Shared displays for promoting informal cooperation: an exploratory study

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ABSTRACT: In this paper we present KOALA, a system realizing shared displays for promoting informal cooperation. We report the results from an exploratory study of real world usage of KOALA that we have conducted to understand how shared display systems are used and how their usage patterns might differ from their paper-based counterparts. This study was conducted with the aim of informing the design of ambient displays to be used in office settings. A number of lessons learned from the experimentation are outlined.

1 Introduction

Shared displays, i.e. large shared interactive screens containing public or community information, have been recently advocated as a novel technology for supporting collaboration [12]. As pointed out in [9], a combination of shared displays and mobile devices can be used to support different degrees of mobility and a smooth switch from individual to collaborative activities, from public to shared information. Shared displays can also facilitate socialization, as suggested in [3].

The growing interest in these devices comes from the popularity of conventional bulletin boards and similar paper-based artifacts. Bulletin boards play a variety of roles in any space inhabited by a group, a family, or a community. Electronic counterparts of these artifacts are developed with the hope to overcome their limitations, such as limited interactivity and no support for remote access.

In this paper we report on the development and experimental usage of the KOALA shared display system. KOALA (KOmmunity Awareness with Large Artifacts) is developed with the main aim of promoting informal cooperation and presence in a community of people sharing physical spaces in their office setting. As discussed in [6], paper based artifacts are in fact widely used for similar purposes. Figure 1 shows the type of paper-based artifact that has guided the development of KOALA. The photo (taken from Telenor R&D's premises) shows three different displays used in a coordinated manner. To the left there is a traditional corkboard with various printouts that can be of interest for the community. In the middle there is a whiteboard where people can mark their availability during the two coming weeks (middle-term availability). To the right there is a printout of a table with the holiday schedule (long-term availability). This simple snapshot clearly points out three ways in which displays promote social presence and informal cooperation in a community. First they provide *traces of community life*. A glance at the corkboard is enough to see

whether there is any news that one should be aware of, what information is relevant for the specific community, who is expected to do what, and so on. Second, these artifacts act as a *community concierge*, proving information on who is in, who is out, and where each person is. Third, as already pointed out in [2], shared displays can play the role of *community memory*. In all these cases displays are mainly supporting asynchronous cooperation by providing information that might be needed by different community members.

Figure 1: Paper-based shared displays

The described usage of these artifacts has many similarities with the usage of displays in the home environment reported in [4]. There the authors introduce the category of coordinate displays, i.e. displays that are introduced "for the express purposes of collaborative actions" and that are ecologically distributed and interconnected.
The paper is organized as follows. In Section 2 we briefly present KOALA and its functionality. In Section 3 we present the results from the usage of the system for one month in the premises of Telenor R&D. In Section 4 we discuss the results and draw some lessons learned that can be useful for the development and deployment of technology of this type. We believe that despite the growing number of research published in the topic there is still a need for experiences like the one that we are reporting here of actual usage of such systems. Empirical investigation is in fact essential to understand how these new applications can be used in different settings and for informing their design [1]. In this perspective, our experimentation is not aiming at evaluating the system, but it is rather an exploratory study of how this type of novel technology is actually used in real world settings.

2 The KOALA system

KOALA is a distributed shared display system designed to provide functionalities similar to the ones described in the Introduction for paper-based displays. Our goal when developing KOALA has been to design a bulletin board like system that is easy to contribute to (by end-users), is interactive, supports geographically distributed users, supports different interaction modalities, and is extensible [6]. KOALA central component is the *shared display*, i.e. a physical public screen where information posted by the user community is displayed (Figure 2). Users can use KOALA's client applications, called *interaction clients*, to post information to the shared display from their desktop PCs, PDAs, or mobile phones. In order to support geographically distributed communities, KOALA allows multiple shared displays to be located in several physical locations. Access to all shared displays in a KOALA installation is coordinated by a central server. All connected displays can share the

information content on the server, but each shared display will in addition have its own specific information to display.

