Modelling Service Delivery System for Wireless Handsets using Instant Alert and Frequency Scanning Technologies: An approach for Bus Service Application

Johnnes Arreymbi[1] & Abdullah Al-Zakwani[2]
School of Computing and Technology
University of East London
Essex, RM8 2AS
Email[1]: j.arreymbi@uel.ac.uk Email[2]: a.al-zakwani@uel.ac.uk

Abstract

Mobile and wireless Internet enabled-devices are transforming business processes, communication and scheduling of individual daily activities. The m-business platform has arrived, in which hand-held devices are the user's front-ends to access enterprise and personal data. Such service data are typically in the form of summarised information tailored to suit the user's needs and timeliness. This paper will address the issues of time and energy efficient delivery of summarised information to mobile hand-held device users. It will also present a comparative analysis of various technologies involved and proposed a system model to possibly implement instant messaging alert system for bus service delivery within a mobile environment. Such a system will have the ability to update and supply effective and efficient timed services to the various interested parties subscribed to the system – an example of the London Bus Service system, enabling users to get fast timely access to bus travel and resource information.

Keywords: *Mobile commerce, Progressive delivery, Mobile Computing, Mobile tracking, Content Broadcast and Scheduling, Bus Services.*

1. Introduction

The awkward physical experience of waiting for a public bus on a cold winter day is soon to be a thing of the past. The advent and progressive developments in mobile telecommunication, the Internet and WWW technologies have together simplified and facilitated mans desire to be in touch and contactable anytime, anyplace. To be able to make instant mobile decisions, users very much rely on up-to-date, business-critical data [1]. With the mobile devices' expansion and miniaturisation, it now possible to also fit network based devices and/or tracking devices into a compact and continuously moving areas such as public bus systems. And with a clever application on the mobile handset, a client could be sitting on a sofa in his home while waiting for a bus. When a bus then get within the device range, an instant alert signal would be triggered to alert the user in time to catch the destined bus at the bus stop. The set up technologies could be achieved using various and already existing mechanisms, following a number of ways:

- The availability of Bluetooth enabled devices, which is one easily exploitable mechanism and very efficient.
- Use of existing tracking devices and bus tracking devices that continuously update in real-time, the time remaining for a bus to get to stop.

- Use radio waves to transmit signals, measure the signal strength and locate the near-location of the bus, with special software in the device to translate the distance and estimate the speed and thus the time to get to the stop.

There are however, many other methods available but in this paper, will cover only the above three methodologies.

2. The mechanism and techniques

The service is based on a signal being transmitted from the bus on a specified radius. This transmission is then received by the mobile device and through special software the signal strength (measured as voltage per square area) is ascertained and is converted into the distance the bus is being perceived to be, due to the strength of the reception.

