An Object Based Conceptual Framework for Location Based Social Networking

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ABSTRACT

In the current technological era the value of information sharing has emerged enormously while the contemporary phenomenon of Social Networking (SN) has provided an avenue for sharing information. The ubiquitous nature of SN services has focused mainly on "Who", "What" and "When", while the "Where" dimension has mainly been neglected. Only recently after realizing that "Where" dimension of information is present in almost 80% of raw data, the SN platforms have started utilizing the location based information. This has led to the emergence of a new field, namely Location Based Social Networking (LBSN). A comprehensive literature review of LBSN reveals several shortcomings in both, the research and industrial implementation. One of the primary weaknesses is that the location in LBSN is being assumed and treated just as an auxiliary part of information (post, pictures, videos etc.) and not as a core element. This treatment undermines the true significance of location based information in LBSN. To overcome this limitation, current paper proposes an object based conceptual framework in which location reforms itself from a mere non-compulsory attribute of information to a completely new form i.e. an object. The location as an object will have its own attributes and associated behaviors. When this new location based information object is integrated into a LBSN platform, the interactions between location and human objects instigates, which resultantly exhibits new aspects of social and spatial communication not witnessed previously in LBSN.

Categories and Subject Descriptors

D.2.11 [**Software**]: Software Architectures

General Terms

Design, Standardization, Theory.

Keywords

Social Networking (SN); Location Based Social Networking (LBSN); Location Based Services (LBS).

1. INTRODUCTION

The ubiquitous process of converting data into information has finally leaded to the concept of Information Technology (IT). The IT has revolutionized the current era by having its impact on countless fields including science, business and entertainment. Historically, acquisition and manipulation of information has been a predecessor to the sharing of information among people, which eventually forms the communication structure of a society. In the technology sense, the sharing of information or simply Information Sharing (IS) is a recent burgeoning aspect of IT. Distinct from managing information (like in IT), IS focuses on sharing of information by incorporating the concept of "Crowd Sourcing" where users are the main source of information provider instead of the system. Hence the users provide information for sharing, while system manages it. The by-product of this process is the domain of Social Networking (SN), which serves as a platform for users to virtually socialize by means of sharing information.

The SN with its huge presence in current digital era has allowed users to share information, focusing on dimensions of "Who", "What" and "When". This implies that "Who" is sharing "What" information and "When" i.e. at what specific time. Only recently by analyzing the importance of location based information, SN has integrated the "Where" dimension on its platform. The high significance of location based information is being observed by the fact that nearly 80% of any raw data contains some sort of spatial or location based component [15]. The integration of location based information with SN actualizes the domain of Location Based Social Networking (LBSN). The LBSN can be thought of as a fusion of Location Based Services (LBS) and SN as depicted in the Fig. 1, where LBS are the web and mobile based services, harnessing the location based information to facilitate users e.g. location based advertisement and vehicle navigations.
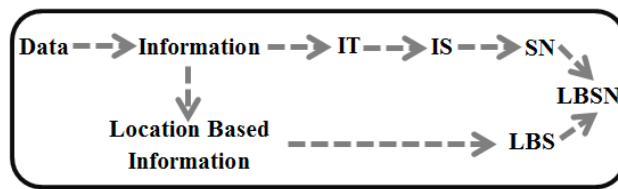

Figure 1. Flow diagram for location based social

With numerous existing LBSN designs and industrial implementations, the real challenge of a comprehensive framework for LBSN is still to be addressed. The main issue with the existing LBSN frameworks is that they limit the scope of location based information sharing because of not treating location as an integral element of the SN platform. This refers to the fact that location is treated as just an attribute of information provided by human users and hence doesn't stand alone as an independent entity which holistically undermines the diverse utilization of location based information in SN. The framework proposed in this paper alleviates such limitations by reforming location based information from an attribute of information to a complete independent entity i.e. an object. The location as an object will have multifarious attributes and associated social behaviors. When such a location object is integrated into a SN platform then location along with the human object acquires the status of a core element of the underlying SN platform which eventually instigates new and better ways of communication and information sharing.

The rest of the paper is organized as follows: The section 2 explains current state of the LBSN research and commercial implementations. The section 3 classifies problems in the current state of LBSN into two categories namely broader and granular level problems. Section 4 proposes a framework for LBSN to cater the problems identified in section 3. Advantages of the proposed framework are explained in section 5, while section 6 concludes this paper with a discussion.

2. STATE OF THE ART IN LBSN

The work on LBSN has shown progress in both industrial implementation and academic research. This section provides a comprehensive background of how implementers have utilized the concepts of LBSN in their respective applications and the areas in which academic research is being conducted in the context of LBSN.

