Viral Geofencing: An Exploration of Emerging Big-Data Driven Direct Digital Marketing Services

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***Abstract*--This paper explores approaches for the effective integration of several focal areas of advanced analytics on currently achievable big data platforms to enable timely, and maximally effective, geofence-triggered interventions (push marketing) that leverages viral or exponential returns. The viral or exponential growth behavior of modern social media-based interactions has garnered much attention in both public and private circles. The potential for harnessing and controlling these epidemic-like dynamics of spread or diffusion represent a significant and, as yet, underdeveloped marketing approach. This is especially true in the context of geo-fencing strategies and designs. Despite the potential for highly-leveraged returns for location-based services (LBS) several barriers remain. Due to privacy concerns, legal issues, the immaturity of big analytics, and constraints presented by physical-level communications and geo-tracking enabling technology, LBS has remained under-developed and under-actualized. This reality is rapidly changing. This paper focuses on recent developments in big analytics, especially the integration of social networking dynamics, text mining, semantics, dynamic behavioral profiling, and real-time trigger-based geo-sensing capabilities that are enabling the next generation of high performance direct digital marketing services.**

I. INTRODUCTION

Viral direct digital marketing services (DDMS) campaigns managed within a location-based marketing context are a relatively recent, novel and cutting-edge approach to effective and profitable marketing [5, 14, 21, 27]. Although viral campaigns are common in non-mobile contexts (through web and social media) the key differentiator and unique value added for this proposal concerns application in a purely mobile location-relevant context. Enabled by the advancement of supporting technologies—including the evolution of DDMS, the performance of virally leveraged returns represents the next step in a long line of technology-based innovations for marketing [5; 14; 21; 27]. Just as DDMS approaches were enabled by mobile technologies, capabilities, and adoption rates over the last decade, viral approaches to geofencing has advanced marketing capabilities [3].

Global location-based services markets are expected to quadruple to more than 10 billion USD by 2015 from 3 billion USD in 2010 [30]. Despite these projections, the industry experienced slower than expected growth over the last decade due to a range of dampening factors such as slow rates of adoption of mobile technologies, slow speeds, poor performance, and limited network coverage issues [17]. However, continued technological advancements in the mobile and telecom industries have largely overcome these barriers [4]. Furthermore, with the migration from 3G to 4G, the potential of "anytime-anywhere" mobile marketing services is radically changing marketing communications and retailing paradigms [30].

Social commerce markets are expected to continue to expand. Booz, Allen & Hamilton recently estimated global social commerce markets will reach 30 billion USD by 2015 [4]. As social-media based markets continue to expand, social marketing's reach, targeting effectiveness and efficiency should continue to improve [13]. For instance, typical response rates for online ads can hover at 1% whereas mobile marketing response rates can be ten times higher [29].

Indicative of an early phase of a radical shift in marketing practice, viral word-of-mouth (WOM) techniques are regularly used by fast-growing social media firms [14]. The perceived value and importance of peer-to- peer marketing is significant and growing [17]. In one controlled study, a Dunkin Donuts viral campaign was resulted in an 18% increase in sales [13]. Social contagion (smart mobs) viral marketing techniques have experienced response rate increases of 243 percent for passive viral and 98 percent for active viral campaigns [5]. Clearly, the potential for highly leveraged returns is significant, but the impacts are contingent upon the quality, sophistication, timing and level of information supporting the effort [5].

Despite the promise of improved marketing ROI for viral LBS, significant technological barriers remain. The intent of this paper is to explore the logic, evolution, business potential, and barriers to full realization of mobile virile location-based marketing services (LBMS). As such, this paper uses the LBMS model as a means of explaining the base elements necessary to the development of an effective framework for viral geofencing.

Based upon the concept of geofence-triggered viral DDMS (viral geofencing), an outline of the logical design and technology requirements are developed. Existing technological enablers are identified and a roadmap for current and future required capabilities and technologies is outlined. The vital role of big data analytics is introduced as essential to the full development of effective viral geofencing.

Within this framework, this paper focuses on the key intersection of two important sub-segments of mobile direct marketing services: geo-fencing and viral messaging. To viralize location-based marketing (LBM) in a geo-fencing context requires the effective real-time integration and processing of multiple data streams in order to select the perfect match to ensure maximal viralization [27]. This can only be effectively accomplished with machine learning or artificial intelligence ready big data sense-and -response capabilities. This challenge is further exacerbated by the complex dynamics of viral network diffusion. Multi-way peer-to-peer communications and social networks must be identified, understood and integrated with other data streams in order to enable viral geofencing. Building upon Shankar and Balisubramanian's [31] definition of mobile marketing as a multi-way interaction between businesses and consumers via mobile devices, a big data architecture is required to support the proposed viral-geofence LBMS framework as the key link between data sources and the effective targeting of consumers.

