have opinions, remarks and

questions, but do not share them with everyone. This is because they do not want to disturb or prolong the meeting unnecessarily. The project leader of the group in the meeting above has organized the meetings in such a manner that all the members send him an e-mail with their status report for the week. This allows him to structure the meetings and can be placed directly in the minutes of the meeting that will be sent to everyone in the group the next day. This meeting also has a ClearCase point in the agenda, every week. The problems with ClearCase will be brought up later, but it emphasizes that there is a problem, seeing that it is a standing point in the agenda.

Every Tuesday and Thursday morning Anders has a telephone meeting with other persons in several projects who are located in Kista and Nürnberg. The persons present are, among others, a hardware responsible and other object leaders, all in all about 15 people. This is an example of distributed coordination and coordination between projects. Before the regular telephone meetings an agenda is created (this is done in Kista), this agenda is published on the intranet and can be updated by the members of the meeting. When being in the telephone meeting the site is in front of them.

Anders gets coffee. Comes to the office and unlocks the screen. Prints out the e-mail from yesterday about the meeting. Gets a new e-mail about the meeting, but Anders is missing a list that he usually gets with this mail. Uses the intranet, the project pages, to read about hardware alert. There are different symbols for different status. Now there are three new issues that will be discussed on the meeting.

The different tools used are presented earlier in the study. This shows how Anders prepares himself for the coming telephone meeting. There are various sources of information that he looks through. Even though Anders has met all of the people involved in the telephone meetings, but he feels that there is a big difference between that group and the one he works with here, who he meets daily. There are also cultural differences. The Germans for example are very formal, which can lead to that they can stop the production for the only reason that there is a document missing.

4.3. Problems experienced

In this section we will bring up the problems experienced by the subjects and others that work at the department. The main problem, as we could see, is the use of ClearCase.

4.3.1. ClearCase

As described earlier, ClearCase is a revision handling system. It is the main tool, besides e-mail, that is used to coordinate each other's work. ClearCase is one of the organization's formal support for distributed work. Much of the work evolves around ClearCase and there is a lot of debate around it. How it is used, how to go around some problems and how it should be used are issues that come up regularly.

Per reports on the status in the lab, refers to the telephone call with Knut from the morning. Mikael is a bit worried to get the wrong versions when he picks up files from the different views, because Knut is not here and Mikael doesn't know how far Knut has gotten. Anders says that this is no problem because they all have been away for some days and no one has been working on the files. The ones who had the views hadn't dared to check-in the files. But it is important to check-in the files to be able to keep the track of them. Anders shall see to that the files will be checked in as soon as they return.

Anders and Per continue to discuss the problems with ClearCase. There are problems with the labels and that it could be "dangerous" to check-in files, but they agree on that this must be done. They find out a way to do this, which also eliminates the risks, and agree to try this way (by using date in the label) which would not be so much different from the way they are doing it today. Anders says that he will inform his guys.

When a file is checked-in it is regarded as finished for the time being and someone else can pick it up and continue the work. This has the consequence of files being checked-out for a long time and people not knowing exactly what is going on and what has to be done.

Per opens ClearCase Environment and looks at the files in Bosse's view that are checked out, to see if there are any he can use. He opens a document in Emacs and looks at the changes in the code. Per also uses ClearCase Diff to see this, and looks at files in Knut's view to see what Knut has changed. Per wants to use one of Knut's reserved files and makes it unreserved. If Per had met Knut he would have told him, but now he just does it. He must be aware of the view in which he is working so he does the right changes in the right views. He sends an e-mail to Knut to tell him that he has used his view.

For practical reasons people borrow each other's views. If changes are made, the person that owns the view has to be informed about them.

Ann-Marie thinks that there are some constraints with ClearCase. For example, she says that it would be nice if COSSAP could have supported ClearCase, that the functions of ClearCase were integrated in COSSAP. She does not feel very comfortable in writing scripts in ClearCase. Sometimes the person that has written the scripts is not familiar with the problem and misinterprets what needs to be done and this is a source of error and irritation. The main problem that occurred in the coordination was at the start of the project, where the use of ClearCase was not commonly shared by all members. Ann-Marie felt that Nürnberg, who did not have the same experience with ClearCase, turned down all their proposals. This was frustrating. It was very hard to share files. Before ClearCase was implemented, FTP with no version handling and visual aids, had to be used. It therefore took some time to get the coordination flowing. ERA choose to use ClearCase in the projects due to pressure from Mölndal, who had used it before.

Ann-Marie, on the telephone: "You have to go to the model and see what branch people are responsible for. That's how we have distributed the responsibility. He has changed it somewhat but we have the responsibility. Why can't they use the one that exists?"

Comment: She opens e-mail and reads the e-mail in question.

A-M: "What model are you looking at? Yes, that's because Göran changed it at one point in time."

Comment: Opens ClearCase. Looks for the particular model and opens it.

A-M: "It's not supposed to be there. We ran a script at Christmas, that Ralph wrote. All the models moved out to a branch. We can't check it in in main because it becomes a branch. We made a list of all the models and decided who should have the responsibility of each model and Per is supposed to be the one responsible in Mölndal. They have a problem with the search, so it seems that they have tried to work around it with this."

Per and Anders discusses problems with versions in ClearCase and how they are named, some are renamed from a, b, c... to 1, 2, 3... there is no standard way.

There are several local solutions to different problems. Different sub projects and sections do things in different ways. This creates discussions on which way is the best and how it should be done.

Ralph, in telephone meeting: "The problem is that we can not accept common files in ClearCase. We have to verify what we should do. If we should have three or four log files, or only one. There are also two branches (in ClearCase) of one model and only one executable file. We should delete the branch that is obsolete. This will be done by our ClearCase expert."

The configuration file is very vital for the use of ClearCase. It works as a filter so that the documents that are shown in the tree structure are the correct ones. To change things in this configuration file one has to know how ClearCase works and how to write the selection criteria. This is regarded as cumbersome and therefore it is easier to copy the configuration file from a colleague. The configuration file allows the user to see specific documents. With different views one can work with different configurations and see different documents. One can either borrow someone else's or get more views.

Ann-Marie: "I mailed Owe to get more views in ClearCase."

Bo: "OK, that's good when doing prestanda simulations."

A-M: "OK. For the views, should I get some for everybody?"

