Switching the role of NFC tag and reader for the implementation of Smart Posters

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***Abstract*—Benefits and opportunities of NFC technology have been discussed for many years. Continuous promises of handset manufacturers to embed this technology into their series of devices anytime soon have been fulfilled only partly so far. Contrasting with that, research and practice have outlined a number of applications that yield great attention among users. Among these applications are Smart Posters. However, the prevailing low market penetration of NFC-equipped smartphones poses a barrier for the implementation of many Smart Poster scenarios. Accordingly, for certain scenarios this paper proposes to switch the role between fixed tags and mobile phones by affixing mobile phones to posters and hand out the much cheaper tags to the users instead. The paper describes the approach and shows its feasibility by reporting lessons learned of a case study.**

Keywords—Smart Posters, NFC, Smartphone, Implementation, Voting Demo

I. INTRODUCTION

Near Field communication (NFC) technology has been announced as a standard for data exchange and wireless connections within centimeter range in 2004. Since then device manufacturers have been continuously announcing to embed NFC capabilities in their next devices. As we know today only a few manufacturers actually did.[1] Contrasting with that, the release of Google's Nexus S at the beginning of 2011 has raised the expectations of NFC again, as it is the first smartphone providing this functionality.

Among the most discussed applications for NFC technology has been the concept of Smart Posters [1]: little NFC stickers attached to objects allow users to access digital services upon touching the tag with their phone. Smart Posters can be simple posters, billboard, magazines, but also three-dimensional objects. A touch point on the posters indicates where the smartphone user should hold their device to read the tag. Representative examples include the use of Smart Posters in tourist information, marketing campaigns with couponing, museums, elderly service meal orders, but also educational events or trade-fairs [1]-[4].

However, given that the current market penetration with NFC-equipped smartphones is still below 0.01%[2] [6], [7], the vast majority of visitors to events like trade fairs, exhibitions, or showrooms cannot interact with Smart Posters, because they do not carry NFC smartphones on them. As of today there is a very limited choice of devices with NFC support available. Even Apple's recently released iPhone 4S still misses NFC support yet. This results in a low number of potential user interactions and hence renders the application of NFC technology to facilitate an efficient Smart Poster setup for many of such events useless [8].

One approach to circumvent the low penetration rate of NFC smartphones among visitors is to use alternative identification techniques such as QR codes [9]. Barcode reader software on smartphones has become a standard among many smartphone users. This software, provided as apps from different vendors, use smartphones' built-in cameras to identify standardized shaped black-white patterns visibly printed on posters. Apart from visual disturbance of these patterns on nicely designed posters, research has also shown that the visual on-sight reading of QR codes vs. the touch-based interaction of NFC comes with several drawbacks with regards to performance, reliability, simplicity, or cognitive load [10].

Another approach to cope with the problem of low NFC smartphone penetration is, at least in the context of temporary or regionally limited events such as showrooms or exhibitions, offering NFC smartphones for lending on the spot. Apart from the practical effort of handing out phones and getting them back, this process mostly contracts the

[1] See http://www.nfcworld.com/nfc-phones-list/

[2] Worldwide shipments of cell phones with built-in NFC capability (52.6 million) in 2010 [7] divided by mobile cellular subscriptions in worldwide in 2010 (5.282 billions) [6] = 0.009

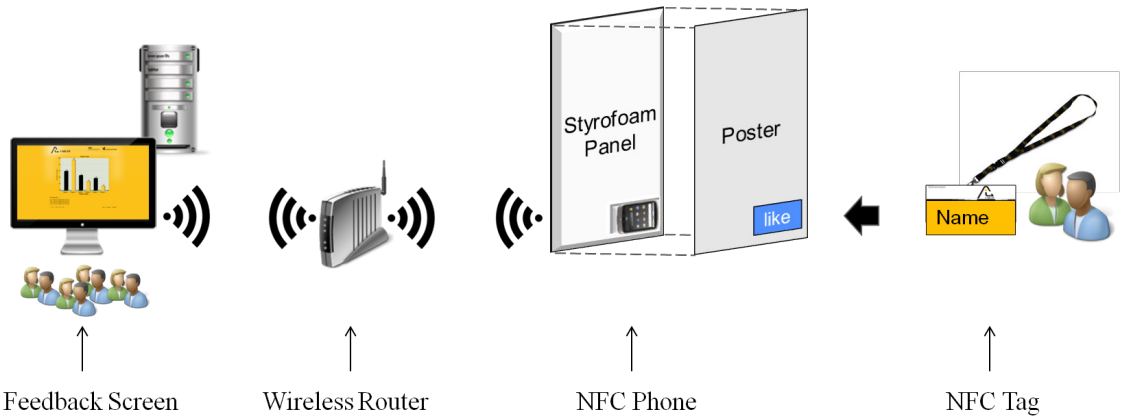

Fig. 1. Smart Poster Concept: Switching the role of NFC smartphone as the visitor's reader and the NFC tag applied to the posters.