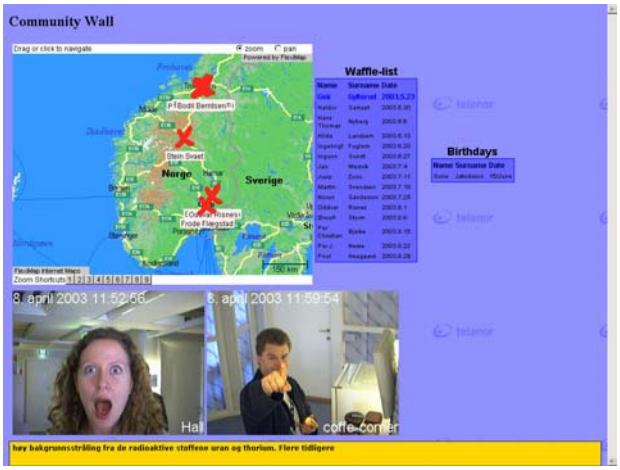

Figure 2: A KOALA shared display

KOALA's current users are the employees at Telenor R&D in Trondheim, Norway. KOALA was developed through an iterative process strongly influenced and informed by its users. The first version of KOALA consisted of a screen showing a map of Norway with the current locations of the employees marked on the map. Telenor R&D is distributed across several cities in Norway. This map screen (hanging on a wall in the coffee corner) was seen as a valuable service, allowing people to see who is traveling and who is in Trondheim. We decided to extend this map service with informal information and increased interactivity through mobile devices, to make it function more as a digital bulletin board. Two consequent versions of KOALA were developed before we did the study of its usage that is reported in this paper. One version added a number of information services to the screen. After this version was installed, we distributed a questionnaire where we asked the users about what mobile devices they used, how they use them, and based on the example services provide in the current version, which type of services they were more interested in seeing on the shared display. The third version added interactivity, allowing people post information to the shared display from their mobile devices.

2.1 KOALA services

KOALA is designed to be extensible, allowing easy addition of services that are relevant for its specific usage context. This extensibility is implemented into the system by using open standards and a component-based architecture (see Section 2.2). In the following we describe the specific KOALA services that we have used during our experiment. Technically, the services fall into one of three categories. *Proprietary services* are those that are implemented specifically for KOALA and use KOALA's database for storing their information. *Proxy services* are services that format and display continuously updated information from the Internet. *Messaging services* allow users to send different types of messages to one or several KOALA displays.

2.1.1 Proprietary services

Proprietary services are made specifically for KOALA. Their information is stored in the KOALA database, and their visualization on the screen is completely decided by KOALA.

In the installation used in our experiment proprietary services include the birthday service (displaying upcoming birthdays of Telenor R&D employees), the waffle service (displaying who is in charge of preparing the Friday waffle for the group's waffle party), upcoming events service (showing events that are relevant for the users).

2.1.2 Proxy services

Proxy services visualize external information, i.e. information not contained within KOALA database but collected from somewhere on the internet. Proxy services provide a convenient means for displaying information from the internet on a KOALA display. Implemented proxy services include the map service (Telenor R&D's initial Norway map showing employee locations), Dilbert strip service (showing the Dilbert comic strip of the day), weather service (showing daily weather forecast for Trondheim) and the news ticker service (providing local and international news from a selected news source).
Another technically more advanced proxy service is the snapshot service. The snapshot service can show a continuously updated image on a shared display (the image is downloaded from any given URL as frequently as every 5 seconds). Each of the shared displays used in our experiment has a web camera located close to it. Images from these cameras are available to KOALA users as snapshot services visualized within the shared displays. This gives the illusion of an almost-live video stream from one display's location to the other (see Figure 2). In addition to providing a synchronous communication link, we used the images taken by the web cameras for our analysis of system usage (see Section 3).

2.1.3 Messaging services

Messaging services allow a user to post messages to KOALA displays. Posted messages are displayed as post-it notes on the shared display. Messages can be sent to all shared displays or a specific display in a KOALA installation. Interaction clients are used for posting messages, where each user has to log on prior to posting a message. A web-based interaction client is developed in addition to a SMS interface for posting text messages. (Currently no support for multimedia messages is provided.) The web-based client is designed specifically for PDA screens, but can also be used on desktop browsers. For each message the sender can specify the period the message should be displayed. For example, if a person is late at work, she can inform the entire group about this by sending a single message that will last for a couple of hours. Unfortunately due to technical problems the SMS interface for posting messages was not available during our experiment.

2.2 System architecture

Figure 3 shows KOALA's overall architecture, which is explained very briefly in this section. An important goal when developing KOALA has been to make its architecture scalable and flexible. KOALA's architecture makes it easy to install new shared displays, add new services to each display, and customize the contents of each display in a very flexible way.

