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M. U. Bokhari · Namrata Agrawal
Dharmendra Saini *Editors*

Cyber Security

Proceedings of CSI 2015

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Preface

The last decade has witnessed remarkable changes in the IT industry, virtually in all domains. The 50th Annual Convention, CSI-2015, on the theme "Digital Life" was organized as a part of CSI@50, by CSI at Delhi, the national capital of the country, during December 2–5, 2015. Its concept was formed with an objective to keep ICT community abreast of emerging paradigms in the areas of computing technologies and more importantly looking at its impact on the society.

Information and Communication Technology (ICT) comprises of three main components: infrastructure, services, and product. These components include the Internet, infrastructure-based/infrastructure-less wireless networks, mobile terminals, and other communication mediums. ICT is gaining popularity due to rapid growth in communication capabilities for real-time-based applications. New user requirements and services entail mechanisms for enabling systems to intelligently process speech- and language-based input from human users. CSI-2015 attracted over 1500 papers from researchers and practitioners from academia, industry, and government agencies, from all over the world, thereby making the job of the Programme Committee extremely difficult. After a series of tough review exercises by a team of over 700 experts, 565 papers were accepted for presentation in CSI-2015 during the 3 days of the convention under ten parallel tracks. The Programme Committee, in consultation with Springer, the world's largest publisher of scientific documents, decided to publish the proceedings of the presented papers, after the convention, in ten topical volumes, under ASIC series of the Springer, as detailed hereunder:

1. Volume 1: ICT Based Innovations
2. Volume 2: Next Generation Networks
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5. Volume 5: Sensors and Image Processing
6. Volume 6: Big Data Analytics
7. Volume 7: Systems and Architecture
8. Volume 8: Cyber Security
9. Volume 9: Software Engineering
10. Volume 10: Silicon Photonics & High Performance Computing

We are pleased to present before you the proceedings of Volume 8 on "Cyber Security." The title "Cyber Security" is devoted primarily to enhance the awareness about cyber security. It brings together much learning from skilled industry experts, academicians, and researchers. The title also covers national and international collaborations and cooperation in cyber security as an essential element of overall security of the system.

The technology in general and Internet in particular are being used widely for various kinds of transactions, information, and communications. It is really a huge challenge to stay secured on the 'open and un-trusted Internet,' and there are potential security risks presented by the Internet. The title uncovers the various nuances of information security, cyber security, and its various dimensions.

The title "Cyber Security" also covers latest security trends, ways to combat cyber threats including the detection and mitigation of security threats and risks. This volume is designed to bring together researchers and practitioners from academia and industry to focus on extending the understanding and establishing new collaborations in these areas. It is the outcome of the hard work of the editorial team, who have relentlessly worked with the authors and steered up the same to compile this volume. It will be a useful source of reference for the future researchers in this domain. Under the CSI-2015 umbrella, we received over 200 papers for this volume, out of which 48 papers are being published, after a rigorous review process, carried out in multiple cycles.

On behalf of organizing team, it is a matter of great pleasure that CSI-2015 has received an overwhelming response from various professionals from across the country. The organizers of CSI-2015 are thankful to the members of *Advisory Committee, Programme Committee, and Organizing Committee* for their all-round guidance, encouragement, and continuous support. We express our sincere gratitude to the learned *Keynote Speakers* for support and help extended to make this event a grand success. Our sincere thanks are also due to our *Review Committee Members* and the *Editorial Board* for their untiring efforts in reviewing the manuscripts, giving suggestions and valuable inputs for shaping this volume. We hope that all the participated delegates will be benefitted academically and wish them for their future endeavors.

We also take the opportunity to thank the entire team from Springer, who have worked tirelessly and made the publication of the volume a reality. Last but not least, we thank the team from Bharati Vidyapeeth's Institute of Computer Applications and Management (BVICAM), New Delhi, for their untiring support, without which the compilation of this huge volume would not have been possible.

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Privacy Protection Through Hiding Location Coordinates Using Geometric Transformation Techniques in Location-Based Services Enabled Mobiles

Ruchika Gupta and Udai Pratap Rao

Abstract Mobile gadgets today are swaggering computing potential and memory at par or at times even higher to that found in desktop personal computers. A wireless interconnection has turned out to be considerably more readily accessible these days. As individuals are growing mobile with regard to the fast lifestyle and working pattern, a new, smarter system came into existence that is termed as "location-based service" (LBS). Such a system amalgamates the location data of a user with smart applications to deliver demanded services. Although LBSs provide major openings for a large variety of markets and remarkable convenience to the end user, it also presents subtle privacy attack to user's location information. Threat to the privacy sneaks into the system due to the prerequisite of sending user's current location to the LBS provider to attain related services. Since the volume of data gathered from dynamic or stationary mobile users using LBS can be high, it is vital to outline the frameworks and systems in a manner that is secure and keep the location information private. This can be portrayed as a big mobile data challenge in LBSs setting. This paper aims to explore the issues related to privacy involved in LBSs. In the paper, we introduce framework structure outline for preventing location-based vicinity inference of users who issue a query and also proposed *VIC-PRO* algorithm which helps to overcome the gaps of well-established K-anonymity approach in the existing system. The suggested approach strengthens the privacy of query initiating vicinity information.