The paper will proceed with a review of the relevant literature on viral geofencing, propose a big data platform for geofence-triggered viral direct digital marketing, and present a concpetual model for the vial geofencing process. The conclusions section will discuss the state of development of this emerging field, identify gaps and future research opportunities.

II. LITERATURE REVIEW

A. Background

At a fundamental level, viral geofencing is built upon the DDMS foundation. DDMS efforts utilize a wide spectrum of technology communication channels such as e-mail, SMS, social networking sites, and mobile media devices and apps. Whereas classic direct marketing is dependent on physical postal addresses, DDMS communications are delivered to digital devices. Mobile marketing is unique in that it is focused on portable, non-localized opportunities for messaging. Portable anytime anywhere messaging included cell phone technologies game platforms, wearable technologies, tablets, GIS-enabled devices, and automobiles [16]. As improved technologies proliferate, the potential for extension and realization of DDMS and viral geofencing improve. Recent advancements in high performance distributed computing in the cloud (using Hadoop clusters and mapReduce, for example) making DDMS increasingly cost effective and available [15, 23].

Mobile services are the enablers of the viral geofencing concept. They are used for a range of purposes ranging from brand building, special offers, timely media teasers, product, service or information requests, competitions and polls.

B. Geofencing

A geofence is a virtual geographic zone around a business, shopping area or other categorized geographic area created to trigger a mobile marketing message to a mobile-enabled consumer as they approach, enter or move through the marketing area [15]. Geographical information systems are critical to LBS as they track time and location coordinates so as to enable geo-fencing as mobile consumers enter a geo-fencing area. Location-based advertising (LBA) factors place effects in addition to classic demographic profiling and market segmentations to advertise, usually on mobile devices. The term also implies technology-enabled or social media-based mobile marketing messaging [34]. LBS is a broader term that refers to geographic or location specific marketing services in a mobile or geo-fencing context.

Within this LBS/LBA mix, the key component of effective geo-fencing is the trigger. When a mobile user approaches or enters a geofenced area, the processing system is triggered. If a good match for desired services, products, or a customer loyalty opportunity is detected, a marketing promotion message is triggered and sent.

In this context, geo-fencing represents an electronic grid or zone triggered direct marketing messaging approach. GIS tracking enables location sensing of mobile consumers. Consumers equipped with a device with mobile tracking capability are sensed as they approach a geographic market or virtually fenced zone. Their stored profile data is queried to match them to existing, zone-specific promotions or opportunities.

Without mobile geo-tagging or GIS tracking technologies DDMS would not be possible. Recent rates of adoption of mobile technologies and levels of market penetration are now key enablers of trigger-based geofencing [23, 30]. Over the last decade, significant strides forward in terms of GPS-based mobile data networks are also key drivers [14, 21, 30]. The slow take-up of these technologies explains why location-based marketing adoption did not keep up with the perceived promise in the last decade and why it is now trending [4].

Geofence-triggered DDMS works through a range of qualifying steps. If a mobile user is approaching or entering a virtual marketing zone, their profile matches targeted requirements, and an existing promotion is underway, a response is triggered and an offer, promotion or notification is sent. Also known as "context-aware" services, geo-fencing campaigns are seen as proactive (versus reactive) and of significant user-centered benefit for consumers [7]. Rather than manually searching for information on local points of interest or available opportunities, consumers voluntarily request to be notified via mobile device in real time based on their geo-spatial location. This frees them from manual searching and provides for convenient, timely and valued information at the point of interest. This information less likely to be construed as invasive or irritating when well informed through advanced profiling and analytics.

There are three basic types of geo-fencing activity identified by Bareth [7]. These are *search-and-find*; *context aware*; and *dynamic information dissemination* applications. Search-and-find geofencing is common in the tourist industry [7]. A target's profile can be matched against like profiles and high-value destinations can be suggested.

For context-aware applications, a typical use case occurs when a mobile user enters a shop. Her presence is detected and an offer is sent while on the store's premises. Alternatively, dynamic information dissemination is focused on notification of a mobile recipient of currently, but not long in duration, key information. This information can manifest as temporary offers in immediate vicinity or it can simply be notice of traffic activity or accidents on a planned travel route. Additional geofence taxonomies include *Push*, *Pull*, and *Viral* [29; 34]. In a push context, targeted consumers receive messages that they did not request directly or indirectly. Pull messaging is based on a request or 'opt-in' action taken by the recipient. Viral approaches will be discussed in the next section.