In the industrial track, location is being attached to every possible information (particularly in SN platform) to make it more worthy. Implementers like Flicker, YouTube, Panoramio, Picasa, Instagram and Jotpix have attached location based information with media like pictures and videos [23]. Facebook and Twitter have also provided mechanisms for merging location
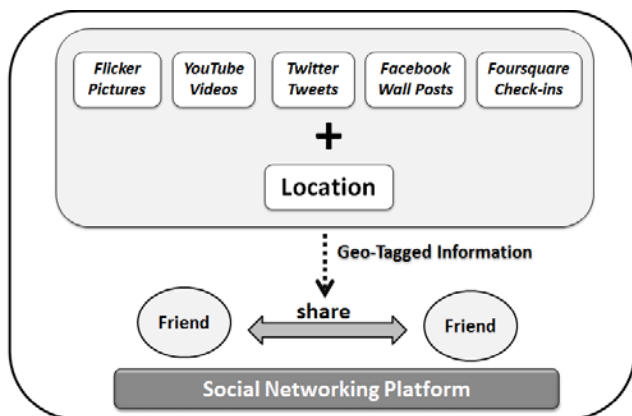

Figure 2. Existing location based social networking platform's framework.

based information with user's posts and tweets respectively, as described in [2] and [14]. The process of attaching location with other forms of information is called geo-tagging and the geo-tagged information is then shared with other users in the SN platform as elicited in Fig. 2.

The geo-tagged information is being consumed in LBS (Location Based Services) which comprise of services like identifying the location of an entity (person or an object), discovering the nearest banking cash machine (a.k.a. ATM) or the whereabouts of a friend. It is discussed earlier that LBS integration with SN has originated the domain of LBSN, thus the location oriented services offered by various industrial players can be generalized either as LBS or LBSN, while currently numerous implementations of both exist.

Among plethora of existing location based information services includes travel assistance by TripAdvisor and GetYourGuide, venue location posting with the concept of "check-in" by Foursquare and Gowalla, review and ratings of locations by Google+ Local, Yelp and Facebook, social issues reporting by SeeClickFix and neighborhood news and discussions by EveryBlock. Some of the aforementioned services can be categorized as LBS (GetYourGuide, TripAdvisor, Yelp, Jotpix) while others are typical LBSN (Foursquare, Gowalla, SeeClickFix, EveryBlock, Google+ Local). The common feature identified in all of these implementations is to link location with their base features (tweets, videos, pictures, ratings, reviews).

To account existing LBSN services including the earlier mentioned ones, researchers have tried to summarize the concept of LBSN by classifying and providing comparisons among them. Yu Zheng in [20] has proposed 3 categories for LBSN namely, geo-tagged-media-based, point-location- driven, and trajectory-centric. A different approach provided in [13] categorizes LBSN as social check-in sites, social review sites and social scheduling sites. Apart from categorization, [9] has given a comprehensive comparison of some of the LBSN services based upon number of criteria.

Categorizations of LBSN presented in literature like [13], [20] and [9] does not account for the exhaustive list of LBSN services burgeoning around. For instance the most general type of LBSN i.e. EveryBlock and the more specific community problems driven SeeClickFix, both does neither fall in any of above mentioned categories nor they are among comparisons in literature.

From the research perspective, new concepts and formulations for location based information sharing are presented with focus on data mining as described in [3], [8], [4] and [5]. Other research areas include finding correlation among locations as in [18], [19] and [22] and algorithms for location recommendations in [1], [3], [5], [16], [17], [21] and [22]. To find correlations among locations, models are designed which find the similarity among locations and then recommend locations to users which have high similarity with user's spatial and social history as in [3], [6] and [10]. Apart from typical location recommendations, location based friends in [10], [18] and location based activities in [16], [17] are also recommended. Other related work focuses on the presentation of location based information feed and their ranking as suggested in [1] and [6]. In literature some of the work has also discussed sensitive issues related to location based

information sharing e.g. user trust and privacy issues as mentioned in [9]. From a broader view, researchers have also tried to accumulate some of the earlier mentioned key research areas to design frameworks for LBSN as in [3], [6] and [21].

After a comprehensive review of literature it is observed that there exist several different designs of LBSN which serves location based information sharing in bits and pieces. Existing implementations and research treat location as ancillary information, attached to textual and media oriented posts made by the users of a SN platform. The sharing of location based information is considered firstly "social-oriented" and then "location-oriented", but this undermines the potential of true location based information in context of LBSN. To overcome this gap a general LBSN framework need to be designed, which should be capable of catering all the features of existing LBSN implementations and should explicitly distinguish location from other forms of information by considering location as an integral part of its design.

3. CURRENT PROBLEMS IN LBSN

In this section shortcomings of the current LBSN frameworks are highlighted in detail. The primary issue with existing LBSN implementations is that every implementation is trying to standardize the definition of LBSN through its own peculiar way. None of these is in the position to lead, because the real structure or potential of sharing location based information seems still to be researched and finalized. Facebook is considered as an informal standard in social networking with the concepts like Friends, Wall, Post, Like, Comment, Tag and Group notifications. In contrast no standard concepts, nomenclature and processes exist for sharing of location based information. Thus the lack of any mature LBSN framework causes various shortcomings as discussed in the following section.

