Being There with Bluetooth

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***Abstract*— In this paper, we describe how a multi-purpose Bluetooth communication software could simplify the daily routines of a vocational teacher significantly with virtually no extra cost and without excessive technical requirements. The attendance of the students can be monitored using the system described in this article. This feature was discovered when testing a short-range communication application intended for information distribution. The conclusion is that, with the addition of a tailored report formatting module, this application has significant potential to improve the quality of the everyday work of both the teacher and the students.**

Keywords-simulation; short-range wireless networks; encounter networks; vocational education.

I. INTRODUCTION

In this paper, we describe how a simple Bluetooth-based mobile application can support the everyday work of a vocational teacher by providing up-to-date information about the attendance of the students. While significantly reducing the time required for everyday routines, this application also facilitates achieving more accurate results and allows the teacher to concentrate on the students during the critical moments of starting a lesson. The system described here helps both the teacher and the students to stay more focused on the subject of the lesson, which is a good starting point for an effective learning experience. An important part of this is the fact that the utility described here does not require immediate attention from either party. Computers (and various mobile devices) can be very useful for learning purposes in some cases, but according to the common experience of the teacher community, they are also notorious for diverting one's attention from the ongoing process, such as the start of a lecture. Various network games and social media services are often seen to gain the students' full attention instead of the teacher. An information system based on "just being there", allowing the presence of the students being examined later, can hence be very effective in such situations.

This paper is organized as follows: Section II describes the related work in the field. Section III gives the necessary background information for understanding the problem in question. Section IV discusses the solution discovered for the problem. Section V describes the field test performed, and Section VI draws attention to the open questions and challenges in the field. Finally, Section VII sums up the process described in the article.

II. RELATED WORK

The potential of using different Personal Mobile Information Devices (PMIDs) in Short-Range Wireless Networking (SRWN) has been examined by us with our colleagues. In [3], a generic platform for Bluetooth-based communication is described. The potential applications for such utility is described in [4], while [5] provides more formal approach to this form of communication. These ideas are further developed in [6], which also points out the significance of just detecting a device, without any communication transactions. These papers created the background for the contribution of this paper, observing the potential of the application in detecting the presence of a Bluetooth device users(s).

The basic concept of encounters between mobile devices ([7]) is utilized here in its most pure form: As suggested in [3] and [6], it is the presence of the device that already provides valuable information, not only the (possible) communication between the devices. This is the background that the system described in this paper is based on.

The focus of this research is on technically less demanding, human time frame applications. We consider this approach to be significantly different when compared to more traditional, connection/data transfer oriented approaches. For example, Sundaresan and Sivakumar [1] search for improvement in communication from the antenna technology. Yap et al. [2] in turn take a higher-level approach in requesting open systems, smoother transitions between different network infrastructures. Spyropoulos, Psounis, and Raghavendra [11] apply the most traditional approach, how to improve the network performance via more efficient data distribution methods. These are all important matters and serve well the mobile communication community. However, we feel that there is still another area of work: Applications and services simple enough to provide significant value without any further development on the areas mentioned above. In this paper, we describe one such a case.

III. THE BEING THERE PROBLEM

Vocational education, from the age of 16 and above, is supposed to provide students with the professional skills of a particular field they have selected ([8]). In Finland, a wide variety of areas is commonly available, although some special subjects may be provided only by a very limited set of educational organizations. The training is organized as three-year vocational studies, divided into courses consisting of lectures (lessons) containing both theoretical and practical

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approaches to the subject, supplemented with a certain amount of supportive courses in, e.g., languages and science. These are required since any three-year vocational degree is supposed to provide a sufficient background for continuing one's studies on the (applied) university level.

In most cases, one must be present during the lessons to practice and to show that one can actually perform the vocational tasks being discussed. If the attendance rate of a student is not high enough, the teacher cannot evaluate his or her learning and the student hence cannot pass the course.

For these reasons, the teacher must keep exact track of the students' attendance at each lecture. This information is in most cases entered into the organization-wide web-based information system (such as StarSoft Wilma, [12]), which is used by not only the teachers but also the students and their parents (in case the student is under 18 years of age). If a student is marked absent, he or she must provide a valid reason for missing the class. The parents of a student under 18 years of age should confirm the information given by the student. The group supervisor of each student group monitores the data and, if required, may take necessary measures.

Due to some of the students coming in late (an unfortunate but rather common phenomenon) and the large number of students (sometimes up to 35 in a single group), this is a time-consuming task. For certain workshop environments, the use of a standard classroom desktop computer may not be feasible at all.

This process is time-consuming especially for teachers working with several groups of students (mathematics-physics-chemistry teachers, language teachers, to mention but a few) who may meet four or five different groups during one day. It takes time to learn to know all the students, so for most part of the semester a roll call is the only method which can be used to monitor the attendance of the students. It takes up a lot of precious learning time. Quite often it has also occurred that even if, on a good day, the roll call only takes a minute or so, it still is a time long enough to divert the attention of the students away from the forthcoming lesson. If this could be avoided, the lesson could start with a more concentrated group of students. Furthermore, it is not mandatory to enter the data into the school's system immediately, since data entry will only provide value after the lesson is completed. In most cases it would be sufficient to update the information system after the whole day is complete.