C. Viral Geofencing

The focus of this paper is upon the functional addition of effective viral campaigns to standard DDMS applications. Viralization implies the rapid diffusion of messaging, but specifically refers to the *intentional triggering* or *catalysis* of a rapid contagion-like spread. [29]. Both mobile geo-fencing viral campaigns and general virtual social-media based viral marketing campaigns utilize these rapid contagion-like diffusion patterns across friend, community, and peer-to-peer networks. Viralization is highly asymmetric, for minimal effort, it engenders maximal result [21]. Through better understanding of the role of key nodes (key communicators) in a potential diffusion network, a well-developed viral campaign can: 1) magnify the ultimate diffusion or spread of a message campaign through a social network over long periods of time, or 2) maximize the immediate whiplash or exponential immediate (in time) returns of peer-to-peer messaging through motivation of key members of a social network to "share" the message or opportunity [28]. Poutschi [29] identifies four main types of viral marketing. Of these, two are active: *motivated evangelism* and *targeted recommendation*, and two are passive: *signaling group membership* and *awareness creation or benefits signaling*.

Viral geo-fencing is similar to general viral marketing, but implies targeting of mobile consumers for geofence-triggered viral messaging to encourage the spread of a particular offer or campaign [10]. The goal of a particular campaign can be: 1) expanding or magnifying immediate sales potential; 2) encouraging long-term customer brand loyalty; and 3) expanding the customer base. According to Kozinets, et al. [20], classic WOM can be further categorized as being evaluatory, embracing, endorsing or explaining a particular product, service, or brand [20]. It is further emphasized that these types of campaigns can extend beyond the mere amplification of a message. Viral campaigns can drive new norms of behavior in a social network community and even ignite "smart" mob behavior [19].

Of key value in viralization are trending social media data that enable the tracking of multiple networked users simultaneously. In a geo-fencing context, this social information can be utilized to initially profile, select, target and inform and then to catalyze peer-to-peer, WOM or viral campaigns. The potential for increased marketing returns with viral geo-fencing is immense [13, 21]. The increasingly dynamic, connected, and mobile marketing operations dictates a unique, timely and customized response. This response is based on rapidly evolving consumer expectations. Additionally, the trend to decentralized, peer-to-peer crowd-based approaches makes for a very customer-centric and social-network-centered operational reality.

For competitive purposes, businesses are forced to rapidly adopt new mediums, abandon shrinking or low-margin markets and appeal to a savvy, well informed and mobile customer base. Discerning customers demand local, customized solutions and freedom from pushy, privacy invasive marketing approaches [21]. DDMS tools, once rare, are now increasingly common, distributed, and decentralized. Customer data, once sparse, disconnected, and unstructured, is growing exponentially. As a result, the current enterprise challenge is less focused upon acquiring new customer data as it is with the effective, timely and useful processing of available customer-data streams [17].

D. Big Data Analytics

To remain competitive in a crowded, information-rich mobile space, better and more sophisticated stratagems based on quicker reflexes, faster evolution, and agile intelligence are continuously employed [13, 21]. For viral geofencing, from the standpoint of informational logistics, understanding just the *why, what* and *how* of customers' emotions and preferences is insufficient. Data informing a *prediction equation* in conjunction with the *where* and *when* are also required.

More critically, the information processing and human decision-making time frames must be rapid and matched. The marketing message needs to be selected in real time and be instantly transmitted to a mobile communication device. The message itself is triggered by the device owner's demographic status, preference history, personal profile, network status, physical movements and location. The message must be well-timed and motivational to convince the target to spread the message in a social viral contagion like fashion. The challenges associated with bringing together these various types of information in a coherent, integrated, strategic and timely manner hold the promise, but if not effectively developed, could delay the adoption of this innovative marketing approach.

Viral geofencing depends on big data analytics. Sources of data include customer transaction records, credit-card data, web-browsing behavior, mobile location, and, increasing, social media behavior. Social network analytics enable leveraged, perfectly timed, intervention (location based marketing to key nodes in social network) and viral geo-fencing becomes possible. This assumes consumer trust; opt-in, location-relevant and offering appropriate, viral inducing messaging.

Classic big data may be characterized by the three "Vs" of *volume*, *variety*, and *velocity*. In a viral geofencing context we must add *vector* (geospatial movements) and *viral* (temporally perfect messages to key nodes in the network). These complete set might aptly be labeled the five Vs of viral location-based marketing. But even these 5 V's are insufficient. Agile, intelligent, and real-time adaptive capabilities are requisite capabilities for realizing the opportunities presented by continuous, viral social media dynamics that are continually trending and de-trending network sentiments and cascades.

