Two Field Trials on the Efficiency of Unsolicited Bluetooth Proximity Marketing

Timo Ojala, Fabio Kruger, Vassilis Kostakos and Ville Valkama
MediaTeam Oulu, Department of Computer Science and Engineering, University of Oulu, Finland
{firstname.lastname}@ee.oulu.fi

ABSTRACT
We report two one-month-long field trials where Bluetooth access points deployed around Oulu, Finland, were employed to attempt to push unsolicited multimedia marketing messages to bypassing mobile devices that had their Bluetooth on and visible. The logs involving ~65000 unique discovered devices of real users show that only 0.12 % of the ~650000 transmission attempts were successful. On average, 1.1 % of the devices received the message and 3.3 % of the owners of these devices signed up to the marketing campaign. These statistics characterize the efficiency of 'carpet bombing' type of proximity marketing realized with the current Bluetooth technology without any support mechanisms.

Categories and Subject Descriptors
C.2.1 [**Network Architecture and Design**]: Wireless communication;

General Terms
Experimentation.

Keywords
Location-based advertising, proximity marketing, in the wild.

1. INTRODUCTION
Proximity marketing refers to the wireless delivery of advertisements into a mobile device, triggered by the proximity of the device to some particular location. Other contextual information such as user profile or time of day can also be involved in the triggering. In terms of policy proximity marketing can be either unsolicited or permission-based depending on if the device is (not) registered or requests to receive ads. In terms of delivery model proximity marketing can rely either on push-based or pull-based message delivery. Obviously, unsolicited proximity marketing can only use push-based delivery. While various wireless technologies (WiFi, NFC, IrDA) have been employed to realize proximity marketing, Bluetooth (BT) has emerged as the most popular choice due to its high market penetration in mobile devices, no-cost battery-friendly short range wireless transmission at relatively high data rates, inherent accurate spatial localization of the devices within the coverage area of an access point (AP), and straightforward deployment with commodity hardware.

BT proximity marketing has received attention in research community, as well. Probably the first such study was reported in 2004 by Aalto *et al.* [1], who introduced the B-MAD system for permission-based proximity marketing. Mobile phones were deployed around a city center as BT 'sniffers' to detect the proximity of mobile devices registered to receive ads. The ads were then delivered as WAP push messages thus the mobile device did not need any client application to receive the ads. Also in 2004, Ojala *et al.* [7] reported a study where commercial BT APs were used to distribute rich multimedia content to mobile devices at an ice-hockey stadium. In this case the user first had to download a client application from the BT AP for pulling the desired content. Since then many commercial products (e.g. Bluegiga, BT-Pusher) and shareware implementations (e.g. BlueMagnet, OpenProximity) have been released for BT proximity marketing.

A crucial performance factor of any BT proximity marketing system is its 'efficiency'. In this short paper we study the efficiency of our in-house BT proximity marketing system in *unsolicited* proximity marketing via two large-scale field trials in Oulu, a city of about 143000 people in northern Finland. About 40 BT APs deployed around the city were configured to conduct 'carpet bombing' type of proximity marketing, i.e. blindly target all discovered BT devices with the same message. The two trials involved ~65000 unique devices of real users. We characterize the efficiency of the marketing system with statistics compiled from the logs of ~650000 transmission attempts. Due to limited space we do not discuss qualitative aspects such as user experience, or issues related to privacy, security and trust. Unsolicited BT proximity marketing is legal under the European legislation, so that the user has to authorize the receipt of a BT message before the actual transmission of the message takes place.

To our best knowledge equally large-scale study on the efficiency of unsolicited BT proximity marketing conducted in such a public setting has not been reported before. Companies providing commercial BT proximity marketing systems have undoubtedly collected large datasets, but they are not publicly reported. Maron and Read [5] reported a 2-month deployment of a BT based news delivery system on a university campus, where 590 (28 %) of the 2100 discovered devices were served and 164 (28 %) of them signed up to receive the news. Aiello *et al.* [2] deployed a BT broadcasting system for 44.5 hours in a dense populated area that succeeded in delivering a message to 2.9 % of the discovered devices. Müller and Krüger [6] reported a field study of a digital signage system that measured audience response with coupons in order to enable context adaptivity. At the requirement analysis stage they conducted experiments to compare the usability of delivering coupons over BT versus letting the users take a picture of the coupon with a camera. Eventually, they elected to implement the camera based solution. After a year 37 coupons were claimed.