Keywords Location-based services · Privacy · User identity and location privacy preservation · Mobility · Big mobile data

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1 Introduction

The fiery escalation of location-detection enabled gadgets along with growing wireless interconnections and mobile databases results in materializing location-based applications which conveys requested information to the clients based on their present location. Location-based store finder, location-based weather forecast information, location-based traffic reports, location-based advertisements, promotions, and location-based geo-fencing are few examples of such applications.

A conventional localization arrangement based on the fundamental communications network comprises of two main elements: a mobile device carried by the end user and the base station or beacon node representing the infrastructure of the communication network (along with LBS provider). Pull LBS (Reactive), Push LBS (Proactive), and tracking LBS are three main types of LBSs (Fig. 1).

In LBS, we incline to use positioning technology to register mobile location movement. There are quite a lot of abstract approaches and real implementations of systems to resolve the place of a cell phone. The most outstanding example of such a positioning system is the GPS [1]. Although LBSs offer major openings for a large variety of markets and remarkable convenience to end user, but at the same time it also presents subtle privacy attack. Privacy of the system is threatened due to the requirement of the current location of the user in order to provide related services. Sharing the location information with service provider actually makes user's physical geographical location on the globe and user's virtual location over the World Wide Web precisely identical.

There are two major obfuscation aspects in the LBS namely (i) Obfuscate user identification and (ii) Obfuscate location identification. This paper focuses on

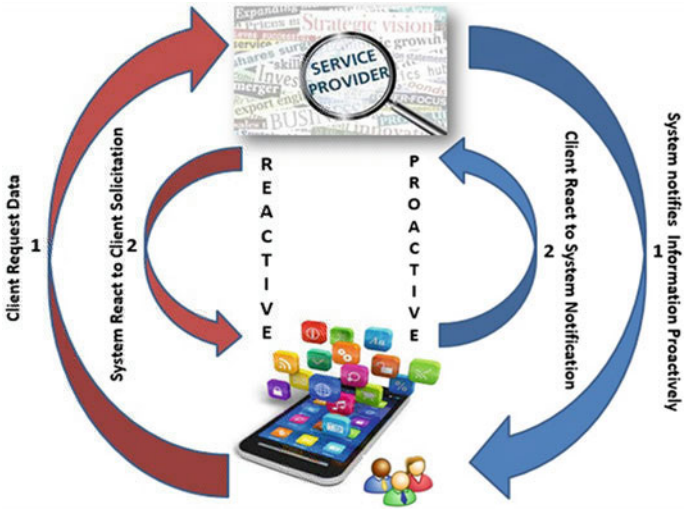

Fig. 1 Types of LBS

strengthening privacy of vicinity identification along with the privacy of location and user identification information.

2 Motivation

With the continual reduction in the price of mobile devices, it is noticed that not only the use of the location-aware gadgets raises in a growing number of civilian and military applications, additionally a developing interest for regularly being informed while out on the road for innumerable purposes. Keeping track of the traffic condition, route information, on the fly parking information, en route grocery store information, meeting a friend on way back home, and catching new movie in theaters are few of such applications. Considering the metropolitan zone with hundreds and thousands of vehicles (especially in a profoundly populated continent like Asia) where every driver or passenger is interested in such information relevant to their trips to plan visits more smartly and save their time in wasteful driving. Such era of voluminous data can be viewed as big mobile data challenge in LBSs-enabled mobiles.

Another major motivation behind writing the paper on this subject is the news of November, 2014, where New York City Mayor declared that an association of four companies named City Bridge will develop and manage up to 10,000 IEEE 802.11 access points for New York City's LinkNYC [2]. It agrees to be the biggest free municipal Wi-Fi operation in the world. In the same motion, the Prime Minister of India announced to develop intelligent cities having geo-spatial mapping, Wi-Fi hotspots, and intelligent transit system with GPS features. In both the mentioned declarations, sharing user's location information would play a major role in order to access the demanded services. Clearly, LBS will be having a sweeping impact of the digital world in the future as pointed out by the market analysis [3] and would reach $63 billion by 2019.