Data needs analysis and context to become useful. Big Information (BI) refers to the sorting, ordering, profiling, analysis, and rendering of data into useful, actionable *information.* This is synonymous with big data analytics which are used to explain and predict. In a marketing context, analytics help to better under understand who might be interested in certain products or service, what features or attributes they might be interested in, when they are likely to be interested (e.g., seasonal or cyclic variation, timing), why they might be interested (motivations, direct or indirect, internal or external influences that might be harnessed) and where they might be interested (in buying or using a service). Analytics help to inform how best to present and construct a product, service or marketing effort. This knowledge is used to reduce waste, improve efficacy, targeting, and increase control. In this sense, big, fast, analytics are a key weapon in the arsenal in modern marketing systems and are necessary to cope with complicated and complex systems such as viral geo-fencing [21, 24, 26].

The value of big data analytics is to explore, in ways never before possible, all possible sets of relations among all possible variables and dimensions, across all possible scales and scopes [26]. Data mining revolutionizes the way we do business and the way we live. It is the means whereby informed, customized mobile marketing systems can be routinely, effectively and instantly employed. Many big data architectures fail to build in agility, scalability and automated machine learning (ML) capabilities. In the context of viral geofencing, the real-time sense-and-respond turnaround time demands dictate an adaptive, agile ML or artificial intelligence (AI) learning architecture. [26]

The necessary architecture for viral geofencing would include network analytics as an enabler of viral messaging. An understanding of how the diffusion of ideas (or viruses, for that matter) is impacted by network structures or typologies is critical to knowing when and to whom a message should be targeted. There are many types of identified network structures. Depending on the type (small world, star, bus, ring, tree, mesh, etc.), they have clear impacts on the dynamics of the message diffusion [6]. Depending upon the network type at any given point in time, the optimal method for triggering, catalyzing, sustaining, or dampening a viral-like cascade will vary [6]. To manage effective viral geo-fencing marketing strategies, information on the type of network a geo-targeted consumer is in is critical. Given the mercurial behavior of social networks, advanced analytics must be utilized to identify optimal message targets, message timing and type – based upon real time predictive algorithms.

Semantic analytic techniques allow for the determination of structure from word usage and linguistics [8]. This structure can be used to understand the relation, purpose, use and meaning of words. This may seem unimportant, but in the contexts of BI, AI, or speech recognition, it is valuable. It is especially valuable if it can be linked to attitudes and behaviors and assist in more fruitful text mining as a means of establishing sentiment from real-time social media sites. Sentiment can then be used to understand, explain, predict and – theoretically – control behavior. Using current and trending data, these methods can be used to construct the perfect pitch at the perfect time for a mobile customer. Or, in the context of government policy enforcement, it can be used to catalyze, magnify or impede the viral social dynamics of Arab Spring-like social events [18, 35].

GIS speaks to the need to factor both time and space in mobile LBM. This implies knowledge of vector and/or movement. In a viral geofencing environment, real time GIS data is coupled with marketing data to generate on-the-fly marketing messaging to mobile-enabled consumers as they move through geofences. GIS technologies are serving to enable increased access, range and penetration for a range of marketing approaches heretofore impossible.

Social media sites, marketing researchers, and governments are interested in text analytics as a means of predicting sentiment and behavior [18, 35]. Through BI, real time texting or use of words in a variety of channels can then be monitored and – when linked to data streams capturing behavior – can help to predict both individual and collective social behavior: especially, viral dynamics.

Figure 1 depicts a big data platform for geofence-triggered viral direct digital marketing. With the increased flows of data of all types, through a variety of channels, the development of massive data processing capabilities (volume, variety & velocity) in an ICT medium that allows dynamic interaction to explore, to nuance, to seek out new relations is historically unprecedented. These technologies can be used to address customers' needs, as connected, mobile individuals in organic societies, in real time and across space. Historically, these capabilities have been limited and cost intensive computationally and in dollar terms [15]. Due to the advent of a range of maturing technologies such as cloud-based systems, high-performance computing, and big data informed insights into social contagion and other relevant fields the real promise of direct marketing is rapidly being realized [15, 22]. As enabling technologies continue to mature and proliferate, the remaining barriers to mobile, location based marketing and viral geo-fencing strategies promise to dissolve and usher in an era of intelligent, dynamic, real-time, sense-and-respond marketing [7]. Historically, marketing analysis activities have been human-centric. Owing to the need to process a broad variety of data types in real time, human-centric processes cannot be relied upon. For these reasons there is increased reliance upon parallel processing, machine-learning algorithms, swarm-based approaches, expert systems, AI, and complex adaptive systems management or holonics' [26].