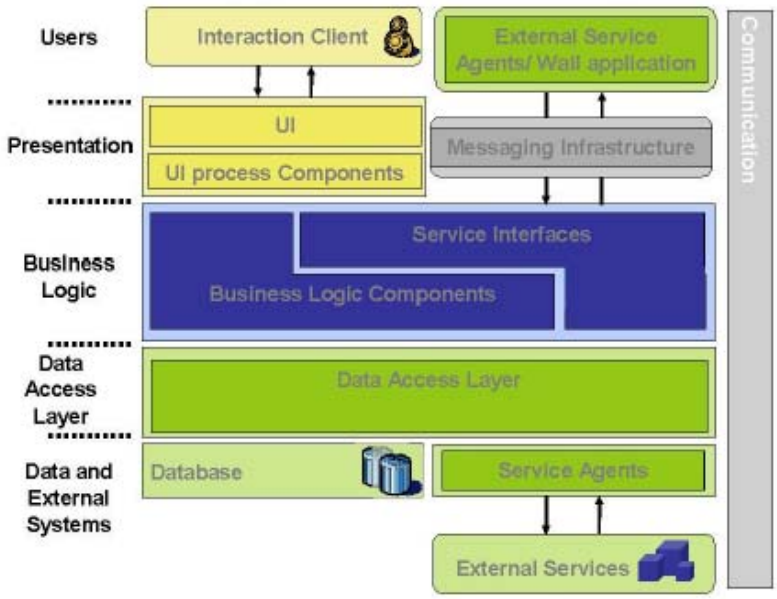

Figure 3: KOALA's overall architecture

Figure 3 shows the main components of KOALA's architecture. Interaction clients (top layer) are operated by users when posting messages to the shared displays. The clients consist of dynamic web pages created by UI process components. Wall application implements the client running on each shared display, and updates its content using KOALA's messaging infrastructure. Business logic components consist of all the utility libraries and servlets used for extracting and representing information for each KOALA service. Access to the database is done through the data access layer. Data for proxy services is not stored in the KOALA database but is fetched from external services using service agents.
Flexibility and scalability is guaranteed by using open standards and a modular architecture. Web services standard is used for all communication among KOALA modules. This allows for loose coupling among services and easy addition of new services. The least flexible part of the architecture is the rendering of shared display user interfaces. For each new service that is added to KOALA, the algorithm for displaying the new and the already existing services has to be modified. This is an area where we expect improvements in future versions of KOALA.

3 The setting for the experiment

KOALA has been installed in the premises of Telenor R&D and its usage has been logged for the first 2 months of adoption. The employees of Telenor R&D consist of 32 persons, and represent our user community. The installation has two shared displays, one in the entrance and one in the coffee corner (respectively X and Y in the map shown in Figure 4). Figure 5 shows the two locations and the shared displays. The offices to the left of the entrance (in the map of Figure 4) belong to a different company whose employees have not taken part in this research study. The displays are located fairly close to each other, but they are out of sight and located in different settings. The first display (marked as X in Figure 4) is hanging on a wall in the entrance to Telenor R&D premises (Figure 5, b). This is a passage point for people arriving at work or leaving. Nothing was hanging on the wall before we placed the display. Any activity in front of the display is therefore likely to be

caused by the presence of KOALA. On the entrance display we installed birthday service, weather service, Dilbert service, message service, news service and a snapshot service showing both display locations each in its own window. The second display (marked as Y in Figure 4) is hanging in the coffee corner. In this location there are two sofas, a refrigerator, and the coffee machine. The location is frequently used by people during the day and is a location where people frequently gather for informal encounters. At this location, before the experimentation started, there was a screen displaying the location service and a number of paper notes tacked to the wall, displaying cartoons, newspaper clippings etc (Figure 5, a). On coffee corner display we installed birthday service, waffle service, location service, message service, news service and the same snapshot service as the entrance display. In this way the two displays were connected through an image link.

