Mobile Location-Based Services in New Zealand

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Abstract

In the past decade, the popularity of location-based services has grown as a topic for research and as an application. Advanced technologies, particularly wireless, positioning technologies and geographic information systems have accelerated location-based service implementation.

The study of location-based services addresses technology, usability, integration, business issues and privacy. In this project, the reality of location-based services in New Zealand is explored from a broad perspective. Factors influencing the development of these services and issues that would improve efforts in the future are also investigated.

The research focuses on: 1) understanding the differences between location-based services in New Zealand and location-based services in other developed countries such as the USA, Japan and the European Union; 2) finding factors that influence location-based service development; and 3) identifying the factors that are significant to New Zealand location-based service development and the issues related to their improvement.

When compared with location-based services in other advanced countries such as the USA, Japan and the European Union, it was found that New Zealand services are falling behind. The main differences are within the areas of: technology infrastructure, service availability, quality of location information and legislation. The experience within other countries would suggest that legislation, technology and business strategies are the main drivers of location-based service development.

To improve location-based services in New Zealand, the most significant factor may be relevant legislation which needs to cover two points: 1) Legislation to enforce wireless operators to provide mobile emergency services to ensure civil safety; 2) Creating a competitive market environment that inspires operators to adopt new technology.

Statement of Originality

'I hereby declare that this submission is my own work and that, to the best of my knowledge and belief, it contains no material previously published or written by another person or material which has been accepted for the qualification of any other degree or diploma of a university or other institute of higher learning.'

I acknowledge the work done by Cat Carruthers in proofreading the final version of the dissertation.

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Chapter 1 Introduction

In the past few years, following advances in wireless telecommunications and positioning technologies, location-based services have emerged as important applications for business and personal environments. Location-based services integrate wireless technology, positioning technology and location information and have the potential to increase revenue for the wireless industry (Docter, Licciardi, & Marchetti, 2007), to improve emergency services (Fritsch & Scherner, 2005), aid people in unfamiliar environments (Antikainen et al., 2006), improve the performance of management (Junglas, 2005), and to provide an attractive service for tourists (Koutsiouris, Polychronopoulos, & Vrechopoulos, 2007) .

Some applications, such as mobile emergency calls, fleet management, mobile yellow pages and route finding have already been deployed, but there are still more under development. Research in location-based services covers technology, usability, technology integration and industry strategy. One specific issue is the identification of a user's location, which has a potential benefit for emergency rescue services but may also pose a threat to privacy, making developing location-based services dependent on government legislation for both improvements and restrictions.

Developing location-based services is a challenging task, as it involves information technology, business strategy, government policy and end user requirements. The process of development may have similar issues playing different roles in different environments. An example of this is legislation for mobile emergency services (Enhanced 911 Emergency Service) in the USA, which has significantly facilitated location-based service development. Today, "E911" has been described as an important location-based application and service. However, in Japan, the same requirements of wireless operators were only recently added to legislation. Emergency services have not influenced the existing location-based service infrastructure, service or future direction in the case of Japan. It does not play as important a role in location-based service development as it has in the USA.

1.1 Research Context

Applications, technologies, privacy, usability and business models are popular research topics in the study of location-based services. Research from developed countries such as the USA and Japan explores characteristics and factors in location-based service development. Most researchers address the issues from specific environments and experience. There is little research examining today's location-based services from a broad perspective. Furthermore, there have been few studies that address the status of location-based services in New Zealand, which is a prime concern of this study. Applying a multiple case study approach, the status of location-based services in several countries are presented, differences between New Zealand and other countries are compared, and factors that influence location-based service development are illustrated. In addition, some significant factors are discussed in the context of improving location-based services in New Zealand. Trends in location-based services are also analyzed.

There are two objectives in this study. Firstly, describing the landscape of location-based services including significant aspects such as basic technologies, current development, service application and relevant legislation, will lead us to understand the difference between the New Zealand situation and that in other countries. Secondly, identifying factors that influence location-based service development through studying the development process, further assists us in finding the factors that would bring about a rapid improvement in location-based services in New Zealand.

The study examines and provides a realistic picture of location-based services in New Zealand. Issues emerging from the implementation of location-based services are identified and their implications are discussed. The results can be used as a guide for future research.

1.2 Outline of the Dissertation

Each chapter focuses on a particular aspect.

Chapter 2 Describes the field of location-based services and the technologies used in these services. Types of location-based services are illustrated. Challenges and issues facing location-based services are presented. Previous studies in location-based services are summarized.

Chapter 3 Introduces the research motivation and objectives. Following the research question, the research methodology and method are presented and the structure outlined. Two research models to be used to identify differences between New Zealand and other countries are proposed.

Chapter 4 Examines the development and current status of location-based services in the USA, Japan and the European Union, as well as New Zealand. Current services, technologies, location information and related legislation are analyzed. Some forecasts for location-based services also are presented.

Chapter 5 Examines the differences between location-based services in New Zealand and other geographical areas. Factors that influence location-based service development and trends in New Zealand are explored. Significant factors that will influence New Zealand location-based services are identified.

Chapter 6 Concludes the dissertation by summarizing key findings and presenting directions for further research.

Chapter 2 Location-Based Services

Location-based services have been studied and developed for many years. From a summarized literature review, this chapter introduces and describes location-based services and the technologies used to deliver them. Current developments, arising issues and future research directions are also presented. Location-based services are defined and categorized based on prior research results and the professional literature on file.

2.1 Background and Definition of Location-based Services

Location-based services have a broad application and a long tradition. The Global Positioning System (GPS) is a satellite positioning technology, a pioneer service enabling the location of people and objects and was primarily conceived for military purposes. Following the availability of low accuracy-positioning data to the public, many industries have taken the opportunity to access positioning data through GPS and now use it to enhance their products and services. A well-known application is navigation, widely used in today's ships, cars and aircraft.

Another technology with a long history and similar to location-based services is Geographic Information Systems (GIS) and spatial databases which provide powerful mechanisms to store and retrieve location data (Tomlin, 1990). Location-based services and GIS have different origins and different user groups. GIS was developed based on several decades of professional geographic data applications. Compared with the GIS, location-based services are quite a recent development coming from the evolution of public mobile services. Generally, GIS are seen as a traditional "professional" system intended for experienced users with a wide collection of functionality (Virrantaus et al., 2001).

Location-based service has no universal definition. The terms 'location-aware services', 'wireless location services' and 'mobile location services' are often used as synonyms for location-based services. These definitions have different focuses depending on a difference in research perspective. Some research defines location-based service as an application that takes the user's location into account in order to deliver a service (VanderMeer J., 2001). A general, and widely accepted definition of the location-based service, is information services accessible through mobile devices and mobile networks, which can make use of the location of the mobile device (Virrantaus et al., 2001). Location-based services can be also discussed in the context of mobile service and applications (Petrova, 2008).

One study viewed location based-based services as an intersection of mobile telecommunication systems, location-aware technologies and handheld devices with the Internet, GIS and spatial databases (Shiode, Li, Batty, Longley, & Maguire, 2002). This definition will be used later in this report as a working definition of location-based services from a technological perspective. A general definition of location-based services covers a very wide area, but this project focuses on a narrow area of location-based

services, those that, through mobile communication networks and cell phones provide information services dependent on a user's location.

2.2 Location-Based Services Infrastructure

Delivering location-based services usually requires co-operation between some fundamental components. . Working together they determine a user's geographic location and provide specific information to the user based on his/her location and service requirements.

2.2.1 Components needed to deliver location-based services

When users want to use a location-based service, several infrastructure elements are necessary. These components and their connections are shown below:

- **Communication Network:** used to transfer the user's data and service request from the mobile device to the service provider and then transfer requested information back to the user.

- **Mobile Devices:** a tool used for requesting and representing information, acts as an interface for the information and as part of the positioning device. Devices most commonly associated with location-based services are PDAs (Personal Digital Assistants) and cell phones etc.

- **Positioning Component:** to process location information, position information and determine user position. Geographically, they are classed as either outdoor or indoor positioning. Outdoor positions can be obtained by using the mobile communication network or GPS. Indoor position can be determined by active badges or radio beacons etc.

- **Service and Application Provider:** offers a number of different services to the user and is responsible for service request processing.

- **Data and Content Provider:** business and industry partners in a particular field which satisfy the user's specific information request or provide data maintenance.

2.2.2 Location-based service model

Location information is usually provided in terms of a latitude/longitude pair that is sent to an application in a server or back to the mobile device, which is then transmitted with some additional identification information to an application in a server that may reside inside or outside the wireless network. The location information can be tied to a location database server that could interest users and will then send a related message to the user about restaurants or hotels, for example. A conceptual model of location-based services includes the network and mobile device, base transceiver station, positioning center, geographic content and location–specific content, as depicted in Figure 1.

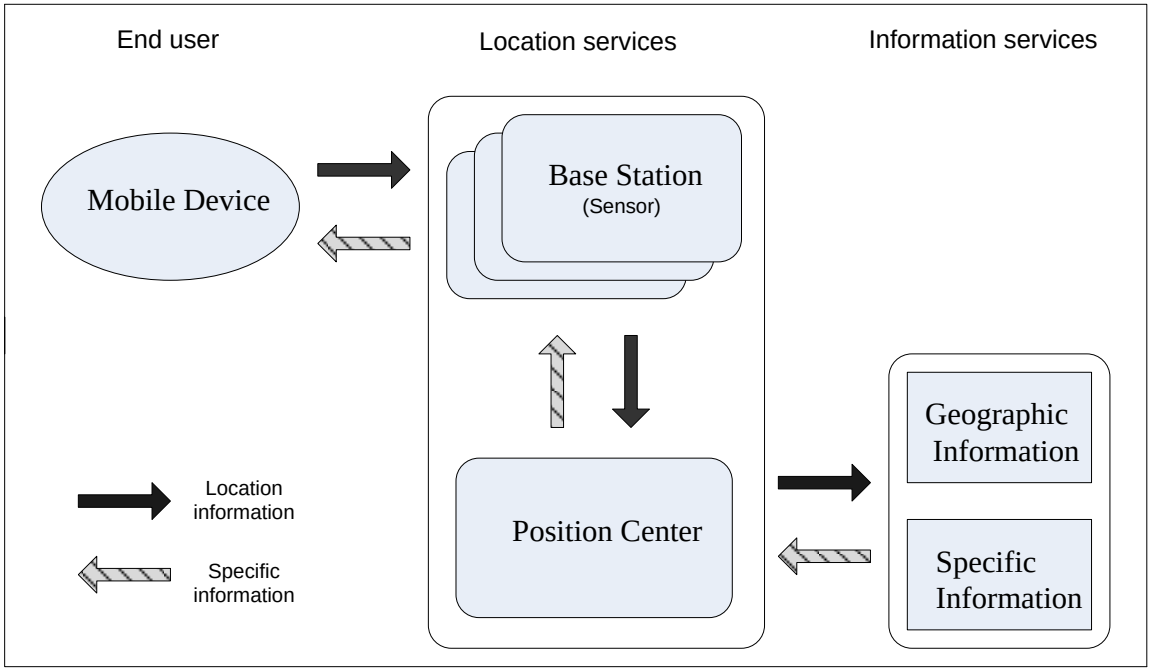

Figure 1 The conceptual model of location-based services

2.3 Positioning Technologies

The key factor in the realization of a location-based service is to let the system determine a user's location in an automatic way. Most position-sensing technologies are based on sensor infrastructure while some of them have sensors integrated into the mobile device. (Hans, Albercht, & Michael, 2002) Based on the nature of the wireless technologies, some are suitable for short distance applications while others can provide long distance determinations. Indoor positioning systems are typically based on small radio or infrared cells, or, for higher accuracy, on sensor arrays in the environment. For outdoor environments, GPS infrastructure and the mobile telecommunication network are the major technologies. Figure 2 shows a summary of current wireless technologies and their accuracy and coverage in location-based services.

