Security Analysis of Location Based Geo-Social Application

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ABSTRACT:

Online interpersonal organizations frequently include substantial quantities of clients who share extensive volumes of substance. This substance is progressively being labeled with geo-spatial and worldly organizes that may then be utilized as a part of administrations. For instance, an administration may recover photographs taken in a certain district. The subsequent geo-mindful informal organizations (GeoSNs) posture security dangers past those found in area based administrations. Substance distributed in a GeoSN is frequently connected with references to various clients, without the distributer being mindful of the protection inclinations of those clients. In addition, this substance is regularly available to various clients. This renders it troublesome for GeoSN clients to control which data about them is accessible and to whom it is accessible. This paper addresses two security dangers that happen in GeoSNs: area protection and unlucky deficiency security. The previous concerns the accessibility of data about the vicinity of clients in particular areas at given times, while the recent concerns the accessibility of data about the unlucky deficiency of a person from particular areas amid given stretches of time. The test tended to is that of supporting protection while as yet empowering valuable administrations. We accept this is the first paper to formalize these two thoughts of protection and to propose strategies for upholding them. The strategies offer protection certifications, and the paper writes about exact execution investigations of the systems.

KEYWORDS: Area protection, security, area based social applications, coordinates change

I. INTRODUCTION

Geo-informal communities (GeoSNs) give a setting mindful administration that serves to partner area with clients and substance. The expansion of GeoSNs demonstrates that they're quickly pulling in clients. Goons at present offer distinctive sorts of Administrations, including photograph sharing, companion following, and "registration." However, this capacity to uncover client's areas causes new security dangers, which thusly call for new security assurance routines. The creators think about four security perspectives key to these interpersonal organizations - area, nonappearance, co-area, and character protection - and depict conceivable method for ensuring security in these circumstances.

In today's reality, Smartphone applications have get to be prevalent among the clients improving processing stage. A kind of use is coming into line light that can be put under the classification of geosocial application. Cases of this social application are nearby companion proposal for eating and shopping, and also amusements and community oriented system administrations. In any case, it has been seen that these application demonstrate detriments as there is a danger of losing clients protection, at present because of insignificant security instrument. Client's all think about the "spots" highlight of face book which was abused by a few criminals. Subsequently, there is a genuine requirement for more grounded protection properties with a specific end goal to make it all the more well disposed to the clients.

Presently days, Geo-social application have turn out to be a vital part of human lives. Be that as it may, these may be abused by somebody to concentrate client's close to home data. LocX has a tendency to furnish with enhanced protection and with result very certain. The essential thing that is done is to utilize secure direction change. This change would be utilized just by companions of a specific client. It permits the server to work appropriately and accurately without getting to the private information of the client. There are clients where there is not a requirement for subjective sets of clients to be determined. Henceforth, by recognizing such area information through clients social gatherings and further change can be utilized on area coordination. The direction changes save separation measurements, upgrading the undertaking of server to perform inquiries on changed information. The change is a sheltered one, since the key is mystery which knows just to the client's bunch.

The proposed framework utilizes the pressure strategy. LZW pressure calculation is utilized for pressure. LZW pressure is quick and easy to apply. Since this is a lossless pressure method, none of the substance in the record is Lost amid or after pressure. Sender first sends GPS location. Like the LocX procedure utilization changes the co-ordinates and recovery those on to the record disjoin .The pressure system is utilized the pack the document and afterward applies the encryption. This method has favorable circumstances of having the capacity to send vast documents to the cell phones which has less memory than the ordinary PCs the framework in which the pressure system is utilized while client send the message