*B: "Well, that might not need to be personal views, but get one view for every person anyway."
Opens ClearCase.*

B: "I have to login in Nürnberg to change that."

B: (About model in ClearCase) "Ralph has checked it out. How has he done that?"

A-M: "OK. Forget about that then."

B: "I can try to check it in."

A-M: "Can you do that?"

He Tries.

B: "Apparently not. I'll send him an e-mail."

Composes e-mail. Sends it. Moves other mails to folders. Ann-Marie leaves.

Closes connection with Nürnberg and ClearCase.

The fact that there is no common strategy in how to use ClearCase gives a lot of room for homemade local solutions and open critique to other places where they do things in another manner.

4.3.2. Problems with lack of standards

During our study we noticed that many problems occurred because of the lack of standards. There are no standards concerning which tools to use and there are no directions for use of these tools. In this section we describe some of the problems that are related to this.

The different systems, programs, applications and environments require different passwords. This is seen as unpractical.

Bo: "The intranet is another option, but it's not easy to reach, you need a password to get in. You also have passwords for the UNIX account, the e-mail program, the Windows center and one for Nürnberg and so on, there are about ten different passwords to remember. One could think that once you logged on the system you were clear, but this is not the case."

Bo thinks that this could be a remaining from the military era. In Kista they do not seem to have the same problem.

EMW's firewalls can be a problem. To connect remotely to another system (Nürnberg, Kista) is slow, due to the bandwidth. There are technical limitations and EMW has restrictions, for example Java-scripts are forbidden, that makes it harder to search for information.

Some project leaders, managers and secretaries use PC:s rather than UNIX which is used by the engineers. This can create some problems and some extra work.

Ann-Marie has received a project plan as an attachment in e-mail. It has to be opened in MSProject. She opens Windows and looks for it. She telephones Jörgen to help her. He follows the installation process step by step with her through the telephone.

There is no problem to actually read the documents seeing that the PC environment is accessible from the UNIX system. However it created more work, as in this case when the program in question had to be installed. There is, however, local help that is available to support difficulties in handling this kind of problem.

4.3.3. Problems with working in projects

It is important to know who does what. Which person to ask and who is in charge.

Comment: Ann-Marie and Jonas go through her COSSAP work.

J: "I wonder what has high priority? Who decides that?"

A-M: "The project manager."

J: "Who should I talk to when Carola is not here?"

A-M: "I don't know, telephone Nina. She should know who to talk to."

J: "I need to know what channel to work on and more details. I don't think they can deliver tomorrow."

A-M: "Neither do I. Well it's better to concentrate on the people here since we can't get a hold of them in Kista. I'm going to save the files so they become elements."

J: "Good, then I can work on them."

Per: "Is Knut here?"

Bosse: "He is in a meeting."

P: "It is important that I get started now, if he isn't."

Later: They discuss who is/is not here. B goes to see if Knut actually is here.

There is a function in R3 that Per is going to look into now, but he doesn't know who to contact to see what have been done so far.

4.4. The future

During the interviews we talked about the future and their ideas of how to improve coordination. We wanted to know what the four subjects' picture of how distributed work can look like. One thing they all mentioned was that nothing can beat the personal, face-to-face meeting. Body language and face expressions say a lot. There were different opinions whether virtual meetings were the answer or not. As one put it:

"I do not see a need for virtual meetings or video conferences. Mail and the telephone are mostly enough. Phone meetings are simple and functional and is complemented by the web."

However, they all agreed on that virtual meetings could be an alternative when personal meetings are not an option, if the feeling that you are all in the same room can be achieved. Another thing that they all mentioned was that a shared whiteboard, where everyone should be able to draw and write during the phone meetings would be useful. This, they think, would improve the telephone meetings a lot.

Per said that for future distributed work it is important to meet the people one is going to work with at the beginning of the project. This is more important than one can imagine. It is also important to become more and more used to working distributed so that you gradually feel more experienced at it.

One general wish is for the net to be integrated with Kista's and Nürnberg's nets. As it is now there are some problems with paths, scripts and versions. Another problem is with passwords and firewalls, the study subjects think this would be solved if they were connected to Kista's net instead.

Bo thinks that the groups in the BPG sub projects that are geographically separated, needs to be more integrated and coordinated. It would be good if the work was based on modules and that the different groups would work tighter together.

“Compatibility and cooperation between Mölndal, Kista and Nürnberg would be great.”

5. Analysis

We have seen that distributed work is not much different from traditional work it occurs in one location. However, there is substantially more coordination with regard to other locations. The IT applications used for coordination of distributed work are mainly ClearCase, e-mail and the intranet. None of them have standards with regard to their usage. ClearCase seems to be a powerful tool with a lot of possibilities. The problem is that not all people are knowledgeable enough about how to use ClearCase.

Distributed work requires different forms of support from the organization. When the different dependencies have been established it is important to manage these coordination processes effectively. The main problems that are seen are not what kind of IT applications or other tools that are used, it is rather their use. Different locations and organizational divisions have different habits and ways of doing things. This creates problems when working in project groups.

In practice there is a lot of coordination within a project. There are regular telephone meetings and information exchange. There is, however, room for improvement, especially when it comes to the use of existing IT applications that are used for information exchange. The coordination between projects does not seem to work satisfactory. This has to be dealt with from the project leaders and management.

5.1. Organization and project structure

The organization structure works as a base to support the work done in project form. Seeing that the projects are very dynamic, the organization structure is the only thing that actually remains somewhat stable. The fact that the department for Radio and Signal Processing belongs to EMW in the organization structure, but works mainly in projects that are run by ERA in Kista, creates some practical problems. The practical problems with this are different e-mail standards, low bandwidth and different intranet solutions. A consequence of working with different Ericsson companies is that there are several networks to login to, with various passwords. This is cumbersome and seen as a rather big problem.

There are also some political problems that can be seen as well. The main problem is a question of who the employer is and which company the workers actually belongs to. Does their organization belong to EMW, or to ERA, who they work with in the projects? This is a stated problem that is discussed locally. However, it is not

something that is always brought up or thought of, but it is a burden that sometimes has to be discussed. A second problem is that when new products are shown by ERA, it seems as all the credit goes to them and nothing to the department for Radio and Signal Processing. This creates some distance between ERA and the division. Thirdly, there is also the alienation from EMW that is reinforced by the fact that the division is located in a building away from the rest of the newly rebuilt head offices of EMW. The fraternity amongst the local colleagues is constrained to the division and not to the rest of EMW in Mölndal.