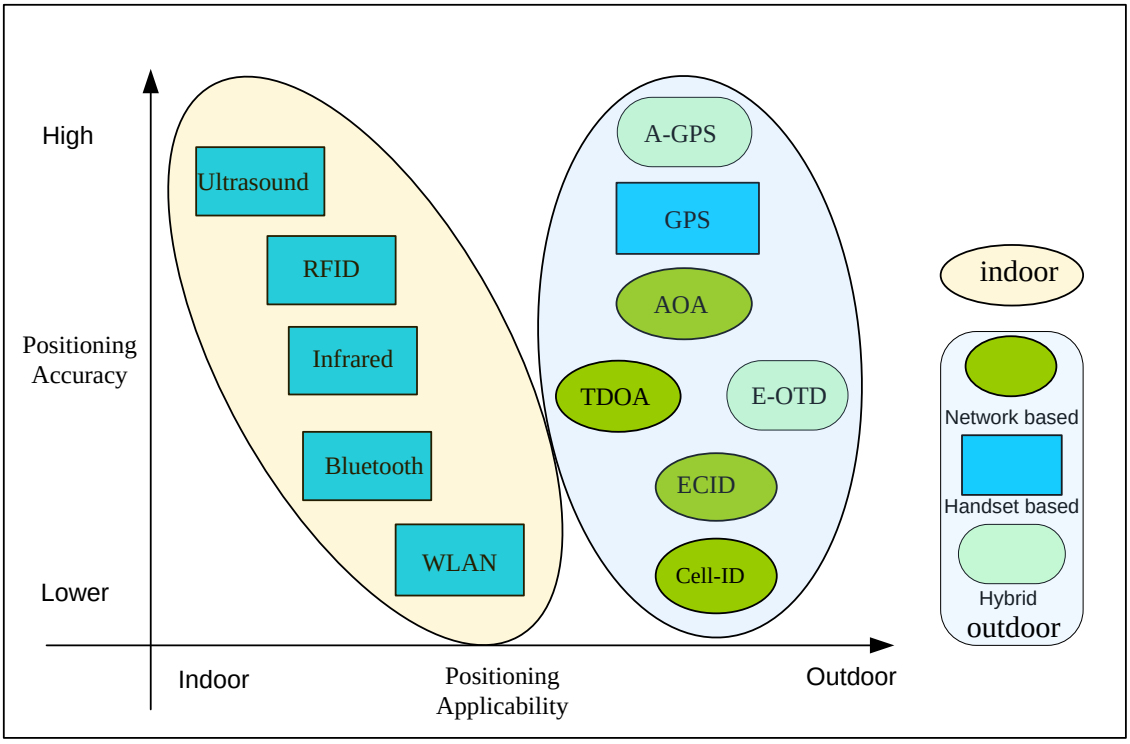

Figure 2 Positioning technologies

2.3.1 Outdoor technologies

For outdoor environments, the technologies used to determine location information can be divided into three categories: Network-Based technologies, Handset-Based technologies and the Hybrid systems. Network–Based technologies depend on the ability of a mobile device to receive signals from a mobile network covering the area of presence and these usually have good performance in densely populated environments. Handset-Based technologies do not need mobile network coverage to work but require hardware or software computing capability in the handset to locate position. The most common application of handset-based technologies is GPS. Hybrid systems are those that incorporate a combination of network- and handset-based technologies. A summary of outdoor positioning technologies is shown in Table 1.

Table 1 Summary of outdoor positioning technologies. (Source: (Unni & Harmon, 2003)

Technology	Description	Advantages	Disadvantages
Network based			
Cell-ID (or COO (Cell-of- origin))	Information generated about cell occupied by user	Uses existing network. Fast implementation No handset modification	Low resolution
AOA(Angle of	Measures angle of	No handset modification.	Expensive (required

arrival)	signal from mobile device to cell station (minimum of 2 cell sites required)		network upgrade) Line-of –sight required Medium resolution
*TDOA (Time distance of arrival)	Triangulate at least 3 stations to measure and compare arrival time of signal from a user	No handset modification.	Line-of-sight required. Expensive Medium resolution (Appropriate for CDMA)
ECID (Enhanced Cell ID	Software-based solution that compares list of cell sites available to user and checks for overlap	Line-of-sight not required Moderate cost to upgrade	Works only with GSM Some modification required in handset and network
Handset based			
GPS (Global Positioning System)	Based on 24 low orbit satellites, triangulation by measuring the time it takes to communicate with three satellites	high accuracy, 5 -10 meters, Not dependent on network	Line of sight issues Significant handset requirement. No indoor services
Hybrid technology			
E-OTD (Enhanced observed time difference)	Similar to TDOA, but handset calculates the location	Accuracy of 50 to 125 m	Suited to GSM only Network and handset Modification needed. Cell coverage necessary
A-GPS (Assisted Global positioning system)	Processing done by network while using satellites	Moderate modification to handset. Line-of-sight constraint	Significant changes to network New handset

*TDOA techniques can be applied to either the uplink signals received by the base stations from the mobile or the downlink signals transmitted from the base stations received by the mobiles. The use of uplink signals for location computation is commonly referred to as Time of Arrival (TOA). The use of downlink signals is commonly referred to as Enhanced Observed Time Difference (OTD)(Vanderspool, 2000).

2.3.2 Indoor technologies (Indoor localization techniques)

For short-range positioning technologies, location identification relies on the co-operation between the moving target object and a fixed reference point(Giaglis, Kourouthanassis, & Tsamakos, 2003). Some popular technologies for indoor environments include:

Ultrasound: Ultrasound transmitters (beacons) send signals to a receiver, allowing the device to calculate its location based on proximity. If using timing differences between the ultrasound and additional radio reference signals, the system can achieve very high accuracy to few centimeters (Harter, Hopper, Steggles, Ward, & Webster, 2001)**.**

Infrared: This system combines infrared sensors which are usually placed throughout a building and an attached device (a badge) on an object to detect object position.(Want, Hopper, Falc, & Gibbons, 1992) Infrared requires visual line of sight and does not have very high accuracy.

Radio Frequency Identification: A low power radio frequency signal is emitted by a movable target and can be detected by receivers placed at specific places around a building. Additional ID information from the signal is used to identify each target.

Bluetooth: A very short-range radio frequency standard used for personal area network (PANs) access. They are mainly conceived as wire replacement (such as between a cell phone and headphones). When a Bluetooth device comes within range of a service point, such systems could be used for proximity-based location services.

Wireless Local Area Network: Primarily used to provide Ethernet connections and high-speed Internet access. Many stations have been deployed to accept device access and each of them have ranges of roughly 50 meters coverage, gross location information can simply be obtained by determining which users are being served by a particular base station. (Yen-Cheng, Yao-Jung, & Cheung-Wo, 2005)

2.4 Types of Location-Based Services

From a geographic point-of-view, location-based services can be simplified into indoor and outdoor categories, but this taxonomy is very narrow in scope. Location-based services are applications that take the user's location into account, in order to deliver a service. (VanderMeer J., 2001) From a value chain perspective, location-based services are services which increase location information value to customers through specific services. Therefore, location-based services can be further defined as a value-added service offered in a wireless environment that exploits mobile terminal location position information. (Schiller & Voisard, 2004) Based on this definition, location-based applications or services can be classified as below:

Emergency Services

The ability to locate an individual who is either unaware of his/her exact location or is not able to reveal it because of an emergency situation. (Steiniger, Neun, & Edwardes, 2006) This requires the system to automatically determine the mobile user's exact location after receiving an emergency call and transfer the location information to the emergency assistance agency.

Navigation Services

Navigation services are based on a mobile user's need for directions within their current geographical location. The ability of a mobile network to locate the exact position of a mobile user can be manifested in a series of navigation-based services.(Steiniger et al., 2006) In navigation services, the system needs to determine the position by direction

prediction and routing calculation, which is based on the destination and relevant information displayed. In addition, services can be provided to allow mobile users to locate friends, family, workers, or other members of a particular group in order to improve communication.

Information Services

Information services generally refer to the digital distribution of content to mobile terminal devices based on their location, time specificity and user behavior (Giaglis et al., 2003). Mobile users can be provided with a wide range of localized information such as landmarks, restaurants, theaters, and public transportation options. The following services can be identified within this category:

a) Travel services that can be provided to tourists moving around in a foreign city. such as guided tours, notification about nearby places of interest, transportation services.

b) Mobile yellow pages that provide a mobile user, upon request, with information regarding nearby facilities.

c) Infotainment services such as information about location specific multimedia content, community events (Giaglis et al., 2003).

Advertising Services

Wireless advertising refers to advertising and marketing activities that deliver advertisements to mobile devices using wireless networks and mobile advertising solutions to promote the sales of goods and services, or build brand awareness. (Yunos & Gao, 2003) Typical location-based service advertising takes the form of mobile banners, SMS messages and proximity triggered advertisements etc. (Brian & Troy, 2003) but its intrusive nature is a big challenge.

Tracking Services

Applicable on both the personal and the corporate level to monitor the exact whereabouts of a person or property. One popular business application is fleet management, which refers to tracking and managing vehicles so that companies know where their goods are at any time and can thereby organize their business. These kinds of the applications can also be utilised by companies in order to locate and manage their working team, this is known as field management. Other applications are those used for product tracking within a supply chain. (Kalakota & Robinson, 2002)

Billing Services

Location-sensitive billing refers to the ability of a mobile location service provider to dynamically charge users for a particular service depending on their location when using or accessing the service. (Brian & Troy, 2003) One example is when an operator offers reduced call rates to subscribers when using their mobile phone at home, thereby allowing mobile operators to compete more effectively with their fixed telephony counterparts. (Brian & Troy, 2003)

All of these services, relevant technologies and environments are listed in Table 2.