2. BT PROXIMITY MARKETING SYSTEM

Our BT proximity marketing system (SYSTEM from now on) is based on a BT delivery system comprising of two principal building blocks: commercial BT AP hardware discovering nearby mobile devices equipped with BT radios and communicating with them over BT, and an application server managing the APs and scheduling the transmission of messages. On top of this delivery system we have implemented incremental prototypes of the BlueInfo mobile information service employing pull, push and proximity based content delivery models. The prototypes have been evaluated in different setting in a usability lab, on university campus and in longitudinal field trials at downtown Oulu [3][4].

When an AP discovers a nearby mobile device with its BT radio on and visible, it forwards the BT ID of the device to the application server. The server checks from a database if the device qualifies for delivery, i.e. the device has not already successfully received the message, or the device has not previously blocked the message by rejecting the request to authorize the delivery of the message, or the device is due a retransmission in the configurable retransmission cycle. If the device qualifies for delivery, the server instructs the AP to attempt pushing the message using the Bluetooth Object Push Profile (OPP). Assuming that the AP and the user device have not been paired before, which is the default in unsolicited marketing, the user is first presented with a request to authorize file transmission from the AP. If the user grants the permission, then the AP attempts to transfer the file to the device. In case of a successful delivery, the server logs the device as not to be contacted again. In case of a failed transmission, the server updates the status of the retransmission cycle of the device.

Unsolicited marketing is facilitated by the fact that the delivery system does not require any proprietary client application on the mobile phone to receive and view BT messages. The delivery system wraps the message using the "data URL scheme" (RFC 2397) that allows encapsulating different media types such as images and text into a single multimedia file. The file can then be viewed with the built-in message viewer of the phone.

(a) (b) (c)

Figure 1. Different BT AP installations: (a) on traffic light pole; (b) inside interactive public display; (c) enclosed in portable cardboard box.

The two field trials reported in this paper were both facilitated and inspired by the network of APs around Oulu (Figure 1): on traffic light poles around downtown (19 units), in interactive public displays at pivotal outdoor and indoor locations (9), enclosed in a cardboard box placed visibly around our campus together with instructions for receiving BT messages (5), hidden around our campus (5), and around our own department (4). We have used Bluegiga Access Server 2293 and AX4 models in the deployment. Both come with three BT version 2.0 radios capable of serving seven clients simultaneously, thus an AP can serve at most 21 clients at any given time. The BT inquiry timeout of the APs was set to 10 seconds.

3. FIELD TRIALS

3.1 Field Trial 1: Treasure Hunt

Field trial 1 (FT1) was organized together with the local Science Centre Tietomaa in July-August 2011. The Science Centre houses about 150 exhibitions that popularize science in a playful and participatory manner. The Science Centre attracts about 70000 visitors each year, mostly tourists and visitors. The Science Centre employs traditional marketing means to attract customers. FT1 was arranged to empirically assess the efficiency of unsolicited BT proximity marketing in getting new customers. The Science Centre did not have to pay any fees for using the SYSTEM.

The campaign was set up so that the message contained a visual riddle, an image of a 'treasure' hidden somewhere at the Science Centre (Figure 2). The riddle used in a particular message was randomly chosen from four candidate riddles. By 'hunting down' and photographing the 'treasure' with a mobile phone and showing the photo at the reception the user received a surprise award. The user had to pay the regular ticket price (11 EUR for children, 15 EUR for adults) to enter the Science Center. The retransmission cycle of the delivery system was configured so that if the first transmission attempt on a given day failed, then retransmissions were scheduled at 1, 2 and 12 hours later.