It is important to remember that the basic tenet behind any kind of social networking is that the humans are social by nature, and they like to share information. Comprehensive study of the related literature reveals the lack of any mature definition, concepts and base framework for sharing location based information which advocates flaws in the existing frameworks. These shortcomings are mainly due to misjudgment regarding the significance of location based information in SN. Eventually it causes the lack of smooth integration of spatial and social information. The authors in [16] and [21] have presented concepts regarding design of a core LBSN framework. It is stated in [16] that graph representing a location based social network is heterogeneous, consisting of at least two types of nodes; user and location and three kinds of links; user-user, location-location and user-location. Additionally [21] asserts that location in current SN is limited to mobile devices by check-in like functionalities and by tracking whereabouts of friends. This approach narrows the scope of location based information and isolates it from the main SN functionalities (posts, news feed, messages etc.). It is further asserted in [21] that location should be ubiquitous in every feature of social networks rather than just an additional attribute of information, like the geo-tagged content. Moreover it is stated in the same paper that instead of inventing an entirely new framework for LBSN, current SN services should be made "location-aware".

Although better concepts are presented in [7], [12] and [20] but apart from considering location with its real value i.e. as a distinct node or object in SN graph, none of the work presents any comprehensive design which rightly consumes the proposed orientation of location. Conclusively it is observed that all the existing work (research and implementation) has limited focus due to their overlooking of the value of location based information sharing. The following discussion defends this claim by classifying the shortcomings found in existing LBSNs, as broader and granular level problems. The broader level problems are the crucial flaws in the design of LBSN implementations, while granular level problems are the gaps discovered in peculiar features offered by various existing LBSNs.

3.1 Broader Level Problems

If location is not among the basic ingredients of a SN platform then it undermines the true potential of LBSN. By limiting the scope of location based information in SN various major design issues are detectable. For example a specific category of LBSN implementers (Foursquare, Gowalla, Brightkite) focuses on allowing users to share their location when they visit a system-registered place, giving it a buzz word of "check-in". Based upon check-in, people are rewarded with various benefits e.g. discounts at that check-in place. This mechanism of LBSN is limited to just sharing one's current location but the versatility of location based information is not harnessed. Moreover current research is also focused majorly to model and mine location based data related to check-in (locations visited by people) and then recommend similar locations. In summary the current mechanisms of dealing with location based information have twofold problems as discussed below:

- The non-compulsory and attribute oriented nature of location in existing LBSNs tends to be a major shortcoming in the design of existing LBSN frameworks. The notion of treating location as an attribute refers to the fact that the existing SN platforms facilitate the association of user-generated content (pictures, videos, posts, tweets, check-ins etc.) with location, terming it as "Geo-Tagged" or "Geo-Referenced". Eventually this "Geo-Tagged" content is shared among the users by utilizing the SN platform. In contrast there exists no such .mechanisms where location is considered as the primary aspect and later additional content is attached to it. The difference between the two approaches will draw the line between existing and proposed LBSN framework as discussed in detail in section 4.

- In all of the existing LBSN platforms, location based information is supposed to come from only peers or friends. This concept limits the true fusion of social and spatial information, since there is no mechanism of directly interacting with location irrespective of the information provider i.e. bypassing the location information provider. With location as mere an attribute of information in SN platforms, this approach is not possible since location information is strictly attached to the user who provided this information. But when location becomes a distinct entity instead of just an attribute of information, then direct feed from the location to users (other than the owner) becomes possible as discussed later in section 4.

- Another potential broader level problem in existing treatment of location is the user's concern about their

privacy. It is generally observed that people hesitate to use LBSN services. It is so because for them using LBSN is synonymous to sharing their current location, like in Google's Latitude, Foursquare and Gowalla, which directly compromise user's privacy as discussed in [9] and [11].

3.2 Granular Level Problems

Apart from the broader level concerns, the current way of dealing location based information in SN platforms with much limited scope, has shown multiple granular level shortcomings. The shortcomings are observed both in literature and commercial applications as discussed below:

- The location based information is always expected to come from the vicinity of the location specified by the user mostly through the check-in like concepts using location enabled devices. Although this vicinity related information seem fine in theory but in real world, a user might be interested in more than one geographically distant vicinities i.e. non-contiguous areas in the whole geographic plane that may be termed as "Zones". These interest zones could be as distant as cities or even countries. Activities in these zones will be preferred source of information for the user under single interest e.g. different parks in a city that might be geographically distant but for a specific user they conceptually form a single interest area. Current research and implementations related to LBSN doesn't provide any such concepts.

- Location as information in SN platform should encapsulate both; physical places (e.g. cafes, shopping malls, parks) and occurrence of events and happenings at locations (commercial activities, emergency news, social events, weather and traffic updates). Contrastingly current LBSN frameworks in research and industrial implementations have concentrated only on the first aspect i.e. physical locations and thus have neglected the other aspect i.e. happenings at locations. Doing so the location recommendation process lacks the versatility of location based information feed and recommendations to the users of LBSN. When location is seen as an entity or object as proposed earlier, then all the happenings in the geographic plane could be considered as location information worthy of sharing e.g. media news, pubic announcement and awareness messages, metropolitan news, weather and traffic updates, sale and purchase activities, job offering, social gatherings, commercial services offerings, general community updates (exhibitions, workshops, theater timings, religious offerings, emergencies, accidents, law and order), general knowledge about locations (Wikipedia style, including famous persons related to a place), utility network updates, local government (municipal and metropolitan) regulation notifications etc. Hence with such versatility the undiscovered worth of location based information sharing can be unveiled.

