Can Active Tracking of Inroamer Location Optimise a Live GSM Network?

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ABSTRACT

The mobile communication industry has experienced huge growth in recent years, which amplified the competition among telecommunication companies. This inspired the search for new means of GSM network optimization that would bring better signal coverage and thus competitive advantage. One of the possibilities is active tracking of inroamer location in order to find where they disappear to a rival network. Data collected in this way can then be analyzed to detect weak points of network or traffic anomalies. This paper presents our implementation of active tracking of inroamer location within a live GSM network and the subsequent analysis of collected data, together with future plans for our platform called SS7Tracker.

Keywords

GSM, mobile networks, active tracking, inroamer, SS7

1. INTRODUCTION

In recent years GSM network optimization has been studied heavily and many approaches to it have emerged ([1, 2, 3] and others). Our team has focused on one of these approaches - active tracking of GSM network subscriber location. Active tracking is a type of monitoring that relies on sending extra queries to the network. In contrast with passive tracking that uses devices to watch the traffic as it passes by, active tracking generates extra load. Our active tracking solution focuses on inroamers, which is a term for foreign roaming clients that subscribed to our network. The reason is that inroamers switch GSM networks freely, according to the strength of the mobile signal, unlike domestic clients that stay in one network constantly.

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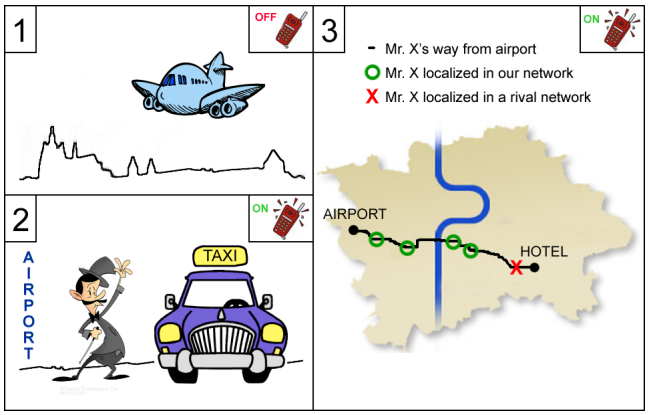

Figure 1: Tracking example - Mr. X arrives to Prague. 1) Arrival. 2) Cell phone switched on. 3) Tracking Mr. X's way.

How does active tracking of inroamer location work? Let's try an example in Figure 1. Mr. X flies to Prague, he deplanes and switches on his cell phone. His cell phone catches the signal of our network and subscribes to it. Using active probes we then start to periodically check if he is still in our network and where. Mr. X takes a taxi to his hotel and on the way enters an area, where our network signal is poor. His cell phone catches a signal of a rival network, subscribes to it and maybe never comes back to our network. To prevent this in the future, we want to find where Mr. X left our network. This can be derived from the active tracking data.

To exploit this principle in a live GSM network many question and technical problems had to be solved. Among others we dealt with the following questions: How to enable choosing the initial set of inroamers to track? How to get suitable location information? How often and how long to track to get the best result while not increasing the load of the network unnecessarily? How to process large amount of collected data to get desired information in comprehensible format? Our contribution consists of confirming feasibility of active tracking implementation to a live GSM network as well as discussing design and possibilities of our implementation.

2. DESIGN

The SS7Tracker platform is split into three modules - QueryCellId, Tracker and TrackerGUI. The expected user of SS7Tracker is operator's technical staff, typically subscriber data analyst. QueryCellId deals with getting the location information from GSM network. Tracker module coordinates the tracking and controls how often and how long an individual inroamer is tracked, taking into account the last location of inroamer, his movement and other criteria. All decisions the module makes are determined by user-defined rules. Module TrackerGUI is a user interface for the platform which allows user to select a representative set of inroamers to track and to define tracking rules for them. Module TrackerGUI also summarises and visualizes results of finished trackings and allows to export results to other systems.

3. IMPLEMENTATION

For the tracking we use the popular SS7 protocol suite[4]. The equipment we use is Intel NetStructure® SPCI4 card[5] which acts as a SS7 signalling point in GSM network which means that it originates and receives SS7 signalling messages as well as transfers them from one signalling link to another. Our implementation of location information retrieval relies on the MAP protocol[6] from the SS7 protocol suite. We use a sequence of three MAP primitives to obtain Visitor Location Register and Cell Global Identity, as can be seen in Figure 2. First we send SendRoutingInfo to inroamer's Home Location Register abroad. If the inroamer's cell phone is switched off, HLR sends us an error code and we stop here. Otherwise we obtain the inroamer's current VLR number and we determine from it the network where the inroamer is subscribed. If the inroamer is not in our network, we stop as well so that we don't burden the rival network. Only if the inroamer is in our network we continue with sending him "invisible" class 0 SMS to update location information in the local VLR, and finally with sending ProvideSubscriberInfo to the local VLR to obtain the just updated Cell Global Identity.

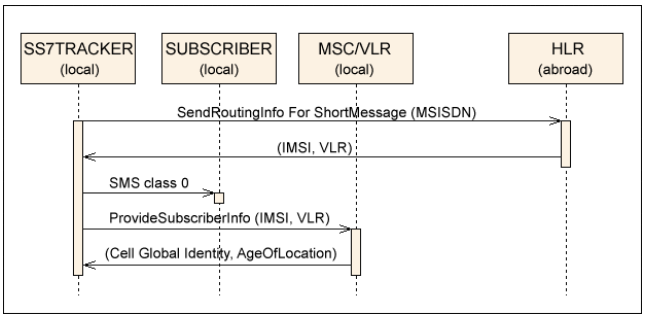

Figure 2: Messageflow for obtaining location of an inroamer

4. RESULTS

The most interesting part of our project will be the final analysis of the collected data. However the analysis is only in the beginning stage since first data were collected quite recently. We expect to find which GSM network cells are weak points or overloaded, some spatial or time anomalies in traffic and to learn more about behaviour of inroamers in our network. We plan to present results in the form of different kinds of statistics visualized in graphs and maps.

5. DISCUSSION

The adopted approach of active tracking has some implications. Generally, active tracking enables to collect data selectively in desired time and extent, at the price of possible impact of extra load on data accuracy or network performance. Our implementation retains the advantage while the impact of slightly increased traffic on collected location data accuracy is irrelevant. However our approach has some risks - location privacy needs to be paid sufficient attention[7] and tracking period needs to be tuned to minimize overhead and the possibility of faster battery discharge in the tracked cell phone.

The focus on inroamers allows us to detect areas where our network signal is weak while a rival network signal is stronger. The alternative approach of tracking domestic clients could provide information about one network signal only, since domestic clients stay in one network constantly regardless of rival networks.

6. CONCLUSION

The presented implementation of active tracking of inroamer location operates within a live GSM network of a large telecommunication operator in the Czech Republic and first data were collected recently. We expect to find some characteristics of the network that could be used to improve the operator's position on the market. In our future research we will focus on collected data analysis and visualization.

7. REFERENCES

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