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Location-Based Services: a vehicle for IT&T convergence

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Abstract

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Keywords

Location-based Services, Convergence, Case Studies, AT&T Wireless, Wherify Wireless, VeriChip, GPS, RFID

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Location-Based Services: a vehicle for IT&T convergence

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SYNOPSIS

Location-based services (LBS), more than any other mobile commerce application area has served to bring together information technology and telecommunications (IT&T) industries. While much has been written on the potential of LBS, literature on how it is a catalyst for digital convergence is scant. This paper identifies and explores the various levels of converging technologies in mobile commerce by using three LBS case studies. Through literal replication the findings indicate that IT&T technologies are converging at the infrastructure, appliance and application level. It is predicted that mCommerce applications will increasingly rely on industry convergence to achieve their desired outcomes.

1 INTRODUCTION

Location-Based Services (LBS) is a branch of m-Commerce that has revolutionised the way people communicate with others or gather timely information based on a given geographic location. Everything living and non-living has a location on the earth's surface, a longitude and latitude coordinate that can be used to provide a subscriber with a wide range of value added services (VAS). Subscribers can use their mobile phone, personal digital assistant (PDA) or laptop to find information relating to their current location. Typical LBS consumer applications include roadside assistance, who is nearest, where is, and personal navigation. LBS business applications differ in their focus and many are linked to core business challenges such as optimising supply chain management (SCM) and enhancing customer relationship management (CRM). Some of the more prominent LBS business applications include: fleet management (incorporating vehicle navigation), property asset tracking (via air, ship and road) and field service personnel management (i.e. people monitoring). The emergency services sector in the United States (US) was responsible for driving the first pin-point location service, demonstrating to the world the potentially life-saving functionality of the technology. As of October 2003, the Federal Trade Commission (FTC) enforced that

wireless operators provide the Automatic Location Identification (ALI) of a caller to the emergency dispatcher. ALI standards designate that more than two-thirds of emergency calls received require the location of the individual to be accurate to within 50 metres, and 95 per cent of calls to within 150 metres. The technology is available for potential mass market deployment, how feasible it is however is a separate issue altogether. This paper provides an overview of the devices, applications and technologies used by three companies that offer LBS applications. The overall aim is to show the current state of development in leading edge LBS product innovations and to demonstrate that LBS have served to bring together information technology and telecommunications (IT&T) industries. The first section of the paper reviews previous literature and develops an analytical framework for the investigation; second each LBS product innovation will be examined; and third a discussion on the high-level effects LBS has had on IT&T convergence ensues.

2 LITERATURE REVIEW

2.1 Who, what, when, where & wi-fi?

The evolution of mobile location-based services has been well documented in a paper by Rao and Minakakis (1). This article summarises the platforms, technologies and standards of mobile LBS and does well to differentiate between the various techniques that can be used to determine an accurate location of an object or individual. These techniques include: cell identifier (cell ID), global positioning systems (GPS), assisted global positioning system (aGPS), and the broadband satellite network. Zeimpekis et al. (2) go into more explicit detail about each of these and identify a whole range of indoor and outdoor positioning techniques categorising these into “self positioning” and “remote positioning”. It should also be noted that location technologies can be classified as either handset-based or network-based. Cousins and Varshney (3) provide a brief overview of the location framework required for mobile location services whereas Varshney (4) goes into greater depth for each element in the framework. Balatseng and Hanrahan (5) specifically use the Global System for Mobile (GSM) to describe the logical architecture required to support mobile station positioning. Maass (6) can be credited with an implementation-level paper on location-aware mobile applications based on directory services. Varshney’s (4) paper however stands out from the rest of the literature in that he makes the important connection between the type of service offering and the level of accuracy required. He also includes the wireless LAN (wi-fi) network in the location management architecture, instituting radio frequency identification (RFID) as a significant technology embedded in the LBS framework.

In terms of target markets for LBS, Rao and Minakakis (1) identify three target markets including the consumer, niche consumer/ business, and industrial/ corporate. Cousins and Varshney (3) also separate state-driven applications from those that are business driven which is important when discussing the overall capabilities (present and future) of LBS (7). Typical services specified by most authors range from mapping, directory services, shopping, alerting, SCM, CRM, intelligent transportation, emergency and e-health. These can be applied in any given scenario- Business-to-Consumer (B2C), Business-to-Business (B2B) and even Citizen-to-Government (C2G) relationships. Interestingly the work of Burak and Sharon (8) on FriendZone is among the few analysing usage of a single LBS commercial application. The distinction between push and pull services is also important (4). The FriendZone service is a ‘push’ mode of operation allowing a subscriber to locate friends and acquaintances nearby,

whereas checking on the next movie showing closest to a location is an example of a 'pull' mode of operation. Some of the more common revenue business models for LBS services include the traditional subscription-based model, pay-per-view, micropayments and application service provider (ASP) facilitator (1).