In a nutshell, the crux of all the limitations (broader and granular) discussed above is the weak structural role of location in SN platform. The proposed framework (as described in section 4) caters all the above mentioned limitations.

4. OBJECT BASED LBSN FRAMEWORK

Based on the literature review and analysis of the shortcomings, this paper proposes a new framework for sharing location based information in a SN platform. The fundamental aspect of proposed framework is to remodel the location from an attribute of information to a complete entity i.e. an object. The location being an object will have its own attributes and associated social behaviors. This structure of location will help encapsulate related information and expose various public services. Finally implanting such a location object in a SN platform will formulate the design of proposed LBSN framework as discussed in detail later in the current section.

When location based information is reformed to an object then it will have its own attributes and associated behaviors. The previously geo-tagged content (picture, videos, tweets, check-ins) will now be treated as attributes of this new location object along with the geographical coordinates of the location, represented as point, line or polygon (area). This object can formally be termed as a "Location Based Information Object (LBIO)". The LBIO would be created by the user of SN platform and a peculiar feature of LBIO would be its creation process. Earlier, user created an information object like a picture and then added location as one its attribute. In contrast, now user would take pictures and add those pictures to an existing or newly created LBIO where location i.e. it's geographical coordinates, serves as the basic and compulsory ingredient. Later this LBIO could grow by incorporating more information like pictures, videos, tweets, comments, likes and rating provided by the users of the SN platform. This LBIO will now have the capability to extend itself by incorporating numerous other functionalities and concepts e.g. privacy details, event happenings, historic information, news feed, registered members etc. This all is possible because location as an object has an independent existence.

4.1 LBIO Geometrical Classification

For structuring location as an object, theoretical support is taken from the domain of object orientation. In the proposed framework, from an object orientation perspective there is a hierarchy of LBIOs and their respective classes, where class acts like a template while object serves as an instantiation of the class. The fundamental or base class representing a LBIO is termed as "Place" and its objects as Place objects. The Place class will be a set of geographical points (x, y coordinates) along with other attributes (pictures, videos, check-ins, ratings, reviews). An additional important attribute of this class is of ownership or the creator's information. Apart from these attributes the location class consists of some associated behaviors which will define the possible social interactions. These social behaviors will help glue location objects with SN platform. It is important to note that Place objects will be a set of geographical points with the constraint of connectivity. This implies that it is always possible to traverse between any two random points represented by the Place object. By this definition Place objects could be:

- a single point (a geographical coordinate) or,
- a set of connected non-looping points (line) or,
- a set of looping points, forming a closed area (polygon).

Hene it is important to note that Place objects cannot be two distant points, lines or polygons.

The second level in the object orientation hierarchy of LBIO is the "Zones" class, which is a composition of Place class. Thus a single Zones object can consist of multiple Place objects. Additionally Zones class differentiates from Place class by modifying the geographical aspects and incorporating flexibility in it. It refers to the fact that a single Zones object can be a collection of adjacent as well as non-adjacent points, lines or areas (polygons) or simply a combination of any of these. In other words Zones objects can be composed of multiple non-contiguous Place objects which can span distantly over towns, cities or even countries.

From a real world's perspective, Place objects are objective in nature while Zones are subjective from user's (creator's) point of view. Thus Place objects qualifies to represent real world locations like restaurants, shopping malls or a bookshop, while Zones are abstract representation of locations that are geographically marked with user's personal interest. Examples of Zones include collection of jogging tracks in various parks or the locations of ATM machines provided by different banks in a specific city.

It is important to note that LBIO objects (Place and Zones) if represented as enclosed areas (polygons) will act as 'watch areas'. The concept of watch areas implies that updates of location objects (by friends and public) that are contained in or overlap with these "watch areas" will be the preferred source of location based information. Additionally, any specific user can create multiple LBIOs (Place and Zones) as per need.

The types of LBIO i.e. Place and Zones are shown according to their geometrical properties in Fig. 3 and Fig. 4 respectively. It is important to note that if a user intends to create Place object, then each marking will create a separate object because of the connectivity and contiguity clause in its definition. In contrast, if a user creates a Zones object, then many combinations of markings can be grouped into a single object.

The categorization of LBIO as Place and Zones are based on geographical properties, while the further discussion provides classification of LBIO based upon the associated social behaviors and privacy levels. Later the details of the both classifications will be unified to complete the design of the proposed LBSN framework.

