

# Attendance Automation using Near Field Communication (NFC) Technology

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**Abstract—** The purpose of this paper is to develop an optimized and automated attendance system using the rapidly developing near field communication technology. The test implications of this technology suggest that a technology supported attendance supervision system can bring value for all end users, primarily serving the teachers and the parents.

**Index Terms—** Near field communication, tags, attendance, teachers, students, parents, value based design.

## 1 INTRODUCTION

This paper introduces a Near Field Communication (NFC) technology supported attendance supervision system. Traditionally, teachers conduct pupil's attendance monitoring everyday with manual roll calls, and mark absences and delays in the backend system. This requires time and effort on every school day, which is taken away from teaching. In addition, students also tend to mark proxy attendance of their classmates thus leading to fallacious results. The NFC-enabled attendance supervision system has been designed to simplify attendance monitoring. The system replaces manual roll calls and gives parents information of their children's attendance in real-time. It also helps in saving paper and various other costs involved in the current attendance system.

## 2 RELATED WORK

Studies by Fraser et al show various transitions between children behavior [2]. Transfer of information about a student between school and home was raised as a critical issue by him. While parents were worried about their children, they suggested that technologies that monitored children's activities, such as the mobile phone tracker and sensors, moved from expressing concern to expressing distrust as children aged. In consequence, Fraser et al. identified as one core issue for future research the discussion of children's privacy in technological design. Not only are there safety concerns about the protection of data collected about children, but also ethical concerns about the rights of children in gathering it. In European countries, children are able to freely move around and have independent mobility to schools and leisure facilities [1]. New technology has made it possible to monitor children by e.g., their cellular phones, and some parents use that deliberately in situations where the children are testing the boundaries of where they can go independently. Monitoring children's movements from a distance seems to

provide some parents with a feeling of control and thus seems to ease their risk worries, even though parents opportunities to save the child from any danger are limited. Fotel and Thomsen state that even though monitoring the mobility of children is often done with a caring rationality, it can transform into a control, which in some cases, the child does not benefit from. Also a Rhode Island school district has announced a pilot program to monitor pupil movements by means of RFID chips implanted into the schoolbags of 80 children [4]. Each chip would be programmed with a pupil identification number, and would be read by an external device installed in two school buses. The buses would also be fitted with GPS (Global Positioning System) devices. Parents or school officials could log onto a school Web site to see whether and when specific children had entered or exited which bus, and to look up the buss current location as provided by the GPS device. The RFID tag would contain only an ID number, not a name, address, or other personal information, so unauthorized individuals are prevented from gaining an access to pupil's private information. The ACLU has criticized the plan as an invasion of children's privacy and a potential risk to their safety.

## 3 RESEARCH SETTING

The attendance supervision trial supported by Near Field Communication (NFC) technology began in Oulu, Finland on September 2008, continuing until December 2008[1]. The trialing phase lasted 14 weeks. The trial was conducted at a local primary school, where two classes with a total of 23 pupils between the ages of 6 and 8 (the majority just starting at school), participated in the trial. Parents' permission for their children to participate in the trial and to the adjacent research had been asked in advance. One of the participating classes represented a first grade class (16 children out of 19 participated in the trial; 9 girls and 7 boys) and the other one was a special-needs class consisting

of special-needs school children (all 7 boys, 4 first-graders and 3 second-graders, took part in the trial) who were diagnosed with minor special needs, such as dyslexia, difficulties with concentration or troubles with perceptive skills. At the same time, a similar kind of study was done at a local secondary school with more advanced technology and more complicated application features. Curtis et al. have argued that disabled children, children excluded from school, and children for whom the discursive nature of conventional interview-based research is less accessible have been less well represented in participatory research than children who are easier to interview. For a range of methodological and practical reasons, children who communicate well, or who are regular school attendees, are more likely to be given a voice in the research literature. Therefore, the class with special needs children was chosen to participate in the trial along with the normal first grade class.

### 3.1 NFC Technology

Touching with a mobile terminal has been found to be an intuitive, natural and non-ambiguous interaction technique that does not incur much cognitive load for users. Viikynen et al. [4] state that touching is an effortless way to select objects in the environment and easy to learn and use. Near Field Communication (NFC) technology is designed to make communication between two devices very intuitive. NFC is a very short-range wireless technology that allows electronic devices to interact with other devices simply by touch. The main advantages of NFC are the simple and quick way of using it and the speed of connection establishment. NFC is based on existing radio frequency communication standards, so it is a special case of implementation of RFID technology. The touch-paradigm prevents reading from a distance because a short physical proximity (a couple of centimeters) is needed to transfer information. Even though NFC technology uses a touch-paradigm, it is technologically possible to read information through NFC from a distance with special powerful reader devices. However, in this paper, we assume that NFC is used through a touch-based interaction paradigm. In our attendance supervision field study, we explore a usage scenario where NFC-enabled mobile phones and smart reader devices located in the classrooms are used to read information stored on pupils contactless smart cards.

### 3.2 System Description

In the attendance supervision trial pupils were given contactless smart cards containing the pupils ID. Upon arriving at school pupils in the first grade class logged in by touching an NFC smart card to an active card reader device and pupils in the special-needs class logged in by touching an NFC-enabled mobile phone. The reader devices recorded the card ID (the child's name), the direction (arrival at school) and a time stamp in the backend system.