Hence, a problem to be solved appears to be how to quickly and silently but reliably record the attendance of the students and to keep the information available for one or two hours so it could be entered into the official school system.

IV. THE SOLUTION

A Bluetooth-based non-communicating network may offer a solution to the problem described above. One can detect the presence of a Bluetooth device owner quite fast and quite reliably. This is not an absolute process, but compares quite well with the standard visual and auditory detection currently used. Such device-detecting application can satisfactorily work on the human time scale (as noted in [5]). The attendance of a student should be recorded with an accuracy of a minute, not a millisecond. The delay in the Bluetooth device detection procedure is therefore quite acceptable for this application.

A student project ("SBSB" for "Simple Broadcast Service/Bluetooth" unofficially called the "BlueInfo", a part of the subject studies of mathematical information technology at the University of Jyväskylä, Finland) related to our research work was carried out during early 2010. The project produced an application which was able to detect Bluetooth devices and pass information to them ([10]). However, it was both recognized and requested that the result of the project be a generic platform allowing different, yet unspecified uses of the software. Being able to detect devices and by request to be able to communicate with them via Bluetooth was the essence of the project. An exhaustive event logging system in the ASCII text file format was implemented in the software, providing the discovery (and discontinuing) times of the devices detected. This already provides sufficient data for the presence detection software.

The fact that virtually every student on this level has a personal mobile phone with Bluetooth support ensures the validity of the scheme suggested here. In addition, since the detection can be based on the MAC ID of the device only, no special features (such as software installation) are required from the students' side. Unlike NFC technology (described in [9], for example), Bluetooth allows the detection within a reasonable distance (classroom–sized spaces).

V. TESTING THE SOFTWARE

The idea has been demonstrated as a part of another software test of the SBSB project. It was run on an N810 device and we wanted to know how the application could handle a larger number of devices and to get an impression of its performance outside the labs. In April 2010, the following test was performed. During a scheduled break between the lessons a group of 23 students was asked if they wanted to volunteer for a software experiment There were no objections; all the students were very interested in the subject (which obviously offered well-deserved variation to the math lessons). They were asked to turn on their mobile devices' Bluetooth feature so the N810 device application could detect them. This was done on a volunteer basis; one could participate in the test if one wished. At most there were 19 Bluetooth devices recorded being present within the same classroom. The application, not yet being the release version, eventually crashed, but during those approximately 10 minutes it was working it became clear that such a system would be valuable in tracking the presence of other devices. The logging feature of the application allows the presence of other devices being examined later. It would be a reasonable coding task to create a post-processor for formatting the log information into a suitable format for the particular use described above.

The N810, even though obsolete in many ways, is very well suited for this kind of task. WLAN and USB connections allow the transfer of information to other devices. Furthermore, the relatively large display allows manual entry of the data being viewed into other systems (even low-tech, still quite a common option and cannot be ignored in this scenario).

One should note that in the group of 23 students everyone did have a mobile phone. One student had a phone without Bluetooth support. This observation suggests that restrictions in usability of the service remain rare (e.g., less than 10 %), and the application can still make a significant contribution.

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VI. OPEN QUESTIONS

The most obvious (technical) question is that since the range and reachability of Bluetooth devices may vary, especially indoors, one could receive inappropriate signals from the adjacent classroom, for example. This could be avoided by using device IDs containing two parts which identify the student group and the student within the group. This could also be done on the server side (during the data analysis phase) by assigning certain MAC addresses to a certain group, i.e., no action would be required from the student's side. However, a permission of the participants (most likely in written form) should be received.

It is highly unlikely that a device within the same area, e.g., within the same open space and less than 20 meters away, is not detected within a couple of minutes. Again, if such cases fit within the 10 % residual, this should not be a problem.

It is clear that this system cannot be made mandatory considering the rights of the students. There is potential for legal problems, concerning the storing of the data. In principle, similar data has been recorded manually for decades, but one cannot guarantee that all the parties involved (teachers, administration, students, their parents) will immediately accept this more advanced version. On the other hand, it would be possible to use nicknames and/or code numbers. As already noted above, the Bluetooth MAC address would be sufficient. A connection between it and the user could be made in the teacher's system, where the information is already present.

The reliability of the software should no longer be a problem. After the test described above (which led to the crash of the software), there were several critical errors which were corrected before the end of the project (June 2010).

VII. CONCLUSION AND FUTURE WORK

In this paper, we presented a small but frequently occurring everyday problem which may be solved quite comprehensively with a very simple information system, which, for the most part, has already been created. A network without communication can still provide information about the devices' presence and the time of arrival (and departure), which, in this case, is what the problem to be solved is all about. Immediate recording combined with the possibility of analyzing the data later is the essential part of the solution.

Based on the brief test made in a real classroom environment, the solution appears to be valid. The creation of suitable parser software for providing more readable output of the particular data required could be executed as another student project. Meanwhile, it is possible to continue field testing on a volunteer basis.

The original purpose of delivering SMS-sized messages to the clients could also be used in a classroom environment, for "silent communication". Such needs may occur when, for example, a student needs to go to the dentist during the following lesson. However, this is an extension to the system which requires a separate development cycle of its own.

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