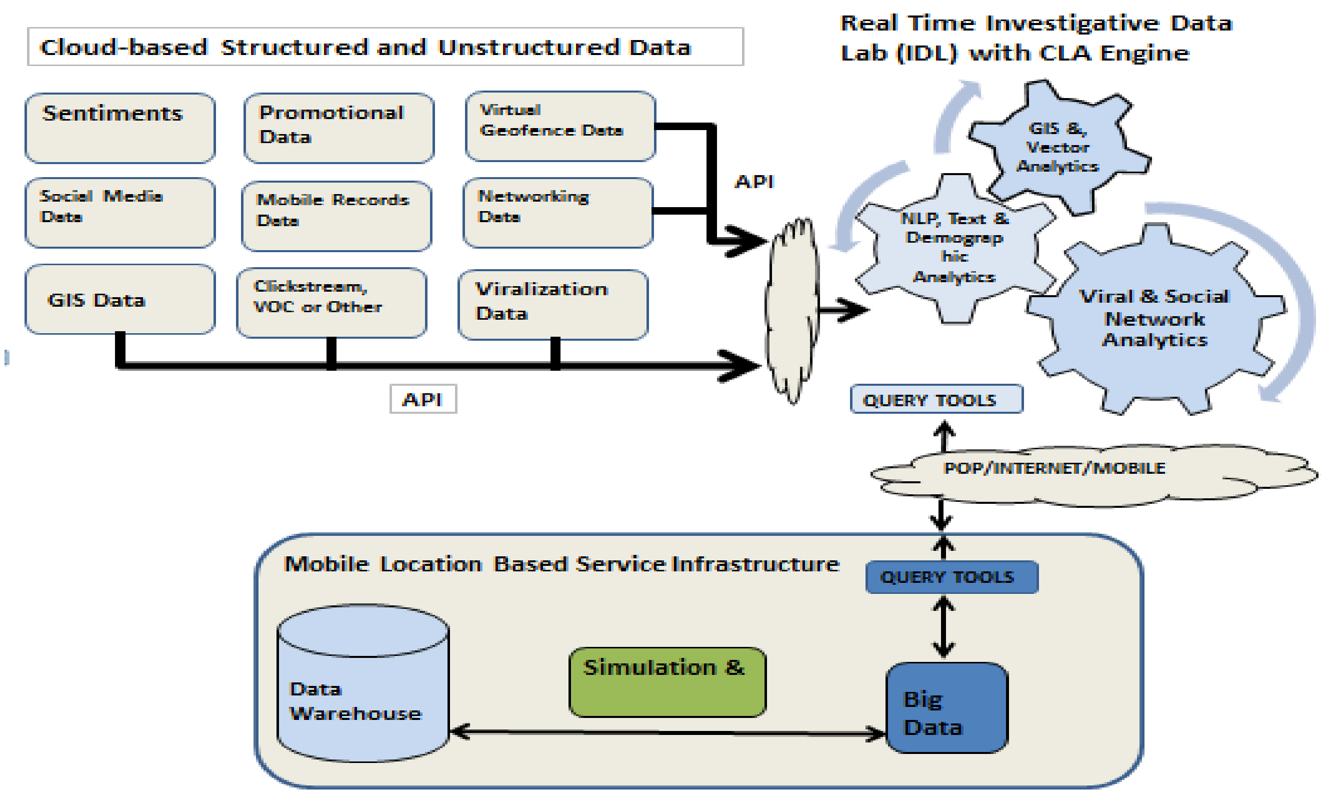

Figure 1. Big Data Platform for Geofence-Triggered Viral Direct Digital Marketing

E. Privacy & Security

Issues of trust, privacy, and security are significant concerns in DDMS. The necessary reliance on metadata to identify, profile, target and market to members of a social network also allows for the identification of personal information and patterns among users. These can create security risks for those users [32]. Despite this fact, use of social networking sites continues to expand and the younger generation expresses significantly less concern over such privacy issues than their forbears. Along with the advent of mobile devices is the proliferation of apps and there is even a "watchdog" app designed to search for person specific potentially harmful metadata [32].

Despite privacy concerns, ready means of addressing them are arising in tandem and adoption rates continue to increase. Cyber Security also represents a potential issue for effective DDMS. Fortunately, thin mobile client technologies are allowing users to run virtual apps from cloud-based servers, thus enabling low impact (and battery drain – a former issue in DDMS) on the mobile receiver or device. This furthermore, allows for Cyber Security Controls to be in place to protect sensitive user data. Contrary to widespread publication of privacy concerns and expressed fears over use of metadata, social networking and mobile opt-in rates continue to rise as users find more benefit than threat in the new offerings [4].