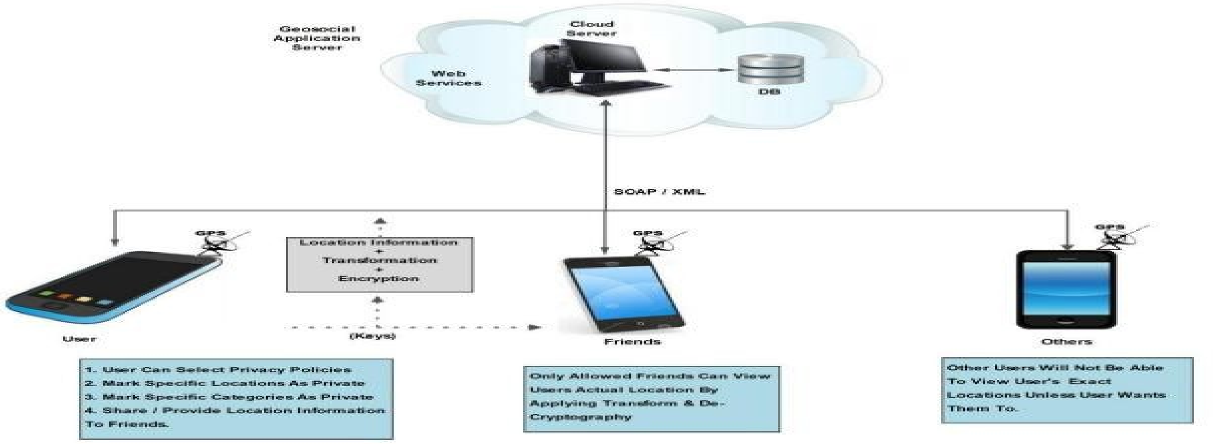
Geosocial Application Server
Cloud Server
Web Services
DB
SOAP / XML
GPS
GPS
GPS
Location Information + Transformation + Encryption
(Keys)
User
Friends
Others
1. User Can Select Privacy Policies
2. Mark Specific Locations As Private
3. Mark Specific Categories As Private
4. Share / Provide Location Information To Friends.
Only Allowed Friends Can View Users Actual Location By Applying Transform & De-Cryptography
Other Users Will Not Be Able To View User's Exact Locations Unless User Wants Them To.

Figure1: System Architecture

II. LITERATURE SURVEY

B. Gedik and L. Liu depicts [4] a customized kanonymity model for securing area protection against different security dangers through area data sharing. Model has two one of a kind components. In the first place, it gives a bound together protection personalization system to bolster area kanonymity for an extensive variety of clients with setting touchy customized security prerequisites. This structure empowers every versatile hub to determine the base level of obscurity it covets and also the most extreme worldly and spatial resolutions it is willing to endure when asking for k-namelessness saving area based administrations (LBSs). Second, it devises an effective message bother motor which keeps running by the area assurance merchant on a trusted server and performs area anonymization on versatile clients' LBS solicitation messages, for example, character evacuation and spatio-transient shrouding of area data.

P. Kalnis, G .Ghinita, K. Mouratidis, and D. Papadias [7] created strategies for securing the protection of clients issuing spatial questions against area based assaults. In particular, keep an aggressor from deducing the personality of the question source by adjusting the entrenched Kanonymity system to the spatial area. At the To the another ussize so the er at first client encode the message by the encryption calculation and after that pack the message and send to another client. Also client includes key hash and arbitrary hash labels for enhancing the protection and execution of the framework. Key hash is essentially more productive than no labels as far as handling time on the client's gadget, while giving the same, solid protection. The irregular hash gives both high Security and high effectiveness. Point when the client needs to discover some data utilizing area based administration (LBS) without unveiling his data. The client utilizes an anonymizer, a trusted server .He builds up the protected association with anonymizer. Anonymizer uproots the ID of the client and changes his area through a system called shrouding. Shrouding conceals the genuine area by a Kanonymizing spatial district (K-ASR or ASR), which is a zone that encases the customer that issued the inquiry, and in any event K-1 different clients. The anonymizer then sends the ASR to the LBS, which comes back to the anonymizer an arrangement of hopeful results that fulfill the inquiry condition for any conceivable point in the ASR. Asking the same inquiry from progressive areas may reveal the personality of the questioning client, who will be incorporated in all ASRs.

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B.Hoh et al. [9] addresses the test of giving solid protection sureties while keeping up high information exactness of time-arrangement area information. In particular, the key commitments of this work are: 1. Presentation of a novel time-to-perplexity metric to assess protection in an arrangement of area follows. 2. Advancement of a vulnerability mindful protection calculation that can promise a predetermined most extreme time-to-disarray.