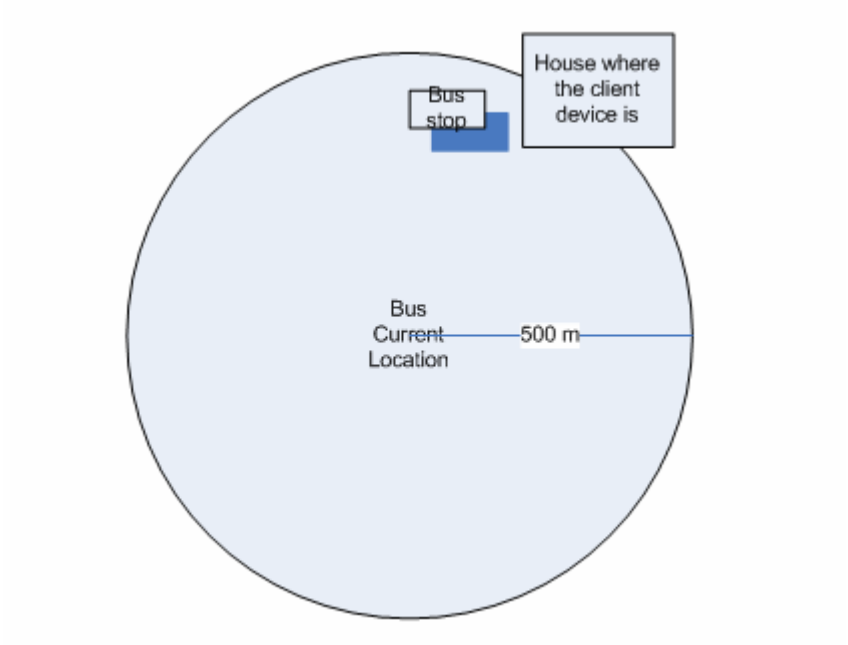


Figure 1. A mechanism for bus alert Service

Reading the signals strength, the embedded software could calculate roughly the whereabouts of the bus [7]. Therefore, as the system software receives the transmitted signal, it will measure the signal strength based on the distance and measured as voltage per square area in decibels (dBm). And according to its interpretive knowledge, the system could translate the distance from the receiving mobile device to the transmitter device. The Figure 2 below demonstrates the structural approach of its software translation mechanism.

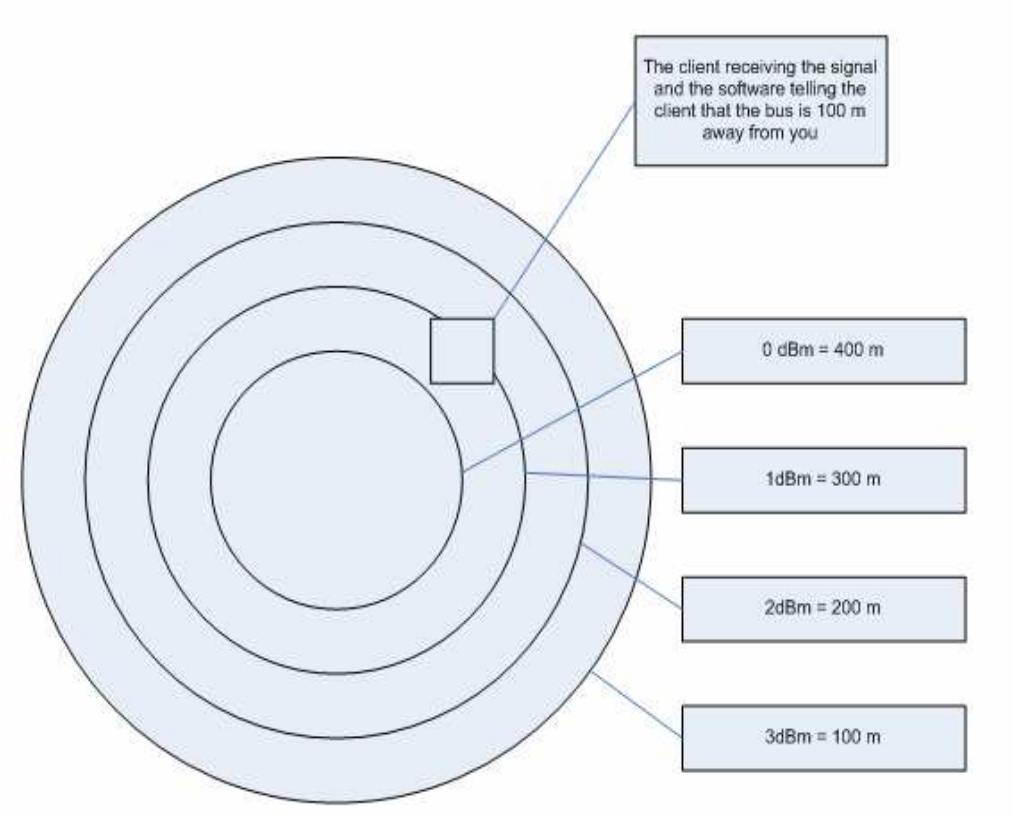


Figure 2. The software translation mechanism

The above system employs and uses most commonly used technologies.