5.2. Way of working

When doing our study we tried to identify different kinds of coordination. Malone says that “coordination is the process of managing dependencies among activities”²⁴ and it was these dependencies we tried to find. Our observations showed that distributed work requires different types of coordination. The result showed that there are some forms that emerge. We have identified the different coordination activities and present them in the figure below (Figure 6).

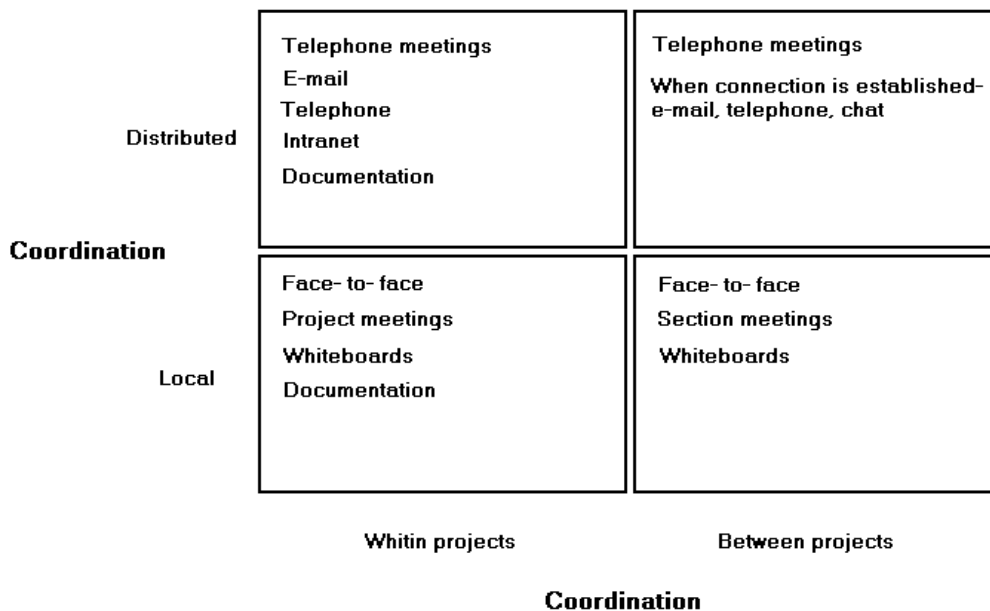


Figure 6: Categorization of coordination activities.

²⁴ Malone, T.W. (1994) "The Interdisciplinary Study of Coordination", in *ACM Computer Surveys*, vol.26, no. 1, pp.87-119.

5.2.1. Local coordination

When working at the same location there are many informal ways to coordinate the work. People run in to each other in the hallways and can leave each other notes. There is always someone familiar around and with whom one can talk to, at the department everybody knows each other. There are also formal ways to coordinate the local work, like the weekly section meetings.

Communication that takes place locally is independent of project groups or organizational belonging. People talk about different projects, problems and solutions and help each other. This is a direct effect of the different projects being so dependent of each other. They are all civil engineers and have similar work tasks. It is easy to stay informed of the status of the different projects locally with informal communication and in section meetings.

One issue, however, is the problem of finding persons and knowing if they are available or not. A lot of time is spent looking for a person. As people have meetings, travel or might have a day off, it is very hard to know where they are and when they are coming back. It is an even bigger problem when one does not know what the person has been working on lately. The fact that one person travels to Kista might affect someone else's work. Sometime it is hard to be aware of how one's work and plans affects others and their work.

The tools used to try to cope with this problem, of knowing where people are, are various. They are all possibly good solutions but the fact that there are many solutions makes it a problem. There is the telephone, electronic calendar, and different whiteboards, both on each door and a general one for the different floors. Some tools are not used at all, while others are used in an ad hoc manner.

Most of the people work very closely with a few others. It is mainly these persons that are contacted when there is a problem of any type. This is even the case when the person in question is not really qualified to help. It is preferred to talk to someone familiar, rather than contacting someone that has the specific knowledge but is located in another location and not part of the personal network. As one might suspect, when people share office their collaboration with that person is very close even if they are not in the same project.

When sharing work or taking over someone else's work, a lot of explaining has to be done for the new person to understand the background. This process takes many different shapes. If the person is present one talk to them,

if not, they leave post-it notes or write an e-mail. The main problem occurs when the person is not aware of that an explanation is needed and has “disappeared”. The person that needs to be reached could have gone to Kista, be in a meeting or taken the day off and has not updated his whiteboard outside the room. Sometimes one succeeds to reach the person on the telephone or to get a quick answer to the mail sent away. If one does not manage to reach the searched person one might be able to find someone else that can inform you. Another option is just to wait with that task and do something else in the mean time. This is of course not a good solution and there should be an easy way to keep each other updated. There should also be an easy way to keep track of people, so they can be located. The small whiteboards outside the rooms is a system for this that is rather new. One problem with this system is that one does not know if the information is correct or not. A sign can say “In Kista” for over a week, whilst the worker has come back three days ago and is now in a meeting. Seeing that this is a new system, this could be a problem that will disappear when people see the benefits of using the whiteboards as they are meant to.

With the methods for sharing information used now, with post-its, e-mails and verbal communication, there is a risk that important information can disappear and not reach the right persons. There is also the possibility that information is not getting through. A lot of information is exchanged in an informal way, e.g. when running in to each other in the hallways. This creates room for assumptions and rumors. Some assumptions are later confirmed or denied, but sometimes one just has to guess. Meetings provide the formal way for exchanging information and will be discussed later.

5.2.2. Distributed coordination

Distributed work is coordinated in many ways. One common way to communicate is through telephone meetings. We found many problems with this kind of meetings and we will analyze them below. The main tools for distributed work are the telephone and e-mail, the documentation is shared through ClearCase. The problems with ClearCase will also be discussed further below.

As work is distributed and project groups are formed by persons from the three different locations, Mölndal, Kista and Nürnberg, it is important that there is some formal support from the organization. This is handled very well in the studied department. When someone needs or wants to go to Kista the person fills in travel report form and books tickets. As the work can be very dynamic, these trips can be very spontaneous.