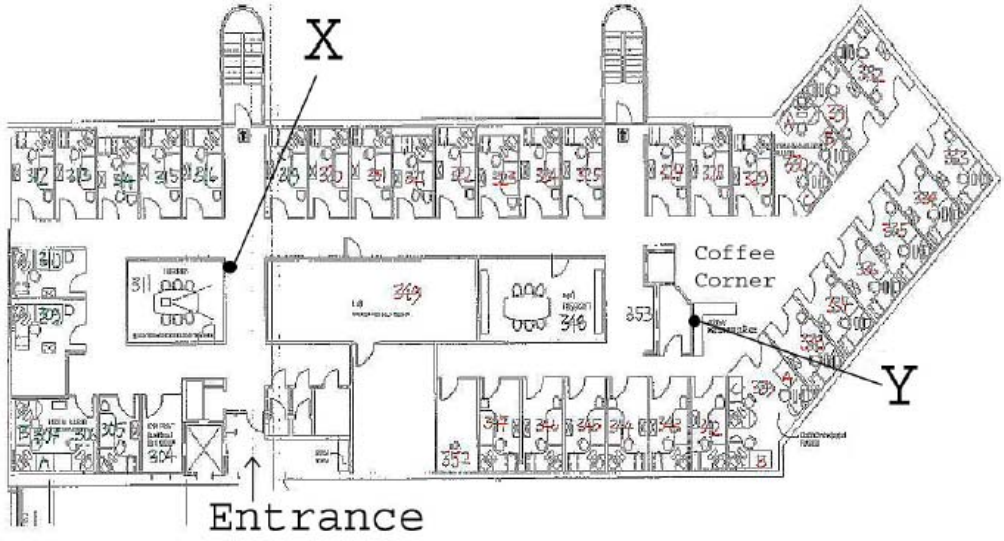

Figure 4: An office map of Telenor R&D with the two displays marked as X and Y

(a) *(b)*

Figure 5: The two displays in the coffee corner (a) an the entrance (b)

To call the attention of the users on the system and to inform them of the possibility to use it interactively, all members of the test group received an e-mail describing the system. We also posted user documentation for how to log on to KOALA next to each display.
To collect data on system adoption we have used several data gathering techniques. During the whole experimentation we have logged the interactions of users with the system. In addition, we have used the recording from two web cameras that are part of the system and mounted close to the two displays. We have also distributed a questionnaire to get a better understanding of people perception of the system.

4 Results

4.1 Different usage patterns

From our observations we have identified four different patterns by which the users use KOALA. The first pattern is represented by *glancing*. With glancing we mean a single user passing by the display and giving it a look before passing by. This use ranges from a passing glance to stopping and studying the display's content. Figure 6 illustrates some occurrences of passers-by.

Figure 6: Glancing at a shared display

The second pattern of usage is represented by *people gathering* around the display. With this we indicate people making conversation induced by KOALA or some KOALA-related topic. The rationale behind the design of KOALA is that shared displays can promote informal communication by creating opportunities for informal talking. The system does this in two ways: by supplying content that can be discussed and by creating a focal point around which users gather. Figure 7 shows one occurrence of people gathering in front of the display. The first frame shows two members of the test group approaching the display, discussing some of its content. As they stand there discussing, several members of the group drop by and attend the discussion.

Figure 7: Example of people gathering at the display

The third form of usage is *remote communication*, indicating interaction between people at the different displays (using the snapshot service). In Figure 2 it is possible to see a case of interaction between two persons at the two locations. In this case the persons at the

different displays have stopped to view some content on the display at the same time. They notice the person standing at the other display, and starts interacting through the web cameras. We observed remote communication even though the displays are located not far from each other.
The last pattern of usage is represented by *active interaction*. This type of interaction occurs mainly when users want to send messages to either a specific display or all the installed displays. Figure 8 shows an occurrence of system-user interaction where we see a member of the test group logging in to the system for posting a message to the display. As he is doing so, others stop by to watch how the display is being used.

Figure 8: Example of interactive use

4.2 User observations

In this section we summarize the data obtained from user observations, as collected from the snapshots taken by the web cameras. (For detailed data see [7].) During the 30 days in the test period we observed 621 usages of the system in one of the categories described in the previous section. After the experimentation period we analyzed 30 days of video recording. We have analyzed only the recordings relating to working hours and weekdays. Moreover, due to technical problems web cameras have been out of usage in some short periods.
Figure 9 depicts the average number of observations per hour for the different usage patterns. Most of the interactions are belong to the glance pattern, with or without stopping. It is however worth to note that there has also been a considerable number of gatherings around the displays. There is a gathering around one of the displays about once every second hour. Remote communication between the two displays happened instead very rarely. Given that the displays are in close proximity and that the communication is only through still images this was expected. Direct interaction is not discussed here since it is better understood looking at the system logging. However, from the analysis of the video we can see that all direct interactions with the displays (in front of the displays) resulted in people gathering, as illustrated in Figure 8.