S.Papadopoulos, S.Bakiras, and D.Papadias[15] proposes strategies for subjective kNN seek with solid area security. There are two primary parts in the proposed plan: (i) the PIR usefulness, and (ii) the inquiry arrangement. The previous guarantees that the LBS is absent of every piece recovered by the calculations. Framework utilizes secure equipment PIR, which is the main down to earth decision for PIR in databases of non-unimportant size. Specifically, this instrument offers private square recoveries with consistent correspondence cost and amortized polylogarithmic computational expense. The inquiry arrangement guarantees that each question recovers the same number of squares amid its execution. A unimportant arrangement would authorize every inquiry to recover a settled and subjectively vast number of pieces. Its execution, albeit enhanced by utilizing uncommon equipment , yet it is still much more regrettable than the various methodologies. Subsequently it is vague at present if this methodology can be connected in genuine LBSs.

III. PROBLEM DEFINITION

S.Papadopoulos, S.Bakiras, and D.Papadias[15] proposes strategies for subjective kNN seek with solid area security. There are two primary parts in the proposed plan: (i) the PIR usefulness, and (ii) the inquiry arrangement. The previous guarantees that the LBS is absent of every piece recovered by the calculations. Framework utilizes secure equipment PIR, which is the main down to earth decision for PIR in databases of non-unimportant size. Specifically, this instrument offers private square recoveries with consistent correspondence cost and amortized polylogarithmic computational expense. The inquiry arrangement guarantees that each question recovers the same number of squares amid its execution. A unimportant arrangement would authorize every inquiry to recover a settled and subjectively vast number of pieces. Its execution, albeit enhanced by utilizing uncommon equipment , yet it is still much more regrettable than the various methodologies. Subsequently it is vague at present if this methodology can be connected in genuine LBSs.

IV. PROPOSED SYSTEM

In the framework the client who needs to share some data about any area recovers the co ordinates (x,y) of that area from the GPS framework. At that point by utilizing the mystery turn edge and movement , he will change those co-ordinates say (x', y'). An arbitrary number generator is utilized to produce the list and is encoded with the mystery key .All the mystery data is passed on to the client's social gathering by utilizing some safe media like email or telephonic discussion.

At that point the changed co–ordinates alongside the encoded record will be saved money on to the list server. The information relating to this area is scrambled with the mystery key .This information is again compacted with the assistance of the pressure calculation for the productive recovery of the data from the information disjoin.

There are various audits present for the same area whether from client's social gathering or from the obscure clients, To recognize these two gatherings we can utilize the hash code. So the record server contains the one more field for the hash code which can be checked by the client 's companion to recover the genuine audit from his social gathering.

To determine the name clashes i.e same names for the better places the framework utilizes exceptional labels.
To enhance the execution of survey recovery from the information server we can utilize the pressure instrument which packs the audits and stores it to the information separate.

At the point when client's companion needs to get to the surveys for the predefined area again he changes the co-ordinates and sends the question to the record server. At that point he recovers the list by utilizing emit key .After recovering the record a different question will be let go on to the information server to bring the survey. The audit will initially decompressed and after that decoded with the same emit key.

Thusly the proposals can be safely corresponded with in the client 's social circle without presenting his area to the outside worl

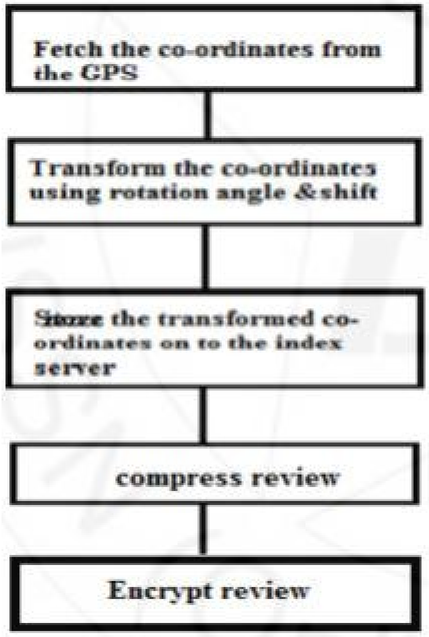

Fetch the co-ordinates from the GPS
Transform the co-ordinates using rotation angle &shift
Store the transformed co-ordinates on to the index server
compress review
Encrypt review

Figure 1: Overview of system operations

System uses following algorithms in our system:

1. Data Compression algorithm

The client information put away in databases may create greater estimated records. Along these lines, the Data Compression calculation is utilized to pack the created information. The client will get these packed records from the database.

