

Customer Tracking Systems based on Identifiers of Mobile Phones

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Keywords: Non-Functioning Communication Cell, Counting Users by Mobile Phone Ids, Collection of Visit Statistics.

Abstract: Gathering statistics about visitors finds more and more applications in various fields of business and commerce. This paper describes the system of impersonal counting of unique visitors by their mobile identifiers. Counting is carried out using a non-functioning communication cell (the system does not provide communication services to users of mobile networks). The system masks itself as the base station of a mobile operator. Mobile devices automatically connect to the system even in case of a strong signal from the towers of mobile operators. Once connected, the user identification data is received. The proposed solution allows to compare data about the number of visits to a particular site in various periods of time and to identify the re-occurrence of the visitors. The system is inexpensive and shows 99% accuracy in the identification of users (compared to the real data about the visitors).

1 INTRODUCTION

It is well known in the industry of online shopping, that collecting statistical data with further data mining procedures can help in marketing of products. In online shopping business it is quite easy for a programmer with certain skills to store information about pages that users of the shop visited, how long did they stay on these pages, what they actually purchased, etc. All these data are used in analytics, the main task of which is to transform the page, site navigation and functionality to increase the sales.

At the same time, much more products are still sold "offline" – in shops, malls, hypermarkets and other places where data collecting is limited. In digital form, the shop usually receives only information about what was sold, how much goods was sold on a specific day at a specific time, etc.

Therefore, the collection of statistics about visitors finds more and more applications in various fields of business. Many companies seek to obtain reliable statistics on the number of visitors, duration of eye contact with the product or advertising signs and other indicators. These statistics can be used, for example, to increase the efficiency of an advertising campaign or to encourage the consumption of a

certain type of goods or services (Positioning 2015, Mikhaylov 2014a).

Many scientific papers focus on the issue of tracking visitors (Cai 2013, Mikhaylov 2014b, Samoylov 2015, Wang 2014, Wang 2013). However, a significant number of systems is aimed at counting the number of people staying in the room. (Types of counting systems 2015) There are also powerful systems for analyzing the faces of visitors, but the processing is carried out on a remote server, or requires the use of a separate powerful server (Audience Engagement 2015, Erns 2009).

For example, there is a well-known system RetailNext (2015), which uses sensor technology (cameras and radio frequency identification) for counting visitors and traffic. DVR CountBOX (2015) is designed to count visitors; it includes a calculation STB-1 unit and a video camera. Counter MC-Ethernet (2015) combines traffic to two different channels – considers entrance and exit of the visitors separately, which allows watching the dynamics of entry and exiting traffic of the site.

Another system – Statistics Dome (2015) – is a professional tool for counting visitors through surveillance algorithms of Orwell 2k computer vision. Video counter Statistics Dome effects a bi-directional people counting with the help of built-in video analytics.

The disadvantage of such systems is the omission of such problems as visiting of malls by family customers, as well as a constant entry and exit of buyers from the room several times. They are also expensive and often inaccurate.

Therefore, it is proposed to use the system for counting the identifiers of mobile phones to improve the efficiency of the resulting statistics on the number of unique visitors, for example, in the mall. The objective of the system is to eliminate the above flaws with the new system giving improved performance.

2 COUNTING VISITORS BY IDENTIFIERS OF MOBILE PHONES

The proposed solution is based on non-functioning communication cell. A non-functioning communication cell (NFCC) is an independent cell of the cellular network, which generates a signal of a mobile operator's base station, but it does not provide access to communication services. NFCC are successfully used for many civilian and military applications.

At the same time, the real operator is an officially registered service provider for the selected user.

Customer tracking systems by identifiers of mobile phones include:

- non-functioning connection cell for receiving data; wherein NFCC is associated with the central server;
- central server that analyzes received traffic, wherein the server is connected to the central computer of the operator;
- computer of the operator, where there are reports of new events in the system arrive.

Figure 1 shows the structure of the system under development. The number of NFCC can vary from 1 to N.