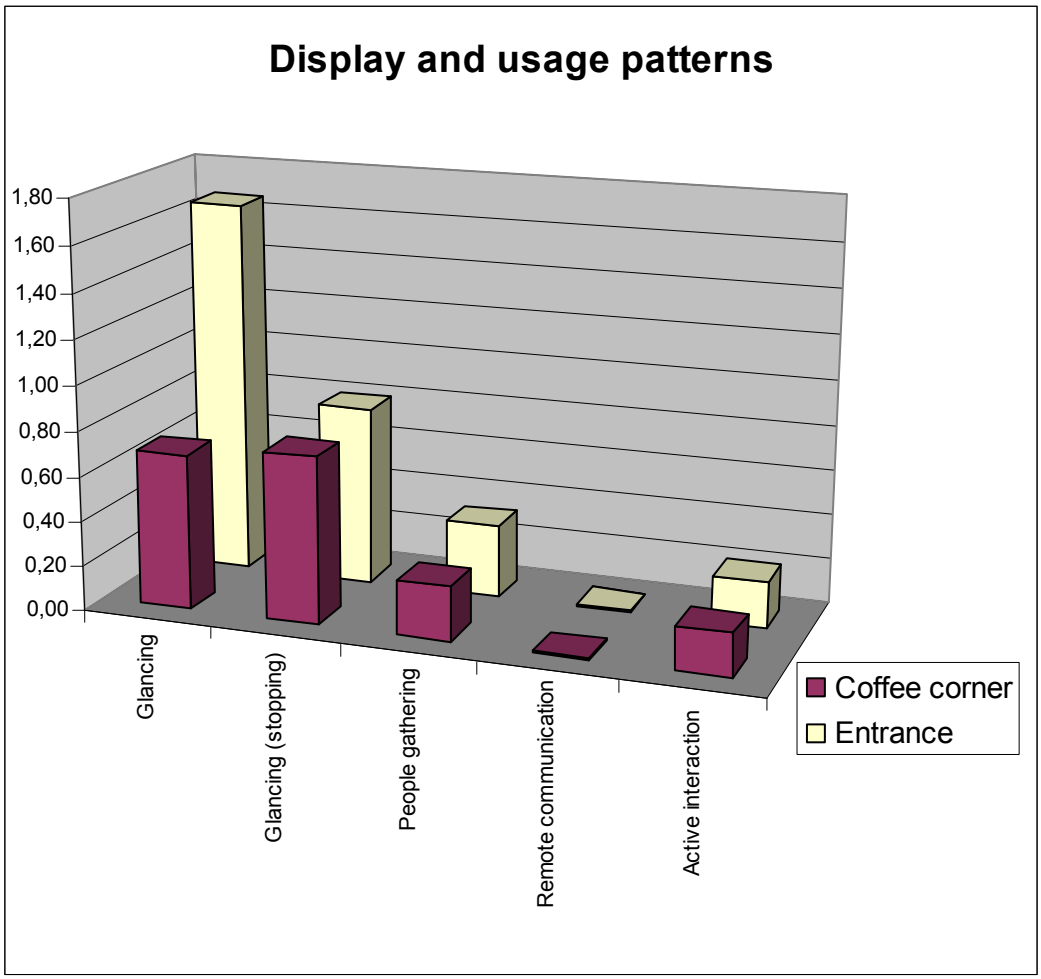

Figure 9: Usage patterns in the experiment

Looking at usage distribution during a workday, we can identify three periods of the day where the use of the displays intensifies. The first of these peaks is at the very start of the day. People are coming to work, passing by the entrance display and entering the office, and making their first cup of coffee at the coffee corner. The next peak is around lunchtime. The third peak is when people go home. This last peak is represented by glancing, with a very low number of gatherings. There are however some differences in the patterns of usage during the day. During lunchtime there is little activity at the hall display, probably signifying that people are at lunch. Since the coffee corner is in an area used for lunch by some employees, this display has a peak during lunch. The entrance display however has peaks just before and after lunch, due to traffic to and from the cafeteria. The number of gatherings around the entrance display decreases dramatically after lunch. Both displays have a small increase shortly after the workday ends. The results seem to yield no major differences between the weekdays, except small peaks at Monday, Wednesday, and Friday with a higher number of gatherings. (On Wednesdays Telenor R&D has regularly scheduled presentations and on Fridays employees gather for waffle party.)

As discussed in Section 3, the two displays have rather different profiles. It is therefore important to understand if this impacts the way they are used. Our observations show that the entrance display has been used as much, in some categories even more, than the coffee corner display. The coffee corner, being the established meeting place at Telenor R&D, was expected to draw more attention than the entrance display. More than half of the recorded gatherings took place at the entrance display. It is here important to mention that if we had counted gatherings that were not related to the displays (i.e. people standing around talking

without any connection to the KOALA) the results would yield more gatherings around the coffee corner.