Table 2 Summary of location services, technologies and environments. (Source; George et al. 2003; Brian & Troy, 2003 and Vasileios et al. 2003)

SERVICES	EXAMPLES	TECHNOLOGIES	ENVIRONMENT	ACCURACY
EMERGENCY	Emergency calls	TOA / OTD / A-GPS	Indoor/Outdoor	Medium to high
	Automotive Assistance	TOA / OTD / A-GPS	Outdoor	Medium
NAVIGATION	Directions	A-GPS	Outdoor	High
	Traffic Management	TOA / OTD / A-GPS	Outdoor	Medium
	Indoor Routing	BLUETOOTH / WLANs / RFID	Indoor	High
	Group Management	Cell-ID / TOA / OTD / A-GPS	Outdoor	Low to Medium
INFORMATION	Travel Services	TOA / OTD / A-GPS	Outdoor	Medium to High
	Mobile Yellow Pages	TOA / OTD / A-GPS	Outdoor	Medium
	Infotainment Services	TOA / OTD / A-GPS	Outdoor	Medium to High
ADVERTISING		TOA / OTD / A-GPS	Outdoor	Medium to High
TRACKING	People Tracking	OTD / A-GPS	Indoor/Outdoor	High
	Vehicle Tracking	Cell-ID/ GPS	Outdoor	Low
	Personnel Tracking	TOA / OTD / A-GPS	Outdoor	Medium
	Product Tracking	BLUETOOTH / RFID	Indoor	High
BILLING	Location-sensitive billing	Cell-ID / TOA / OTD	Indoor/Outdoor	Low to Medium

2.5 Issues and Challenges for Location-Based Services

The potential of location-based services is attractive to both industry players and customers. However, results from academic and professional literature show that location-based services also face challenges, with issues arising mostly from the

technological, business, and social perspectives. Some of the most critical issues identified in prior work are summarized below:

User Privacy

One important issue that has emerged in location-based services is wireless location privacy. This involves both keeping a user's location information confidential and preventing users from being illegally tracked. Public concern about potential threats to personal security and use of personal location records for commercial purposes and legal action has resulted in a desire to be able to control who receives their location information while still being provided with highly personalized services and applications. (Dao, Rizos, & Wang, 2002) Developing strict location information protection is still a challenge for many countries. Currently, location-based services and location data are not regulated in most parts of the world. Protection is provided under other legislation such as general data protection acts (Adusei, Kyamakya, & Erbas, 2004).

Interoperability

Location-based services involve more than one mobile network and operator. There is a need for services that cross different networks. One scenario is when a user is using services from one operator and trying to locate his friend who is using a different operator. This kind of service requires the crossing of networks and operators, and is a big challenge for the operators, particularly when the two operators have different mobile network infrastructures.

Accuracy and Reliability

Accurate, high performance and reliable positioning are a high priority in the location-based services. The more accurate the position, the more relevant the information that can be provided. Generally, high accuracy depends on technology and infrastructure integration such as the A-GPS technology, which provides reliable accuracy of between 5-30 metres (Mohapatra & B, 2005). The time of determination is another issue in location-based services as it usually conflicts with high accuracy, one study showing that determining position within 30 seconds or less is thought satisfactory (DTI Global Watch Service, 2004).

Information availability

As an important component of location-based services, location sensitive information can change daily, keeping this information up-to-date is essential for the quality of the services, updating information objects such as newly opened restaurants and deleting closed ones is necessary to satisfy users' location information requirements. For navigation services particularly, new geographical and road information is crucial for the system to determine direction and routing.

Legal, Ethical and Social Issues

Theoretically, when a user employs location-based service technologies to look after her/his family members, particularly the elderly or young children, this may involve monitoring and restricting the subject's activities, especially when he/she is alone. This brings up the question of control in location-based services that are used for care or convenience purposes (Perusco & Michael, 2007).

2.6 Research in Location-Based Services

Location-based services have been studied for many years. Based on the nature of the research objective, different research methods have been adopted to address different issues. The research covers both theoretical and practical perspectives. Theoretical research focuses on fundamental knowledge, using survey, theoretical models to explore the issues involved in location-based services. This research provides a rich source of information regarding the characteristics of location-based services. Generally, research objectives can be categorized into technology, business, social issues and applications. Table 3 shows the focus of a sample of research on location-based services.

Table 3 Research relevant to the area of location-based services. (Source: Author of this dissertation)

Category	Focus	Author
Technology	Cell-ID location techniques	(Trevisani & Vitaletti, 2004)
	Usability of location-based services	(Chincholle, Goldstein, Nyberg, & Eriksson, 2002)
	Integration of diverse simple sensors	(Hans et al., 2002)
	A domain model for location-based services	(Vasileios, George, & George, 2003)
	Effective location-based services with dynamic data management in mobile environments	(Shiow-Yang & Kun-Ta, 2006)
	Location based services in 3G cellular networks	(Rudesindo, & Hwee-Pink, 2006)
Business	Characteristics of mobile services from a customer perspective, four-level framework for classification of mobile services	(Heinonen & Pura, 2006)
	Location Based Services in Mobile Commerce	(Steinfield, 2004)
	Value chain for mobile business	(Peppard & Rylander, 2006)
	Opportunity for telecom companies	(Docter et al., 2007)
Social and Ethical	Ethical and privacy issues in location-based services.	(Perusco & Michael, 2007)
	Law and regulations governing the use of wireless location information in the United States, the European Union, and Japan.	(Ackerman, Kempf, & Miki, 2003)
	A framework for managing location privacy.	(Jason & James, 2004)
	A privacy enhancing mechanism based on pseudonyms for identity protection in location-based services	(Jorns, Quirchmayr, & Jung, 2007)
Applications	Crime Control	(Boondao, Esichaikul, & Tripathi, 2003)
	User requirements of location-based services	(Kaasinen, 2003)
	Advertising	(Yunos & Gao, 2003)
	Traffic management	(Ragia & Deriaz, 2006)
	Digital library	(Hinze & Osborne, 2007)
	3G location-based services; innovative entertainment	Koutsiouris, Polychronopoulos, & Vrechopoulos, (2007)

Practically based research addresses issues in location-based service development and implementation. The USA and Japan are the most popular subjects for this kind of research. This is because in the USA, E911 emergency call services represented an important factor in accelerating location-based services. In Japan, i-mode is a famous mobile business model from the NTT Company that has been adopted by many other wireless operators. This research, for example, Grajski & Kirk (2003) Srivastava & Kodate (2004) and Griffiths et al (2001), mainly focuses on factors, impact and features involved in location-based services in a specific context.

Research shows that New Zealand is not advanced in location-based services, but, like other countries, there is a lot of research in this area in New Zealand, such as challenges for interaction in mobile tourist context awareness systems (Hinze & Buchanan, 2005), exploring the perceived value of location-based services in New Zealand tourism (Leung, 2006), implementing simulators for the location application programming interface for Java 2 micro Edition (Parsons, 2005) etc. One particular characteristic of location-based services research in New Zealand is that a lot of it is linked to tourism.

2.7 Summary

Delivering location-based services is complex and challenging. Three important infrastructures emerge; wireless networks, positioning technology and location-relevant information. Previous studies provide useful, detailed information about technologies, services categories, issues and challenges in developing location-based services, but following a summary of previous studies, it was found that few studies provide an overall picture of today's location-based services in practice, as most previous studies address individual aspects and lack a broad perspective.

Chapter 3 Research Methodology

This chapter presents the motivation for the research and the research questions. Included in the research methodology are; data sources, data collection, data organization and analysis. Limitations and contributions of the research are also discussed.

3.1 Research Motivation, Questions and Significance

In New Zealand, tourism plays a key role in the growth of the economy through employment, foreign exchange earnings, investment and regional development. Tourism directly and indirectly contributes to almost 10% of New Zealand's GDP(Ministry of Tourism, 2007). Previous studies have emphasized the potential influence and opportunity location-based services may have on the tourist industry (Berger, Lehmann, & Lehner, 2003; Dias, Rhin, & Scholten, 2005; Schwinger, Grün, Pröll, Retschitzegger, & Schauerhuber, 2002). Much research in New Zealand is, therefore, linked to tourist applications (Hinze & Buchanan, 2005; Leung, 2006; Parsons, 2005).

Koutsiouris, Polychronopoulos, & Vrechopoulos (2007) provide rich information about location-based services in current business practice in six European countries, but, there has been no research so far into the current location-based service situation in New Zealand and the factors that may influence their development and subsequent adoption. Based on the premise that a scholarly investigation of the current location-based service landscape might provide useful insights and inform future research efforts, this study will form an overall perspective to understand current location-based services in New Zealand. The study aims to achieve the following two goals: 1) To identify, describe and classify the range of location-based services in New Zealand, 2) To identify and analyze factors and issues relevant to their development and adoption. From these goals the following three research questions were formulated:

1. How does New Zealand differ from other more technologically advanced countries in its development of location-based services?
2. From these differences what might be slowing down the progress of location-based service development in New Zealand?
3. How can these issues be addressed, in order to achieve more rapid development in New Zealand?

To meet the goals and answer the research questions, the study observed and studied the New Zealand location-based services landscape, characteristics of location-based service development, and factors that affect location-based service development. The research followed these four steps: 1) Understanding the current landscape of location-based services 2) Finding factors that influence location-based service development. 3) Identifying how factors differ depending on circumstances, 4) Analyzing and identifying factors significantly influencing location-based services in New Zealand.

The outcomes of the study, including analyzing the implications of the findings, may provide some useful practical recommendations to the business community and to local

government bodies, which would aid the development of location-based services and thereby increase New Zealand's international competitiveness in important areas such as tourism.

3.2 Research Strategy

Since positioning technology covers everything from short-range wireless technology to wide area mobile telecommunication networks, location-based services cover both indoor and outdoor applications. This project focuses on a particular application area, based on mobile telecommunication technologies and handheld devices, from Internet and from Geographic Information Systems (GIS) with spatial databases (Shiode et al., 2002). It concentrates on services offered to mobile users in which the user's location information is used in order to add value to the service as a whole. The reason for this focus is that mobile communication is the most popular and important method of communication today. In 2007, globally, mobile phones will be used by a 3.25 billion population (TelecomsEurope, 2007). Therefore location-based services, which are based on mobile communication networks and cell phones, can be seen as being critical services and applications in the future.

Different research problems require different research approaches (Singleton & Straits, 1999). The two main research approaches are quantitative and qualitative. Quantitative research methods were originally developed in the natural sciences to study natural phenomena. The qualitative approach attempts to examine a situation from a more open-ended perspective, and was developed in the social sciences to enable researchers to study social and cultural phenomena. Qualitative methods include action research, case study research and ethnography. This is a more flexible approach and has the ability to capture unexpected outcomes during analysis that might otherwise have been missed. Qualitative analysis does not normally allow intervention so it mainly involves observation and interviews. Thus, the phenomenon to be investigated will need to have occurred or to occur during the time of observation or it cannot be captured. In this object, based the characteristic of research object and questions, the qualitative research approach was chosen.

A multiple case study approach was chosen as the research strategy in this project. Case study is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between phenomenon and context are not clearly evident(Yin, 1994). It has the ability to deal with complex systems and has the capacity to allow intervention to promote change in an organization, it also examines the phenomenon in its natural setting. It is a useful methodology to capture knowledge of practitioners and to develop theories from this knowledge and it is suitable for the exploration, classification, and hypothesis development stages of the knowledge building process (Benbasat, Goldstein, & Mead, 1987). At the same time, a case study approach is appropriate when the researcher is interested in the relation between the context and the phenomenon in question (Pinsonneault & Kraemer, 1993). In this research, the case study approach allows the analysis of location-based service development through observing its characteristics and connecting factors in a particular context. Once this connection is demonstrated, the basis of the analysis will lead to the understanding of the factors that

affect location-based service development. The advantage of multiple case studies is that it serves the same purpose as multiple experiments. In this research, multiple case studies provide the opportunity to examine the characteristics of location-based services in different situations in order to identify common and unique factors.