5.2.3. Coordination in projects

The majority of projects are run by ERA in Kista and the members mainly come from Kista, Mölndal and Nürnberg. This requires coordination within the project group. It is important to know what the other members of the group are doing and eventual problems they might have. When work is shared it requires communication between the participants, e.g., when one person takes over someone else's work. If the person is located in the same building it might be easiest to talk directly to him. If he is not there at that time it is preferred to wait for a later opportunity, instead of making a telephone call or leave a note. If the person on the other hand is located somewhere else a telephone call is made or an explanation is written in an e-mail. Work is done differently when working in a distributed way rather than locally. The communication with persons that are not located in Mölndal is not as straight forward and open as it is locally.

It is important to find the right information, to stay updated in the project. There are several ways to give and get information. Using the web is one way that is used at the department. EMW has an intranet with information about the organization, the projects and other things that can be of interest to EMW's employees. The problem for the sections studied is that the project information needed is presented on ERA's intranet, so they have to login there as well. ERA's intranet is perceived as unstructured and hard to find information in. The main reason is said that it is constructed after the organizational structure of ERA and does not follow the project structures. Therefore it is not used to its full potential. It is easier to ask someone nearby or make a phone call, than to search for the information on the intranet. However, the intranet is used sometimes. This happens when it is known where to find the information or when the function has been used before. It seems that there are favorite spots that are used frequently. If the intranet was widely used it would enable information sharing and maybe create an even better unity amongst the project groups and between the different locations.

The fact that documentation is the first thing that is neglected, or overlooked when there is a shortage of time and resources, makes sharing work hard. It is understood and agreed that documentation is very important, but it seems not to be very highly prioritized. This can be a problem in the near future when someone else takes over a product or uses it for further development. Everyone is aware of the importance of documentation and that not doing it will make it harder to work in future projects. The lack of documentation from the previous work also implies that there could be more work for future development.

There does not seem to be a problem with information overload, as concerning the e-mails. The intranet on the other hand is experienced as full of irrelevant information and too much information makes this forum hard to

handle. ERA thinks that everyone should spend some time every day just surfing around their intranet, but the persons studied do not think that they have time for that.

5.2.4. Coordination between projects

The projects that are undertaken are often very large. This is handled by dividing the project into various sub projects and categories. According to Malone²⁵ this would be a top-down approach, i.e. decomposing the goal in different parts to make it more attainable. However, the different sub projects are very interdependent and require coordination. The work and result of one sub project directly or indirectly affects many other projects. A specific solution that is developed in one area may affect future work in various ways. Decisions on different ways to go when a problem occurs is often made locally in the sub project, but the members of the sub project might not be aware of all consequences of their decision. This could be a consequence of having employees that are empowered. It is difficult to get the right balance between empowerment and formal rules for controlling the work. The work done at the department for Radio and Signal Processing demands that the employees can make their own decisions and work in their own ways. The rules and standards in the organization must be a support in the work and not a hindrance. This is an issue that always could be improved further. This is always going to be a question of balance between formalization for controlling the work and effective, happy employees that feel that they are an important part of the company.

The fact that there are many sub projects brings us to the issue of priority. Work has to be divided and done in different order. Some work might be critical for one area and other work is critical for another part of the project. Which should come first? Who is in charge to have an overall view to make these decisions? It is important that these persons are known to the ones that work in different projects, so that the one who is responsible can be reached. This is not always the case at the moment. Responsibilities and priorities in the projects are often unclear. Sometimes the problem seems to be that no one is willing to take the overall responsibility. A consequence of this can be that problems are not taken care of.

Another problem concerning coordination between projects is that as a project comes to an end, new projects are often started in conjunction with it. When time is supposed to be spent on finishing one project and doing it well, people get involved in these new projects. The members of the new project feel that it is important to participate at the early stages of the project in order to get their own ideas and thoughts accepted by the other

²⁵ Malone, T.W. (1994) "The Interdisciplinary Study of Coordination", in *ACM Computer Surveys*, vol.26, no. 1, pp.87-119.

project members. This problem is something that should be an important question to both the unit manager and the different project leaders.

The allocation of resources between projects is the responsibility of the unit manager, but when a project is delayed it is nearly inevitable that it takes resources from another project. The project manager should be able to coordinate with other sub projects to know what is done and if there are delayed projects, that will need more resources in the future, and how it affects other projects. As the workers allocate the time they have spent on different projects, for accounting reasons, there is information of how much time is spent on different projects. This could be more used by the project managers to know what is being done and how long it is taking. Maybe it should be done in advance, predict how much time one will work on a project the coming week and then only report the changes. A risk with this could be that the time report would not be changed at all, thus giving a misleading picture of the time allocation.

5.3. Meetings

We have identified four kinds of coordination, local, distributed, within and between projects. There are different kinds of meetings to support all of these coordination forms. There are project meetings and organizational meetings, there are regular meetings and ad-hoc meetings. All meetings aim to keep each other updated and to exchange information.

The section meetings, run by the organizational section manager, is the place where people are informed of what is going on in other projects. This is a good way to get an overview of what is happening and maybe get a clearer picture of how one's own work affects others and the different sub projects. Local and organizational problems and other issues are also brought up here. This is the only time people formally meet outside their project group. It contributes to the unity of the division.

The project meetings are often telephone meetings. These are often done in a regular manner. The project manager runs the meeting and follows his own structure. There is no standard way that is followed. However, the members of the project are familiar with how things are done in that project, so there is no problem with the lack of standards. This is not experienced as a problem even when someone is involved in many projects. Normally the regular telephone, that is standard equipment in the offices, is used. The quality of sound is not very good, especially when several persons are using the same telephone. When things are not heard it is not always made known to the others. This is sometimes because it is perceived as unimportant or not very crucial

for the time being. There are also minutes taken from some meetings, so the information that is not heard or understood can be retrieved from them. Some project groups are very well prepared, by sending e-mail reporting on each others status before the meeting and using the intranet to share information. Others are very informal and unstructured.

One remark made in the interviews was that privacy is not respected during telephone meetings. People can come in to the office and disrupt the meeting. This would not be the case in a regular meeting. The small whiteboard that is placed by the door is sometimes used to note that one is in a telephone meeting, so that one will not be interrupted.