3. Cost Effectiveness of the technology

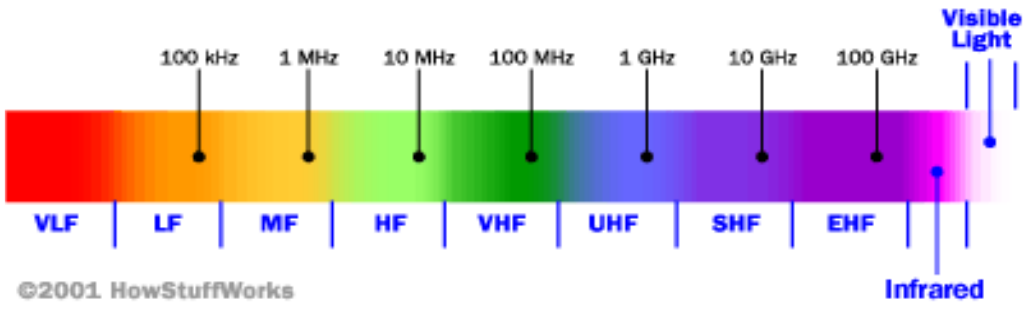
The production and adoption of this technology has its own implications, such as cost effectiveness. The cost effectiveness of this system is its ability to adapt and use some existing and readily available technologies. The use of readily available technologies is one way of keeping and managing deployment costs low. According to [13], Transport for London (TfL) recently commissioned over £120 million to improve the London bus service. This project is supposed to also improve bus tracking systems and to deliver improved accuracy of information and countdown displays at the bus stops [6]. London bus systems have been using beacon system to track buses. The system works by placing the beacons on the roadside and as the bus passes, a signal is sent to a central control point and which is then relayed to bus operators who in turn update the displays at bus stops. This structure has been initiated through automatic train control developed by [10]. The problem with using pure beacon based structure is that, when the bus gets caught in traffic, the system simply cannot detect it and thus giving wrong information at the bus stop displays. Some of the technologies would be exploited as below to determine their possible application within the system:

3.1 Radio Frequencies

Radio frequency is a modulation mechanism that uses an electromagnetic wave that is propagated by an antenna. The actual word frequency implies directly to the actual cycle that the wave takes to travel to its destination. Radio waves can be modulated at different frequencies. Therefore, it is possible for two devices to communicate using a specific frequency and such that, the device it aims to communicate to, can pick up that frequency and respond to it. The possible frequency modulations that can be used in these services are:

- *Amplitude Modulation (AM) radio* (bands from 0.535 MHz -1.7 MHz)

- *Short Wave (SW) radio* (bands from 5.9 MHz - 26.1 MHz)
- *Frequency Modulation (FM) radio* (bands from 88 MHz - 108 MHz)
- *Global System for Mobile communication (GSM) -900* (bands from 890 - 915 MHz)
- *GSM-1800* (bands from 1710 - 1785 MHz)
- *GSM-1900* (bands from 1850 - 1910 MHz)
- *Universal Mobile Telecommunications System (UMTS)* **(**bands from 2110-2170 MHz)
- *Bluetooth* **(**bands from 2400 – 2483.5 MHz)



The Radio Frequency Spectrum. [5]

All the above mentioned bandwidths could be found on the LF, MF, HF, VHF, UHF, and SHF in the spectrum. However, in this paper we will only concentrate on the VHF – SHF frequencies and their modulation capability as used in the mobile devices.

3.2 GSM and UMTS transmission capability.

The antennae radio wave transmission capability of mobile devices is in fact very limiting. GSM and UMTS mobile communication devices normally use low-power transmitters and receivers (TX/RX, TXCO, and Synth), that are fitted inside the confined device and controlled via Radio Frequency Circuit (RFC). Mobile phones have signal strengths of 0.6 watts or 3 watts which is very low compared to the common FM, which operates normally at 4 watts (with ranges from 1 watt to 14 watt). This is very high compare with Bluetooth operating at 4 watts.

The use of very low frequency is appropriate for this system in that, with the very small range of bandwidth available for the Mobile devices, it is necessary to be able to re-use the frequency bands for connecting calls (only 56 different bands are available on every base station). Also, even more sophisticated frequency allocation is needed to be employed as with only 56 different channels per base station, only 56 calls can be placed at one time. Therefore, a small output signal limits the transmission strength and thus a base station will only transmit to only a small distance (unlike FM and AM). This guarantee that each base station can have the same frequency channel and still operate without interference or other channel associated problems [5]. Another advantage of using low power output is conserving the very minimal power battery available on the mobile devices[1].