Qualitative data sources include phenomena and participant observation. Data are collected through interviews, questionnaires, documents, texts and the researcher's impressions and reactions (Myers & Avison, 2002). In this project, the data is based on a literature and document survey. Data sources were categorized into three groups: 1) academic literature, which provides information from a theoretical perspective; 2) industry and organization reports, which focus on deployment and industry issues; 3) material from location-based service operators, including newspapers, white papers, and advertising.

In this project, the multiple case study approach was be adopted to study and compare environments and factors affecting location-based service development, as it is an effective research approach to explore issues in location-based service development. It enables easy identification of common and unique factors affect location-based service development. The multiple case study needs to focus on several representative situations. Based on a previous literature review, the development of location-based services in the USA, Japan and the European Union were selected to be observed and studied. The reasons for this selection were: firstly, the USA is the most advanced country for certain technologies which have been adopted for today's location-based services such as the GPS and GIS. At the same time, the legislation of E911 has greatly advanced location-based services in the USA. Secondly, Japan is the most advanced country in the adoption of location-based services. There is a lot of research which uses Japan as a research subject to explore the issues and experience of location-based services. Thirdly, European Union is promoter of GSM (Groupe Spécial Mobile), which is the most popular mobile system standard and account 82% of the global mobile market (GSM Association, 2007). Fourthly, in these countries, location-based services have been developed over several years, and there are many services available. The choice of these countries as research subjects provided a rich source of information and ensured that the research was of high quality.

3.3 Research Process and Model

Based on the research strategy and sequence, the fist research activity is data collection, which focuses on the three categories of information as discussed above (3.2). The quality of the data is a crucial factor and influences the final research results. Two key issues for data collection are 1) to maintain a high quality of information and 2), gather as much information as possible. The iterative approach requires the repeated gathering, identifying and classifying of information.

3.3.1 Information analysis

Analysis of the information involved; 1) The examination and summation of location-based service landscapes in the USA, Japan, the European Union and New Zealand. 2) Identifying the differences between New Zealand and other areas. 3) Finding factors that influence location-based service development and 4) Analyzing and identifying the significant factors influencing location-based services development in New Zealand.

Chapter 4 presents the examination and summary of development, available services, population coverage, technology, business model, relevant regulation and future trends in location-based services in our research countries.

Chapter 5 includes identification of the differences between New Zealand and other countries; the identification of factors that influence location-based service development and the analysis of factors significant to New Zealand.

The differences between location-based services in New Zealand and the USA, Japan and the European Union are identified through analyzing the current location-based services landscape in each of the above countries. A landscape model and development model (maturity model) are used to assist analysis and present the results.

Through the examination of the location-based service development process in the USA, Japan and the European Union, the factors that influence location-based service development are to be discovered. Significant factors will be identified and their background will be discussed.

To analyze and identify factors significant to New Zealand, a background of New Zealand location-based service development is examined, circumstances within New Zealand are compared with other countries, and issues that may be significant to New Zealand are identified and discussed. Location-based service trends around the world will also be analyzed.

3.3.2 Landscape model and development model (maturity model)

Two models are proposed to assist and present our analysis.

The landscape model is used to illustrate location-based services in real-world terms. It provides an easy and clear approach to identifying the differences among the countries studied. The definition of location-based services applied in this study focuses on the intersection of mobile telecommunication technologies and handheld devices, from the Internet and from Geographic Information Systems (GIS) with spatial databases. This model includes three major aspects of location-based services, they are: available services, technology infrastructure, and quality of locality information. In addition, as previous studies show that policy and legislation are important issues in location-based services, the fourth aspect of our landscape model is legislation relevant to location-based services. These four aspects can reflect the realities of location-based services.

A three-step location-based service development model is proposed to assist in the identification of differences from the perspective of development. This model is developed from the above landscape models. Each of the four aspects is rated on detailed criteria. Results of the ratings are put together to identify which stage of development the countries being researched belongs to. The criteria for positioning technology focuses on network infrastructure and accuracy; location information focuses on the amount of service information and how much is static or dynamic, available services focuses on the number of services and categories, legislation focuses on the coverage of both location-based service promotion and restriction. Finally, through the rating of each of these four aspects, the level of location-based service development may be identified.

The maturity model is a popular tool for evaluation. An initial Capability Maturity Model (CMM) was originally developed as a method for objectively evaluating contractors for software projects (Paulk, Curtis, Chrissis, & Weber, 1993). The original CMM and its successors were, and still are, used for many government projects. Depending on the motivation for a CMM, many maturity models have been proposed to study various areas such as; the Enterprise Resource Planning Systems (Holland & Light, 2001), determining the capability maturity levels of formal specification processes in software development environments (Fraser & Vaishnavi, 1997) and a computing education model (Lutteroth, Luxton-Reilly, Dobbie, & Hamer, 2007).

The development model used in this study to distinguish differences between New Zealand and other countries is a natural outcome of the research and is similar to a maturity model, and therefore it has been called the location-based services maturity model. The value of this staged model is that it provides a road map for understanding the evolution of location-based services. This model provides a picture that lets us compare staged New Zealand location-based services. In addition, it provides a useful framework for the development of further research.

3.4 Limitations and Expected Contributions

The main contribution of this research is that it will help create a detailed and accurate picture of the current landscape of location-based services from the perspectives of service, technology, social issues, and government regulation. Several development stages of location-based services in different nations will be investigated. By applying a multiple case study approach, the underlying set of factors influencing the development and the adoption of location-based services can be identified through an examination of the differences between the individual circumstances of the selected cases. Shared and unique characteristics can be identified and classified, based on this comparison. The results may provide useful directions for further research and development.

The main limitations of the study stem from the limited scope of the data sources. Qualitative research generally uses multiple data sources such as documents, interviews, questionnaires, observations, among others. Multiple data sources can and do provide a rich source of information; interviews and questionnaires are widely used in qualitative research as data collection methods, as they can be used to obtain not only deep, but also

specific information. Since the information gathered for this research is based on a literature survey, to ensure the high quality of the information sources, information gathering was done widely and identifying and refining was done repeatedly, however the author is aware that this alone cannot guarantee the highest quality. Any bias in this information and restructured information would be reflected in this research.

As some of this research relates to business information, more literature, reports and news were sought to get a richer data source. For confidentiality reasons, there was still more information that would have helped improves the study but could not be obtained. Lack of this information will affect the quality of the results. A time constraint is another factor affecting research quality. Even so, as primary research, an overall picture of location-based services has been presented and all research questions have been answered. The research method and results provide some useful information for further study. It also provided an opportunity to examine the author's research skills.

3.5 Summary

In this chapter, research motivation, questions and methods involved in this report were presented. The study will examine the actual situation and development of location-based services in New Zealand from a broad perspective. A multiple case study method is adopted and through studying location-based services in three research areas: the USA, Japan and the European Union, the differences between New Zealand and these countries in location-based services will be understood. To assist and illustrate our research, two research models were proposed, they are a location-based services landscape model and a development model (maturity model). Limitations and expected contributions of this project were discussed based on our research motivation.

Chapter 4 The Landscape of Location-based Services: A global perspective

Understanding the current status of location-based services is a primary and fundamental step in this study. Based on information gathered through a survey of the literature, this chapter presents findings related to the wide range of location-based services in the USA, Japan, some European countries and New Zealand. It examines the development of the location-based services in these countries in relation to population, existing mobile telecommunication infrastructure, available services and technologies, market and consumer needs, and accuracy. The range of countries was selected based on data on the level of adoption of location-based services (relatively high in Japan, Europe and the USA), with the aim of comparing these later to New Zealand. This chapter builds a comprehensive picture of the landscape of location-based services from a global perspective.

4.1 Location-based services in the USA

In the USA, location-based services became popular when new emergency services legislation was introduced involving emergency stations (Federal Communications Commission, 1999). In the last decade, an increasing number of emergency calls (911) originated from mobile phones. Unlike landline telephone networks, where each number corresponds to a registered address and can therefore be automatically detected, in the case of an emergency call from a mobile phone, the caller needs to tell the operator their physical address in order to guide a unit to their correct location. However, in many cases callers did not know where they were. In 1996, to improve 911 services, the U.S. Federal Communications Commission (FCC) introduced a piece of legislation known as Enhanced 911 (E911). The legislation requires wireless operators to provide automatically the caller's location information in a 911 emergency call situation. This means that when placing an emergency call from a mobile phone, the geographical position of the caller is automatically detected and transmitted to the closest emergency station.

The E911 outlined some specific performance outcomes for location determination as well as a timeline for implementation. It requires wireless operators to locate 67 percent of calls within 100 meters and 95 percent of calls within 300 meters and the deadline was set for 2001 (Federal Communications Commission, 1999). Since few wireless operators met the requirement before initial regulation of E911, FCC relaxed the date and most operators were given extensions that carried through until full compliance in late 2005 (Federal Communications Commission, 2001) .

The accuracy requirement of E911 determines precision depending on whether the wireless operator has deployed a handset-based or a network-based solution. It puts a higher value on handset-based solutions than on network-based solutions. These requirements greatly influenced the adoption of positioning technology. Initially, there were many technologies that could be used to determine location, such as GPS, A-GPS, U-TDOA (Uplink Time Difference of Arrival), E-OTD, AOA, Cell-ID, Enhanced Cell-

ID etc, but only three technologies have been found to meet the E911 requirement: A-GPS, U-TDOA and E-OTD (Wilde et al., 2004). Among the top five wireless operators in the USA, Cingular, AT&TWS, and T-Mobile are based on GSM infrastructure. E-OTD technology was the initial choice but it could not satisfy all the requirements (Kerton & Kerton, 2003) Eventually, U-TDOA, a network-based solution, was adopted because it has a lower requirement for accuracy (Wilde et al., 2004). Operators with CDMA (Code division multiple access) technology such as Sprint-Nextel and Verizon adopted the handset solution-A-GPS, which means their positioning technology uses a type of GPS, which provides very high accuracy, but requires an upgrade in the handset.

Today, in the US, two technologies, U-TDOA and A-GPS, have the capability to meet the performance requirements outlined by the FCC in the E911 mandate and have been adopted by wireless operators to provide location services. (Wilde et al., 2004) Eighty percent of the USA's population now reside in areas where phone calls to 911 emergency services from a mobile phone now include delivery of the caller's call-back number and location to the appropriate Public Safety Answering Point (PSAP) (www.location.net.in, 2007).

At present, all top five wireless operators in the USA are in a position to benefit significantly from the implemented network infrastructure and their positioning capability. Besides the E911 emergency services, most of operators also provide different kinds of commercial location-based services (Maxon, 2005). Verizon is one of the top-five wireless operators and their services are based on CDMA EVDO technology. Its location technology is A-GPS, reaches 260 million Americans, and has 60.7 million customers.(Verizon, 2007d) Since most of the handsets sold in 2002-2003 and 100 percent of the new handsets sold by Verizon Wireless from December 31 2003 are GPS-capable, in order to comply with E911, a progressive approach has been used, first, older and non-GPS built-in handsets will not be turned off, but once it is disconnected it will not be reactivated. Second, only new GPS-capable handsets will be allowed to be activated on the network. Third, in emergencies, older phones that are not GPS-capable cannot assist in estimating their location (Verizon, 2007b).