2.2 The gap in the literature

The gap in the literature is two-fold. First, a paper needs to be written showcasing cutting edge LBS product innovations that reveal the current state of development. A lot of sensational material exists in the popular media about what is possible with LBS but a candid view of billable applications that are being offered now is required. Second, a look at how LBS is spurring on convergence at various levels within IT&T needs to be demonstrated. Traditional telephone companies are no longer the typical service providers (SPs). New business models are changing the rules of engagement between established companies and new entrants who are looking for niche markets. The definite move toward a packet-based solution using Internet Protocol (IP) is also blurring the line between the once easily identifiable carrier-grade applications and enterprise-level offerings. The need to reduce the time-to-market (TTM) for opportune LBS was exemplified during the SARS outbreak in 2003. Hong Kong mobile telephone operator, Sunday, rapidly developed and launched an application that warned subscribers via short message service (SMS) about buildings with confirmed or suspected SARS cases within approximately one kilometre radius of their location.

3 METHODOLOGY

The research approach for this paper is exploratory. Multiple case studies will be used to gather evidence to satisfy the two main objectives stated above. The main unit of analysis is the product innovation, and the sub-unit of analysis is the LBS technology used to implement that product innovation. Three US companies have been chosen for this study, each with billable LBS market applications. AT&T Wireless (www.attwireless.com), Wherify Wireless (www.wherifywireless.com) and Applied Digital Solutions (www.adsx.com) offer product innovations that represent the diverse ways that LBS applications can be implemented. The case study protocol is composed of the following questions: What is the product innovation? What are the LBS applications the company can support? When were the company's LBS services officially launched? Who is the target market? What kind of device(s) is/ are being used by the subscriber? What are the subscriber pricing plans (i.e. connection, monthly, usage fees)? Is it a carrier-grade or enterprise-level application? What is the level of accuracy when locating a subscriber? What do the LBS services require in terms of IT&T? It is the latter question that pertains to showing that LBS is a catalyst to IT&T convergence. In citing Kampas, Chen (9) provides a high-level framework for possible convergence at three separate layers occurring at the infrastructure, appliance and application levels. Chen also describes the notion of "colliding industries" including the communication, electronics, computing and information/ entertainment sectors.

The data gathered by the researcher will be drawn completely from information provided on the company web sites published between the period of April 2002 and April 2004. The online documentation reviewed will typically include: company background, product briefs, application user guides, technical specifications and press releases. In this manner, the method of investigation can be considered wholly e-research (10). External validity is ensured given that the companies are registered on the New York Stock Exchange and must provide factual

content to their present and potential subscriber base. The possibility of researcher bias is minimised in this paper given its intent is not to prove that one service is better than another, but to document the current state of development.

4 CASE STUDIES

4.1 Product innovations

4.1.1 The versatile mMode

AT&T Wireless was the first mobile carrier to launch m-Commerce applications in the US in July 2001. Following the success of NTT Docomo's i-mode and c-mode in Japan, mMode provided a value-added data-centric package to AT&T's voice and SMS basic plans. Subscribers to mMode can use numerous devices to communicate including IP-enabled phones, PDAs, handhelds and even vertical devices such as the Panasonic Toughbook and Microslate Sidearm. The service is carrier-grade and is based on a GSM network architecture that uses new network elements, namely the Gateway Mobile Location Centre (GMLC), Serving Mobile Location Centre (SMLC), and the Location Measurement Unit (LMU). AT&T Wireless is now rolling out the general packet radio service (GPRS) network and EDGE technology, increasing bandwidth by targeting specific coverage areas as demand increases and it becomes economically justifiable to do so. The accuracy of the specific location-based applications is dependent upon the general location of the mobile transmission tower most recently contacted by the customer's device. For example, the IP device could be right next to a tower or some fifteen kilometres away. In metropolitan areas the accuracy is greater given the number of base transceiver stations is higher than in less urbanised areas.