4.2 LBIOs Social Hierarchy

One of the critical aspects of the proposed LBSN framework is seamless fusion of social and spatial information, for which we have transformed location from attribute of information to independent entity i.e. LBIO. The approach used here is that the LBIOs should possess some social characteristics and expose them as behaviors. Doing so, LBIOs could easily be plugged into a SN platform. For achieving such a scenario, a complete hierarchical categorization of LBIO w.r.t. social aspects is formed. This hierarchical categorization comprises of five levels as discussed below:

- At level 1, LBIO (Place and Zones) are categorized as "Self-Created" and "Other's (friends, public) Created". The "Other's Created" LBIOs are those with which a user may
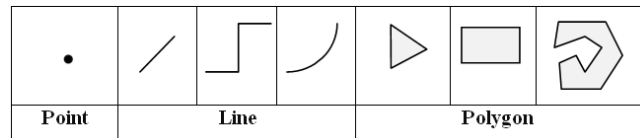

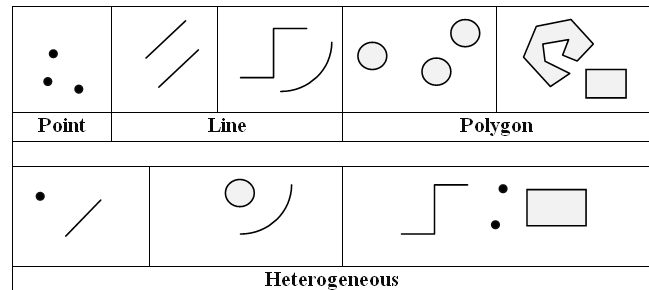**Figure 3. Geometrical types of Place objects.**

Figure 4. Geometrical types of Zones objects.

communicate (search, register, comment, like, get news feed etc.).

- Some of the LBIOs are entirely private while others are meant to be shared. Thus for each of the LBIOs at level-1 two further types are formed at level-2 namely, "Discoverable" and "Non-Discoverable". The "Discoverable" LBIOs are for sharing while "Non-Discoverable" are entirely for private use.

- The "Discoverable" LBIOs are further classified at level-3 as "Discoverable in Friends" and "Discoverable in Public".

- Each of these discoverable LBIOs can require users to register with it, for fetching or posting information. The concept of registration is synonymous to becoming a member of a group in a SN platform. Hence at level-4, each of the "Discoverable" LBIO is classified as "Registration Required" and "Registration not Required" LBIO.

- Lastly each of the LBIO defined at level-4 defines the mode of communication i.e. whether a user can only fetch information or can also post to the LBIO. This forms the last classification of LBIOs (at level-5) in the hierarchy, namely "Read" and "Read-Write" LBIO.

In summary this categorization helps add a social coating over LBIO, so that it can be seamlessly plugged into a SN platform. The Fig. 5 summarizes all of the above discussion about hierarchical categorization of LBIOs.

4.3 Social LBIOs

As discussed earlier every possible user of the proposed LBSN framework will have the capability to create two types of LBIOs i.e. Place and Zones. The actual instantiation of Place and Zones type location objects in correspondence to above discussed social hierarchical structure(ownership, discovery, registration, read and write) will produce three types of LBIOs i.e. private, shared and public. These three LBIOs when functional in a SN environment, will define the final structure of our proposed LBSN framework. Brief description of these three types of LBIOs along with their respective examples is presented in the following text.

- Private LBIO: It is an LBIO that is hidden from the outside world and hence it is entirely for personal use. No registration and read-write modes for friends and public are available for it. Following are some of the examples:

  a) Creating a LBIO by marking the location as Place object intended for shopping purpose.

  b) A business person marking locations as area oriented Zones object (representing his regular visiting locations) to get updates from within those locations e.g. better food options, road blocks etc.

- Shared LBIO: A LBIO created for sharing among friends. It can provide both read and write operations. Following are some of the examples:

  a) Sharing the location of a new ATM machine in a neighborhood or announcement of an upcoming social gathering event and its location with friends as a Place object.

  b) A tennis player marking the locations of his favorite tennis courts in a specific city as Zones object, and sharing it with likeminded friends.

- Public LBIO: A LBIO for sharing in public which can provide both read and write operations. It can be thought of something to which a creator intends to claim ownership and eventually expose it to public with personal rights. Following are some of the examples:

  a) Owner or representative of a business (theater, cafe, bank) adds his business place as Place object and tries to update people in vicinity about happenings at that location e.g. discounts, working hours etc. (users can get updates of the business, by marking area based LBIOs that have common location with the business owner's LBIO or by explicitly registering with the business LBIO.)

  b) Curator of a museum notifies tourists (registered with museum's Place object) about any unscheduled closing of museum and its timings throughout the year. The curator does this by updating an earlier created public Place object of museum.

These three types of LBIOs i.e. private, shared and public help in filling the gap between SN and location based information so that location as LBIO can avail all the features and benefits of existing SN platforms.

The Fig. 6 provides a better understanding of proposed assertions about LBIOs (Place and Zones) in the form of a matrix. The matrix summarizes behaviors (discovery, registration, read and write) associated with different types of LBIOs (private, shared, public and registered) with reference to users (self, friend, and public).