2. Data Decompression algorithm

The documents that client will get from the database will be in packed structure, as expressed previously. Accordingly, a decompression calculation is essential.

3. AES Encryption algorithm

We are utilizing the AES Encryption calculation, rather than some other, is a direct result of the security that it gives. Here, the client area data will be encoded before it is sent to the server for capacity reason. Accordingly, regardless of the possibility that the aggressor gets this data by one means or another, it won't have the capacity to get to it.

4. AES Decryption algorithm

The unscrambling calculation is utilized to for decoding the client area information, when the real information will be fundamental for the handling.

V. PRIVACY PRESERVING TECHNIQUES

A. Adaptive-Interval Cloaking :

The key thought basic this calculation is that a given level of namelessness can be kept up in any area paying little mind to populace thickness by diminishing the air conditioner curacy of the uncovered spatial information. [5]To this end, the calculation picks an adequately vast region, so that enough different subjects possess the range to fulfill the secrecy imperative The coveted level of namelessness is indicated by the parameter kmin, the base satisfactory obscurity set size. Moreover, the calculation takes as inputs the present position of the requester, the directions of the zone secured by the namelessness server, and the present positions of every single other vehicle/subjects in the area[4].

An orthogonal way to deal with spatial shrouding is worldly shrouding. This system can uncover spatial directions with more precision, while lessening the exactness in time. The key thought is to defer the solicitation until kmin vehicles have gone to the region decided for the requestor. The spatial shrouding calculation is adjusted to take an extra spatial determination parameter as info. It then decides the observing region by isolating the space until the specfield determination is come to. The calculation screens vehicle developments over this territory. At the point when kmin diverse vehicles have gone to the territory, a period interim [t1,t2] is figured as: t2 is situated to the present time, and t1 is situated to the season of solicitation less an arbitrary shrouding variable. The zone and the time interim are then returned[10].

B. Anonymizing Location Information :

The versatile hubs speak with outer administrations through a focal secrecy server that is a piece of the trusted figuring base. In an instatement stage, the hubs will set up a verified and scrambled association with the namelessness server. At the point when a portable hub sends position and time data to an outer administration, the secrecy server unscrambles the message, uproots any identifiers, for example, system addresses, and annoys the position information as per the accompanying shrouding calculations to lessen the reidentification hazard. [5]Moreover, the obscurity server goes about as a blend switch, which haphazardly reorders messages from a few portable hubs, to keep a foe from connecting ingoing and active messages at the namelessness server. At last, the namelessness server advances the message to the outside administration

C. Location Transformation :

Changing IDs is insufficient to give area security to clients in light of the fact that a few areas (e.g. homes) are firmly connected with client IDs and may in this manner reason data spill [2]. Area change, which is an essential component received for security. The principle challenge in the advancement of suitable capacities for area change is to keep the relative separation in every sub-dataset (the dataset got from the same specialists) unaltered by the change with a specific end goal to bolster location based services (e.g. nearest neighbor queries). [1]Possible transformation functions include scaling, rotating, translation, and their combinations.

D. Query Transformation :

An extent inquiry recovers all questions the area of which falls inside of the round reach at a given question timestamp. Because of the various change on the clients' positions, a question needs to handle information from diverse transformations.[5] [6] One arrangement is to change the inquiry utilizing all change capacities, and after that execute numerous inquiries , this is not proficient and may unveil the relationship among change capacities. Such circumstances we can utilize super inquiry, which covers all inquiries after different changes. It promises that the span of the super range question is at most λ bigger than that of any changed inquiry. Beyond any doubt the super inquiry may bring about some overhead because of the hunt of a bigger space contrasted with the question changed by any of the change capacities.

Along change the directions it is additionally important to stay away saving worth. For that the change must be precise. To change a certifiable direction into virtual direction, mystery shift (bu) and turn point is Θu utilized [