Some location-based services provided by Verizon include "*Chaperone*", "*VZ Navigator*, *Field Force Manager*, etc. (Verizon, 2007d) Field Force Manager is a location-based mobile resource management tool that provides businesses with the ability to locate, monitor and communicate with their mobile field workers. (Verizon, 2007c)

There are four features of "VZ Navigator" services, the first being 'Navigation", which provides turn-by-turn directions with audible prompts when the customer is approaching a turn. The second is "Local Search", which provides the ability to search for places of interest such as restaurants, gas stations and ATMs. The third is "My Places", which provides quick access to locations users have saved or recent location searches customers have performed. The last one is "Maps", which provides the ability to select a location and view maps of the selected location (Verizon, 2007d)

The "Chaperone" service helps the customer determine the location of their child's or family member's mobile phone from the Internet to determine their position.(Verizon, 2007a) "*StreetFinder*" is a service that delivers maps, directions, and points of interest to a customer's mobile phone based on a customer's query. Fleet management services provided by Verizon are used to locate, monitor and manage vehicles equipped with the necessary vehicle tracking hardware from any office computer.

Besides these, there are some third party business partners that provide more location-based services. For example, Rand McNally Traffic is a third party application provided by the Rand McNally company, which uses the traffic information collected from aircraft, police, highway patrol, and many other sources to deliver real-time information on accidents, congestion, construction, road closures, event delays, toll plaza backup and personalized traffic maps.

The other wireless operators have services similar to Verizon's. Generally, location-based services which have emerged in the USA include navigation, direction, map, fleet management, field management, people finder and property management. Some of these location-based services come from a wireless operator (or cooperator with a third party company but who uses the operator's brand for marketing promotion) and some of them come from third party business partners. The following table is a summary of all the available location-based services from the top three wireless operators in the USA. The information is sourced from the operators' websites and white papers, and related news and reports.

Table 4 A summary of location-based services in the USA. (Source; author of this dissertation)

SERVICES	Examples	Company and services
EMERGENCY	Emergency calls	Sprint-nextel, Verizon, At&T,
	Automotive Assistance	Sprint-Nextel , Verizon, AT&T
NAVIGATION	Directions	VZ Navigator(Verizon) Sprint Navigation(Sprint-Nextel) TeleNav Maps (AT&T)
	Traffic Management	Sprint Navigation(Sprint-Nextel) TeleNav Traffic. (AT&T)
	Navigation	Sprint Navigation(Sprint-Nextel) TeleNav GPS Navigator (AT&T) VZ Navigator(Verizon)
	Group Management	Field Force manager(Verizon) fleet management(Verizon) Sprint mobile Locator (Sprint-Nextel) TeleNav Track(Sprint-Nextel)
INFORMATION	Travel Services	V TeleNav Track(Sprint-Nextel) VZ Navigator(Verizon)
	Mobile Yellow Pages	VZ Navigator(Verizon)

	MAP	VZ Navigator(Verizon) Sprint Navigation(Sprint-Nextel) TeleNav Maps (AT&T) TeleNav GPS Navigator (AT&T)
	Points of interest	Sprint mobile Locator (Sprint-Nextel) TeleNav GPS Navigator (AT&T) Sprint Navigation(Sprint-Nextel)
TRACKING	People Tracking	Field Force Manager(Verizon) Sprint Family Locator (Sprint-Nextel) Sprint mobile Locator (Sprint-Nextel) @Road GeoManager iLM™(Sprint-Nextel) AirClic® MP(Sprint-Nextel)
	Vehicle Tracking	fleet management(Verizon) Sprint mobile Locator (Sprint-Nextel) @Road GeoManager iLM™(Sprint-Nextel) AirClic® MP(Sprint-Nextel) Comet Tracker(Sprint-Nextel) TeleNav Track(AT&T)
	Personnel Tracking	Field Force Manager(Verizon) Sprint mobile Locator (Sprint-Nextel) AirClic® MP(Sprint-Nextel)

The future market of the US location-based services is forecast to grow from 582,000 to 1.1 million subscribed devices by the end of 2010.(In-Stat, 2006) One issue is location-enabled enterprise applications, which constitute a small but important segment of the market for mobile applications. Future applications mainly include business applications such as fleet management/dispatch, workforce and sales force management as well as a variety of public sector location applications. Another issue is the availability of handsets that are compatible with location-based services, which is largely dependent on marketing and expenditure decisions by carriers (In-Stat, 2006).

4.2 Location-Based Services in the European Union

Unlike the USA, in European Union (EU) countries, location-based service adoption was initially driven by business requirements and competition (Northstream, 2001) despite the fact that a significant number (50% to 70%) of the 80 million EU-wide emergency calls each year originate from mobile phones (Helios Technology Ltd, 2002). Following the E911 experience, in 2002 the EU Commission passed Article 26, a directive on universal service and users' rights relating to electronic communication networks and services("Directive 2002/22/EC " 2002). This article asks member states to develop national regulations for mobile operators to enforce the automatic positioning of emergency calls and all calls to a single emergency call number 112, called E112. But there are no positioning accuracy and implementation deadline requirements. Mobile network operators are to do their best to determine and forward the most reliable caller location information available for all calls to the emergency number (European Commission, 2003).

Experience and knowledge gained from the development of location-based services in the US brought benefits to the European Union emergency services. Two significant factors for the EU are they already have a unified wireless system (GSM) and competition in the US has already identified the advantage of some available technologies (Wilde et al., 2004). However, compared with the US, the variety inherent in European languages, its governmental structure, culture, and technical infrastructure increase the difficulty of achieving its objective. For example, the networks are defined on a relatively small scale, in hundreds of kilometres rather than thousands. Furthermore, each national area contains a mix of wireless providers that is not necessarily shared with their neighbors across the border. Each country's network contains equipment from numerous vendors, each with a different approach to standardization (Wilde et al., 2004).

Cell-ID is the most basic and inexpensive positioning technology for most GSM network operators, which localizes a subscriber to within a cell, or enhanced Cell-ID (Northstream, 2001). A few pure 3G operators such as "3" in the UK are offering A-GPS location services from the moment the network is launched. Today, without any specific accuracy requirements in E112, several other technologies have been deployed throughout the EU supporting various commercial location–based services. Cell-ID, U-TDOA, A-GPS and E-TOD were all considered suitable for E112. Another reason these technologies are adopted is that they require less expenditure for operators to update their network infrastructure (Mobile Europe, 2003).

In the UK, in September 2004, an Industry Working Group, led by the MBG (Mobile Broadband Group), published a Code of Practice for the use of mobile phone technology for passive location services in the UK. Today, each of the wireless operators in the UK can provide emergency services to customers which are mainly used for child protection and other content (Mobile broadband group, 2004). Other location-based services like mobile positioning and real-time traffic information is available to customers. In Germany, over one third of O2's customers have opted for the Genion service - a location-based billing plans, which offers a discount tariff at their home location. Through location-based tariffs the users can receive discounts on both voice calls and mobile broadband data traffic at home and pay regular charges elsewhere. Berg Insight estimates that 18 million mobile users in Europe will subscribe to location based billing plans by 2010 (OSS News Review, 2006). Table 5 is a summary of available location-based services in the European Union.

Table 5 Location-based services at Europe countries. (Source: Koutsiouris, Polychronopoulos, & Vrechopoulos, 2007)

Country	Company	Services	Country	Company	Services
Germany	Vodafone D2	Home billing	Italy	Vodafone Italy	Navigation
		Gas stations			Yellow pages
		Restaurants			Traffic information
		ATM finder			Fleet management
		Yellow pages		Telecom Italia Mobile	Navigation
		"Find your friends"			Taxi finder
		Fleet management			Fleet management
	O2	Home billing			Traffic information

		Yellow pages		WIND	
		Fleet management		H3G	
		ATM finder	Switzerland	Swisscom	Weather
		Entertainment info			Map
		Gas stations			Navigation
		Navigation			Friend finder
		Taxi finder			Yellow pages
	T-Mobile	Navigation		Sunrise	Weather
		Car finding			Home billing
		Home billing		Orange CH	Yellow pages
	E-plus	Fleet management			Tourist guide
		Find your friends			Navigation
Greece	Vodafone	Fleet management			Traffic information
		Fleet management		Tele2	--
		Gas stations		In&Phone SA	Business Customers
	Cosmote	Navigation (i-mode)		Coop	MVNO: Orange network
		Tourist guide (Voice portal)		Migros	MVNO: Swisscom network
	TIM	Navigation (maps)	Austria	Tele.ring	Yellow pages
		Yellow pages		Mobilkom	Navigation, Car security
	Mo'MAD	MVNO: TIM network			Road help, Travel calculator
	Frog Mobile	MVNO: Cosmote network			Yellow pages
UK	O2	Traffic information			Fleet management
		Maps (i-mode)		T-Mobile A	Fleet management
	Orange	Nearest bank, cinema, train station, Weather services			Yellow pages
	Vodafone UK	Fleet management		One	Yellow pages
		Yellow pages			Entertainment guide
		Maps and navigation (Vodafone Live!)			Traffic information
	Hutchison 3G UK	Maps, Navigation			Fleet management
		Nearest hotels, restaurants and shops		Hutchison 3G Austria	"Friend finder"
	BT Cellnet	O2			Navigation
	Virgin Mobile	MVNO: T-Mobile network		Tele2 A	MVNO: One network
	Tesco	MVNO: O2 network		YESSS!	MVNO: One network
	EasyMobile	MVNO: T-Mobile network			
	Talk Talk Mobile	MVNO: T-Mobile network			

Today, location-based services are popular in the European Union. Existing services cover a wide range from navigation, map, yellow pages, fleet and force management. In the future, research shows that by 2010, Navigation services will account for 48 percent of mobile location-based services. Eighteen million mobile users in Europe will subscribe to location based billing plans and A-GPS positioning is emerging as a preferred technology among operators in the European Union. The total revenue from mobile

location-based services is predicted to grow by 34 percent annually to reach about $622 million (Berg Insight, 2006)

4.3 Location Based Services in Japan

Japan is a leader in the development of location-based services (DTI Global Watch Service, 2004; Srivastava & Kodate, 2004). Two of the biggest wireless operators in Japan are NTT DoCoMo and KDDI. NTT DoCoMo started its location-based services in 1998, and now it serves more than 48 million customers. The initial network operated by NTT DoCoMo was Pacific Digital Cellular (PDC). In 2001, it launched a CDMA FOMA network, which was the first 3G mobile network in the world. Their positioning technology is based on Cell-ID. All services run on NTT "DoCoMo Location Platform" (DLP), which works for both 2G and 3G networks. Their location-based services are integrated as a part of the DoCoMo portal known as i-Mode (DTI Global Watch Service, 2004).