On the telephone there is a secrecy button, that can be pressed in order not to bother the person talking at the moment. This is often used, but it does happen that it is forgotten and the meeting is then disturbed by people talking locally to each other. When there are several people sharing the same telephone it is common that they discuss things amongst themselves. This is because they do not want to disturb the meeting unnecessarily. not even when they actually could contribute to the discussion. Comments are also made about the discussion, maybe they think it is boring or irrelevant. This is not usually done in a normal meeting when everyone can be seen and heard by everyone else. When there are several persons sharing a telephone it is also very easy for them to discuss things amongst themselves, even though everyone hears them, it might be hard to understand. Sometimes, if there are several persons in the same location, they are drawing on a local whiteboard or making gestures, not thinking about the others that can not see them.

Despite the problems that are present with the current telephone meetings it is generally perceived as a satisfying way of communicating and coordinating work. The subjects are aware of the problems and have complaints about it, but they do not use the conference telephones available or try to change the situation. The fact that the members of the projects often have had real meetings and met each other, makes the telephone meetings much easier to follow. One thing that was wished for was a common whiteboard that can be used to illustrate one's point. The whiteboard should be able to be used by, and be visible for, everyone in the telephone meeting. This could then also be used for documentation purposes in the minutes that are taken.

5.4. Tools

There are many tools available and they can be divided into different groups. There are tools for communication, others for coordination and then there are those used when solving the work task. The latter

are tools like COSSAP, Matlab, Framemaker and Emacs and will not be discussed further. We have not studied the document flow between these applications, even if it could be seen as a way of coordination. Because of the lack of time, we had to limit our study.

We have used Johansen's matrix²⁶ (see Figure 1) to identify the different groupware, see Figure 7. The matrix contains both communication and coordination tools, i.e. the kind of applications used when working in a group and/or a group that are geographically separated. Some of the tools used can fit in to several of the boxes in the matrix, but we have labeled them according to how they usually are used. There are some tools used today where the functions could be extended and be used in another way. One example is the calendars. Some use both electronic calendars and agendas. The electronic calendar could be used to show who is at the office and if they are available or not. This will be discussed further in the solutions section.

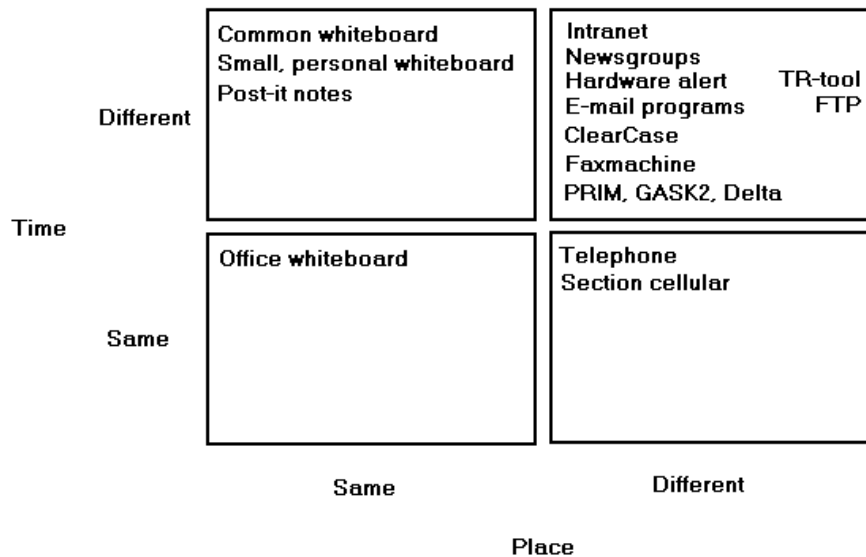


Figure 7: Categorization of the used tools according to Johansen's matrix

The tools in the matrix are classified as groupware applications. They are divided according to the time and the place they are used. Most of the tools used are supported by the organization. This is important and indicates

²⁶ Johansen, R. (1988) *Groupware: Computer support for business teams*, New York: The Free Press.

that the organization is aware of the need for coordination and communication. In the same place, at the same time, there are the face-to-face meetings. The support from the organization for these meetings is the access to conference rooms with round tables, overhead projectors and whiteboards. There are also whiteboards in the individual offices that are widely used when having a discussion. Tools used for communication at the same time, but at different places, are the telephones. These are also used to have meetings. There are specially made telephones to support this kind of meetings. These kinds of telephone are available in the conference rooms, but for some reason these telephones are not widely used. It seems preferred to use the own telephone in the office even if these telephones are not made to support the group conversations. When it comes to tools used at different times, but at the same place, there are now a few systems supported by the organization. That is the small whiteboards outside every room, talked about earlier in this section. There are also the common whiteboards with general information. The whiteboard for project information is not used. This is unfortunate since this could be an excellent way to keep others updated (at the same place that is). The reason this is not done could be that there is no one responsible for the updating of the whiteboard. Most of the tools used are those to support the work that are done at different places and at different times. The web, e-mails, document storing are all applications to fulfill the need to coordinate ones work with others. Here there are some problems because there are many applications to chose from and it is often one's personal taste that decide which is chosen. The fact that there are no standards can lead to problems with version handling, data lost when converting files and so on.

Many problems with the coordination at the department studied seem to be connected to the structure of the intranet (discussed above) and the use of ClearCase. ClearCase is the revision handling system that is used. ERA implemented it after influence from the department for Radio and Signal Processing. The workers in Nürnberg were not pleased with this choice, since they were used to another revision handling system. The main problem with ClearCase is that there are many different ways of doing things and there does not seem to be any standards. Here is a list of some of the problems we could identify, it is not certain that this is perceived as problems every where or by all. There are probably more problems than these. The following list of problems is only relevant for those who are knowledgeable about ClearCase.

- There are problems with the views. There are not enough views pre-specified.
- There are problems with the labels and it could be “dangerous” to check in files, but this must be done.
- Some are a bit worried to get the wrong versions when picking up files from the different views, because the files are not checked in and the people that have them checked out can not be reached.
- It is important to check in the files to be able to keep track of changes in files, but there seems to be some risk connected to this.