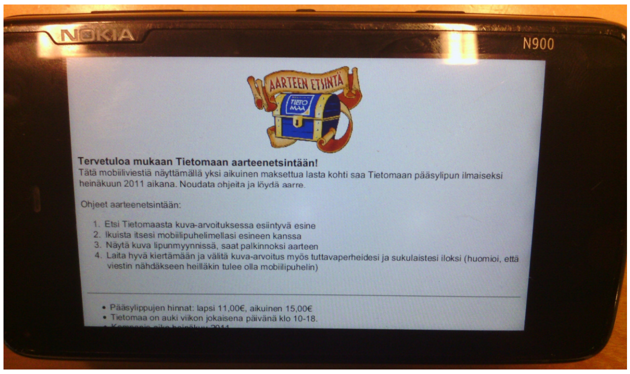


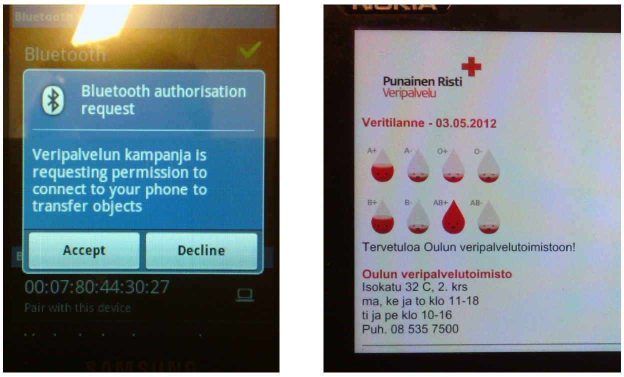
Figure 2. Part of the Treasure Hunt message on Nokia N900.

The campaign lasted for 34 days and employed 36 APs, excluding the portable cardboard boxes that were not yet deployed in 2011. The SYSTEM discovered 39981 unique devices and made 406477 transmission attempts. 304 (0.12 %) of them were successful, thus 304 (0.76 %) devices received the message. 11 (3.6 %) users later showed up at the Science Centre to purchase the ticket and to conduct the treasure hunt. Although 11 may appear as a low turnout, the staff of the Science Centre was subjectively very pleased. Further, we have to keep in mind that a large proportion of the discovered devices were locals that are not the primary target group of the Science Centre. Actually, only 90 (30 %) of the 304 devices receiving the message had not been seen by the SYSTEM before the field trial.

3.2 Field Trial 2: Red Cross Blood Service

Field trial 2 (FT2) was organized in collaboration with the local branch office of the Red Cross Blood Service in May-Jun 2012. The Blood Service is the non-profit nationwide blood service provider, responsible for recruiting blood donors, organizing blood donation, collecting and testing blood, and making cellular blood products to hospitals for treating patients. The Blood Service employs various conventional marketing mechanisms to recruit donors. FT2 served as a national pilot to empirically assess the efficiency of unsolicited Bluetooth proximity marketing in recruiting donors. The Blood Service did not have to pay any fees to use the SYSTEM. The setup of the trial involved the graphical design of the messages and equipping the donation site with a BT AP for logging visiting BT radios. Further, a questionnaire was designed to be filled in by the donors on a PC at the donation site.

Figure 3(a) shows the BT authorization request on a Samsung Android phone. 'Veripalvelu' is the native title of the Red Cross Blood Service. Upon accepting the request the device would receive the actual campaign message rendered on Nokia N900 in Figure 3(b). The message contains an illustration of the real-time status of the national blood bank for each blood type so that a 'smiling' full blood drop denotes ample reserve, whereas a 'sad' empty blood drop indicates shortage of that particular blood type. The retransmission cycle of the delivery system was configured so that the system tried to catch the attention of the user by immediately pushing the message up to three times in a row. If none of the attempts succeeded, then retransmissions were scheduled at 5 minutes, and 1, 2 and 12 hours later.



(a) (b)

Figure 3. (a) BT authorization request on Samsung Android phone; (b) Part of the Blood Service message on Nokia N900.

The campaign lasted for 31 days, during which the SYSTEM discovered 34162 unique devices. 9694 (28 %) of these devices were also 'seen' in FT1. The SYSTEM attempted 406477 transmissions, of which 486 (0.12 %) were successful, thus eventually 486 (1.4 %) devices successfully received the message. According to the questionnaire data 15 (3.1 %) users went to donate blood after receiving the message. 8 of them were logged to come to the donation site with the BT device receiving the message, 4 on the same day within 4 hours of the receipt of the message.