4.3 System logging

In this section we present the results from the logging of users' interactions with KOALA through an interaction client. In general, the possibility to interact with the system has not been used much. This is partly in line with the indications collected during the design of the system when in potential users ranked very low the need for interactive services.
It was evident from early in the project that some people were more interested in KOALA. This fact is clearly reflected in the logs. Out of a total number of 32 users, 17 logged in one or more times, two of these used the displays considerably more than others. If we look at the number of logins we can clearly identify a peak following a message that was sent to the user community informing about the system. It should be noted that just after the period of observation ended some people have "rediscovered" the possibility to use KOALA interactively and started sending messages. However, we have no data for explaining what triggered this new usage.
When we look at the device through which users logged on, we get 55% of the login made via a PDA, and 45% via the PC. No log in was done via mobile phones, despite many employees have mobile phones allowing it. During the experimentation users have mainly logged in for changing their profile. There has been however very little usage of the possibility to send messages.

4.4 Questionnaire

After the period of observation we have distributed a questionnaire for understanding the perception of the system that users developed during the period. In the questionnaire we asked users their opinion e.g., about the placement of physical displays, their location, and suggestions. Out of the 32 distributed questionnaires, we have received 20 filled-in questionnaires.

4.4.1 System usage

A first set of questions aimed at clarifying the perceived usage and problems encountered during the experimentation. Users have been asked to rate how often they were using the system in the different categories identified in Section 4.1. The results are in line with the results from the observations and logging. However, there are some discrepancies around how often users perceived they have been gathering around the display and the usage of web cameras, with perceived usage much higher than the recorded one. A possible explanation for the higher perceived frequency of gathering is that users tend to consider all gatherings around the display, independently by the fact that they were in some way directly triggered by the presence of the display. The discrepancies in the usage of web cameras is that the video recording only reveals usage when it is visible that users are in fact using the cameras. If a person is looking at a display it is difficult to say if the focus is on the image of the other site or on some other piece of information. Considering the feedback from users we tend to believe that usage of video cameras is more relevant than appearing from the initial observations, even if this might have not resulted in actual communication between the two locations.
One of the many reasons for creating KOALA is that it should foster informal cooperation by gathering people together and creating occasions for informal communication. With the questionnaire we tried to understand the reasons behind the gatherings that we have

observed were taking place relatively frequently. From the questionnaire it emerges that 44% of the times people perceive that their gatherings around the displays were due to content displayed at the display. In 39% of the cases, it was due to the display and KOALA. Only 17% of the gatherings were not related to the display at all.

4.4.2 Interactivity and ease of use

As evident from the observations and the logging, the usage of interactive services has been very low. This is in line with the low interest for interactive services expressed during the design of the system. However, during the experimentation we felt that the interactive services, in particular messaging, should have been used more.
We have therefore asked users to express their impression of how easy it was to use the system. The respondents did not find the non-interactive part of the system difficult to use, while the interactive part proved more challenging. This is surprising since the test group consists of persons with a good familiarity with novel technology. However this result must be read together with the difficulties that users have identified as a reason for not using the interactive part of the system. (The questionnaire was asking to select from a list of statements the one that was more in line with the motivations of the user.) All the respondents were aware of the possibility to log in to the system. 20% did not log in because they thought it was not providing any added value. 20% could not take advantage of this possibility because they were lacking the necessary equipment, 10% found the web logon difficult. For 50% of the respondents the lack of interactive usage was due to technical problems. These problems mostly relate to the existing infrastructure at Telenor R&D such as firewalls.
Given the low usage of interactive possibilities, we have asked users if they had any suggestion for alternative means of interaction, asking them to rank the suitability of different tools. In general, users seem to be open to different interaction devices, with a slight preference for touch screens, which would allow users to interact directly with the system. Users also ranked as well suited RFID[1]. By equipping each display with an RFID-transceiver and embedding an RF tag into, e.g., the access card that all the employees already carry, users could log on to KOALA automatically just passing by. This approach was used in the "Active Badge" system [13]. One member of the group proposed a system with RFID for identification and login (which would then become a passive event) and touch screen for simple interaction with the display. As he said "It must be easy there-and-then to communicate with the system."

4.4.3 The physical displays

95% of the test group found the placement of the display in the coffee corner to be good and 5% neutral. In contrast, only 35% of the users found the placement of the entrance display good and 10% bad. These answers suggest that the test group prefers to have the displays placed on sites that are already used for gathering and socializing. In the words of a user: "Coffee corner is an established meeting place. The entrance is not." This is an interesting result when compared to Figure 9, which shows that the entrance display is used at least as much as than the coffee corner display.
When selecting the actual device to use as KOALA display during the experimentation, we anticipated that the size of the displays would be of paramount importance, but we chose to use relatively small displays, 15" LCD displays with a resolution of 1024x768 pixels,

[1] Radio Frequency IDentification is a system based around a small RF-tag programmed with unique identification.

mainly for economical reasons. When we asked about the size of the screens however, 65% of the test group found the display size to be adequate, only 35% finding it to be too small.