- There is no standard way to name files or how to build the trees.
- It is difficult to write the scripts needed when picking up files, so other's scripts are often used but then you can not be certain you get the right file.
- It is easier if you know a lot about ClearCase, and not everyone does.

6. Solutions and Discussion

We have now observed and analyzed the situation at the department for Radio and Signal Processing at EMW, with regard to coordination of distributed work. A few problem areas have been identified and in this section we propose and discuss some solutions.

<u>Coordination problem</u>	<u>IT solution</u>
Organization and project structure creates conflicts of belonging.	Project intranet forum, not bound to organizational structure. General guidelines and standards on the tools used. Improve skill on tools.
It is difficult to find people.	Merge the existing tools for messaging and planning into one integrated computer application.
Telephone meetings are of bad quality.	Computer support for communication and information exchange during meetings.
Information is not always easy to pass on.	Complement the e-mail application with the possibility to add voice mail and pictures.
Documentation is time consuming and often overlooked.	Half automated application with pre defined fields.

6.1. Organizational structure and project belonging

The project groups that the division is involved with are located in Kista and Nürnberg. Some things are done differently at the different locations. The syndrome of “us-them” is often the cause of many problems. This problem might have appeared over a long period of time, often by misunderstandings or ignorance. It is hard to know why something is done in a specific manner and a lot of speculation is made. This is nothing that is easy to get rid of, but if the communication between all parties were improved one might understand each other better and know why certain things are done in certain ways. The highest management should reflect upon the organizational belonging of the unit. It might be an idea to move the unit from EMW to ERA. However, these are strategic decisions that we are not in the position to discuss.

An IT solution to this problem could be a general project information forum where everyone that is directly or indirectly involved in the project, would have the possibility to see what is happening. We think that it would be advantageous to have a forum for projects that is not bound to an organizational structure. If the project group could feel that they may do whatever they please in their intranet forum they could be more unified as a group. This forum should also have room for informal communication and information. A discussion about different problems can give a lot of ideas, even if it is not about a specific problem. It is not necessary that all the information presented is agreed upon or triple checked if there is an informal forum. If it is wished by the group this area could be accessible only by them, if they feel that they do not want to be responsible for someone else reading information that might not be fully correct.

ClearCase has been a highly debated topic during our study. The main problem seems to be that there is no standard regarding the usage of the tool. There are many functions and many ways one can use ClearCase. This has given rise to many different solutions, which sometimes come in conflict with each other. We believe that these problems could be solved if a general standard of the usage of the tool was formed. This standard does not have to be overwhelming so that it covers every possible use of the tool, but should at least be a general guideline that can be followed by all the members of the projects despite organizational belonging. Another problem that is very important, with ClearCase, is that everybody does not seem to master it. For example, the configuration file is essential to what is seen in ClearCase. It presents the different files that are available. If the files are old or wrong, all the work done in them would be of no use. Despite of this, these configuration files are copied from colleagues, that might have different installations. The reason for this is the difficulty in knowing what to change and how to change things in the configuration file. Seeing that this is very important it should be solved. People might have to take some time off to go to courses in ClearCase. At the moment there are a few people that are seen as knowledgeable about ClearCase and these people are often consulted for help.

6.2. *Integrated tool for messaging and planning in order to find people*

There are many tools used to convey information to others about one's whereabouts. These tools do not work or are not used by everybody regularly. The practical solution to this would be to integrate all the existing tools into one computer application. This application would replace the tools used today, such as some of the whiteboards, calendars, telephone codes and post-it notes. With a computer based system used by everyone it would be easy to see where the person looked for is. There could be a list of who are logged on the net and if they are active or not, a possibility would be to connect it to the screen saver. One would then be able to know if

the person one is looking for is in his room or not. This function must be possible to disconnect if one for some reason feels observed or surveyed. This can be compared to the list in ICQ²⁷, where you also can send messages to others and chat with those who are online. The possibility to plan meetings and invite the participants would be facilitated if everyone had and used the tool. The application could also be integrated with the existing e-mail programs. When an invitation to a meeting is received by e-mail, there could be an accept or reject button. This would reduce the workload for people. It is often the case today that when an e-mail is received, the person looks in the calendar program and shifts between the programs, this could be avoided in the future.

The travel report forms could also be integrated in order to be able to see when a person is planning to be back. If this is regarded as too much information to others, it could simply be marked if one is available or not. All other details could be filled in voluntarily. Seeing that there would only be one system, it would be used by everybody and therefore immediately have a critical mass of users. The use of this system could be limited to the department for Radio and Signal Processing and achieve its purposes. However, it could be an idea to have a similar system for all Ericsson. Seeing that this has to be a standard system, to achieve the benefits wanted, there could be a policy conflict. Today there are recommendations on which applications to use at EMW, but that is not the same as forcing the workers to use a certain system. For the system we suggest here to work, it demands as many as possible to use it and use it regularly.

However simple the system, it is important to have stated policies on how it should be used. Maybe even a short seminar for all the people that would use it would be necessary. A critical thing is that the system must be implemented and taken in use at the same time at the whole department. Everyone must be prepared before the implementation so that it can be used immediately.

6.3. Computer support for telephone meetings

Telephone conferences are a part of the everyday work. There are regular telephone meetings a couple of times a week. It is generally seen as a good way of coordinating work. However, some see it as the only possible solution and therefore have to cope with it. The regular telephones, with loudspeakers and secrecy buttons, are mostly used. There are special conference rooms with special equipment for the purpose. These are, however, not widely used. It is regarded more comfortable to stay in ones office with all the necessary things at hand. The computer, for instance, is sometimes used to retrieve information, possibly on the intranet.

²⁷ ICQ is an application for knowing which of your friends that are logged on to Internet, see <http://www.mirabilis.com>

What has been wished for is a general whiteboard that can be shared by all the members in the telephone meeting. This is very possible to integrate in a web solution on the intranet. The thought can even be extended to become a virtual room or area. The common whiteboard could be complemented with a chat window. The participants could also have small cameras attached to their computer in order to be able to see the rest of the participants. An alternative to this could be to have small drawings to simulate expressions people have, and also to see if they are present (that the telephone link is not broken). All this could facilitate the communication between members. If somebody disagrees when something is said, or thinks that it is irrelevant, he can show it on his expressions without interrupting the person talking. A panel of buttons could be on the screen as well, with buttons that said 'yes', 'no' or '?', so one would not have to interrupt the meeting when having a remark, but everyone still knows that some has a question or an opinion. There could also be the possibility to write on electronic post-its and drop them to whoever is going to need the information. This could be done in the list one has on the screen (see section above) with ones colleagues and it could be done immediately, without interrupting your meeting and without losing information. The computer would be a good addition to the telephone. It has been the case in the past that videoconference systems have not lived up to the expectations, mainly because of bad response time with regards to speech. This is avoided when still using the telephone for speech and the computer for the rest. This would bring telephone meetings a bit closer to real meetings.