F. Research Gaps

The technologies that support viral geofencing capabilities are approaching critical mass. However, there are notable gaps and calls for further development and inquiry. For example, although having advanced significantly in support of DDMS, sentiments mining is still in its infancy and deserving of further inquiry [8]. And, despite the widespread use of viralization approaches to marketing via the internet and social media, it is generally recognized that the current state of the art is non-optimal and requiring further research, refinement and inquiry [18, 29, 35]. In yet another under-explored aspect of viral marketing is the identified need for research on the potential for design of classes of products, and especially services, better suited to viral marketing [4].

The authors of this paper found very few examples of research directly addressing viral geofencing. Though a significant volumes of classic web based viralization research has been conducted, the literature on mobile viralization is sparse. Strikingly absent from the research are articles addressing optimal means for viral messaging and intervention within varied network topologies.

III. VIRAL GEOFENCING MODEL

There is ongoing development and refinement of a range of novel big data designs intended to support the complex processing needs of viral geofenced DDMS [10, 22, 26]. For this paper, however, a unique approach built upon an open source system from *Numenta, LLC* known as the *Cortical Learning Algorithm* or CLA. Products built on this include *Grok*® from *Grok Solutions*® (formerly Numenta, LLC) is proposed. This mobile ready, big data processing system is designed after the human brain. Equipped with capabilities including complex pattern detection, automated modeling and adaptive learning, this promising new technology provides ready, real time mobile processing.

At the developmental phase, the initial market implementations of this product have outperformed competing approaches in a number of ways, including speed, intelligence, learning, pattern identification and multi-channel ready capabilities. The big data processing requirements of a viral geofencing system are extensive. However, amongst a range of competing cloud-based approaches that hold significant potential for viral geofencing, CLA offers an easily mobile enabled, real time machine learning capability with performance and speed that exceeds that of competitors.

Numenta's Cortical Learning Algorithm is unique in other ways too. Utilizing a completely novel, brain-based cortical learning algorithm and run on Cloudwatch API, *there is no need for data cleansing, preparation or restructuring* [3]. The CLA engine based Investigative Data Lab (IDL) big data system is triggered when opt-in consumers approach or enter a geofenced zone. Cloud-based data from a range of sources is pulled in and processed. With the objective of finding a complex multi-dimensional "sweet spot" that triggers a customized viral message, a variety of filters and analytic techniques (as well as a generalized search for hidden patterns as part of the ML feature set) are utilized. The system is capable of handling these requests, detecting patterns and learning – in real time. Network topology, relative position of social network members, preference and demographic profiles – along with trending moment to moment sentiments expression are integrated. Based upon the optimal match to existing types of viral campaigns, continuous real time viralization can occur anytime and anywhere.