Inside the central server, to which the NFCC are connected, an analysis of the data is carried out, but the interim results of processing are not saved in the memory of the equipment and the external memory.

The system is a non-functioning communication cell, which is determined by the network as a base station of a cellular operator, whereby the mobile devices within the range of the complex will automatically switch to work with it. Once connected, there is a receipt identifying the user data that are needed for the further calculation.

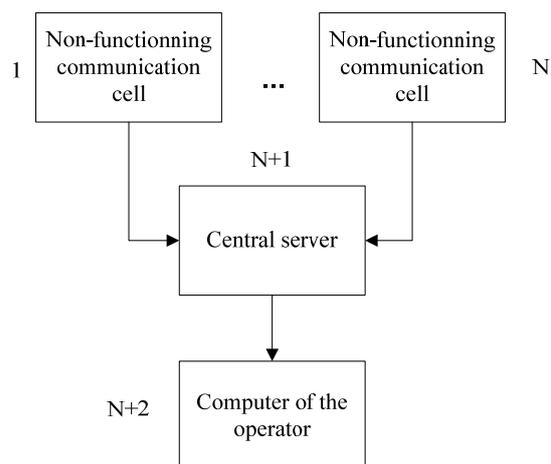


Figure 1: This caption has more than one line so it has to be set to justify.

Further, the mobile device resumes functioning with the network of its real operator. The central server, when analyzing, can also identify the model of the mobile device and the operator of the mobile device. NFCC effects the switch of the mobile device to collect identifying information even in case of a good signal from the base station of the real operator due to the high base station selection criteria (cell selection and cell reselection criteria).

The described device does not allow any kind of data transfer that is why the mobile devices connected to the complex switch back to the network of the real operator. This scheme of work does not affect the quality of communication services of the real service provider, so the complex does not prevent the data transmission.

The system operates as follows: NFCC conducts partial authentication, and after receiving the user data for identifying the mobile device, switches back to the base station of the operator. The system allows keeping a record of the duration of a visit to the selected area with up to six minutes accuracy. In the case of inactivity, every six minutes a mobile device of the subscriber updates its connection status. Thus, it is possible to build the statistics length of stay in the territory of the subscriber. Automatic connection of mobile devices to the NFCC within one standard connection occurs even in the case of a strong signal from the towers of mobile operators.

Figure 2 shows a schematic block diagram, which can be realized by the proposed system of counting visitors by identifiers of mobile phones.

Figure 2 shows:

- 1 – mobile device of the subscriber whose identifiers are to be determined;

2 – base station of an operator to which the subscriber's mobile device is connected;

3 ... N – NFCC working by standards 2G\3G\4G, which switches the mobile device of the user (due to better reception). It is necessary to create conditions for switching the mobile device to the new base station, thereby the mobile device performs a new authentication in the network, providing the ability to process the required IDs;

N + 1 – central server that handles the received identifiers;

N + 2 – computer operator who receives the anonymous analysis results.

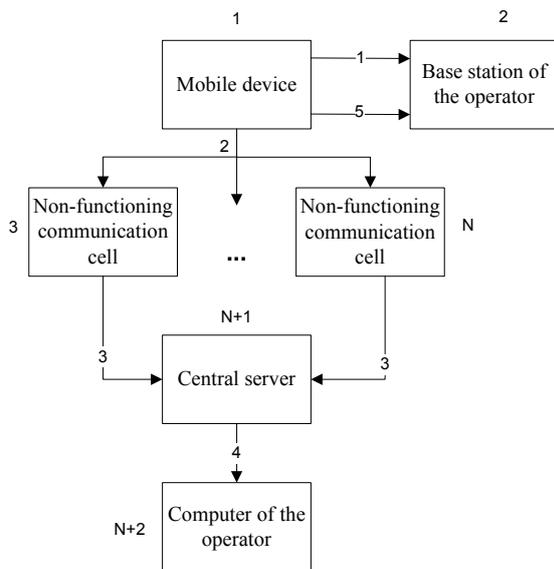


Figure 2: Schematic block diagram of system implementation.