The most well-known location-based services from NTT DoCoMo is "ImaDoCoMo", which includes services like tracking, navigation, find nearest, yellow pages. For example, the iArea and i-Appli map services are Java mapping applications through i-Mode. There are two business modes as part of the NTT DoCoMo location-based services. One is content-based and the second is ASP-based (application services provider-based). In the content-based services, the mobile device provides location information directly to the content operator to require the services, and NTT DoCoMo earns packet charges on the data traffic generated. ASP gets location information through the DLP, and pays a location charge to NTT DoCoMo, while the customer pays a packet charge to NTT DoCoMo for the data traffic generated (DTI Global Watch Service, 2004).

The network infrastructure of KDDI is CDMA. Today, it also operates its 3G CDMA2000 network. The location-based service of KDDI is based on A-GPS technology and started in 2001. So far, there are more than 100 applications offered solely by KDDI (Kamil & Ellen, 2003). A famous location-based service platform is Naviwalk, which provides services such as maps, directions, navigation, yellow pages, route finding. For example, "*Safety Navi*" is a service allowing users to easily check the location of family members or other people they are concerned about (KDDI, 2005). *NAVITIME* is a simple and useful application that rapidly displays maps, directions and points of interest on your mobile phone. Based on the handset orientation (direction), the mapping information displayed is automatically updated by handset application software processing of mapping data returned by the network. COCO-SECOM services were initially developed to locate people and vehicles. Today, it also offers services for locating cash and valuables, cases, safes, automated teller machines (ATMs) and pets. There are also tracking services for commercial vehicle fleets and employees, and for prevention of child disappearance and abductions.

In Japan, services fall into three categories: They are 1) Carrier-hosted, 2) Mobile Station-hosted and 3) ASP-hosted (Kamil & Ellen, 2003). An example of a carrier-Hosted application, which resides within the network, is KDDI's *EZ@NAVI* service.

Mobile Station-hosted applications reside within the handset (or wireless device), making use of information provided by the network. These applications can be tightly integrated with the handset user interface and hardware such as NAVITIME which is provided by a third party company, Navitime. ASP-hosted application resides on servers outside of the carrier domain. While these applications rely on data transported by a carrier network, a company independent of the carrier provides the LBS. An example of an ASP-hosted application is the *CoCo SECOM EZ* provided by SECOM. Table 6 is a summary of available location-based services in the Japan.

Table 6 Location-based services at Japan. (Source; author of this dissertation)

Company	Services (example)
NNT CoDoMo (i-mode platform)	Emergency calls (limited to certain regions)
	Navigation and direction (*I-area*)
	Map
	Location information services (weather; Restaurant; Café; ATM; Convenience Store; Parking; Accommodation; Movie, Town Information(nearby places to visit))
	Train Connections 9Check train schedules and connections for your area).
	Traffic (Find the latest road information for your area).
	Finder family or friend(*imadoco*)
	Fleet management (*DoCo-desu-Car*)
KDDI (EZ-Naviwalk platform)	Emergency calls (limited to certain regions)
	Navigation service for pedestrians and driver.
	Traffic information
	Yellow page
	Maps
	Friend or family member location (*Safety Navi*)
	Direction
	Fleet management

Japan is currently leading in the development of location-based services but is falling behind in the development of mobile emergency services. Mobile emergency calls have increased sharply, for example in 2005, 5.54 million, or about 60 percent, came from mobile telephones (Ministry of Internal Affairs and Communications, 2007). In 2004 Japan's Internal Affairs and Communications Ministry (Soumusho) started working to change regulations with "The Emergency Location Reporting System", which automatically notifies the recipient organization of the call's location when a call is made to an emergency number (110 for police; 118 for Japan Cost Guard and 119 for fire station and ambulance) from a 3G mobile telephone or an IP phone. With telephones that are equipped with GPS, the GPS information is relayed, and with phones that are not equipped with GPS, base station information is sent (Ministry of Internal Affairs and Communications, 2007). This service was set to start with some organizations from April 1 2007, followed by gradual nationwide expansion.

4.4 Location-Based Services in the New Zealand

Two operators currently dominate the mobile market in New Zealand, Vodafone New Zealand and Telecom Mobile, and Vodafone has partnered with TelstraClear to resell mobile offerings (BuddeComm, 2006). Today, TelstraClear is already using Telecom NZ's CDMA network, and is starting to provide services to small and medium business customers (NZ_Herald, 2007; TelstraClear, 2007). In 2006, the fourth player, Econet Wireless New Zealand (EWNZ) was in the process of rolling out a network (BuddeComm, 2006).

Vodafone has 1.3 million mobile customers with a 51 per cent market share. Vodafone New Zealand operates the GSM and W-CDMA 3G network. Telecom operates on CDMA 1xRTT with the EVDO network. Both companies claim that they have 97 percent national coverage. Wireless operators have no legislated obligation to support location technologies through their networks. There is information to indicate that Vodafone has a primary Cell-ID location technology that is able to support some location-based services (Vodafone NZ, 2007). At present, only a few location-based services are available on the market.

Vodafone provides TXT message location-based services, one example being "*what's on?*" Using this TXT service customers can find places of interest such as restaurants etc, but these services are more like the yellow pages, and cannot detect the customer's location and provide related information. *"Close to me"* is another service provided by Vodafone TXT messaging. By using this service, customers can find an ATM, fast food outlets, vending machines, petrol stations, car parks, taxi stands etc nearby. But now, Vodafone has closed this service and replaced it with *SmartFind*. SmartFind is a subset service of Vodafone Live. Vodafone Live is a services package operating in the Vodafone 2.5 and 3G networks. Under the heading of 'Out & About', SmartFind allows the user to find a location, view a map, zoom in and get turn-by-turn directions from their location to the selected destination. SmartFind has a huge range of searchable locations including community features such as schools, public toilets and libraries, through to over 40,000 businesses (Cappel, 2005). For commercial applications, both Vodafone and Telecom provide fleet management to businesses. At Vodafone NZ, the service is called *Fleet Management*. Telecom, call it *"location +"*(Telecom NZ, 2007).

The fleet management services provided by both companies are services offered in cooperation with third party business partners and require a specific GPS device which receives the signal from the satellite, calculates the user's position then transfers the information to the user's company's control panel. Both Vodafone NZ and Telecom Locate+ service incorporates Navman, one of the most famous GPS navigation manufacturers in New Zealand. At the same time, some fleet management and property-tracking services are available from individual companies. These services are based on a similar mechanism that uses a wireless network to transfer the location information detected by the specific GPS device. An example is Snitch Inc., which provides a vehicle tracking service called "*snitch*" and a fleet management service called *Armada* to commercial customers (Snitch, 2007). These services run on the Vodafone network and use a combination of text alerts and web-based management software to give fleet

managers a real-time picture of where the fleet is. Some similar services are "*here I am*" (Here I Am Ltd, 2007) and "*Mr hawk*" (Mrhawk Company, 2007) which provide fleet management and asset protection, among others. All these services require a GPS position obtained through Telecom or Vodafone in order to transmit the data to the customer's PC control panel.

Table 7 Location-based services at New Zealand. (Source; author of this dissertation)

Company	Services
Telecomm , New Zealand	Fleet management (*location* +)
Vodafone, New Zealand	SmartFind (*Vodafone Live*)
	Fleet management

Currently, there is no mobile emergency services legislation or other related legislation in New Zealand.

4.5 Summary

In this chapter we investigated development, available services, technologies, and relevant legislation of location-based services in the USA, Japan, European Union and New Zealand. The available services presented were diverse and can be classified by the existing research results into emergency services, navigation, tracking etc. One important point is that emergency services emerged as a very important service in most of these researched countries. Information in this chapter provides us with a realistic picture of location-based services, as well as an opportunity to explore the differences between New Zealand and other research subjects, which will allow us to further study the issues which influence location-based services in New Zealand.

Chapter 5 Discussion

This chapter focuses on processing the research questions, analysis and comparison of the development and reality of location-based services in the USA, European Union, Japan and New Zealand. First, previous studies will be summarized and applied to the landscape model to explore the differences from a landscape perspective. The differences from a development perspective will be based on the three-stage development model (maturity model). Significant factors that influence location-based service development will be identified from studying the development process. Finally, recommendations concerning a more rapid development of location-based services will be provided. .

5.1 How does New Zealand differ from other more technologically advanced countries in its development of location-based services?

In the previous chapter, we studied location-based services in the USA, Japan, the European Union and New Zealand. In the USA, location-based services started with the emergency services regulation. Today, positioning network infrastructure is well constructed. All wireless operators provide emergency services based on the E911 commitment. Besides emergencies, many commercial location-based services are available in the market to both business and private customers. The services can be classified and matched to categories from previous studies such as, tracking, navigation, information, and billing. Location information for these services includes maps, yellow pages, and dynamic information like real-time traffic information, business promotions and business information. E911 legislation ensures that wireless operators provide location information to the public while protecting privacy. Some private information legislation extends to location-based services to protect the privacy of location information.

Japan has more mature and more successful location-based service development than both of the USA and the European Union. Some successful Japanese business models, like DoCoMo, have been studied and adopted around the world. In Japan there is a well-operated positioning network infrastructure and location-based services have been available for a long time. Users include business and private customers and cover most mobile phone users. Services like those in the USA cover a very wide application area. Information provided by the services includes maps, yellow pages, the real-time traffic information, business promotions, etc. Although development of emergency services is behind that of the USA and is under-developed, location information legislation has been developed well early on.

In European Union, positioning network infrastructure has been constructed. Many services are available and cover a wide range of applications. Emergency services (E112) have been proposed and most wireless operators can provide basic location information in emergency situations. Legislation relevant to location-based services is still being formulated, but other regulations have been used to ensure location information security.

In New Zealand, location-based services are under-developed. Research shows that such services are lacking in the market. Positioning network infrastructure has not been officially supported. There is no legislation requiring wireless operators to provide location information in an emergency. No related legislation has been published or developed.

To assist in the analysis and comparison of the current location-based service situation in the areas covered, a landscape model has been applied. This model looks at four aspects; location technology, available services, location information and relevant legislation. A summary table is applied to the landscape model shown below:

Table 8 landscape in the USA, Japan, European Union and New Zealand (Source; author of this dissertation)

Area	Location technology	Available location–based Services			Location information		Legislation
		Commercial	Private	Emergency services	Static	Dynamic	
USA	A-GPS U-TDOA	Fleet management Force management Property tracking Traffic information	Navigation Friend finder Interest point Direction Tracking Traffic route	Yes (E911)	Yes	Yes	Some (Mobile Emergency Services)
Japan	A-GPS Cell-ID	Fleet management Force management Property tracking	Navigation Friend finder Interest point Direction Tracking Route Weather	Yes (110,119, 118 emergency call)	Yes	Yes	Some (The Emergency Location Reporting System)
European Union	Cell-ID, U-TDOA A-GPS E-TOD	Fleet management Force management Property tracking	Yellow pages Tracking Direction Traffic Finder	Yes (E112)	Yes	Yes	Some (Directive 2002/22/EC)
New Zealand	Cell-ID*	Fleet management* tracking *	Tracking* Find close*	None	Yes	No	None

*Cell-ID technology exists on the Vodafone NZ network but is not officially supported
*Location-based services in New Zealand like fleet management, tracking etc are not based on Cell-Id technology.