There are applications similar to the one we suggest on the market. They support the work done in projects that works distributed. These applications often have a common whiteboard, a chat window, pictures of the participants, a calendar, and the possibility to write messages to each other and the possibility to work on a document simultaneously. TeamWave²⁸ is a commercial application available from the Internet. Other applications are Basic Support for Cooperative Work (BSCW)²⁹ and Virtual Workplace (VW)³⁰ and are also available on the net. These applications are rather new on the market and there is still room for improvements, mainly it is the bandwidth that is the limitation, the connection is too slow. Security is another aspect that must be considered when using these applications.

²⁸ *TeamWave Software LTD.*, <http://www.teamwave.com/>

²⁹ *BSCW, Basic Support for Cooperative Work*, <http://bscw.gmd.de/>

³⁰ *VW, Virtual Workplaces*, <http://vw.sisu.se/>

6.4. *Cumbersome information exchange*

When working together in projects it is often the case that people have to fill each other in on details about the work. If the person that they want to talk to is not there, there are some ways to solve that, one option is to wait for the other to arrive, this can take from ten minutes to two days. Another possibility is to write a note or an e-mail. When an e-mail is written it often takes a long time, due to the many details that need explaining. It can be difficult to express the issues in an understandable way. It is often much easier to explain things verbally than in writing. This is something we have been thinking about when coming up with our next suggestion.

To get information to each other in an easy way voice mail can be used. As we understand it there is support for voice mail today, but it is not used. We think that it must be easy to use and seen as beneficial by everyone, to start using a new tool. That is, it must be easy to use and fulfill its purposes. If there were an integrated tool, with the possibility to use both written document complemented with a sound file, we think that it would fulfill this needs. If for example a screen dump could be made, and then drawn on, maybe an arrow to point out an important paragraph, a speech could then be recorded about this area. The recipient would both have a picture to look at and an explanation to listen to. There should be functions to write notes and draw other pictures as well. It should also be possible to attach a file or a link to some page on the web, the project information for example, which could be relevant for the work to be done. If there is a wish just to send the voice mail or just the screen dump this should be possible to do. This would be an extended function to the ordinary e-mail program. We think that there must be a possibility to edit the voice mail before it is sent away. Before considering building and implementing an application like this, one has to find out why voice mail, that is available today, is not used.

6.5. *Documentation is often neglected*

The lack of documentation is a big problem, a problem that the workers are aware of but find hard to do something about. The documentation is experienced as boring and time consuming and since the benefits are not seen at once, makes it easy to postpone that work. Everyone is well aware of the necessity of documentation though.

Our suggestion is that one could try to have a half automated application that does the documentation for you, this application could be connected to the program one normally works with (COSSAP, ClearCase, etc.). The documents should be structured in advance, once and for all, and as a comment and information is added in the

ordinary program it would also be added in the document to be. There would be prepared sections and the application could be told which section to work on. There would of course be some editing to do afterwards, cut and paste, some deletion and maybe some insertions as well, but the thought is that all relevant information would already be in the document in the form of raw data.

6.6. *General thoughts on distributed work*

We have tried to identify some general thoughts when talking about distributed work. This section is not complete, there are probably many other things to think about when working in projects like they do at the department for Radio and Signal Processing. There should also be more studies done to be able to state more general guidelines for working distributed. Therefore, this section is not complete and consists only of our thoughts.

Before starting to work distributed there are several things that need some serious thinking and investigation. There is not only the question about practical issues, but also the organizational ones. These are issues of a strategic art, while the ones we have been talking about in this essay is more of the operative kind. The strategic issues are very important and, we think, are the ones to be discussed when thinking about changing the way of work. The task may not be suited for distributed work or there could be alternative ways to do the work. Maybe moving a department or dividing the production in a different way would be a better solution. Another issue is about where the workers shall belong, it could be in the line organization or in the project. Seeing that it is easier to cooperate with people you know, it is important that everyone meet their future colleagues, especially those who are not going to be in the same location. There should be many social activities and traveling to each other in the beginning of projects.

One tactical question could be about responsibilities. Who is going to be the formal manager and where are the responsibilities going to be? These are questions that must be answered. Who makes which decisions? How is the responsibility going to be divided? Between the line and the project organization? Between the projects? Between the different geographically locations? There will be many managers and leaders if the line organization is separated from the project organization. There will be project leaders, object leaders, organizational managers and a lot of others in charge and projects often merge together. Working distributed makes dividing and distributing tasks and responsibility even more important. When there are many different groups it is likely that some things are overlooked and not dealt with, there is also the risk that no one is

prepared to take the overall responsibility in different sub projects. This must be done if there are several project groups that work tightly together and are dependent of each other's results, which often is the case.

Priorities are another tactical issue that must be discussed. This is closely related to responsibility. Who is going to set the priorities in the projects as well as between the projects must be decided. Should it be the project leaders or the organizational managers? Maybe it should be the ones who are working on the projects? This is of course depending on where the decision must be made and when, and as many of these occasions as possible should be identified. There is also the question of allocating the resources. Again one has to decide what issues should be handled by the line organization and which to be handled in the projects. Anyway it is important to try to identify and discuss as many of these issues as possible.

On the operational level one has to deal with the practical problems of working distributed. What tools and applications should be used and how to use them. There should be some directions for use, both general and specific. The general directions should follow the company policy and be directions for all the work done at the department. The more specific directions could be decided in the projects. This could be done at the start of the projects and involve those who are going to work with the tools and perhaps an expert as well. There are also the question of which equipment to use, working distributed demands powerful computers and high bandwidth on the net for fast and safe distribution. The thoughts above is only a fraction of the things that needs consideration when working distributed and a lot of studies could be done to identify more problems and opportunities.