E. Personalized Location k-anonymity

The Location Based System(LBS) framework comprises of versatile hubs, a remote system, namelessness servers, and LBS servers. Area data is commonly dictated by an area in arrangement source, for example, GPS beneficiary in a vehicle. Area data incorporates worldly data (when the subject was available at the area) notwithstanding spatial data. Versatile hubs correspond with outsider LBS suppliers through one on the other hand a gathering of obscurity servers situated at trusted registering bases. The versatile hubs set up correspondence with a secrecy server through a validated and scrambled association. Every message bound to a LBS supplier contains area data of the portable hub, a timestamp, notwithstanding administration particular information.[6] [12] Upon accepting a message from a versatile hub, the secrecy server unscrambles the message and evacuates any identifiers, for example, IP addresses, and bothers the area data through spatio-worldly shrouding, and after that for area data incorporates fleeting data (when the subject was available at the area) notwithstanding spatial data. Versatile hubs correspond with outsider LBS suppliers through one or an accumulation of namelessness servers situated at trusted processing bases.[6] The portable hubs set up correspondence with an obscurity server through a validated and encoded association. Every message bound to a LBS supplier contains area data of the versatile hub, a timestamp, notwithstanding administration particular data.

After getting a message from a versatile hub, the namelessness server decodes the message and evacuates any identifiers, for example, IP addresses, and bothers the area data through spatio-worldly shrouding, and afterward for The principle errand of an area obscurity server is to change every message got from portable hubs into another message that can be securely (k secretly) sent to the LBS supplier. The key thought basic the area k-secrecy model is two-fold. Initial, a given level of area secrecy can be kept up, paying little respect to populace thickness, by diminishing the area precision through extending the uncovered spatial region, such that there are other k − 1 portable hubs exhibit in the same spatial ran.

F. K Nearest Neighbor Query :

Given a question object with position (qx, qy), the k closest neighbor inquiry (kNN inquiry) recovers k objects for which no different articles are closer to the inquiry object at a given inquiry timestamp. One approach to figure this sort of question is to change the position of the inquiry article utilizing every one of the capacities as a part of the operators' change table.[9] And the server needs to consider kNN[5] for each changed inquiry position. For straightforwardness, register the kNN

inquiry by iteratively performing extent questions with an incrementally extended pursuit locale until k answers are gotten. Like the reach inquiry, a kNN question additionally should be sent to all operators. The principle contrast is that every specialists needs to change over the kNN question to a reach inquiry first. At that point the specialists changes the extent question and the development parameter rq, and sends them to the server.[10] The server will continue handling the reach inquiry q with the span stretched out by rq every time, and return the question result to the operators once it gets k qualified answers. At last, every operators processes the right separation, and sends the separation alongside the client IDs to the client that issued the question. The client then joins these to locate his actual k closest neighbors.

VI. ATTRIBUTE BASED ENCRYPTION

In a disseminated communitarian framework, it is regularly advantageous for the individuals to speak with the others in the framework utilizing traits that portray their parts or obligations. These properties are exceedingly alluring if the individuals join/leave the framework alertly. Consider an Internet gathering where the individuals are sorted out into client gatherings in view of the individuals' aptitudes or benefits. It is a characteristic prerequisite that the individuals from a client gathering ought to have the capacity to set up secure correspondence with alternate individuals having a place with specific client bunches. The correspondence in these gatherings is by and large brought out through starting a string or by posting messages inside of a current string.

To empower valid and private correspondence, the discussion head may determine an entrance arrangement with the client gatherings being characteristics. Clearly, just the individuals from the discussion whose qualities (e.g. participation to client gatherings) fulfill the strategy ought to have the capacity to have read and/or compose access to the string. There is a pattern for touchy client information to be put away by outsiders on the Internet. For instance, individual email, information, and individual inclinations are put away on web entrance destinations, for example, Google and Yahoo. The assault

relationship center,dshield.org, presents amassed perspectives of assaults on the Internet, yet stores interruption reports exclusively submit

Ciphertexts are connected with sets of traits, while client mystery keys are connected with approaches. As we have talked about, this set ting has various regular applications. Another possi bility is to have the converse circumstance: client keys are connected with sets of properties, while

ciphertexts are connected with arrangements. We call such frameworks Ciphertext-Policy

Property Based Encryption (CP-ABE) systems.CP-ABE frameworks that take into account complex arrangements (like those considered here) would have various applications. A critical case is a sort of advanced Broadcast Encryption, where clients are depicted by (and in this manner connected with) different qualities. At that point, one could make a ciphertext that can be opened just if the traits of a client coordinate a strategy [16]

VII. EVALUATION

A. Implementation and setup

We executed LocX in Java. We utilized AES with 128 bits keys for encryption and unscrambling. The execution of closest neighbor questions was in light of the R¬-tree bundle from HKUST [45]. We designed every client to reserve 1000 arbitrary number labels from each of her companions.