The active reader device was chosen for the first grade class because it works faster than an NFC enabled mobile phone for large groups. The application in both the reader device and the mobile phone recorded the time of the login; it was possible to choose the direction of the pupil registration (in or out) through both devices. At the end of the school day pupils touched the reader devices again to mark their departure. The attendance supervision system (through NFC phone) was also used in extended day care programs where some children went after school [5]. The day care is held in another building outside the school, so with the help of the supervision system parents were also able to follow how much time it takes for their child to walk to the day care from the school (the time between logging out at school and logging in at day care) and to ensure that their child has safely made his/her way from school to day care. The log of arrivals and departures was automatically compiled by a backend system, and could be read by a teacher in a classroom in real time. If a login did not occur, the pupil was marked absent by default. If a pupil logged in late, the backend system recorded the lateness. Parents were able to get information of their children's attendance details via an online citizen's portal and through text-messages sent to their mobile phones. The system prevented truancy by informing tutors Administrators and parents of absences in real time, enabling instant intervention.

### 3.3 Design Procedure and Research Goals

The attendance supervision concept was planned and designed in close cooperation with teachers, service and technology providers, and researchers. During the design phase the ultimate goal of integrating the concept into normal school practices was especially emphasized, so that the trial would not be an extra effort related to the research project. The aim was to create a viable concept that could also be adopted in the school as a routine to be used after the research trial. This required close involvement of teachers and school administration in planning and implementing the applications, and in organizing and supervising the trial. It was also seen very important that children were given a possibility to participate in the system design to empower them and get them committed to the use of the system. During the trial, the researchers were only involved in the data collection activities; teachers took full responsibility for organizing and supervising the actual attendance supervision trial. Participating teachers volunteered for the trial, and it was their responsibility to adopt the attendance supervision system for everyday use in their class. The teacher's explored new working practices introduced by the system and were expected to report their experiences and observations regarding the system. The goal of the concept was to (1) enhance and secure children's independent mobility in home-school transition and (2) to increase the rationalization of home-school communication.

The objectives of the field study were to test the attendance supervision system for school children and their parents and teachers, and to examine the value the attendance supervision concept brings to these stakeholders, as well as the attitudes of each user group concerning the use of the system.

## 4. USER EXPERIENCE AND INTERACTION

### 4.1 Classroom Observations

Classroom observations were made to collect information about how the pupils learned to use NFC kind of spontaneous reactions and discussion took place in using the attendance supervision system. Children in the first grade class were observed twice over the course of the research. The first visit happened in a very technology, what kind of routines they had established after using the system for some time, and what early phase of the trial: the attendance supervision system had been taken into use only a day before the visit. At the time of the second observation the attendance supervision system had been in use for two weeks. The special needs class was observed when they had used the attendance supervision system for two weeks. Observations with both classes were conducted during a normal school day by attending the first lesson in the morning. The login process was observed from the back of the classroom to minimize the disturbance caused by the researcher's presence. During the observation the children's behavior and actions were videotaped and photographed. The children seemed not to be disturbed or bothered about the researcher's presence.

### 4.2 Interviews with Teacher and Children

All the children participating in the trial as well as their teachers were interviewed in order to investigate their thoughts and experiences about the technology and service concept under evaluation. The interviews took place on the same days as the classroom observations. After login was done and children started their school work, interviews were conducted very informally by chatting with a few pupils at a time either in the classroom or in a separate place. Children in the first grade class were interviewed twice over the course of the research. The teachers were interviewed informally partly in the midst of teaching, partly during breaks between classes. The children seemed to be proud and excited those adults outside their school had come to their class just to chat with them and ask about their thoughts. The children were very happy with answering the questions and spoke freely and frankly about their own thoughts and opinions.

## 5. IMPACT FOR THE SYSTEM DESIGN PROCESS

### 5.1 Individual Impact

After thorough study and analysis of the design process, it can be concluded that the system involves equal and active participation of teachers, students and parents. Using the system seemed to be easy according to the children: You just put the card there like this, You can put it either way, You don't need to wave it, just flash it there quickly, When it [the device] says OK, login has succeeded. The pupils seem to remember well to carry the card with them every day, with only a few exceptions. This proves to be a beneficial system as findings reveal that children value that they were able to participate and be active in the design, use and evaluation processes. By participating, they can have their voices heard and influence the decisions that affect their school days. Also, experiences indicate that by participating in the design and use processes the children became aware and internalized the functionalities and goals of the system, which can lower the barriers for adoption and use. Participation of teachers was seen to be especially valuable in integrating the application and processes into the daily routines of a school day. The teachers took the responsibility of integrating and supervising the adoption of the new practice. Our experiences indicate that this is essential for the success of adoption. The teachers said that the children had been extremely excited when they had heard they could participate in the experiment. The pupils had waited intently to receive their own cards, and after a few weeks use had only positive thoughts about the attendance supervision: This is easy to use, login has worked well. Teachers reported that the children had easily learned how to use the card, and the login had soon become an integral part of their school day.

### 5.2 Downsides

- Parents concern over late logging in of their students due to various reasons.
- Parents need to know more information about their pupil.
- System breakdown due to various reasons (hardware, software).
- High cost of NFC tags.

## 6. CONCLUSION

In the trial, information about user experience was obtained by combining different data collection methods. The findings were analyzed from the viewpoint of three end user groups, namely, children, parents and teachers. The attendance supervision system can reduce unnecessary doubt by allowing parents to receive real-time information on non-attendance or if a pupil is late from school. The main benefits for the home are that parents can follow their

children's attendance status in school and day care in real time, thus eliminating the need for calling the child or the teacher to inquire about the child's whereabouts. The service also facilitates teachers work by offering technology and a system for gathering the information about children's attendance and keeping a log about their possible tardiness at school. It also needs to be noted that security at school is improved via an attendance supervision system: it is easy to see which pupils are in which classrooms. Real-time attendance logs are also important for a pupil and for his or her legal protection.

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