very personal nature of the phone. The mobile phone has become the most intimate aspect of a user's personal sphere of objects, both physical and emotional attachment to mobile handsets are increasing [10].

Generally, this yields low participation of the technology and does not really represent a seamless way of introducing it into daily practice. Borrowing devices instead of using personal smartphones imposes additional technological and psychological barriers on the visitors [8]. First, it is likely that many visitors are not familiar with the borrowed phone. Second, they are put into an unnecessary opt-in situation. Their default status is, not to be able to participate in the evaluation of Smart Posters. Just by lending a NFC-enabled smartphone they opt-into the participation in the Smart Poster evaluation process. Third, the number of visitors exceeds the number of posters significantly for most reasonable applications. This requires expensive NFC smartphones to be distributed to a high number of visitors.

Summing up research has shown great potential of NFC, however, low penetration of NFC nowadays still puts NFC applications as a challenge:

1) *Usability:* Alternative identification techniques don't have the same level of usability as NFC.
2) *Personal nature of smartphones:* People are used to their personal phone. They don't like to share phones, respectively want to use smartphones they are not familiar with.
3) *Costs:* Lending smartphones to a high number of visitors results in high investments.

In this paper we present a novel concept for implementing Smart Poster scenarios that while using NFC technology circumvents the problem of low NFC-equipped smartphone penetration. This concept is especially useful in events where the number of visitors is high compared with the number of posters. We tackle the problems of typical low visitor participation by switching the role of NFC smartphone as the visitor's reader and the NFC tag applied to the poster. In our approach the visitors are equipped with identification badges augmented by NFC tags. These NFC tags are cheap to distribute with the badge and can then be read by stationary NFC smartphones hidden behind the Smart Posters. This way, visitors do not have to borrow any devices. They are enabled to interact with the posters by default. From the economic point of view, only as many smartphones as Smart Posters to be presented are needed instead of having to supply all visitors with smartphones.

The remainder of the paper is structured as follows. Section II describes the concept of our approach. Then Section III presents details about the implementation of the concept. Section IV describes a small case study, where we report a first proof-of-concept tested at a real event. Finally, we describe the results (Section V), discuss the outcome (Section VI), and conclude the paper (Section VII).

II. CONCEPT

The goal is to allow visitors to express positive feedback about specific posters they are looking at. In our concept we adopt the Facebook "like-button" and transfer it to the real-world using the touch interaction of NFC technology. The visitors receive immediate feedback to indicate that their voting was successful and aggregated results should be displayed to show the current evaluation of the posters.

Instead of placing the tags on the posters and using the smartphones as active readers for the visitors, we suggest switching the role of tags and readers: placing the phone as stationary tags into the posters while visitors use the NFC tags to actively vote. In this setup the visitors use a common identification badge that holds a NFC tag to vote for a poster by dragging their badge over an indicated touch point on the poster. On the back of this touch point a smartphone acts as the stationary tag and provides immediate feedback to the user for example by playing a sound that confirms the successful vote. A wireless router is used to connect the smartphones to a backend and to display aggregated results

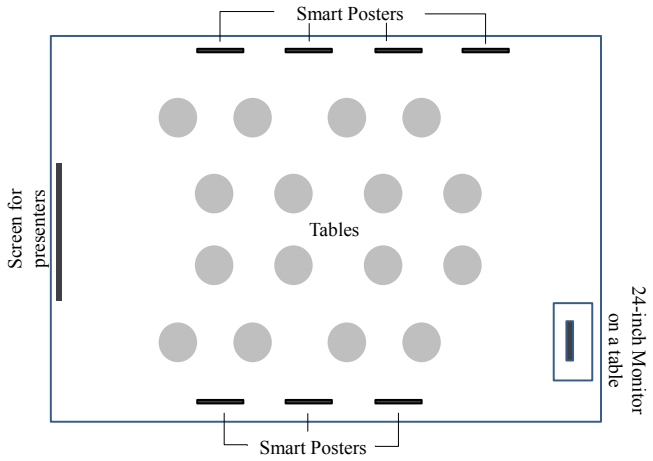

Fig. 2. Layout of the room of the dissemination event. Dark items represent parts of the Smart Poster setup.

on an external monitor. The overall setup is shown in Fig. 1.