5. CASE STUDY

Defining the types of location objects along with their associated social behaviors is the fundamental aspect of the proposed framework. Doing so, the final model of the framework consists of defined LBIOs with which users communicate in terms of the location object's geometrical types, associated behaviors and the ownership. Example could be, users getting feed from friend's shared Place object or users commenting, rating or uploading
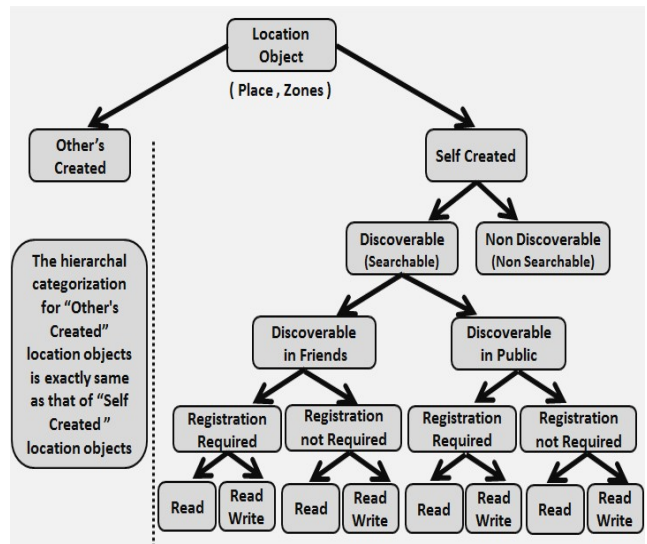

Figure 5. Framework of location based social networking (transition from existing to proposed framework).

Location Type	User Type	Discovery	Registration	Read	Write
Private Location Objects	Self	-	-	Yes	Yes
	Friend	No	No	No	No
	Public	No	No	No	No
Shared Location Objects	Self	-	-	Yes	Yes
	Friend	Yes	Yes	Yes	Yes
	Public	No	No	No	No
Public Location Objects	Self	-	-	Yes	Yes
	Friend	Yes	Yes	Yes	Yes
	Public	Yes	Yes	Yes	Yes
Registered Location Objects	Self	-	-	Yes	Yes
	Friend	-	-	Yes	Yes
	Public	-	-	Yes	Yes

Figure 6. Location objects matrix representation.

pictures to a public Zones object. This multidimensional (spatial and social) communication behavior between users and location objects is the real essence of the proposed framework.

The real implementation and validation of the proposed LBSN framework is scheduled as the next phase of this research activity. But to support the proposed framework, a comprehensive case study is formulated as depicted in Fig. 7. Case study states that user A and user B are friends, while user A is also registered with a shared Zones object of user B. If user P1 (friend of neither user A or B) instantiates a LBIO (public Place object) that falls inside the shared Zones object of user B (spatial aspect) then this information will be propagated to user B and also to user A (social aspect) since A being friend of B has registered with B's shared Zones object. Thus the location based information provided by user P1 has two hopping, first due to spatial factor of overlapping areas of LBIOs created by user P1 and user B and second due to the social factor of friendship between user A and user B (user A is able to register with a shared Zones object of user B only because of their mutual friendship). This style of information flow forms a "Social-
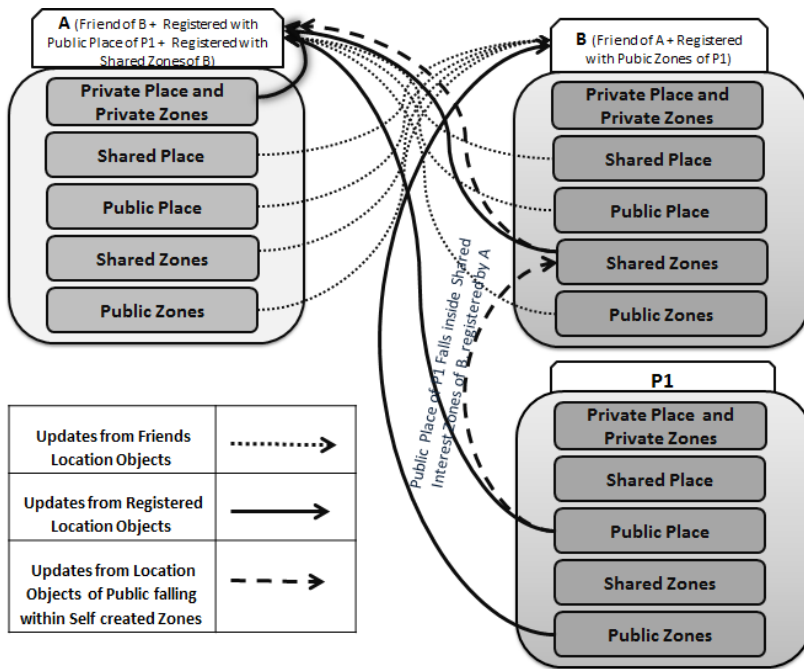
Figure 7. Social-Spatial Communication in the proposed framework.

Spatial" bond. It is quite important to note that distinct from fetching location based information, a user can also write or post information to LBIOs, subject to permission allowed by the specific LBIO.