3 Related Work

A survey of literature in the related field has brought forth several architectures, algorithms and techniques that have been proposed by many authors in which they have discussed about anonymity based, different cloaking mechanisms based and trusted third party based privacy preservation models. A location estimation enabled smart mobile device allows users to submit location-based queries to web-based LBSs. Once the mobile apparatus throws the service request, the sender has no control over the facts contained by the submitted query. An observer with a right to access the information included in the query may utilize that information to guess the user's location. This makes a profound challenge of location privacy protection that must be ponder upon. In this concern, most of the previous work

relies on trusted third party called as Anonymizer that works as an intermediary amidst user and LBS provider [4].

Location anonymity is vastly discussed by Mokbel et al. and others [5–7]. These techniques are based on hiding the position data before conveying them to the LBS provider. *K*-anonymity operates by hiding the position of the end user within a set of "*K*" members. Anonymizer includes additional $K - 1$ users from same vicinity and then forwards the anonymized query to LBS provider. It is now difficult for the LBS provider to distinguish the correct user from a set of *K* anonymous users. It keeps client recognizable proof private yet bargains the user location's vicinity information. To request a desirable level of privacy assurance, a client required to select the value of *K* cautiously. Regrettably, specifying an apt value of *K* is not easy. A user would always choose a bigger *K* value to ensure sufficiently large privacy preservation, yet this in turn will result in an unnecessary reduction of location accuracy [8]. Trusting third party and choosing an optimal value of *K* is a critical issue in this situation.

In [9], authors Chow et al. provide a clear and interesting system for avoiding identification inference based on location of users who issue spatial queries to LBS. Background knowledge attacks, when the adversary has extra data regarding specific user's preferences, are still possible.

Authors of paper [9] have taken it to the next level where mobile user forms a group and randomly select a peer from the group as agent to initiate a query. But this approach in proactive mode incurs high communication overhead and low quality of service. Bettini et al. [10] have categorized privacy problem in LBS on the basis of attack and existing defense mechanisms. In [11], authors have discussed a novel approach for privacy using encryption method for location and trajectory path which shows remarkable improvement in computational speed. This work fails to protect the current location in certain cases.

Damiani, Bertino, and Silvestri presented PROBE framework for the customized shrouding for the protection of sensitive locations using a greedy strategy [12]. They have discussed the privacy issue based on a privacy profile which also unable to keep user location private when the adversary is aware of multiple attributes of the user. No authors to our knowledge have actually discussed privacy preservation of user's vicinity information.

4 Problem Formulation

4.1 Problem Statement

Preserving the privacy of originating query vicinity information of the user by including additional $K - 1$ users from diverse directions.

The addressed setup as depicted in Fig. 2 incorporates an admirable focus on *K*—anonymity concept. The main focus is on the inclusion of additional $K - 1$ clients from diverse directions. The fundamental objective of this proposed

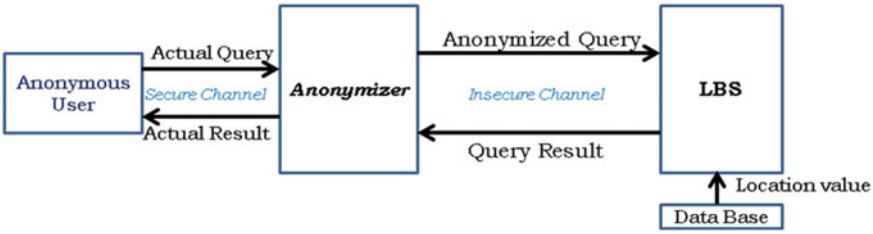

Fig. 2 General framework

approach is to obfuscate the vicinity information of an end client submitting an inquiry to LBS by including additional users from diverse directions as part of the query.

5 Proposed Approach

In our proposed framework, after accepting the location information from the sender, anonymizer runs proposed algorithm (*VIC-PRO*) and instead of including $K - 1$ more users of same vicinity, this algorithm computes K users after performing the following geometric transformation techniques and produces a final anonymized query set Q:

a. Translation
b. Reflection

Figure 3 shows the instance after computation of suggested geometric transformations.

The algorithm computes diverse $K - 1$ values assuming the nearest beacon node as the center of origin. Each new direction is now having the same probability considered to be the query initiator vicinity by an adversary. Anonymizer forwards this anonymized query to LBS provider and after processing, the result set is communicated back to anonymizer. Now, anonymizer has the actual result and some false hits. Anonymizer filters out the incorrect results and sends the genuine result to the end client.

6 Vic-Pro Algorithm

The *VICinity-PROtection (VIC-PRO)* algorithm (Fig. 4) obfuscates the query initiator vicinity information by making use of the fundamental geometric transformation techniques [13].