Thus, visitors can use their badges to show appreciation for specific posters. Immediate feedback about the successful vote is provided by sound. The current voting results are instantly displayed on the screen.

III. Implementation

The implementation of the system consists of a MySQL backend, an Ajax driven website, and an Android application. The website development used the open source software FusionCharts Free[3] to display a bar-chart and the Prototype JavaScript Framework[4] to pull information out of the database into the bar-chart with a periodic update of five seconds that grabs the latest information from the backend PHP script and pushes it to the chart.

The Android application (v2.3.1) connecting the posters with the backend was developed and installed on Google's Nexus S smartphones. A preference-menu allows setting the id of the corresponding poster in the application. The role of the application is to read out autonomously the unique identification string in each tag, if any badge was held to the like-button on the poster. The scanned unique identification string is then sent by the application to PHP script which is linked to a SQL database. The SQL database is composed of three tables. The first maps the unique identification strings of the tags on the name badges to the participants' real names. The second contained the aggregated number of votes assigned to the posters. The third stored the ids of voters with the corresponding poster id and a timestamp. The role of the PHP script was then to increment the number of votes given for each poster in the SQL table and display the voting results as well as a stream of the five most recent voters on an external monitor.

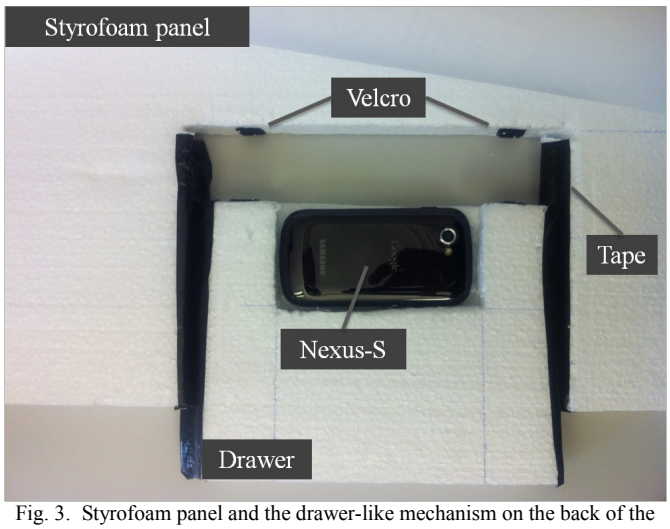

Fig. 3. Styrofoam panel and the drawer-like mechanism on the back of the poster.

Fig. 4. Distribution of votes from 31 voters out of 45 visitors.

IV. Case Study

We tested the implemented Smart Poster system in the context of a dissemination event in September 2011, where we presented ongoing research on seven posters to a group of 45 visitors from several Swiss companies.

The overall layout of the dissemination event can be seen in Fig. 2. The Smart Poster setup comprised a 24-inch monitor providing visual feedback, seven Smart Posters, each attached onto a styrofoam panel of the same size as the poster, seven Google Nexus S mobile phones used as NFC tags for each poster, 45 NFC-tags each adhered to a badge, and a wireless router to establish a local wireless network. Each styrofoam panel had a drawer like mechanism cut out of the styrofoam panel itself in order to hold the NFC phones just behind the area of the like-button. The drawer like mechanism is shown in Fig. 3. It is a simple construction using tape and Velcro fastener.

The setup of the scenario was briefly explained to the visitors in the beginning of the event but also directly on the poster as shown in Fig. 4. In this initial setting, visitors touching the like-button with their badge got an audio feedback in form of a "jippie" sound. The 24-inch monitor provided visual feedback showing aggregated votes in form of a bar-chart and a stream of the most recent voters as depicted in Fig. 5. Visitors were allowed to vote as often as they wanted.

V. Results

Apart from the development of the system and material costs for styrofoam panels or name badges, the only significant costs that occurred were the costs for the seven Nexus-S phones (€300 each) and the 45 NFC tags (€1 each). This accounted only to about 16% of the cost of a scenario where 45 phones would have to be arranged and rented out to the visitors (€2.145 vs. €13.507).