4.1.2 The wrist-worn GPS Personal Locator

mMode's location identification is not pin-point such as in the Wherify Personal Locator solution that is based on a combination of GPS satellites and code division multiple access (CDMA) PCS network triangulation methods. The Personal Locator wrist-worn device is accurate within 30 metres of the wearer, possibly even as close as a metre. The GPS device can be controlled by both the subscriber and individual wearer, allowing the parent subscriber to track the wearer, and for the wearer to alert the parent subscriber and/or location centre headquarters in case of an emergency. Coverage is available throughout the US given the GPS capability but is dependent on the PCS network coverage footprint. The Wherify frequently-asked-questions (FAQs) page (11) states: "[i]f a GPS signal is received, but the Locator is outside the digital wireless coverage area or does not receive a digital wireless signal, no location report will be provided. If the Locator receives a digital wireless signal, but no GPS signal is available, a CDMA tower-based location report will be available for emergencies." On December 30th 2003, Wherify unveiled its new GPS Universal Locator Phone which is targeted at all age groups of both the consumer and business market.

4.1.3 The VeriChip implant

While mMode requires the subscriber to *carry* a device, and the Personal Locator requires an individual to *wear* a device, VeriChip is radical in that it requires the subscriber to be *implanted* with a microchip (see table 1 for a comparison list of attributes). The campaign to *Get Chipped* was launched in early 2003, and the first person to do so formally was implanted in September of that year. The chipping procedure only lasts a few minutes. There are a

number of Veri centres where the procedure can take place in the US and internationally. There is even a high-tech *ChipMobile* bus fully equipped to perform the implant procedure, 'on the road'. Applied Digital Solutions (ADSX) initially invested heavily in another product they called the Digital Angel in 2002, which resembled the Personal Locator solution but aimed at a broader market base than just children. The Digital Angel wristwatch was more slim-line but required the user to carry an additional wallet with battery power. While remnants of the Digital Angel web site are still operational today, it is the VeriChip which has become the flagship product of the VeriChip Corporation (a subsidiary of ADSX). About the size of a grain of rice, the VeriChip is the world's first subdermal radio-frequency identification (RFID) microchip. According to an ADSX press release (12): "[t]he standard location of the microchip is in the triceps area between the elbow and the shoulder of the right arm." In theory an implantee could be identified in a wi-fi network, such as in a workplace or university campus. Whereas GPS has limitations in-building locations due to construction materials used, RFID thrives in a local area network (LAN) setting, allowing walkways and door entries to act as scanners. RF energy from the scanner triggers the dormant VeriChip and in turn sends out a signal containing the unique verification number. The exchange of data is transparent and seamless in the case of RFID, there is no need to physically stop to verify a biometric feature- the network is ubiquitous. In another scenario, an individual could be identified by the RFID implant, giving emergency services access to the implantee's medical data and history that could be potentially life-saving. Unlike other fixed services, m-Commerce applications grant the subscriber access to services twenty-four hours a day, seven days a week. In the case of the VeriChip it is not only "always on" but "ever-present" inside the body of the subscriber. Unlike physical biometric attributes, the VeriChip is inconspicuous to the naked eye.

Table 1 LBS product innovations and their attributes

Company Offering LBS	**AT&T Wireless**	**Wherify Wireless**	**Applied Digital Solutions**
Product Innovation	mMode	Personal Locator * new product: GPS Universal Locator Phone	VeriChip * old product: Digital Angel
Launch Date	July 2001	October 2001	September 2003 (1st person implanted)
Device Used	- IP-enabled Phones - PDAs & Handhelds - Vertical Devices	GPS Wristwatch	RF/ID Chip Implant
Network Type	GSM/GPRS * 2003 EDGE began to be rolled out	aGPS + CDMA 1900 MHz PCS network	RFID * old product: aGPS + GSM or CDMA
Bandwidth	* future 2 Mbps	(n/a) based on alerts	* dependent
Coverage	millions of customers in > than 6,500 cities	national with greater accuracy when locator in PCS footprint	local area network (LAN), personal area network (PAN), wi-fi
Type	Carrier-grade	Carrier-class * blurry/ Enterprise	Enterprise-level * dependent
Accuracy	General location (typically < 10 miles)	1-30 metres	* 1-30 metres