The following discussion will be based on the above landscape model in order to analyze the differences between location-based services in New Zealand, the USA, Japan and European Union.

5.1.1 Differences in location technology

Technology is an important factor in location-based services. It is a fundamental requirement. In the USA, Japan and Europe, there are different positioning technologies that have been adopted based on network infrastructure. These location technologies have been implemented in most networks and can generally achieve 20-100metre accuracy. That means, location-based services can be achieved with the current network infrastructure and third party devices are not required.

In New Zealand, Vodafone NZ has the basic Cell-ID technology which can be used for location services but operators are not willing to provide related location-based services. (Vodafone NZ, 2007) One possible reason is that limitations of the existing technologies would not satisfy location-based service requirements either in capacity or accuracy. Telecom NZ has no official information about positioning technology in its network infrastructure.

5.1.2 Differences in available location-based services

The survey shows that in the USA, Japan and Europe, there are many services available in the market. These services provide both commercial and personal applications. Mobile emergency services were seen as a high priority among location-based services in these areas. Besides services from wireless network operators, there are many applications from third party companies, for the benefit of professionals in particular fields, and these services usually focus on a particular market and provide high quality service. Services such as fleet management, force management, tracking, location finder, yellow pages and route, navigation are key in attracting customers.

As seen in Table 6, there are some location-based services offered by wireless operators in New Zealand. Most of them focus on commercial customers like fleet management. In addition, there are some new entrants (third party companies) working in the same market and providing similar services. Compared with the other areas, the spectrum of location-based services is rather limited. A prohibitive factor is the lack of networks that can provide positioning ability, which means that all services requiring positioning would require an additional third party device.

5.1.3 Differences in content of location information

Location information includes the user's GIS information and location-aware information, some of which is static while some dynamic. Information such as maps and yellow pages are static, they can be kept a little bit longer before needing to be updated. Dynamic information, such as traffic status and business information such as promotions need to be frequently updated. Static location information is the basic information provided in most

location-based services. Advanced applications can integrate static information such as maps and dynamic information such as real-time traffic information to a customer's handset through the automatically detected user location. In the USA, Japan and the European Union, the services can provide both static information and dynamic location information. For example car navigation can display maps (2D or 3D) and calculate the route based on the pre-input source and destination, dynamic traffic information is also displayed to help the driver and to calculate new routing.

In New Zealand, the most common location-based services are the yellow pages and fleet management. Location information in these services is based on static GIS information such as maps and telephone information, and dynamic information such as real-time traffic information, which has been widely used in navigation, has not yet appeared in New Zealand.

5.1.4 Differences in location-based service legislation

Today, legislation related to location-based services focuses on two issues. One is the use of location-based services to provide public safety and protection, such as providing location information in an emergency. The other issue is to prevent location information abuse and protect privacy. Following a rapid increase in mobile emergency calls, emergency location services have emerged as a key service in public safety and an important location-based service. The USA, Japan and the European Union have already legislated for mobile emergency services.

Protecting location information and privacy is a complex issue. Today, there is no legislation that focuses on privacy in relation to location-based services. Some related legislation can be used to cover this area as in the USA, the Privacy Act of 1974 prevents the disclosure of any record which is contained in a system of records by any means of communication to any person or agency (Dawn, 2005). In The European Union, privacy is protected by several pieces of legislation, the legal framework of location-based services has been studied and this process is ongoing (FIDIS, 2007). In Japan, besides the mobile emergency requirement, Guidelines on the Protection of Personal Data in Telecommunications Business of 1998, clearly established that operators shall not disclose location information (the information indicating the location of the party in possession of a mobile terminal) to a third party except when the data subject gives consent. In 2003, the Personal Data Protection Law superseded all previous legislation and protects consumers' privacy as well as allowing location-based services to develop (Ackerman et al., 2003).

In contrast, in New Zealand there are no regulatory requirements with respect to providing location information in case of an emergency. At the same time, there are no regulatory requirements with respect to protecting private location information.

5.1.5 Differences from the perspective of development

In the above paragraphs, analysis was based on the current location-based service environment. In this section, analysis will address the differences in development process. In order to understand these differences, a three-phase development model (maturity model) is proposed to identify the development level of location-based services of each of the four research subjects; the USA, Japan, the European Union and New Zealand.

Since location-based services are an intersection of mobile wireless communication, positioning technologies and GIS location information, phases in the development of location-based services reflect the level of advancement in positioning technologies and network infrastructure, the available scope of services, and the quality of GIS location information. In addition, as it is so important, legislation of location-based services has been taken into account.

Looking at Figure 3, in stage one, "location-based services possible", mobile network infrastructure lacks positioning ability and accuracy is less than 300metres, the infrastructure cannot complete positioning independently. Services are based on static location information, there is a lack of dynamic information and relevant legislation. When stage two is reached, "location-based services feasible" location-based services have an operable positioning infrastructure with accuracy at 20-200metres, and the system has independent positioning ability. Services include static and some dynamic GIS information, there is some legislation to improve and control location information applications. In stage three, "location-based services viable", there is a well-established positioning network infrastructure. The positioning infrastructure is fully operable, has 20-50 metre accuracy, and it can independently complete all tasks. The services include static and dynamic location information. In each of these phases positioning ability is supported by the whole network. Legislation covers both emergency and location information protection.

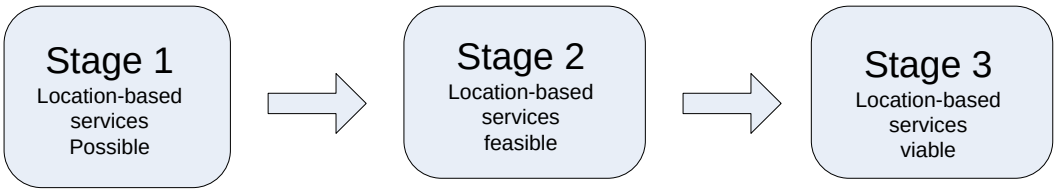

Figure 3 Proposed three stage development model (maturity model)

Table 9 The criteria for the three-stage development model (maturity model). (Source; author of this dissertation)

	Criteria			
	Infrastructure	Services	GIS location information	Legislation
Stage 1	lacks positioning infrastructure deployment	Few	Static information	Few
Stage 2	Operable positioning infrastructure	Many	Static and some dynamic	Some
Stage 3	Well-operated infrastructure	Many	Static and dynamic	Covers many aspects (includes specific legislation)

Based on the three-phase development model (maturity model), the development of location-based services in the USA, Japan and The European Union (EU) can be identified as having reached Phase two. In these regions/countries, network operators have an operable location infrastructure, which has positioning ability; positioning can achieve 50-200metre accuracy both in the case of network-based positioning technology or phone-based positioning technology. These infrastructures have the ability to complete positioning independently with third party devices such as GPS. Network operators and third party companies have made many services available – including both static GIS information such as 'find the closest place of interest', and dynamic GIS information such as real-time traffic information in car navigation.

In New Zealand, mobile network infrastructures lack basic positioning ability. The technology used for positioning, such as Cell-ID, has 300metre accuracy. The most popular services - fleet management and tracking services rely on the positioning ability of third party GPS devices. Information used in location-based services is mostly static information for example map and yellow page in Vodafone SmartFind. Based on the criteria of each of the phases in the proposed evaluation model, the development of location-based services in New Zealand can be identified as having reached phase one.

5.2 Factors in Developing Location-Based Services

The literature survey shows location-based services involve many issues including, positioning technology, geographic information, user requirements, price, legislation, business strategy etc. All these issues influence location-based service development and the following section analyses the development process in the USA, Japan and the European Union as a way of identifying the significant factors in location-based service development.

Examining the development of location-based services in the US reveals that they were almost exclusively driven by E911 regulation and meeting E911 requirements was the top priority for mobile network operators with respect to location-based services, and providing value-added location-enhanced services was a distant second.(Kerton & Kerton,

2003) Two main influences of the E911 regulations are: 1) the accuracy requirement affected technology choices, and 2) the deadline for E911 compliance sped up location-based service implementation. E911 regulation includes requirements not only for the wireless network operators but also for emergency services, public services etc. From the network operators' side, duties include locating the caller and transferring the location information with the caller's number to the emergency services. Because the existing network infrastructure has no ability to automatically determine a caller's location, developing location technology and infrastructure become the main task for network operators. To complete deployment before the deadline, operators have had to find appropriate technology to meet both the time and positioning requirements. Some GSM operators, like T-mobile and AT&T etc, when initial in-phone E-TOD technology could not achieve the accuracy needed for E911, adopted network-based positioning technology, as it has a less strict accuracy requirement. Although the deadline for compliance has been postponed due to technological and financial problems, today, both government and the operators benefit from this new positioning infrastructure. For the government, they can provide mobile emergency services to the public. Operators can provide various location-based services that have the potential to increase their revenue.

The development of location-based services in Japan illustrates a different course. Location-based service development was driven by network operator business strategy to find new services to increase profit (Ackerman et al., 2003). Location-based services in Japan initially started in 1998. Before an emergency requirement had come about, most Japanese operators had already implemented and upgraded their network infrastructure to include positioning ability. In the middle of 2003, KDDI upgraded its network to allow mobile-based positioning and all position fixes can be provided in two seconds to allow true turn-by-turn navigation (DTI Global Watch Service, 2004). Today, through early adoption and upgrading of the location network infrastructure, Japan is in the leading position in regard to location-based services in the world. Their development of location-based services has been studied by many countries and researchers(DTI Global Watch Service, 2004; Kamil & Ellen, 2003). Since mobile emergency calls have rapidly increased, in 2004, the Japanese emergency services asked network operators to provide 15metre positioning accuracy and for this to be delivered within a 15 second period. The Japanese mobile emergency call positioning requirement also asks that by 2009, 50% of all handsets should be GPS capable, and by April 2011, 90%. (DTI Global Watch Service, 2004) This requirement will greatly affect A-GPS cell phone development and adoption. Therefore, in Japan, business strategy is an important factor in location-based service development. The influence of regulation is that it accelerates the provision of location-based services and could potentially change the future of technology.

In the European Union, the primary effort towards location-based services is similar to Japan. Location- based services is a means of increasing revenue for operators(Ackerman et al., 2003). Based on the successful experience of Japan, wireless network operators started location-based service implementation in 1999. Following the US emergency services experience, the European Union proposed E112 for mobile emergency services in 2002. Today, following the network infrastructure upgrade and advances in technology, there are many services available in the market from navigation and field management to

child protection etc. In the European Union, business strategy is the main driver of location-based service development. Regulation of mobile emergency calls will accelerate its development.

So far, analysis of the USA, Japan and the European Union location-based service development process shows legislation of location-based services and operator business strategy are important factors in location-based service development.