4.0 Comparative analysis of the various technologies

This section provides an argument as to which technology best suit the bus alert system. It looks at FM, AM, Bluetooth, WAP and GPRS technologies to determine suitability and then propose a new model to best determine and provide adequate solutions.

4.1 Applying FM for the service

The proposed system is intended to use FM technology. However, the problem with relying on FM signals is that, the available spectrum is very small, with little scope for expansion. And with the number of buses available on the streets of London, so many spectrums will be required, about 700 frequency bands of the FM spectrum. This thus forces serious implication on radio stations and other

services using the spectrum. Transport for London [12] reported that “every weekday over 6,800 scheduled buses carry around six million passengers on over 700 different routes”. With such capacity, the system is bound to have technical difficulties. Spectrum allocation is normally done by an organisation that decides who is able to use which frequencies and for what purposes. For example in the United States, the Federal Communications Commission (FCC) and in the United Kingdom, the Office of Communication (OfCom) makes the decisions for various service needs).

FM is normally modulating at 88 – 108 MHz (millions of cycles per second). This means that the transmitter can oscillate at a frequency of 88,000,000 – 108,000,000 cycles per second. Therefore a device with a reception capability can catch the wave transmitted in any band of frequencies on the given oscillation.

The problem using this mechanism to provide this service is that, not all the commonly used phones in the market support FM signals receptions. However a number of strategies discussed later would attempt to resolve the problem.

4.2 Using AM for the service

The AM bandwidth has very similar problems as using FM and even worse is the fact that, AM frequency has even small range for bandwidth. This will result to more constraint on available bandwidth and judging the required amount of division. AM waves range from 0.535 MHz to 1.7 MHz which means that AM frequency modulates between 535,000 to 1,700,000 cycles per second.

Apart from also having similar problems like those of FM even worse for this modulation structure is that almost all phones currently do not support the AM signals to be received by mobile phones - the main mobile device targeted for the service. This issue takes AM radio signal out of our choice of communication mechanism for this service.

4.3 Applying Bluetooth technology

Bluetooth is arguably one of the most known data communication mechanism there is in the market. This shows its importance as it has not been around as long as radio or GSM networks. Today a number of devices are already heavily depending on this technology. Some of these devices include mobile phones, laptops, printers, and palm PDAs etc [1]. Bluetooth can maximum connect up to eight devices simultaneously (at the same time) and in effect, all of these devices normally have to be in within a ten meter radius. This circle of which devices can communicate can be expanded 10 folds to more than 100 meter radius [9] by increasing the transmit power. Bluetooth uses a technology known as spectrum spreading which is a structure that is defined by frequency hopping. This is done by 79 hops displaced by 1 MHz starting almost at the beginning of Bluetooth’s allowed spectrum of 2.402 GHz and stopping almost at the end of it at 2.480 GHz. Frequency interference and noise are very unlikely to Bluetooth modulation due to the frequency hoping and this makes it rare for more than one device to be transmitting on the same frequency at the same time. However in this service, the major problem of using Bluetooth is the number of devices able to connect at one time. As obvious as can be seen, there could be more than seven clients waiting for a bus at the same time in the same location, and therefore who get the update and who does not will be a difficult choice.

The problem could be resolved by a touch and go mechanism. The touch and go mechanism is defined as the Bus device, it is paired to the mobile device and required to communicate to it. Like a Bluetooth headset, they recognise each other then they pair up. In this case, as soon as the devices recognise each other, the handset is then given just enough time to measure the signal strength. The connection is immediately dropped, giving a chance for another device to communicate. This is a very useful mechanism if the reach problem is to be overcome. The reach problem is identified as the distance of communication a Bluetooth device can connect. And for the new system to operate adequately the distance must be at least 500 meters, else it will be of no use to the client or user.