4.2 LBS applications

4.2.1 "My mMode: this time it's personal"

mMode is heavily oriented towards the consumer market, although AT&T Wireless also offer package deals to business users specifically for the purposes of email (plus attachments), web access, and remote access. mMode was marketed as the beginning of mLife, next generation services that 'one could not live without' (13). Among its mCommerce suite that includes news, music and finance services are a number of LBS solutions (a list of these can be found in table 2). mMode's LBS applications are diverse- everything from a mobile traffic report to directions 'to the nearest' and find people nearby (14). Some of the more creative LBS are chat and date, and travel and dining. There are four plans subscribers can choose from including: mini, mega, max and ultra. The plans are charged monthly ranging from $2.99 to $19.99 USD and include a limited megabytes (MB) download. Additional usage fees are charged at between 2c and 0.6c per extra kilobyte (KB) received or sent, dependent on the plan. These fees do not include voice calls and SMS. The mMode service is bundled allowing the subscriber maximum personalisation to choose from any application they require. The myMode web site allows the subscriber to customise their preferences and settings.

4.2.2 Personal Locator "Just For Kids"

In contrast to AT&T Wireless, Wherify strategically chose to enter the market with a niche LBS application for a Personal Locator *Just For Kids*, specifically targeted at parents of children between the age of four and twelve. The device previously cost $399 USD but was recently slashed for a "back to school special" to $199. Monthly plans for the LBS application range from an average of $19.95 to $44.95 dependent on the plan chosen (liberty, independence or freedom). There is a one-time activation fee of $35 USD plus usage fees related to additional page requests above the included locates, additional operator assistance calls and subsequent emergency calls. Wherify makes it clear that it is looking to diversify to other niche applications including Alzheimer's and law enforcement, even though the Locator for Kids is the only marketable application demoed on the web site at the present time (15).

Table 2- Present and future LBS applications as stated on the company web site

Product	Applications
mMode	Weather & Traffic: Mobile Traffic, AccuweatherAlerts, My Snow Report What's Nearby: 10Best, Find People Nearby, Find Things Nearby, Go2 Directions, Go2 Directory, White Pages, Yellow Pages Chat & Date: Match Mobile, Upoc Communities Travel & Dining: 10Best, 10Best Dining, 10Best Nightlife, Go2 Dining, Go2 Travel, Sabre Virtually There, Vindigo
Personal Locator	Locator For Kids, Corrections (Monitoring Parolees), Law Enforcement, Executive Security, Auto Recovery, Vehicle and Cargo Tracking, Fleet Management, Mobile Workforce Communication, Property Asset Tracking, Personal Electronics, Pet Care, Child Safety, Parental Supervision, Personal Protection, Alzheimer's and Memory Loss, Supervision, Animal Identification
VeriChip	VeriPay: Payment Technology for Cash and Credit Transactions VeriMed: Healthcare-related Information that is Patient-Supplied VeriGuard: Versatile Secure Access Technology Corrections: Offender Monitoring (Released on Parole, Probation or Pre-trial)

4.2.3 "Get Chipped" with VeriChip: "technology that cares"

There is little information on the ADSX web site about the pricing of the VeriChip, however it is stated that the global VeriChip subscriber (GVS) registry subscription fee is $9.95 USD monthly. There is a cost for the implant medical procedure as well, although this is not provided. In 2002 the first one hundred pre-registered persons were granted a $50 USD discount on the chipping procedure (16). The pricing for the new VeriPay and VeriGuard services has yet to be published on the WWW and probably will not be given these are typically targeting business-to-business-to-consumer (B2B2C) solutions which are highly complex in design. The "Trusted Traveller" and residential security programs (i.e., prisoners serving their sentence from home) are two examples of VeriGuard LBS applications. One desirable feature of VeriGuard is that it could operate in conjunction with other auto-ID technologies like smart cards and biometrics, rendering customer legacy systems reusable.

4.4 Information technology and telecommunications (IT&T) requirements

4.4.1 mMode: how does it work?

Using the "find people nearby" service, the GSM/ GPRS network works as follows to determine a subscriber's approximate location. An application request is made by a subscriber. The application server subsequently makes a location request to the gateway mobile location centre (GMLC). The GMLC in turn queries the home location register (HLR) and then contacts the appropriate mobile switching centre (MSC). Another location request is generated to identify the base station controller (BSC) where the mobile is currently using the serving mobile location centre (SMLC). The BSC then can use the location measurement unit (LMU) alongside the appropriate base transceiver stations (BTS) to determine the location of the subscriber by using the uplink time distance of arrival (UTDOA). The location information is then sent back via the above-mentioned pieces of hardware/ software until the message reaches the application server and a response is given to the subscriber. The AT&T Wireless web site provides an excellent facility to aid external developers of mobile solutions (17). Freely available for download are whitepapers, style guides, software development kits (SDK), programming guides, sample code and emulators. In table 3 can be found the major building blocks of the mMode technical solution.