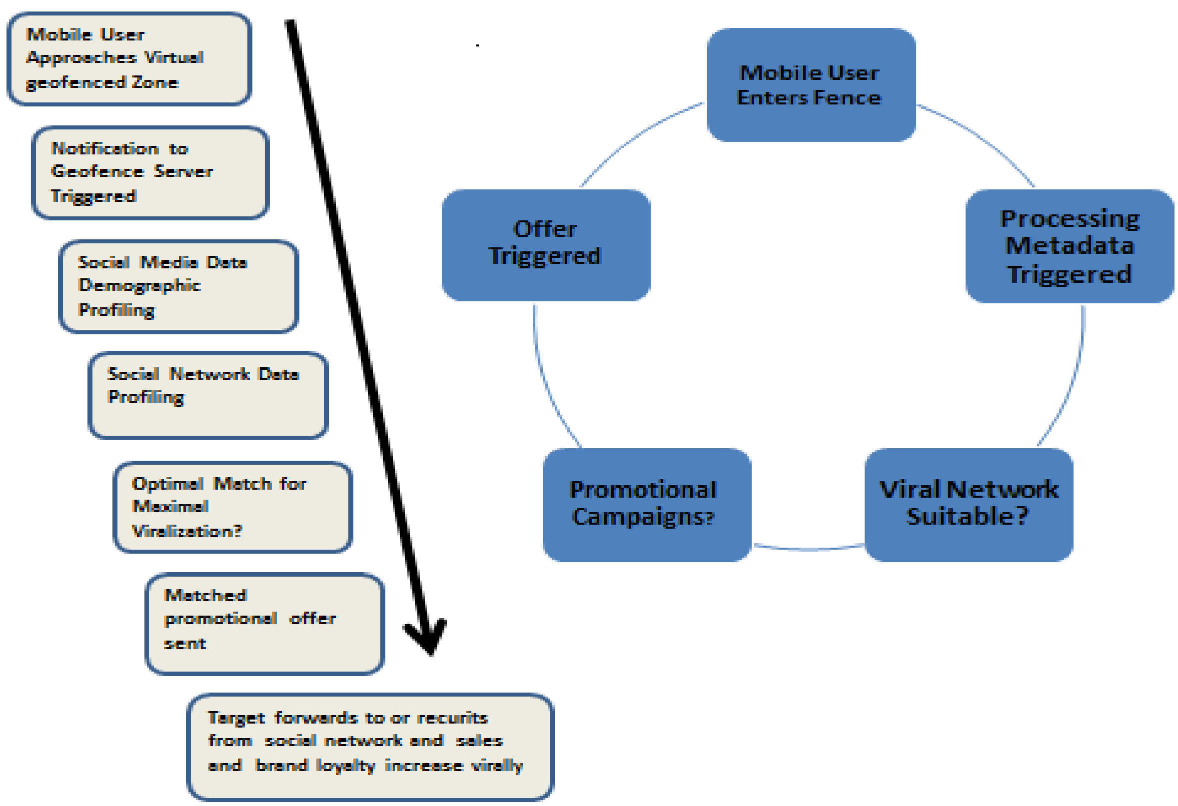

Figure 2. The Viral Geofencing Process

A. Use Case for Viral Marketing

There are a variety of potential use cases for viral location based marketing – as mentioned in the literature review. For this paper one particular use case will be addressed for purposes of exemplification of the necessary process and Big Data supports. The selected use case concerns application of viral geofencing for brand loyalty and increased sales.

As a potential customer equipped with a mobile device travels, their movements are tracked. If they have opted in to location based marketing services and if there is a record of their consumption history or demographic data, offers matching their identified consumer profile can be sent as notifications to their mobile device. This process is usually triggered as they enter or approach a geofenced zone.

Consider a customer that fits the profile of a high end coffee consumer. With or without historical consumption data, a special offer can be sent to them as they near or approach a local bistro participating in a LBM service. This offer might encourage an immediate discount offer that is valid for 20 minutes. This has the impact of increasing sales through marketing to mobile-equipped consumers that might typically drive by and not stop. Additionally, this can encourage brand loyalty.

Adding the viral component to the mix, the mobile consumer is profiled and then their social network status is determined. If they are determined to be a 'maven' or key influential node within a network, then a mobile offer can be tendered that offers them a discount if they contact and recommend to four of their friends to participate with them in the special, time sensitive offer of a service or product special promotion or discount. In the case of a coffee bistro, a targeted mobile consumer might be encouraged to invite identified members of their social network to meet them for coffee. The effect of peer to peer contact and influence increases the impact of messaging and brand loyalty.

IV. CONCLUSIONS

The departure from classic approaches to marketing and the migration to customized, highly data informed (profile based), technology-driven, geo-spatial-temporal approaches has brought along with it a new vocabulary: a vocabulary intended to capture the differences between these new approaches and classic ones. Behind this complex lexicon are some simple realities, however. Understand these and the lexicon becomes far more transparent. If classic marketing was shallow in its penetration of individual preferences, it worked well in capturing the presence of large demographically similar segments of the population. If classic marketing did not fully capitalize on social dynamics in real time, it did understand classic word of mouth – to a degree. If classic marketing was relatively static and did not have to manage a constantly morphing array of new technologies, it did effectively manage long product cycles and sustained campaigns via old media. It is these key differences (among others) that have made all the difference.

Marketing has moved from stationary to mobile [28]. It has also migrated from periodic to instant in terms of its tempo. Businesses are no longer just interested in how a set of customers will individually react to a marketing campaign, they also want to harness the leveraged power of peer to peer dynamics and generate sufficient data-driven profiling data so as to maximize viral impacts. These new concepts would not be possible without technology. And it is both the pull of new untapped opportunities coupled with the push of keeping up with the competition that keeps the innovation-marketing-innovation engine humming. In today's world historical sentiments and consumer preference patterns are not as useful a real time social media based channels and trending sentiments. The widespread availability of this data provides the impetus for use in real time marketing. And real time viral marketing requires automation and a deep, applied understanding of diffusion dynamics, key nodes (based upon current and past, recorded, behavior), friends and networks. This knowledge must be applied in the present moment in order to trigger a viral cascade. Waiting, even minutes, may translate into missed opportunity.

Within the context of location-based approaches to marketing, geographic location must be taken as an influencing entity in its own right: an influencing entity with unique features, attributes, attractors and detractors. The role of big data in LBS, marketing or advertising, centers on appropriate matching of geographic or physical area attributes with predicted profiles for a particular consumer or related (networked) group of consumers. Cloud- based BI enables the rapid, real time, integration of multiple channels or data streams simultaneously. In marketing, this allows for the mining of and processing of multiple dimensions at once so as to precisely customize a marketing message or offering to the data-driven profile of a given customer or a group of customers.