4.4.4 Added value

We asked the users how they rated the overall impact of KOALA on their working environment. None of the group members felt that KOALA had a negative impact and most of the users declared that KOALA provided "some benefit". From the answers it is also clear that they felt that the system was more helpful for social and entertainment purposes, rather than as a source of information. This can be partly explained with the type of available services.
During the study period we experienced some technical problems that limited the availability of the system. We asked the test group whether they noticed that the displays were out of order and how much they missed them on these occasions. Just about everybody in the test group noticed the displays being out of order. How much the system was missed varies. Almost a third of the test group did not miss the displays at all, whereas the rest missed them to a certain degree. This of course might depend on many factors, including e.g. the down time and the type of problems. For example, at times the system has been working correctly apart from the web cameras that were not updating the still-image on the display.

5 Discussion: implications for design and deployment

Our experience shows that computer-based systems can be used to provide services similar to the ones illustrated in the introduction and currently provided by paper-based displays in the workplace. However, our results also show differences in the pattern of usage and important factors that need to be taken into account for the wide adoption of this type of systems.
As it is emerging from the results presented in the previous section, KOALA has been used on a regular basis throughout the test period. The data also points out that the two displays have been used in slightly different ways, coinciding to some degree with the profile of each display. The entrance display, being in a transit area, has many people just glancing at it, and the usage peaks are at slightly different times of the day than what is the case for the display in the coffee corner. However, we need to point out that during our experimentation KOALA was used mainly as a background service with only a few episodes of interactive usage.

LL1: Displays can become community places. There is a striking difference between the usage of traditional paper-based displays that we experience every day in the workplace and the one that we observed for KOALA, namely the number of gatherings that are trigged by the display, in our case a gathering almost every second hour. According to the feedbacks that we have collected from the questionnaire, this was mainly due to the content of the display, followed by the display as a phenomenon, and only 17% of the respondents related the gatherings to reasons external to the display. This was a surprising result also considering the limited content available. The gatherings cannot be explained by the novelty effect of the technology since they continued to happen for a rather long period of time (two months) without any large variations. We believe that this can be explained by the dynamic nature of the content. During the experimentation we have seen displays become appreciated not only as devices, but also as places for people to meet. This is for

example witnessed by the high number of gatherings around the display in the hall, location were previously people were just in transit.
This lesson learned has important implications for the design as well as the deployment of shared displays. From the design point of view it means that the system must be designed so to support a "virtuous cycle":

- It must be possible to easily add relevant information, even for users who are remotely located, e.g. for an external meeting. This helps to keep the interest for the system high by increasing relevance of the content and dynamicity and consequently provides occasions for gatherings.
- It must support an easy transition from informal communication to focused cooperation, possibly producing new relevant information, more integration of the display system in the local practices, and more occasions for encounters. For example, the system could give the possibility to the people that are gathering to access and visualize documents that they need to discuss and work on. KOALA was not able to support this transition, but after this experience we believe that this could provide a key advantage when moving from paper-based to computer-based displays. In this way chance encounters would not be only a moment for socialization and knowledge sharing, but could trigger contextualized and focused cooperation "on the flight".

From the deployment perspective, this lesson learned implies that displays need to be put in places where they are highly visible and where people can gather around. There need to be people passing by the display in order for people to stop at it, and people need to have the space to stop and gather in order to facilitate conversation opportunities.

LL2. Display systems are highly visible and they get adopted quickly. Our results show that the KOALA displays have been used regularly during the experimental period. Also, according to the results from our questionnaire, 95% of respondents declared they noticed when the system was down (even though the displays were used in an ambient manner). This shows the potentiality of this type of systems that are easily adopted and highly visible. We also observed that some people have taken more ownership of the application than other users and have at several occasions started the system if needed, rather than waiting for the responsible to do it. Though we cannot expect in all the settings users with the willingness to take care of the system from a technical point of you, we believe that the emergence of "super-users" can be a general phenomenon. The system should therefore be designed so to promote the involvement of super-users, possibly supporting the tailoring of the systems to the specific context of usage [11]. At the deployment level, this implies that tailoring should be promoted and rewarded.