We gauged LocX's execution on both desktops The record and information servers were keep running on the same Dell PowerEdge server outfitted with Quad Core Xeon L5410 2.33Ghz CPU, 24GB RAM and 64 bit Federal Core 8 portions. Customers were keep running on another machine with the same design. We utilized the same code base for both desktop and portable tests. Be that as it may, we needed to adjust the code marginally for Android OS to manage some missing libraries. Furthermore, we needed to make certain advancements to restrict the memory use to under 16MBs for LocX prepare in Android.

Workload.We utilized both manufactured and genuine LBSA workload datasets for our tests. The engineered dataset with default parameters was made after experimental perception on mainstream geo-social destinations, for example, FourSquare: First, we divided a two dimensional space into 100 cells, each of which is a city. In every city, we arbitrarily produced 100 sets of area directions. At that point we appointed 1000 inhabitant customers to every city. Every customer had 100–1000 companions taking after a force law dispersion with α = 1.5 [52], among whom 70% companions were from the same city as the customer and 30% were from different urban areas. Every customer did 20 area puts, among which 70% puts were at areas in the customer's occupant city and 30% were at areas in different urban areas. area put message was arbitrarily created comprising of greatest 140 bytes, taking after the tweets in Twitter. Subsequently, every city had 20K area puts by and large, and the aggregate number of area puts was 2M. After every one of the puts, every customer presents a point inquiry and a closest neighbor question with 70% likelihood of being inside of the customer's inhabitant city and 30% likelihood of being in different urban areas. Each closest neighbor inquiry demands for 10 closest areas (we just assess closest neighbor inquiries, as we found in our preparatory tests that the execution of round extent questions to be like that of closest neighbor inquiries). We set clamor to a settled 10 focuses per question until further notice, and study the effect of commotion later. We creeped www.brightkite.com for genuine LBSA follows. We creeped utilizing BrightKite's open APIs, at a rate slower than the rate indicated in the API Terms of Use. Because of the moderate rate, we appropriated the slithering assignments to 20 machines, and creeped for around a month beginning from August twentieth, 2010. Beginning with an introductory seed of clients, we creeped every client's profile, companions rundown, and registration information. The slithered information altogether had 25,314 clients, 123,438 remarkable GPS coordinates with 259,775 registration by clients. While utilizing this information for analyses, we treated every registration as an area put, and let every client inquiry from one of her registration areas. Since registration messages were not accessible for us to creep, we created irregular messages of changing sizes.

Experiment setup. To assess the overhead that our methodology is adding to today's LBSAs with no security, we contrasted LocX and arbitrary labels, alluded to as LocX, with an execution of a today's administration that has informal community on the server and specifically maps an area to its information, alluded to as L2D. In L2D, information is in plain-message, along these lines no encryption or unscrambling is required. We gauged the correspondence expenses in the middle of customers and servers, the customer handling time, the inquiry finishing time (counting system inertness), and the server preparing time.

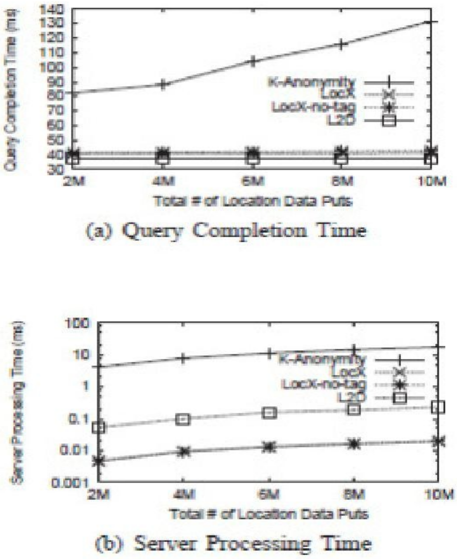
B. Experimental Results

We report results from our tests on desktop PCs

Execution of an area put. We exhibit the expense of a solitary area put in manufactured dataset. A put in today's framework (L2D) costs no preparing time on customers as there is no crypto operation. However, we can see that a put in LocX with encryption and extra list information just somewhat expands the overhead, which is not by any means discernible by clients. The normal message size was 84.5 in L2D, however it was expanded to 140 in LocX. k-Anonymity, notwithstanding, has significantly higher size because of the data in regards to the shrouded spacial district in the message.