Besides legislation and business strategy, positioning technology is another important factor in location-based service development. Positioning technology is a fundamental issue in location-based services, and gives rise to two main issues in location-based service development. First, the huge investment in upgrading location technology is always a challenge for businesses and the public sector. Second, although not all services require high location accuracy, some services are likely to benefit from higher accuracy. Since the required investment for highly accurate technologies is quite high, a balance between costs and benefits must be considered. That is why most European and Asian operators are using the fairly inexpensive Cell-ID technology. Even in the USA, in order to meet emergency requirements, the government have had to impose levies to support technology implementation and upgrading(Kerton & Kerton, 2003).

5.3 Demand for Location-Based Services

Value chains or value networks show that several actors co-operate to deliver location-based services(Peppard & Rylander, 2006; Steinfield, 2004). Network operators, services providers, content providers and customers are all important actors. Network operators provide network equipment including air interfaces, core communication capabilities and positioning ability. Content providers have the information and services that wireless customers desire and eventually, a service provider packages a service to be delivered to the customer.

Today, the requirements of developing location-based services are extensive. Each actor in the value chain is required to develop these new services from their own perspective. For the network operator, there are two ways to increase their revenue. One way is to increase customer numbers and another one is through increasing usage by existing customers of their mobile devices. Increasing customer numbers is becoming difficult, because attracting customers from competing operators will eventually becoming a zero sum game because competitors too are looking to attract customers in a similar fashion. Research shows in Europe, churn rates are running at around 30%, with subscribers jumping from plan to plan and provider to provider (MapInfo, 2001). Using new services to attract customers to make greater use of their mobile devices appears to have more potential. In the future, voice services will not be such an important part of a company's business, and significant value will not be created through the transmission of digital 'bits'. Cost is based on the amount transmitted, not connection time or distance. Value, rather than pure cost, is what is important and should be a key driver in the construction of any competitive strategy (Peppard & Rylander, 2006).

On the customer's side, the attitude of users towards location-based services in most research was quite positive both in group interviews and in user evaluations (Bayer, Ross, & May, 2004; Kaasinen, 2003; Osman, Maguire, & Tarkiainen, 2003). Location-based information was expected to be especially useful in special situations such as in unfamiliar environments and location-based services were found to have a wide variety of uses (Kaasinen, 2003).

The expectations of emergency location-based services are high (Anghelina, Kögel, Köhler, Propstmeier, & Loy, 2005). One of the fundamental roles of government is to help ensure the security and quality of life of its citizens. Today, telecommunications and information networks have been identified as critical infrastructures for of quality of life (Gavras, 2007). An increasing number of mobile phone emergency calls has forced governments to recognize the importance of acting on mobile emergency calls. E911, E112, and the Japanese mobile emergency call legislation are good examples. Today, more and more countries are considering mobile emergency services, such as India, Malaysia, Korea etc.

5.4 Issues for Location-based Services in New Zealand

Our study shows that there is a big gap between location-based services in New Zealand and other technologically advanced countries. Location-based services development in New Zealand falls behind the USA, Japan and the European Union. Compared with these countries, location-based services in New Zealand apparently lack commercial application, have poor positioning accuracy and infrastructure. Location-based service development in those countries researched shows government legislation, operator business strategy and positioning technology are significant factors influencing location-based service development. Today, location-based services as a potential way to increase business revenue; a critical service for public safety and civil protection; an attractive tool to enhance quality of life, get more and more attention and investment. Developing location-based services is a challenging task faced by both government and business in the future. Understanding factors and issues specific to the New Zealand environment, learning from the experience of other technologically advanced countries will add significantly to future efforts.

5.4.1 Requirements for New Zealand

Besides increasing operator revenue, providing new opportunities for businesses and improving services for customers some issues particular to New Zealand strongly require location-based services.

Tourists form a very important part of the New Zealand economy. Tourism is one of New Zealand's largest and most important industries, comprising 4.8 percent of GDP, 5.8 percent of employment and 18.7 percent of total exports in 2005 (Statistics New Zealand, 2006). Location information such as restaurants, closest shops, theaters and routes are important information for tourists. The needs of the tourist include functions of location-based services: (1) locating of persons, objects, and places, (2) routing between places, people or objects, (3) searching for objects in proximity such as restaurants, shops, hotels,

or sights, and (4) information about traveling conditions, such as traffic-related data. Mobile location-based services have the capacity to satisfy these requirements. Advances in technology and services will bring more opportunity to New Zealand benefiting individual tourists and the entire industry and economy.

Public safety and protection is another area where location-based services can be deployed. The need for mobile emergency services is strong worldwide and of course in New Zealand as well. The message from New Zealand fire service and ambulance shows support for legislation that would require Telecom and Vodafone to install the technology and make it possible to see location details and account details from cell phones (Schwarz, 2006).

5.4.2 Advantages and challenges facing the development of location-based services in New Zealand

In facing the development of location-based services in New Zealand, there will of course be challenges and some advantages. Understanding these issues will help future location-based services.

One plus for New Zealand is that several technologies have been tested and widely adopted. A significant technology for location-based services is A-GPS technology. Today, the A-GPS handset represents a good future-proof technology based on its accuracy and it has been forecast that 25% of WCDMA handsets will offer GPS by the end of 2008. (ABI, 2006) Even in New Zealand, about 20 per cent of Telecom's 1.88 million mobiles, including the vast majority sold since April 2005, have "assisted GPS" technology, or A-GPS. Vodafone, on the other hand, says only a handful of its phones are A-GPS-capable. (Schwarz, 2006)

Upgrading the location network infrastructure will be the first task for operators and will require a huge investment. For example, in the USA, for the TOA infrastructure, some quotes were US$10,000 to $30,000 per cell tower site. With more than 104,000 cell site base stations the cost for E-OTD or TOA solutions in the US could reach US$3 billion (McGeough, 2002). To aid the operators' investment in upgrading their network, the US government applied an extra tax on cell phones help make up any shortfall (Kerton & Kerton, 2003). Technological advances may help decrease the cost of upgrading.

Although we have not found any studies in this area, low population density in New Zealand would be a disadvantage in developing location-based services. Although, several technologies have been examined and proved suitable for location-based services, the particular geographic environment and sparser population would still be a challenge. Since the emergency service is a high priority in location-based services, the technologies need be carefully studied before adoption. When and how to develop location-based services in New Zealand is an issue for both government policy and business strategy.

A study of the New Zealand telecommunication market (Kaspar, 2006) shows a light regulation regime has delayed the development of competition. At the same time,

technological differences between the two national mobile networks set up by the only two competitors, Telecom NZ and Vodafone NZ has resulted in less intra-technological competition. In New Zealand, network operators can rely on a relatively high monopolistic scope, which – in conjunction with low market regulation - has resulted in high termination fees. Today, customer revenues in New Zealand are mainly driven by voice communication but the use of data services has grown strongly as a result of new services (Kaspar, 2006).

5.4.3 Improving development of location-based services

From previous studies, legislation, business strategy and technology are significant factors influencing location-based service development. Existing examples show two possible ways to develop location-based services. As in the USA, location-based services can be driven by policy and regulation. Whereas in Japan and the European Union, location-based service development has been mainly driven by business strategy. In Japan, emergency location requirements are seen as key drivers for improving location-based service performance and for driving the adoption of GPS-enabled mobile phones (DTI Global Watch Service, 2004).

Today, due to its small size, physical isolation and limited regulation, the New Zealand telecommunications market is considered to be an appropriate test market for product and service innovations by international telecommunications corporations (Ministry of Economic Development, 2005). But it is also a most costly market in terms of mobile communications (NZIER, 2005). In contrast wireless companies in Japan and the European Union have intense competition which forces them to develop new applications and services to attract customers and further increase their revenue. New Zealand is also unlike the USA, where the government plays a key role through legislation which forces operators to provide emergency services which then drives location-based service development. These issues can be addressed in order to speed up location-based service development.

Some studies show that lack of legislation in the telecommunications market is the main reason for a lack of competition in the mobile market (Kaspar, 2006). In general, competition is a key factor in driving operators to find new opportunities, provide new services and adopt new technology. Secondly, the location-based services are a critical application for public safety. As seen in other countries, it is only achieved by government legislation. Thirdly, although advances in technology would reduce the cost of deploying the location infrastructure, it still requires a big investment and would involve other government departments. It would require the government to solve the conflict between what is required and investment needed. In New Zealand, even though there is still no widespread positioning infrastructure, Telecom and Vodafone say they are willing to put in upgrades that allow location tracking, but are not going to pay for them, saying that that is up to the emergency services (Schwarz, 2006).

Based on the above analysis, legislation would be an important factor that will influence location-based service development in New Zealand in future years. Regulation would mainly need to cover 1) increasing competition among mobile telecommunication companies, 2) legislation forcing operators to provide mobile emergency services in order to improve all location-based services.

5.5 Summary

Based on information presented in the previous chapter, to which the landscape and development models (maturity model) were applied, differences between location-based services in New Zealand and other countries were viewed from two perspectives. The study shows that there are big gaps between New Zealand's position and that of other countries. Examining the development of location-based services in countries, emergency legislation, operator business strategy, and technology emerged as significant factors in developing location-based services. The New Zealand mobile market has little competition and has no relevant emergency legislation, and these factors are delaying location-based services in New Zealand. One recommendation to develop location-based services more rapidly in New Zealand is to improve relevant legislation, which would need to cover two aspects of the mobile market. Improving competition between operators and legislating for the provision of mobile emergency services is a trend in the world, relevant legislation will accelerate location-based services development and at the same time bring benefits to the public.

Chapter 6 Conclusion

Location-based services are an important application for the future, which will benefit businesses and the public. Safety, convenience, and productivity are three value propositions from location-based services for the end user (MapInfo, 2001).

This document focuses on the current situation of location–based services in New Zealand, how it differs from other countries and what issues can be addressed to speed up development. A multiple case study has been conducted which observes location-based services in four countries; the USA, Japan, the European Union and New Zealand, and explores factors that influence location-based service development in these countries. Research models show New Zealand has fallen behind other countries in its location-based service development. This lag is reflected in four areas: positioning technology infrastructure, available services, location information and legislation. New Zealand has poor positioning infrastructure, available applications are far fewer than others countries, relevant information provided by location-based services is static and there is a lack of legislation to drive development or protect location privacy.

In this document, mobile emergency services legislation, operator business strategy and positioning technology are significant factors in developing location-based services, but play a different role in different areas. In the USA, legislation plays a critical role in driving location-based services. In Japan and the European Union, operator business strategy is the main motivator of initial development.

New Zealand's small size and physical isolation makes it a good place for testing wireless technology but loose legislation in the mobile industry has caused a lack of competition between wireless operators resulting in high service costs and slow adoption of new technologies. Today, there are many reasons for developing location-based services in New Zealand. Developing New Zealand's economy and ensuring public safety are two main factors. Specifically, the convenience of location-based services and mobile emergency services has potential for the tourism industry.

Based on these specific aspects of the mobile environment in New Zealand, and analyzing the experience of other countries/areas and their environments, legislation is identified as a significant factor for New Zealand location-based services development. Legislation can address two issues by improving competition in the mobile market, forcing wireless operators to more energetically adopt new services and technologies and emergency service legislation would force operators to upgrade their positioning network infrastructure, bringing benefits to all location-based services. Therefore, in order to accelerate location-based service development in New Zealand, legislation is the key factor.

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