4.4 Using WAP and GPRS

Both these services are Internet based which implies that the client will incur changes as he connects to the service. They are normally pull services but with specially designed software system could be forced to push information. This process would work similar to the push-to-talk model. In such situations, the bus based device sends a burst of data to all the registered devices that are waiting for the particular bus. The mechanism is activated and accessed by the client pushing a button specifying the bus number they are waiting for, and at this time the client number is added into the recorder system devices waiting for the bus. The bus access read this data and broadcast to all linked devices on the list and within the 50 meter range and distance interval.

A major problem with this structure is that, all the hard work will be pressed on the vehicle (moving bus) system. The vehicle will always be required to know of its own whereabouts and to frequently post this information onto the internet where it could be either simply viewed, or converted into burst of small binaries that contain its service type, route and current location, which will then be translated by the software system (similar to that mentioned earlier for use with the waves transmission based structure such as FM and Bluetooth) in the device. The argument for this model is costs implications. The appropriateness of this is because the system will transmit small burst of data (less cost) and faster and the mechanism will partially be switched back to the client device.

Currently the London Bus uses tracking system provided by V-SOL. The V-SOL [14] system claims to "provide real time positioning of the engineers along with immediate access to the current day's activities," which should be sufficient for generating the means of locating an exact whereabouts of a bus. The system information is normally collected in the server [14] which with a small intelligence planning mechanism, could calculate a possible time of arrival to a bus stop. However, the mechanism exhibits its own small problem, that of actually calculating and knowing the distance between the bus stop and the client. This problem could be overcome by using map-based GPS software on the device (instead of simply displaying the times and when is the best time to leave the client location to the bus station). It could be structured such that the bus is shown on the map and as the user knows how close he/she is to the stop, the user will be required to estimate roughly when to leave their location in time to catch the bus.

5. Implementing Hybridisation Structures

Using combination of some the techniques mentioned above might provide the best solution for delivering such a service. Outlined here are some of the possible hybrid structures that could be adopted.

5.1 FM - Bluetooth mechanism

Currently, mobile devices vary on their functionality and services provided by the devices vendors. Many of today's mobile devices already have built in FM receiver which can easily be operated using the scope of the technology proposed herein this paper. However there are still many devices that are not capable of receiving FM signal and are therefore handicapped in operation and use of the service. And in the same token, almost all the handheld 2.5G and 3G mobile devices today come with built in Bluetooth networking mechanism. Therefore a possible structure to use in this instance will be, to use a separate device that has an FM receiver and Bluetooth that can catch the FM radio waves, read the signal and translate them for the Bluetooth to send to the mobile devices. And the device connects to software that reads the Bluetooth input and defines the bus distance to the client. An example of such software is BlueAware [3] that runs passively in the background of mobile phones and helps to log the whereabouts of the closest devices. Also similar to this is the Bluedar technology, developed to continuously scan for visible devices and wirelessly transmit detected Bluetooth ID (BTID) to a server over 802.11b. A class 2 Bluetooth chipset could be used to maintain this structure and controlled by an XPort web server [8].

The hybrid structure is similar to that proposed by [11] home automation system, where close by devices (the home devices) are interconnected using one hub and an access point sends the overall signal using WAP to far way device (the client device). The difference in this (bus) case is that, the bus

system will need to be switched the other way round. The clients devices would be using a single connect point (the cell) and the bus location information is sent to this point.

5.2. FM – GSM/UMTS conversion mechanism

Other possible structure is to force the GSM/UMTS receiver in the mobile device to accept FM radio waves via an internal modulator. This structure would be able to support the free to receive FM signal into any mobile device without needing any extra peripherals, only by using internal software. The main problem with this structure is the unstandardised structure of mobile device OS platforms. Therefore each mobile device would need to have its own software implemented, thus providing overhead expense to provide this structure. This structure is also similar to the WAP-SMS hybridisation system for home automation proposed by [16], which involves having the gateway to translate the type of communication mechanism required. The actual functionality and performance of this structure is currently under trials by the authors of this paper.