7. Conclusion

Distributed work is a natural consequence of the current trends in technological and organizational evolution. Using open ended interviews and “quick and dirty” ethnography, we have investigated how distributed work is practiced at the department for Radio and Signal Processing at EMW. This includes the way of work, the IT applications and their use. Our perspective on distributed work was from the point of view of coordination.

Our research question was:

How is coordination practiced in distributed work and how can existing IT be used and developed to improve the different kinds of coordination?

Judging from studying only one workplace, distributed work is not much different from traditional. However, there is substantial more coordination with regard to other locations. The collaboration with other locations is more accentuated than it is when working in a more traditional manner.

Malone says, “coordination is the process of managing dependencies among activities”. Our observation show that distributed work requires various types of coordination. Working distributed requires coordination both within and between projects. This coordination is mainly supported by telephone meetings, e-mail and intranet. Distributed work also demands coordination of the local work, even more than with traditional work. The local coordination is mainly supported by face-to-face meetings, both formally and informally.

Our general conclusions are that there is a need for (at EMW):

- Standardization of tools (IT applications) and their use.
- New backup from the organization to support projects and workers.
- Realization of interdependencies between different projects and work tasks.

Besides these general thoughts we have also found some specific coordination problems and have given IT solutions to improve the management of these dependencies. The problems and solutions are as follows:

- The project structures do not follow the organizational structure, this creates conflicts of belonging. It is important that it is the different projects that are supported, and not the different divisions according to some organizational structure. We suggest an intranet that does not follow the organizational structure, but rather the project structure.

- The main problems, however, is that there is no unity or standard when it comes to the use of the applications. This is because the projects involve staff from different units. We therefore recommend some standards to be made regarding the use of the applications. It is often the case that it is hard to make standards that cover all different situations that can occur, so it might be sufficient with some general guidelines that can be followed.
- ClearCase seems to be a powerful tool with a lot of possibilities. The problem is that not all people are knowledgeable enough e.g. when it comes to making advanced changes in the configuration file. Skills should be improved in this area with the help of courses.
- One problem is to locate people and in order to find people more easily we suggest an integrated tool to do so. This computer application would replace the different calendars, whiteboards and post-it notes that are used today.
- Within a project there is a lot of coordination required. Telephone meetings are widely used to support information exchange within and between projects. The quality of these is not good and there is room for improvement. In order to support the telephone meetings we suggest a web based application with a common whiteboard, chat window and eventually a video picture of the participants.
- Sharing work tasks often requires information exchange. If a person can not be reached, long e-mails are written or time is spent waiting for that person. To facilitate this information exchange it could be advantageous with an e-mail application with support for voice-mail and drawings.
- Lack of documentation is a problem. Documentation is time consuming and often overlooked. To diminish the burden of documentation we suggest a semiautomatic application that will structure the information required in a practical way, that is linked to the applications that are used.

We have seen that distributed work requires new forms of support from the organization. For instance, people also have to start to think in new ways. There should be unity within a project group even if people belong to different organizational divisions. Besides the problems of coordination within projects, the coordination between projects does not seem to work satisfactory. This has to be dealt with from the project leaders and management. The coordination required is substantial. When the different dependencies have been established it is important to manage these coordination processes effectively. The main problems that are seen are not what kind of IT applications or other tools that are used, it is rather *how* they are used. Different locations and organizational units have different habits and ways of doing things. This creates problems when working in project groups. Everyone has to know what to do and understand how things might be done in different locations. It is important to realize how work is linked together with that of others and that one's actions can affect many others.

8. Future work

Our study has focused on how distributed work is perceived by the people who actually work in a distributed environment. We have carried out short ethnographic studies to understand how the work is done, what problems occur and what can be improved. In order to get a complete view and understanding of the entire work environment at the division for Radio and Signal Processing and all the project groups, there are various things that could be done. These have either fallen out of the scope of our study or been left out for lack of time and resources.

Firstly, we chose to do qualitative interviews and ethnographical studies. This could be complemented by quantitative methods like surveys. This would give a more general picture of what people perceive as being the problems as well as identifying the possibilities of distributed work. We believe, however, that qualitative methods give a deeper understanding of the situation, but others might think differently.

We strongly recommend that the unit managers and especially project managers are studied to see their perspective of how distributed work is handled. Areas that concern project support, time allocation, responsibility and priority are very interesting from their point of view. There is also the question of interconnectivity of projects, how this affects the people working in the projects and the project managers. This could give very different results and contribute to a more holistic view of the situation. Further studies could be made at ERA to see their point of view in running the projects.

The problems with the tools, especially ClearCase, that have been revealed and discussed, should be further investigated. The person responsible for the tool should be interviewed. Other revision handling systems might be studied and considered. However, it does not seem as if it is the tool that is causing the problems and conflicts, but rather its use. There might be problems with ClearCase that we could not identify because we are no ClearCase experts. It might be useful to do a study on how ClearCase is used in the different locations today. A clear picture of what one wants to be able to do with a tool like this would also be desirable and what functions would fulfill the needs at the division for Radio and Signal Processing.

Seeing that meetings and telephone meetings are a very central part of distributed work, it is an area that should be further investigated. The presented solution could be elaborated and maybe in the near future there is the possibility of virtual meetings.

The results from the study raise interesting questions that can be brought up with the local IT unit. Some question about different tools, what standards exists today and how they coordinate their work with other IT units within Ericsson. This also leads us to the questions about general standard for application between different Ericsson companies and should be discussed with the corresponding IT-strategic management.

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10. Appendix A

Questions for the interview:

Presentation

- Who we are.
- What we are doing here.

Introduction. Who are you?

- What is your position in the company?
- How is the company organized?
- What are your work specifications?

Coordination in the company

- Who do you work with?
- What are the differences between the group here and the others (geographical distance)?
- Why do you need to cooperate and collaborate with your colleges?
- How is this collaboration and cooperation done (supported) today in the different groups you work with?
- What kind of technology exists? Applications?
- How do you collaborate with the different groups?
- How do these differences affect the way you work?
- How is your work dependent on the technology?

What can the future bring?

- What aspect of the technology can be improved?
- How can the *usage* of this technology support collaborative work for the user?
- Can you describe how you think this support would look like?
- If there were no technical limitations, how would you like to work?