Query performance with increase in the # of puts. We thought about the execution of LocX (with arbitrary labels), LocX without any labels, k-Anonymity, and L2D for point inquiries and kNN questions. On manufactured dataset, we fluctuated the quantity of area puts per customer from 20 to 100, while settling the measure of commotion in a question to default 10 and message size to default most extreme 140. Aggregate number of customers was settled at 100K. As area puts per customer builds, the aggregate information size expands, consequently more information should be handled and the sizes of inquiry answers increment. Figure 3 demonstrates the increment in inquiry answer sizes. Clearly, the reaction to a kNN question contains more information than a point inquiry (by more than 6 times).

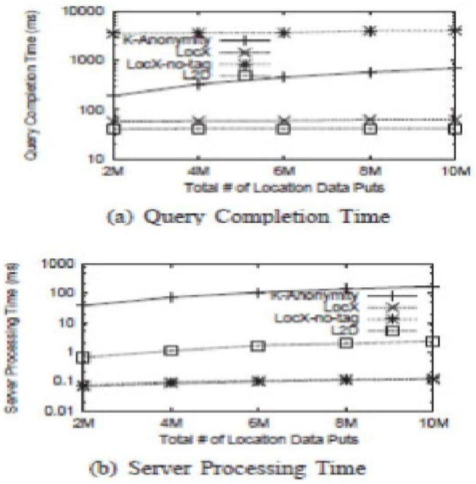
From Figures 3(a) and 4(a), we see that preparing a question in LocX takes is practically identical to that of L2D, in a LAN IEEE TRANSACTIONS ON MOBILE COMPUTING This article has been acknowledged for distribution in a future issue of this diary, however has not been completely altered. Substance may change preceding last publication.12 setting. Be that as it may, the other two methodologies – k-Anonymity and 'Locx-no-label' – perform ineffectively. k-Anonymity has higher overhead as the whole shrouded spacial area is incorporated in the reactions, which prompts increment in the inquiry consummation time, and server handling time or burden (demonstrated in Figures 3(b) and 4(b)). In 'LocX-no-label', a customer can't separate in the middle of companions' and non-companions' messages, so the customer tries to decode each and every message got, which prompts expensive reckoning and time to culmination. This issue turns out to be especially more regrettable while preparing nearestneighbor questions, as demonstrated in 4(a). The server time of LocX is really superior to L2D because of the way that the application rationale is moved to the customers and server basically needs to do lookups. The correspondence expense of LocX is close to 3 times the correspondence expense of L2D for point inquiries and close to 7 times the correspondence expense of L2D for closest neighbor questions, We additionally measured the customer preparing times. LocX, not surprisingly, pays a slight preparing cost on the customer side in unscrambling records and area messages. In any case, we find that this increment in overhead is really insignificant. Because of space impediment, we forget the charts for manufactured information. The outcomes are comparable in both c



(a) Query Completion Time

(b) Server Processing Time

Fig.3 The various costs of running point queries while varying the number of location puts in synthetic data



(a) Query Completion Time

(b) Server Processing Time

Fig-4 the various costs of running nearest neighbour queries while varying the number of location puts in synthetic data

VIII. CONCLUSION AND FUTURE WORK

Geo person to person communication is a standout amongst the most developing patterns today. With the development in the systems administration innovation loads of protection related issues are likewise rising in this present reality. In this paper we talked about diverse protection related issues and a few arrangements which can be received in the current framework. Longitude is convention that presented area change and deals with two way secure key. Longitude's intermediary re-encryption plan is provably secure and thecryptographic capacities advanced for versatile stages however have computational overhead. Tor is programming that can beused for giving online anomity. Be that as it may, new research found that assaults can be made between the last transfer and the destination. Area to list mapping is another component which receives the area change from longitude convention furthermore presents part of area and information into two sections and putting away it in distinctive servers. The companions of a client share this present client's insider facts so they can apply the same change. This permits all area questions to be assessed effectively by the server, however our security systems ensure that servers are not able to see or surmise the real area information from the changed information or from the information access. This includes minimal computational and correspondence overhead to existing frameworks. Area to file mapping makes a major stride towards making area privacy practical for a large class of emerging geo-social applications.

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