6. Conclusion

We have discussed the technologies involved in implementing a mobile-instant bus alert system. We have also looked at the cost effectiveness and proposed a model mechanism in the use and application of such a system and exploited how the mechanisms could be applied to this service. It could be that a system which uses a combination of technologies: satellite tracking and GPRS data transfer along with the existing beacon [6] would solve some of the pending London Bus service system. This system would accurately pinpoint all of the 8000 numbered buses that operate in London and supply reliable information to all the parties involved and including the passengers. The information from such a reliable source will reach the driver, passengers and the Central Control post in a real timely manner. This technology is expected to improve the accuracy of the information displays at the bus stops and due to its GPRS connectivity it is able to send SMS to the subscribed users, to inform of its current location [13]. Each option discussed has its merits and limitations and the choice depends on the desired nature of the service provider. A local government (council) might consider using the system to provide easy, timely and reliable transportation access to its citizen. In such environment, the WAP/GPRS service system would be more preferable. And for a small charge, the system could be operated on a payment structure that is serviced and charged on monthly payment scheme or Pay-as-you-go (PAYG) structure with possibility provided by the use of FM broadcasting. We have also considered the possibility of the hybrid mechanism as providing the best possible solution for delivering an effective and efficient instant bus alert service to users. The proposed mechanism could also be very useful media system means, providing information resource to clients including local area information, which could be achieved by having a cell transmitting local information; such that, every client in the area gets instant updates of what is happening in their neighbourhood. This could facilitate and improve delivery of local services such as security (e.g. site evacuation), entertainment and other advertising functions.

References

[1] Arreymbi, J and Dastbaz, M., (2002) Issues in Delivering Multimedia Content to Mobile Devices. Proceedings of the 6th International Conference on Information Visualisation, IEEE Computer Society, London, UK. July 2002.

[2] Bar-Shalom, O., Chinn, G., Fleming, K., Gadammsetty, U. (2003) On the Union of WPAN and WLAN in Mobile Computers and Hand-Held Devices, INTEL Technology Journal, Volume 7, Issue 3

[3] Eagle, N., Pentland, A., (2005), Reality Mining: Sensing Complex Social Systems. *Journal of Personal and Ubiquitous Computing.* June 2005.

[4] Fischetti, M., Jacur, G., Gonzalez, J. (2003) Optimisation of the interconnecting network of a UMTS radio mobile telephone system. European Journal of Operational Research 144: 56–67

[5] HowStuffWorks (2006) http://electronics.howstuffworks.com/cell-phone.htm Accessed 10-03-2006

[6] IEE (2006) Passenger information trialled on London buses http://www.iee.org/oncomms/sector/transport/SectionNews/Object/DE7B17FD-A1F1-4F3B-1EA0E12716B47D53 Accessed on 15- 02-06

[7] InfromaTelecoms (2005), Handset Technology. Telecoms Academy

[8] Laibowitz, M., (2004), Parasitic Mobility for Sensate Media. MS Thesis in Media Arts and Sciences. Cambridge, MIT.

[9] Mobile Info (2006) http://www.mobileinfo.com/Bluetooth/air_&_band.htm Accessed 20- 03-2006.

[10] Pistre, J., Zardini, C. (1987) Radar detector for automatic control of trains. Sensors and Actuators, 12: 313-322

[11] Sriskanthan, N., Tan, F., Karande, A. (2002) Bluetooth based home automation system Microprocessors and Microsystems 26: 281–289

[12] TFL (2006) About London Buses http://www.tfl.gov.uk/buses/cib_about.asp Accesses 25 -03-2006

[13] Thomas, D. (2006) Real-time system trial boards London buses http://www.vnunet.com/computing/news/2149572/real-system-trial-boards-london Accessed on 20-02-06

[14] V-SOL (2005) On the buses: V-SOL has been selected to provide Vehicle Tracking System Technology to Transport for London, London Buses – TSG. V-SOL Limited

[15] Wikipedia (2006) Signal strength Wikipedia, the free encyclopaedia

[16] Wu, C., Jan, R. Wu, C., Jan, R. (2003) System integration of WAP and SMS for home network systems Computer Networks 42; 493–502, 501