Expanding the above case study, where users would be creating, sharing and registering with LBIOs across cities or even countries, provides the glimpse of the domain of the proposed LBSN framework. The whole example signifies the multi-dimensional flow of information as both social and spatial factors are playing their vital role. The conclusive fact is that location being an object becomes versatile and dynamic w.r.t. information sharing, while location as an attribute is devoid of it.

6. ADVANTAGES

The crux of the proposed framework is that location as itself has a concrete value, instead of treating it as a part of some other entity. LBIO fulfills actualizes this concept of indecent location entity, so that every city, town, street, restaurant, building, lake etc. has its own representation. The LBIO will encapsulate any type of information related to that location and additionally will expose various public services to be invoked by the user of SN platform. Services related to LBIO include public alerts, questions by LBIO members, news feeds including current and historic happenings. Such a structure transforms location from a piece of information to active and valuable SN entity, providing numerous advantages.

Among various benefits achieved due to the proposed framework the most significant are discussed below:

- The proposed framework facilitates the possibility of users directly communicating with LBIOs (created by friends and public) either through registration with the LBIO or because of geographical commonality. The advantage gained is the direct access to the information instead of focusing on the information provider. In this regard, Facebook provides the

concept of "Pages" which represent locations. The users can directly communicate with a location's page but the missing factor is that the Facebook's pages lack any sort of spatial or geographic component. For example the page of "Paris" city on Facebook doesn't contain any information about which local theater is producing most tweets or the locations within the city where most users have commented and liked. Although Google+ Local provides basic social networking features by implicitly creating an independent page for locations already marked on Google Maps, but still the location based communication mechanism lacks. It means that users still have to know about locations either through other users of Google+ or through searching by keywords. But in proposed framework any user can have access to location based information solely on the basis of geographical properties contained in the LBIO. This provides a new dimension of socializing where users socialize with focus on locations, while existing LBSN offers socializing solely by interacting with other users and treat location as just a piece of information.

- The LBIO bring great value in context of geographical properties. Firstly locations must not be limited to objective physical real places as frequently used in Foursquare's check-in concept. It is so because a combination of coffee shop in a super-market and a nearby garden may a subjective "recreational" place for a specific user. The LBIO type, Zones as discussed previously; help us achieve the notion of locations with personalized geographic extent. The personalized geographic locations can still be manipulated socially by setting it as private for fetching information or turning it as a shared or public entity. Additionally by definition a single Zones object can be a composition of geographically distant Place objects. This geographical distant aspect of Zones helps in breaking the stereotype of location based information always originating from the surroundings of user's current location. Such concepts of personalized locations with social characteristics offer customized source of location based information that does not exist in any of the existing LBSN implementations.

- In general SN platforms, user gets information feed from various sources including friends, groups and pages. But the existing LBSN implementations doesn't offer much versatility in sources of location based information. Most LBSNs doesn't offer location based groups or pages, while some like Google+ do cater this but with focus on social aspect and not the location itself. In such scenario, a user must socialize (find friends, join groups, register with pages) according to his social circle and knowledge. But in case of location based socialization, a user concern should be firstly about the geographical extents rather than keywords. This is because it is natural to thingk in terms of locations, when the intention is ot get location based information. None of the current LBSN caters this gap of place location at the first step for socializing. For instance,

Yelp although facilities user about best recreational facilities for limited set of cities, but still doesn't offer any mechanism, where users implicitly get information based on custom geographic extents. To cope up with this, Yelp has given the concept of prebuilt custom areas within a city, termed as Neighborhoods, which is high non-intuitive for a novice user. A better approach according to the proposed framework would have been to create LBIOs for all the recreational places for a city and visualize them on map. Then will give users the freedom to either explicitly register with any of the LBIO or mark area oriented LBIOs to implicitly fetch location based information.

- The essence of proposed LBSN framework is the realization of LBIOs. Numerous possible ways of location based social interaction exist; like a user can create a LBIO and other users can post information on it. Similarly a user can get information from friend's created LBIO. Additionally a user may register with a public LBIO (discovered due to geographical commonality) and then build friendship with the members of that specific LBIO. Such mode of communication between location objects and human users and are totally devoid in current LBSN domain.

In a nutshell advantages gained from proposed framework are either partially implemented or completely missing in existing LBSN implementations.

7. CONCLUSION

Because of the ubiquitous nature of location based information, the SN platforms are integrating location into their frameworks and hence forming LBSN. From detailed literature review it is analyzed that current LBSNs are underestimating the potential of location based information, by treating it as a mere attribute of information. This causes several issues like limiting the scope of location based information sharing to concepts like "check-ins". Additionally location based information is always bound to the users of SN and never exist as an independent entity, to play its versatile role.

To overcome the gaps in existing LBSN, the proposed framework states that location must be among the basic ingredients of the underlying social network. This is achieved by transforming location from an attribute of information to an entity i.e. an object, formerly termed as LBIO. The LBIO is a set of attributes (pictures, comments, geographical position) and social behaviors (registration, news feed, recommendations etc.). From geographical aspect LBIO comprise of Place and Zones, while actual instantiation of Place and Zones objects in SN platform produces private, shared and public LBIOs. A working exampling of proposed framework is given to better convey the asserted value of the framework. Finally to emphasize the need for the proposed framework, the advantages gained through it and their comparative analysis with existing LBSN implementations are discussed in detail.