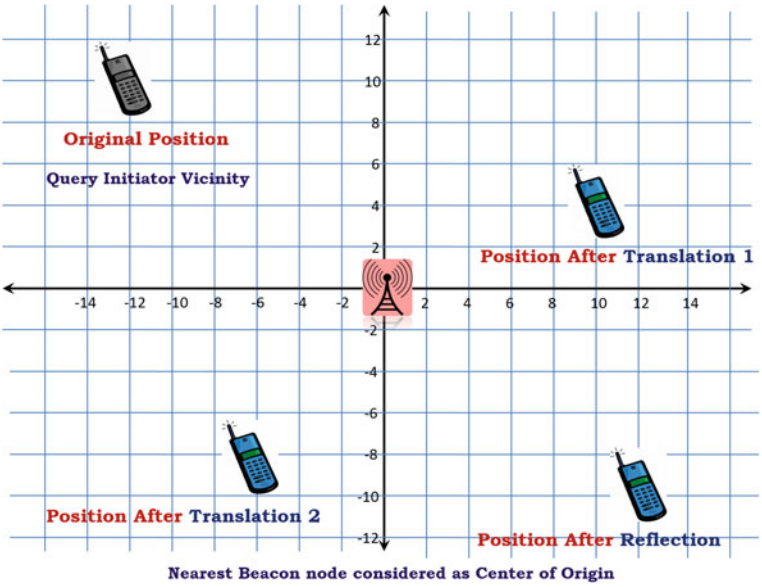

Fig. 3 An instance after transformations

Fig. 4 *VIC-PRO* pseudocode

VIC-PRO

Input: Current location coordinates *(x, y)* of the mobile client submitting query request

Output: Anonymized Query Set *Q* (consisting K users)

Initially K=0

1. *Anonymized_query_set Q = Empty Set*
   Let, current_loc = (x, y)
2. *x' = Reflection(x)* and *y' = Reflection(y)*
   //Reflection method computes reflection geometric
   //transformation for the given input point
3. *Anonymized_query_set Q = Q U { x', y'}*
4. **while** (K<=18) // as K= 20 is assumed
5. {Select random translation factors δt_x and δt_y
6. *new_x = x + δt_x*
7. *new_y = y + δt_y*
8. *Anonymized_query_set Q = Q U {new_x, new_y}*
9. Increment K by 1}
10. *Anonymized_query_set Q = Q U {current_loc (x, y)}*
11. **return** *Anonymized_query_set Q*

Considerations and Assumptions:

a. The utilized mobile devices are LBSs enabled and have the ability to determine their approximate location (i.e., can determine their longitude and latitude).
b. Mobile devices are being used for outside searches and utilizing Global Positioning System.
c. Coordinate representation of location is used by the algorithm to keep the explanation simple and easy to understand.
d. Proposed algorithm runs at anonymizer.
e. The value of $K = 20$ is assumed and random translation factors generated could be either homogeneous or heterogeneous.
f. Service provider is efficient enough to handle mass query requests.

This anonymized query set Q further is sent to LBS provider.

7 Example

The example shows the research gap in K-anonymity concept. SVNIT is taken as the query originating region. Consider the geographical context as depicted in Fig. 5.

Considering the case where a SVNIT student is generating a query asking for a "Nearby 34 in. by 48 in. poster printing shop". In K-anonymity principle, K users become the part of anonymized query. Anonymizer includes K-1 more client from the same vicinity and after that advances the anonymized inquiry to a service

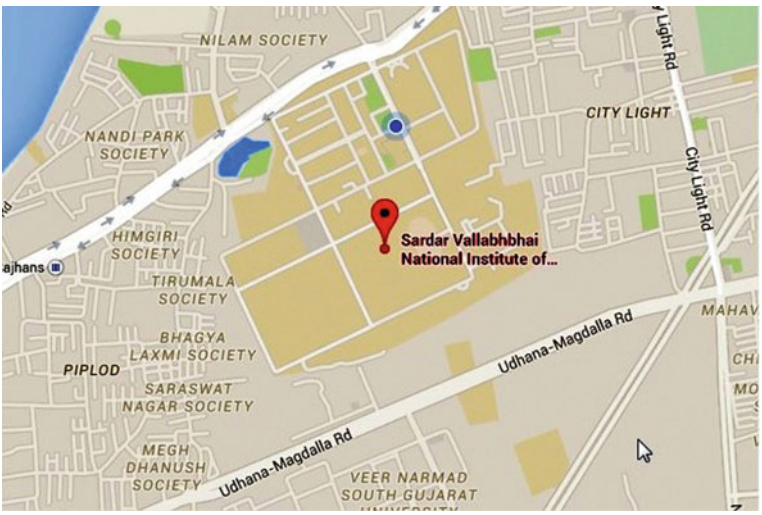

Fig. 5 Query originating location: SVNIT, Surat

Fig. 6 **a** Vicinity—industrial area, **b** vicinity—Hazira, **c** vicinity—Varachha, **d** vicinity-new textile market