The event lasted about six hours in total including talks from several speakers and smaller workshops. In the breaks between the talks, visitors were able to have a closer look at

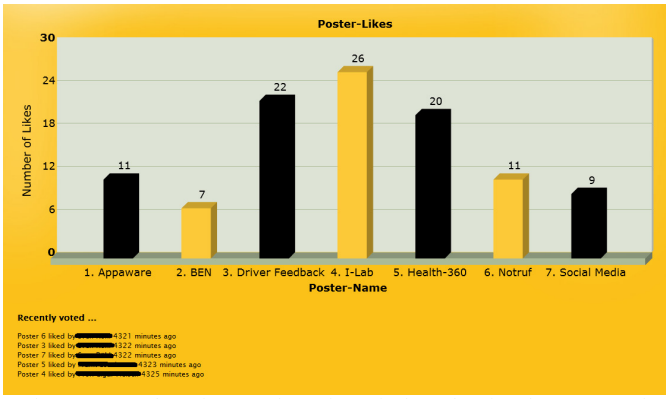

Fig. 5. Screenshot of External Monitor Display: Showing the aggregated number of votes for each of the seven posters and the recent stream of voters.

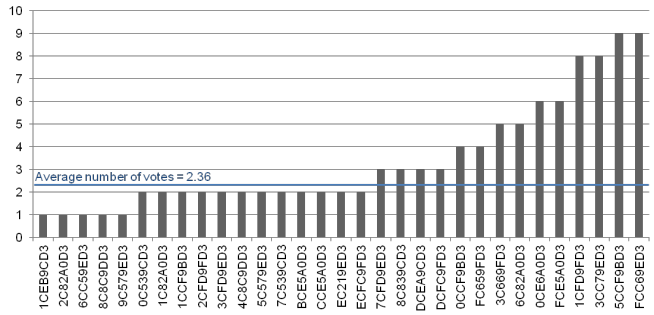

Fig. 6. Distribution of votes (n=106) from 31 voters (tag-ids) out of 45 visitors.

the presented posters and vote if they liked. From the 45 visitors that had the opportunity for voting 31 visitors gave 106 votes. Thus the turnout of voluntary voters was 69%. The average number of votes was 2.36. The final distribution of votes for each poster can be seen in Fig. 5. The distribution of votes for each visitor can be seen in Fig. 6. The maximum number of votes given from a single visitor was nine votes.

VI. DISCUSSION

We gathered insights from our event observations and discussions with the visitors but also gained insights from the concept planning and implementation phase. With regard to the Smart Poster event, our findings relate to three main categories: (1) user interface, (2) user feedback, and (3) overall appraisal of the Smart Poster event.

In general visitors voted successfully without any further support. Fig. 7 shows the process of voting for a poster by a visitor. In rare exceptions users dragged the badge over parts of the poster other than the like-button. As NFC gets more popular using the "N-Mark" promoted by the NFC Forum as the global symbol to indicate that NFC functionality is available could be a future solution for that problem [1]. However, so far this symbol is mostly unknown among people.

Discussions with visitors showed that they liked the idea of using a common identification badge. They mentioned this interaction as a daily routine when opening doors at their workplaces with badges. Also the notion of our one-time badge handed out for this specific event characterized it much more as a ballot than a rented non-personal and most likely not familiar smartphone.

Visitors also mentioned the audio-feedback as helpful for confirming the successful release of a poster "like". However, some people complained that the sound could have been louder because a lot of background noises from the crowd made it hard to recognize the sound. For the participants that heard the "jippie" sound, it was clear that the voting was completed. For the participants that did not hear the audio feedback it was confusing to figure out if the voting process was completed. Hence, some participants pulled the badges away from the poster assuming that the voting was done, though it was not. On the other hand, some of the participants reattempted the voting, though the voting was successfully done. For that reason the feedback given to the participants after a scan process should be clear and intuitive to avoid any confusion.

The external monitor was rarely visited. This could be due to the positioning of the monitor, which could not be clearly seen directly from visiting the posters. Using a larger screen that can be seen from the point of voting could help but is probably not feasible in many scenarios as it may distract the user from the Smart Posters. Providing visual feedback on the smartphone sitting behind the poster, maybe through a small window in the poster, could be a solution. However, this is currently prevented by the fact that the Google Nexus S device only allows NFC scanning only on the back of the device.