A customer tracking systems by identifiers of mobile phones works as follows:

- Step 1 – In normal mode, the mobile device of the subscriber is connected to the access point.
- Step 2 – At a pre-set time the mobile device of the subscriber changes the connection from the base station of the operator to one of the N virtual base stations, thereby performing authentication of the new network, which provides the possibility of receiving the desired identifiers. This is achieved by using a special radioreceiver of signals during a new authentication of the mobile device in the network when switching from one base station to another, due to forced creation of conditions for the best quality signal.
- Step 3 – Central server that is connected to N non-functioning communication cells, processes the information obtained.

- Step 4 – Unallocated analysis results from a central server are transferred to the computer of the operator.

- Step 5 – Once the correct identities of mobile devices of subscribers are gathered, they switch the connection from one of NFCC to the base station of the real operator.

Thus, the system of counting the identifiers of mobile phones allows determining the number of unique visitors, without affecting the quality of cellular connection. The system collects anonymous data and does not receive any personally identifiable information of the visitors.

In terms of information security the proposed system can:

- redirect packet traffic in the data leak prevention (DLP) system;
- record all calls with copies of conversations sent to DLP system;
- control of SMS messages;
- control of employees presence on the workplace;
- selective blocking of subscribers;
- mass dispatch of SMS notifications.

It is possible to develop the client for the mobile operating systems Android, iOS, Windows Phone, with integrated DLP system that will allow to block camera, microphone and sending images.

There are several spheres of the system application, for example:

- marketing research, integration with loyalty programs;
- communication systems;
- protection systems from data leakage (DLP systems);
- intelligent connection blocking with no threat to health;
- security systems, physical security of facilities.

The latter has the following advantages:

- large coverage area, it is advantageous to use for the control of remote objects and sparsely populated areas (pipelines, electrohighways, border, etc.);
- possibility of drawing up white lists, operation in mode “friend/foe”;
- ability to identify the offender (in case of special permissions).

3 EXPERIMENTAL DATA

To test the effectiveness of the developed system for counting mobile phone identifiers a special territory

was allocated. It was a bandwidth monitoring area of 200 m² and 20 employees. Control of access to the territory was carried out by using access cards, allowing us to conduct a comparative analysis of the system.

As a part of the experiment, which was conducted during five weeks, antennas and amplifier were installed around the perimeter of the zone so as to completely cover-control it. For ease of testing, the system was set up for one mobile operator (the employees who worked in the territory, used the services of the same operator). The results of the experiment are given in Table 1.

Table 1: Results of the experiment of counting visitors.

Timeline	NFCC inspection results (entrance to the facility)	Access cards inspection results (entrance to the facility)
1 week	586	578
2 weeks	565	563
3 weeks	586	586
4 weeks	574	569
5 weeks	592	589

During the entire time of the experiment, the system shows stable operation. The results obtained with the help of NFCC were compared with the data, fixed by means of electronic access cards to the territory. The results do not differ by more than 1%. Inaccuracy is due to the fact that some employees had a tablet with access to the Internet or a second cell phone while being at the controlled territory.

4 CONCLUSIONS

Thus, this paper describes a system of impersonal counting of identifiers of mobile phones, which would greatly increase the efficiency of counting unique visitors in shopping malls, exhibitions and other similar events. The system requires a small financial cost for its installation and operation, it does not affect the quality of services provided to users by the operator of communication and has no adverse impact on the information security of mobile devices.

Ongoing testing of the prototype system demonstrated its high efficiency, where the accuracy of the results obtained by the device is 99% compared to the actual data. In the future, this figure will be increased to 100%.

The limitations of the study are the following:

- legal difficulties as there is no regulation of use of such devices, albeit low-power, at frequencies of mobile operators;
- the system only supports the 2G (GSM), other cellular standards are not supported. It is necessary to develop a system or jammers for them. But the latter encounter legal difficulties.

Today, the system is being tested and further developed. It is planned to conduct scientific research to address the problem of the calculation of several unique devices from one owner (for example, the visitor has two mobile phones and a tablet).

The scalability of the system described will also be examined.

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