Table 3 The mMode building blocks

Network	**Technologies & Platforms**	**Devices**
GSM/GPRS/EDGE	AT&T Wireless Communication Manager	Internet-enabled Phones
Migration- CDPD (Cellular Digital Packet Data) to GPRS	BlackBerry Handhelds	PDAs and Handhelds
Network Evolution	e-Wallet Billing Platform	Modems
Building Wireless Solutions	Wireless Java™ (J2ME)	Vertical Devices
Network Security	Markup Languages	Interoperability
	Messaging: SMS, SMPP, Multimedia Message Service (MMS), Wireless Application Protocol (WAP) Push, e-mail	
	mModeSM, Palm, PocketPC Smartphone, WAP 2.0	

AT&T Wireless differs significantly from Wherify and Applied Digital Solutions, given it owns much of its network infrastructure. AT&T Wireless also has a large existing customer base that is used to an excellent quality of service (QoS) and certain level of post sales support. Launching LBS applications nation-wide with potentially tens-of-thousands of new subscribers joining daily, requires equipment that can handle data traffic levels and systems that have been thoroughly tested for faults. mMode contains diverse LBS services- ensuring that each of these works properly and is interoperable with a range of media devices is a labour-intensive activity which is one reason why they have decided to outsource as well.

4.4.2 Personal Locator: all the bits and pieces

Wherify's location service centre (LSC) is at the heart of its current and pending product innovations. A carrier-class server and software hub, the LSC manages and presents location-based information. Unlike mMode, Wherify utilises wireless data and aGPS. Consider the following scenario where a parent wants to be reassured that their child made it to school alright after missing the bus. The parent requests a location report via the Internet using a Microsoft IE browser (or ringing the toll-free telephone number). The LSC contacts the child's Personal Locator via the PCS network (if within the footprint), and then downloads the current GPS data and requests a location. Using the data from the LSC, the device that is identified by an electronic serial number (ESN), finds the closest satellite and then computes the longitude and latitude coordinates of the child's location. The Personal Locator then communicates location information to the LSC and the LSC generates a location report for the parent via the Internet. The whole process from request to report takes about sixty seconds. The parent is able to look at the report visually on a scalable map which shows streets and other feature points in a vector or aerial view, using geographic information systems (GIS) capabilities. Each report requested by the parent is logged in the customer's event file database for billing and subscriber profiling. The location database includes a time stamp along with the longitude/ latitude coordinates. The wearer's profile is also stored including: age, gender, height, weight and features.

Wherify make no secret of their technology partners. They include an impressive list of companies: SiRF who provide the GPS chipset that is integrated into the Personal Locator based on a-GPS; Qualcomm for the CDMA chipset; Baldwin Hackett & Meeks who are applications developers, Conexant who provide the RF board; Advanced Micro Systems who specialise in flash memory; Compaq for the server technology; Intrado for emergency communications; and GlobeXplorer Online for the component of aerial photography. Security firewalls are paramount in the Personal Locator system as is redundancy and fault tolerance. During an emergency situation for instance, the LSC is even able to interact with public safety answering points (PSAP) through Wherify's emergency operation service. There are customer care representatives available 24x7x365.

4.4.3 VeriChip made very easy

The least complex of the three case studies in terms of technology requirements is the VeriChip. RFID networks are usually small in scale when compared to nation-wide or global networks. They include the following components: the RFID transponder, a reader that captures information, an antenna that transmits information, and a computer which interprets or manipulates the information gathered. In the case of VeriChip, there is a requirement that each subscriber registers their personal details (and other relevant information they desire) on the GVS database. At this stage all the transponders issued by VeriChip are passive but it is

likely that active transponders will be issued in the future, despite the fact that they require on-board battery power to operate internal electronics. When an individual passes an associated scanner, information is read and sent to the computer via an antenna. Dependent on the application, a log may be retained or the implantee's location updated a predefined number of times in a set period. Given global standards are an issue for debate in RFID, proprietary systems are used.