3.3 Quantitative analysis

The SYSTEM logs all device discoveries and file transmissions for subsequent analysis. We quantify the efficiency of the message delivery with following statistics: 1. the proportion of successful transmissions of all transmission attempts, 2. the proportion of devices served (receiving the message) of all discovered devices, and 3. the proportion of owners of devices receiving the message that signed up to the marketing campaign. These statistics are shown in Table 1 with some supporting data. The size of the data, ~65000 discovered unique devices, has to be considered relative to Oulu having about 143000 inhabitants. The fact that on average ~1000 new BT devices were discovered every day shows that people do own BT phones and have BT enabled and visible. Based on our past gate counts, about 10% of people in Oulu carry a phone with BT enabled and visible.

Table 1. Statistics on field trials

	FT1	FT2
Duration (days)	34	31
Access points pushing messages	36	42
Devices discovered	39981	34162
Transmission attempts	243868	398861
Blocked transmissions (devices)	1269 (3.2 %)	150 (0.44 %)
Successful transmissions	304 (0.12 %)	486 (0.12 %)
Devices receiving the message	304 (0.76 %)	486 (1.4 %)
Devices receiving the message at the first transmission attempt	53 (17 %)	60 (12 %)
Median number of attempts for a successful transmission	5	8
Users signing up to the campaign	11 (3.6 %)	15 (3.1 %)

We see that only 0.12 % of the transmission attempts were successful in both field trials. On average, 1.1 % of the devices eventually received the message, and 3.3 % of the recipients signed up to the campaign. Several factors explain this seemingly low delivery success rate. First, excluding the cardboard boxes, the user was not informed about the presence of the APs or about the possibility of receiving an unsolicited message. Second, most mobile phones do not give any sensory alert to the user upon receiving the authorization request. Thus, in many cases the device received the authorization request while bypassing an AP, but the user noticed the authorization request later on, beyond the transmission range of the AP. To improve the delivery success rate, commercial deployments often use visible cues such as a large blue circle painted on a floor with text 'stand here to receive Bluetooth message'.

Regarding the notable differences in the statistics of the two trials, the larger number of transmission attempts in FT2 is explained by its retransmission cycle involving seven attempts to four in FT1. The differences in blocked transmissions (3.2 % vs 0.4 %) and in devices receiving the message (0.76 % vs 1.4 %) were probably due to several factors. Three outdoor public displays contributing many blocked transmissions in FT1 were not available in FT2 due to a major renovation of streets at downtown Oulu. While FT2 took place in late spring, FT1 was conducted during summer holidays when a large number of tourists visit the city. Thus, a larger proportion of devices discovered in FT1 were owned by out of town people who necessarily did not recognize the local Science Centre stated in the authorization request and consequently blocked the transmission. In contrast, the Red Cross Blood Service is a well-known and trusted national brand, which

Table 2. Transmission statistics of different AP placement categories

	FIELD TRIAL 1					FIELD TRIAL 2				
	LAB	CAMPUS	DISPLAYS	POLES		LAB	CAMPUS	DISPLAYS	POLES	BOXES
Transmission attempts	56	608	42717	191487		8456	8556	80056	299923	1870
Blocked transmissions	4 (7.1 %)	31 (5.1 %)	932 (2.2 %)	302 (0.16 %)		4 (0.05 %)	39 (0.46 %)	97 (0.12 %)	1 (~0 %)	9 (0.48 %)
Successful transmissions	7 (13 %)	17 (2.8 %)	262 (0.61 %)	18 (0.009 %)		3 (0.04 %)	57 (0.67 %)	390 (0.49 %)	4 (~0 %)	32 (1.7 %)
Failed transmissions	45 (80 %)	560 (92 %)	41523 (97.2 %)	191167 (99.8 %)		8449 (99.9 %)	8460 (98.9 %)	79569 (99.4 %)	299918 (~100 %)	1829 (97.8 %)

may have convinced people to accept the delivery of the unsolicited message. We do not have any comparative qualitative data from the two trials to assess the impact of the name of the sender of the message on the acceptance of the message, however.

The location and the placement of the APs are of importance in this type of unsolicited proximity marketing. Table 2 shows the transmission statistics for the different AP placement categories in both field trials. The statistics for the 'lab' category in FT1 may be biased by the researchers' curiosity to try out the new service they were aware of. We see that the APs installed high up in the traffic light poles provided the lowest delivery rate. The boxes with general purpose instructions for receiving messages achieved slightly higher delivery rate than other categories. We must point out that excluding the boxes, our APs are not deployed for the sole purpose of conducting (unsolicited) proximity marketing campaigns like those reported here. The APs in the traffic light poles log BT traces for modeling urban traces and traffic flows. The primary purpose of the APs placed inside the public displays is to support mobile interaction with the display [3].