8. REFERENCES

[1] Chi-Yin Chow1, J.B., Mohamed F. Mokbel. Towards location-based social networking services. 2010. *ACM LBSN '10, November 2, 2010. San Jose, CA, USA, 2010.*

[2] Facebook. Share Where You Are. Available at: https://www.facebook.com/about/location. (Accessed: 30th June 2013).

[3] Hassan A. Karimi, B.Z., Alper Ozcelik, Duangduen Roongpiboonsopit. 2009. SoNavNet: A framework for social navigation networks. *ACM LBSN '09, Seattle, WA, USA.*

[4] Jonathan Chang , E.S. 2011. Location: how users share and respond to location-based data on social networking sites. *Association for the Advancement of Artificial Intelligence (www.aaai.org).*

[5] Mao Ye, P.Y., Wang-Chien Lee. 2010. Location recommendation for location-based social networks. *ACM GIS '10, November 2-5, 2010. San Jose, CA, USA, 2010.*

[6] Mohamed Sarwat, J.B., Ahmed Eldawy, Justin J. Levandoski, Amr Magdy, Mohamed F. Mokbel. 2012. Sindbad: A location-based social networking system. *SIGMOD '12 , Scottsdale, Arizona, USA, 2012.*

[7] Mohamed F. Mokbel, Jie Bao, Ahmed Eldawy, Justin J. Levandoski, Mohamed Sarwat. 2011. Personalization, socialization, and recommendations in location based Services 2.0. *PersDB 2011 Workshop, September 2, 2011, Seattle, Washington, USA.*

[8] Nan Li , G.C. 2009. Analysis of a location-based social network . *International Conference on Computational Science and Engineering, IEEE, 2009.*

[9] Nan Li, G.C. 2010. Sharing location in online social networks. *IEEE Network, September/October 2010.*

[10] Panagiotis Symeonidis, A.P., Yannis Manolopoulos, Pinar Senkul, Ismail Toroslu. 2011. Geo-social recommendations based on incremental tensor reduction and local path traversal. *ACM LBSN '11, November 1, 2011. Chicago, IL, USA, 2011.*

[11] Sarah Jean Fusco, R.A., Katina Michael, Anas Aloudat.2012 Location-Based Social Networking: Impact on Trust in Relationships. *IEEE Technology and Society Magazine - Summer 2012.*

[12] Scellato, S. 2012. Spatial social networks: measurement, analysis and applications. *Computer Laboratory, University of Cambridge.*

[13] The Search Agency. 2010. Comprehensive guide to location-based social media. Available at: http://www.thesearchagency.com/sites/default/files/tsa_whit epaper_location_based_social_media.pdf (Accessed: 30th June 2013).

[14] Twitter. How to Tweet With Your Location. Available at: http://support.twitter.com/articles/122236-how-to-tweet-with-your- location#. (Accessed: 30th June 2013).

[15] Vikram Talada. Unleashing the power of Geographic Information Systems. Available at: http://proceedings.esri.com/library/userconf/proc00/professi onal/papers/pap455/p455.htm. (Accessed: 30th June 2013).

[16] VincentW. Zheng, B.C., Yu Zheng, Xing Xie and Qiang Yang. 2010. Collaborative filtering meets mobile recommendation: a user-centered approach. *Association for the Advancement of Artificial Intelligence (www.aaai.org).*

[17] Vincent W. Zheng, Y.Z., Xing Xie, Qiang Yang. 2010. Collaborative location and activity recommendations with GPS history data. *WWW 2010, April 26–30, 2010, Raleigh, North Carolina, USA. ACM 978-1-60558-799-8/10/04.*

[18] YU Zheng, L.Z., Zhengxin MA, Xing Xie and Wei-Ying MA. 2011. Recommending friends and locations based on individual location history. *ACM Transactions on the Web, Vol. 5, No. 1, Article 5, 2011.*

[19] Yu Zheng, X.X. 2010. Learning location correlation from GPS trajectories. *Eleventh International Conference on Mobile Data Management, IEEE,2010.*

[20] Yu Zheng, X.Z. 2011. Computing with Spatial Trajectories. ISBN:978-1-4614-1628-9. Presentation available at: http://research.microsoft.com/pubs/153826/08%20and%2009-Location-Based%20Social%20Network.pptx

[21] Yu Zheng, Y.C., Xing Xie, Wei-Ying Ma. 2009. GeoLife2.0: A location- based social networking service. *Tenth International Conference on Mobile Data Management: Systems, Services and Middleware, IEEE.*

[22] Y.Z.a.X., "Learning travel recommendations from user-generated GPS Traces," ACM Transactions on Intelligent Systems and Technology, Vol. 2, No. 1, Article 2, 2011.

[23] Digital Inspiration. Find Videos Recorded at a Particular Location. Available at: http://www.labnol.org/internet/find-videos-by-location/19742/. (Accessed: 30th June 2013)