5. DISCUSSION

5.1 Defining Convergence

Convergence means different things to different people and is usually loosely applied to denote the coming together of two distinct technologies, i.e. the merging of several products into a single good. The *2003 Penguin Concise Dictionary* states that *convergence* is a "jargon term" and gives examples of the merging of the television (TV) and computer, or telephone and computer, or TV and WWW. To anyone who has studied technological trajectories at any length, convergence is far from being a jargon term, but a well-constituted concept in the field of innovation (18, 19, 20). Terms like "digital convergence", "technological convergence", "application convergence" and "industry convergence" have been used interchangeably in some instances, and in others each has carried a loaded meaning. For example, Covell (18) states: "(d)igital convergence is the merging of these improved computing capabilities, new digital multimedia technologies and content, and new digital communications technologies. This combination of computing power and functionality, digital networked interconnectedness, and multimedia capability enables new forms of human interaction, collaboration, and information sharing." Greenstein and Khanna (20) on the other hand, distinguish between "convergence in substitutes" and "convergence in complements". The distinction of these 'kinds' of convergence finally puts an end to the debate over usage. Convergence thus can occur at any level of detail, in any part of the subsystem.

5.2 LBS: a catalyst for IT&T convergence

Throughout this paper, technologies at the appliance, application and infrastructure level have been shown for each of the LBS cases. What can be seen is a coming together of what were once somewhat unrelated technologies. Most obvious perhaps is the convergence of wireless capabilities and the Internet as depicted in the mMode case. For example, IP-based phones can already receive voice, text and multimedia. And as for the vertical devices mentioned, many of these are converged technologies in themselves (e.g. the wireless PDA that is also a phone and MPEG3 player). In the case of Wherify, the traditional wristwatch has now been turned into a Personal Locator with the aid of a GPS chipset. And chip implants have found there way under the skin of human beings to converge with living tissue- chips once as big as bricks, now smaller in size than a grain of rice.

Yet it is not only at the device level that convergence is occurring. A whole suite of new applications are being created using content from syndicates, once considered to be unrelated. The Yellow Pages directory for instance, used to "find the nearest", or "the best 10 nightlife" locations as well as providing "shopping discount alerts". And geographic information systems once used for computer-aided design (CAD), now used to visually represent the geographic location trail of a child, using high resolution aerial photography once synonymous with superior defence intelligence systems. There are even applications like VeriPay that are

forecasted to change the way that humans interact with other technologies like automatic teller machines (ATMs). Who needs to carry a card at all? Applications once used solely for businesses purposes, now permeating the consumer market given their cross-functional nature. At the infrastructure level also, multiple network technologies are being used in tandem to locate subscribers including PCS with aGPS. Another example provided, was the VeriGuard system that will have the capability to incorporate other automatic identification (auto-ID) reader equipment belonging to smart card and biometrics. Even at the protocol level, the very essence of traditional voice calls will be packetised, i.e. voice will be data. It is obvious through the evidence provided in this paper that *convergence in complements* is occurring, given the products are working better together than separately (20). LBS has shown itself to also involve a diverse range of businesses from vertical and horizontal industries- from independent software vendors (ISVs) developing the applications, to third party suppliers building enabling technologies and platforms, to industry bodies setting the appropriate standards for communications, to marketing consultants invited to develop and spearhead brand awareness campaigns. LBS brings not only the industries but the technologies to increasingly work together to form larger and larger systems (20).

6 CONCLUSION

Location-based services are pulling together a vast array of digital technologies like never before. The convergence between technologies is a cultural-changing force. Miniaturisation in design in particular is allowing for once separate technologies to be fused. From handset phones to smart watches to implants, the more invasive the technologies are becoming, the greater the precision for locating the subscriber or wearer or implantee. The question now, that all this technology can be used in an integrated fashion, is how far will entrepreneurs take LBS in the future? How many different players can become involved in offering LBS specifically before the state of affairs becomes too cluttered and confused? Do content providers reach mutually exclusive agreements with service providers (SPs) so that there is minimal conflict of interest? And if so, does this not limit the number of SPs to a few large players that can actually deliver LBS? And how many different types of LBS can one service provider practically offer? Looking at the dilemma from another perspective- will consumers require subscription to mMode, the Personal Locator and the VeriChip solution and carry with them a PDA, wear a GPS watch and be implanted with a chip, to circumvent a variety of limitations of each technology? Or are future directions set on a trajectory of even greater convergence proportions between all of the technologies discussed in this paper. For instance, will one device be able to cater for the needs at each level of accuracy- global, national, regional, local and in-building or will service providers amalgamate their networks to offer super-LBS services from satellite-based to network-based to LAN-based and PAN-based. Whatever the outcome, we are surely entering into a period where pervasive computing will become a dominant force in the way we live, work, and interact with one another.

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