With regard to the overall appraisal, the demo was perceived as an interactive element that added extra value to the event.

Switching the role of tag and reader clearly limits potential interactions between user and device. While complex interaction scenarios, e.g. [11], might be hard to realize, extended interaction such as voting "like" or "dislike" would still be possible in a couple of ways. First, by using a second smartphone and corresponding touch point in the poster, second, by giving users a second tag. In combination with visual or audio-feedback there emerge a variety of potential scenarios that can be implemented in a still cost-efficient way as described in this paper.

Compared with scenarios where visitors use their personal smartphones to interact with the posters, we also realized that our approach enables organizers to plan the event more efficiently: when visitors' names are known in advance, one is able to preconfigure the backend with the corresponding visitor names and tag ids. This avoids that people have to provide their contact details when voting. While services like Facebook-Connect that allow third-party websites exist, applications, or mobile devices to login with

their Facebook identity, the process of authenticating on the spot could pose another barrier for visitors to participate.

Furthermore, especially when the number of visitors is high compared to the number of Smart Posters our approach can be still cost-efficient, as the number of smart phones remains the same and the costs of tags are neglectable. Although, the visitors' potential interaction with the Smart Poster might be more limited than in scenarios where the visitors use their own personal smartphone, this poses several advantages with regard to economic reasons but also with regard to reducing the psychological and technological barriers to participation for visitors.

We further encountered that for common events the length of battery duration shouldn't be a problem. We tested the setup with all energy consuming services running in the phone turned off (GPS, Display, and Bluetooth). We scanned a poster several hundred times in varying frequencies. After six hours the battery was still above 50%, which should be good enough for most scenarios. However, phones should be fully charged at the beginning of the event and all energy-consuming services that are not needed for the setup should be turned off. In the end, using the phone as the tag needs much less energy than using it as reader with many energy-consuming services turned on.

While there potentially exist cheaper NFC devices than smartphones to act as readers behind the posters, to date they usually require USB connectivity to a local host in order to ensure power supply and access to the local network. Compared to our approach with smartphones, this would induce more hardware load on the poster side. However, if this kind of Smart Poster setup gets wider usage in the future, more cost-efficient, standalone, chargeable, Wi-Fi enabled NFC-Readers could be developed to support various Smart Poster scenarios.

VII. Conclusion

In this paper we present a concept for NFC-supported Smart Poster scenarios with specific characteristics such as in showrooms, on trade-fairs, or exhibitions. In these scenarios the number of visitors is often high compared with the number of posters.

We addressed the prevailing low market penetration of NFC-supported smartphones by attaching phones and handing out tags in order to avoid the complexity of renting out phones. This approach allows implementing Smart Posters even with larger numbers of visitors, as the costs of the required tags can be scaled.

Our results further provide support for the importance of immediate feedback upon scanning an NFC tag as outlined by [13]. In a majority of Smart Poster scenarios such as the voting- demo described in this paper, enhanced interaction from the visitors' side is not required. While it is still unclear when NFC technology will reach mass adoption,

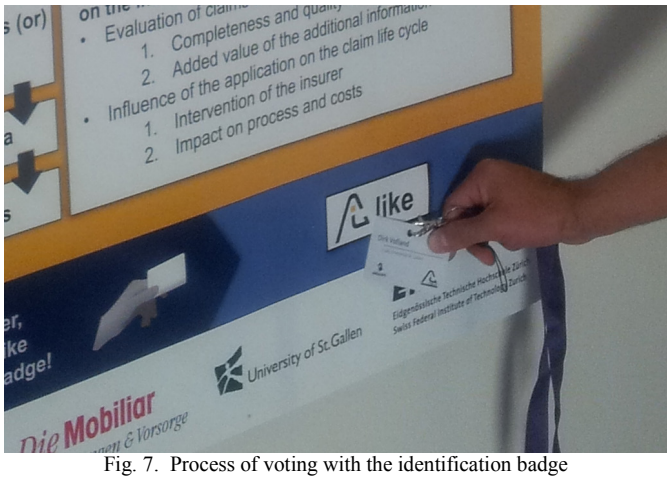

Fig. 7. Process of voting with the identification badge

today, event organizers should consider switching the role of tag and reader. The presented approach shows how the benefits of NFC technology can be exploited already under the circumstances that prevail today.

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