4. DISCUSSION

The statistics of our field trials shows what kind of performance can be expected from 'carpet bombing' type of unsolicited BT proximity marketing without any support mechanisms such as visual cues. Current Bluetooth conventions on the authorization and delivery of messages in the OPP profile are the main technical obstacle towards achieving higher message delivery rates. Bluetooth services generally require either encryption or authentication, and as such require pairing before they allow a remote device to use a given service. However, the OPP originally designed for exchanging objects such as business cards on the fly is specified not to explicitly require authentication or encryption so that pairing would not interfere with the user experience. However, when devices are not paired which is the de facto situation in unsolicited proximity marketing, the receiving device always prompts the user with a request to authorize the transmission of objects. If the user does not notice the request until beyond the transmission range of the AP, the delivery is bound to fail. Potential remedies are thus improving the user's awareness of the authorization request and allowing pre-emptive transmission of objects. In the latter case the objects would be transferred immediately in the background to a secure sandbox in the user device while it is within the coverage area of the AP, without waiting for the user's authorization. Depending on the user's response to the authorization request, the objects would be then either deleted or moved to message folder for viewing.

5. ACKNOWLEDGMENTS

The authors gratefully acknowledge the support of the Finnish Funding Agency for Technology and Innovation, the Academy of Finland, the City of Oulu, the Science Centre Tietomaa, the Finnish Red Cross Blood Service, and the UBI consortium.

6. REFERENCES

[1] Aalto, L., Göthlin, N., Korhonen, J., and Ojala, T. 2004. Bluetooth and WAP Push based location-aware mobile advertising system. In *Proceedings of the Second International Conference on Mobile Systems, Applications and Services* (Boston, MA, USA, June 06-09, 2004). MobiSys'04. ACM, 49-58. DOI= http://dx.doi.org/10.1145/990064.990073.

[2] Aiello, M., de Jong, R., and de Nes, J. 2009. Bluetooth broadcasting: How far can we go? An experimental study. In *Proceedings of the 2009 Joint Conferences Pervasive Computing* (Taipei, Taiwan, December 03-05, 2009). JCPC'09. IEEE, 471-476. DOI= http://dx.doi.org/10.1109/JCPC.2009.5420140.

[3] Kukka, H., Kruger, F., Kostakos, V., Ojala, T., and Jurmu, M. 2011. Information to go: Exploring in-situ information pick-up in the wild. In *Proceedings of the 13th IFIP TC13 Conference on Human-Computer Interaction* (Lisbon, Portugal, September 05-09, 2011). INTERACT'11. Springer, 487-504. DOI= http://dx.doi.org/10.1007/978-3-642-23771-3_37.

[4] Kukka, H., Kruger, F., and Ojala, T. 2009. BlueInfo: Open architecture for deploying web services in WPAN hotspots. In *Proceedings of the 7th IEEE International Conference on Web Services* (Los Angeles, CA, USA, July 06-10, 2009). ICWS'09. IEEE, 984-991.DOI= http://dx.doi.org/10.1109/ICWS.2009.142.

[5] Maron, M. and Read, K. 2007. CAMPUS NEWS - an intelligent Bluetooth-based mobile information network. In *Proceedings of the 4th International Conference on Mobile Technology, Applications and Systems* (Singapore, September 10-12, 2007). Mobility'07. ACM, 84-90. DOI= http://dx.doi.org/10.1145/1378063.1378078.

[6] Müller, J. and Krüger, A. 2009. MobiDiC: Context adaptive digital signage with coupons. In *Proceedings of the 3rd European Conference on Ambient Intelligence* (Salzburg, Austria, November 18-21, 2009). AmI'09. Springer, 24-33. DOI= http://dx.doi.org/10.1007/978-3-642-05408-2_3.

[7] Ojala, T., Korhonen, J., Sutinen, T., Parhi, P., and Aalto, L. 2004. Mobile Kärpät – A case study in wireless personal area networking. In *Proceedings of the Third International Conference on Mobile and Ubiquitous Multimedia* (College Park, MD, USA, October 27-29, 2004), MUM'04. ACM, 149-156. DOI= http://dx.doi.org/10.1145/1052380.1052401.