When mobility, geography, time, movement and network diffusion dynamics are added to this equation, the requisite set of inputs to drive viral, geofence triggered, location based campaigns is complete. As location tagged shopping behavior profiles – on the part of individuals and/or groups – is received via integrated and mobile social media based sources, and is integrated and factored, we receive a much better informed and refined understanding of how location, social networks and individual demographically induced preferences interact over time. This allows for much more effective campaigns and higher response rates for mobile or geofence triggered messaging. It also creates the base platform for developing effective targeted viral campaigns on a continuous basis.

BI represents the core enabler for successful viral geofencing. At a base level, the requisite set of: 1) mobile and location influence factors, 2) personal demographic preference factors, and 3) social network dynamics (cross-time social influence factors) could not be effectively integrated and managed in the required time frame without BI capabilities. BI supported by cloud-based HPC systems, specifically the Grok Engine, represents the key enabler, or perhaps barrier. This technology allows for and enables continuous refinement through scalable integration of additional sources of influence (factors) and continuous learning. The potential number of factors influencing consumer purchasing behavior is practically infinite. As additional factors or dimensions are brought into the purview of BI error terms of the customer-offering fitness prediction equations (e.g., reduce negative response rates, improve positive message conversion to purchasing behavior/brand loyalty or increase magnitude of viral contagion impacts) can be reduced.

Despite the positive reviews and the cited promise of viralized campaigns in the literature, the literature itself can also be characterized as varied and complex in its conclusions as to the necessary elements of a successful viral campaign. Camerero points out that despite the lack of consensus, at a general level, "viral" always implies the existence of WOM with the addition of the potential for affect-based arousal and passion [11]. In this he suggests that viralization can be effectively seen as more a publicity maneuver than an advertising campaign. Camerero also highlights the need to consider three primary factors to measure the success of a viral campaign: 1) spread or diffusion extent (penetration), 2) rate of transmission and 3) emotive depth [11]. These conclusions fit well with the general recognition of the key roles of: social network dynamics, influential nodes and diffusion patterns. Indeed, there is supporting evidence for the moderating role of arousal on responsiveness within networks: research that suggests that arousal may not only increase viral transmission, *it may also impede transmission* depending upon local community dynamics or demographics [8].

The assumed role of networks has also been questioned. Selective research indicates that the variant or particular topological type of "opportunistic, transient and serendipitous" social networks play a significant role in viral diffusion or success [1, 10]. As such, viralization is highly contingent on local factors, ephemeral network attributes, message content, demographics and network-specific cultural dynamics [10]. The contingent and necessarily local (in context, time and space) nature of viral campaigns presents a complex challenge to marketers. This issue is compounded in a mobile geofencing context as the necessary turnaround or response opportunity zone can be measured in minutes.

Other research illuminates the nonlinear impact of social status on diffusion dynamics [34]. The lack of universal rules for viralized geofencing demands highly agile, extensible, data mining capabilities by which to customize the content, timing, emotional appeal and targeting for messages. To these ends, rapid data mining techniques (e.g., swarm algorithms) perfected on social media networks have demonstrated significant promise is providing the local and contingent rule set by which to understand unique local and temporal dynamic social networks [18]. And, despite these significant and complex challenges, architectures have been developed that afford sufficient, timely and data informed insight necessary to fund effective viral campaigns – even in a geofencing context. [10].

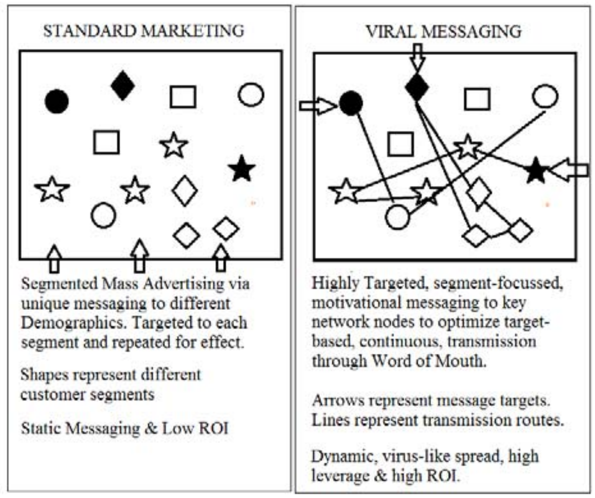

Figure 3. Standard vs. Viral Marketing

Despite significant volumes of research concerning viralization within a non-mobile or web based context, there is a paucity of research on applications within a mobile digital direct marketing space. Within traditional viralization literature there is a call for additional research on appropriate triggering timing and network influence profiling for different network topologies. Furthermore, additional research in the areas of machine learning applications and/or artificial intelligence designs to support big data initiatives for viral geofencing are called for given the sparse coverage in the literature.

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