LL3. Content plays a key role in the adoption of the system and it is related to the place where it is made available. The content on the display plays a significant role in determining system usage. This is for example witnessed by the differences in usage of the hall display that we observed among people belonging to the test group and the ones not belonging to it. Based on the results from the video recording people external to the test group rarely stopped or gathered in front of the displays and when they did it was for shorter periods of time. These results are in line with the findings in [10] which state that personalized and customized content on public displays help to create conversation opportunities. The relevance of the content strongly depends on where the display is positioned and how its users use that space. If the content on the display is focused towards the situation in which the display is placed and the audience it addresses, people are more

likely to stop and for a longer period of time than they would without directed content. Furthermore it seems the content has a profound effect on the way in which people use the displays, e.g. in terms of their tendency to gather. Data on the usage of the two displays during the working day help support the conclusion of a spontaneous and opportunistic use of the displays and to identify clear profiles of use.
From a design point of view this lesson learned points to the need to design flexible systems that are be easily tailored to the expected needs of the community. At the deployment level, it suggests that for each display it is necessary to identify its profile. This is not depending only from the physical position of the display, as we assumed when we started the experiment, but also, and possibly more important, by the work practices that characterize the specific location. The differences in profile must then be taken into account when choosing the content of the display. For a location where users are mainly on transit, one can place content that "catches the eye", such as a comic strip. In places where users are more prone to slow down, more complex content like news and messages, which is less noticeable and takes a bit longer to read can be placed. This however needs to be carefully tuned to the work practices and can vary for example during working hours. It is also important to take into account the emergence of patters of usage different than expected and be ready to adapt consequently. For example, during the adoption of KOALA people found subjectively the coffee corner display more important and one could have expected it to trigger a higher numbers of gatherings, but this was not actually the case.

LL4. Interactivity is problematic. One of our initial assumptions, shared also by other researchers in the field, is that a higher level of interactivity can represent the added value of computer-based displays on paper-based ones. However, during our initial investigations we noticed a low interest of users in interactive services. At the same time, interactive services such as sending messages have been seldom used during our period of observations. There are two factors that, in combination, we can use to explain these results. First, interactivity is not always part of the mental models that users have of a display, that is normally seen as a source of information to be used mainly passively, at least in the workplace. This means that starting to use the system interactively requires understanding and embracing the system more thoroughly that to use if for simply reading the information that is available on it. Second, interact with the system can be technically demanding and this creates an additional barrier to the interactive usage of the system. We therefore agree with [8] that easiness of interaction is a key success factor for these systems. This however has to be understood not only in terms of usability of the interactive services, but also in terms of, e.g., compliance of the system to the mental models of its users, support for interactivity via different devices, easy integration of the system in the existing network. Easiness of access to and usage of interactive services have to be carefully taken into account during the design of the system, but it has also implications on its deployment since it is necessary to promote the interactive components among users.

LL5. Functional and technical flexibility. Since the very beginning of the project it was evident the need of developing a system that is scalable, flexible, extendable, and easy to integrate with a range of different technologies. Our results strengthened this assumption and showed the need to have flexibility as one of the requirements strongly influencing the design of these systems, starting from the technical infrastructure on which they are developed. In fact these systems must be able to grow with their community, both in terms of the new services that might be needed and in terms of new technical possibilities, for example, for promoting interaction by using new mobile devices.

6 Conclusions

In this paper we have presented KOALA, a system for promoting presence and informal cooperation by using shared displays enriching the support offered by paper-based displays common in any workplace. In the paper we have also presented the results from the initial adoption of the system in the organization of one of the co-author. During the experimentation both displays have been used on a regular basis. The data points out that the two displays have been used in slightly different ways. Patterns of usage are directly affected by the placement of the display as well as by the working and social practices of the user group. The system was mainly used as a background service, not taking advantage of the possibility to use it interactively, i.e. for sending messages to other users. The results of this experimentation allowed us to point out some strengths and weaknesses of this type of systems, and a set of empirically grounded lessons learned for their development and deployment. We are fully aware of the limitations of our experimentation. It has involved a limited number of people and is limited to one specific system and one specific social setting. However, we believe that some of the implications from our results are fairly general and can be used to design better systems that can be tried out in more complex contexts.

Our work is proceeding mainly in two directions. First, we want to improve the flexibility of KOALA, both at the functional and technical level. With this aim we are integrating KOALA into a ubiquitous platform that we are developing [5]. Second we want to make available through KOALA services for supporting a smooth transition between informal and formal cooperation, for example, by temporally tailoring a display to be used for supporting a local meeting by accessing shared workspaces.

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