

VEHICLE ARRIVAL NOTIFICATION SYSTEM

Field of the Invention

[0001] The present invention relates to a system and method to notify users of the estimated arrival times of vehicles.

[0002] In particular, this invention relates to a system comprising computers at city bus stops and computers using a method to track the locations of public transport vehicles such as buses so that passengers can find out when particular buses serving particular routes will arrive at a specific bus stop.

Background of the Invention

[0003] In today's fast paced life in the cities, passengers riding public transportation such as buses would like to know when the buses they wish to board will arrive. While public transportation companies publish bus schedules, these schedules become less useful in dynamic city traffic conditions where traffic conditions change rapidly, or when the buses break down or are otherwise delayed.

[0004] Accurate bus arrival information will allow the passengers to better plan their time, to maximize time for other activities and minimize time waiting at the bus stops. Minimized time waiting for buses can also mean less exposure to inclement weather conditions, enhancing the passengers' safety and comfort.

[0005] To this end, a number of inventions have been patented (or have pending patents) to inform passengers of the arrival times of their public transport. An example of such an application may be passengers at a bus stop initiating a request for information by pressing a request button. The system will then return information on the estimated arrival times of the buses serving that bus stop. While the objectives of these inventions are

the same, the methods by which the objectives are attained and features provide by the inventions differ.

[0006] For example, US 6,006,159 (Schmier) and WO 02/23507 (Winkler) both use the Global Positioning System (GPS) to track current bus locations. On the other hand, JP2002329293A2 (Ishikawa) uses car navigation technology to track each individual bus's position. JP3029098A2 (Yamashita et al) requires installation of an infrastructure of devices along the route of the buses to broadcast positional information to on-board devices on the buses. In most of these examples, passengers can also request for the bus arrival information through the personal devices such as mobile telephones.

[0007] While these solutions appear to work, in reality, there are problems. The Global Positioning System is notoriously unreliable in densely built-up areas such as cities where high-rise buildings block the GPS satellite signals from the receivers. This problem is not solved even with the use of differential or assisted GPS methodologies. Other systems such as that of JP3029098A2 require heavy capital outlay in installation of location broadcast devices along the routes plied by the buses to be tracked.

[0008] Therefore, a need exists for a system that enables passengers of public transport systems to find out when their buses will arrive at their particular bus stop and without need for heavy investment in system hardware or use of unreliable positioning systems.

Summary of the Invention

[0009] In one aspect, the present invention provides a system for determining and displaying the estimated times of arrival of vehicles at a particular stop, the system comprising a location-based application; a data transmission application; a database administration application; a plurality of stops, each stop being equipped with at least one computer and at least one display; and a plurality of vehicles, each vehicle being equipped with at least one mobile device.

[0010] In another aspect, the present invention provides a method for determining and displaying the estimated times of arrival of vehicles at a particular stop, the method comprising receiving a request for arrival information; retrieving stop identity; retrieving list of vehicles serving the particular stop; retrieving identities of vehicles serving the particular stop; determining positions of vehicles serving the particular stop; computing distance information of nearest vehicles to the particular stop; computing arrival times of the nearest vehicles to the particular stop; and displaying arrival times of nearest vehicles to the particular stop.

Brief Description of the Drawings

[0011] A preferred embodiment of the present invention will now be more fully described, by way of example, with reference to the drawings of which:

[0012] FIG. 1 illustrates the functional block diagram of the system in accordance with the present invention; and

[0013] FIG. 2 is a flowchart illustrating the method of the present invention.

Detailed Description of the Drawings

[0014] A detailed description of the present invention will now be given in accordance with a preferred embodiment of the invention. In the following description, details are provided to describe the preferred embodiment. It shall be apparent to one skilled in the art, however, that the invention may be practiced without such details. Some of these details may not be described at length so as not to obscure the invention.

[0015] The preferred embodiment of the present invention is a system makes use of existing location-based systems (LBS) that are part of a mobile telephone operator's system in a city or locale, to track the location of buses. As such, the present invention may be implementation in any geographical area or locale covered by, or will be covered by, a LBS. LBS are also being made use of merchants to target consumers via their mobile

telephones. For example, when a consumer holding an active mobile telephone steps into a shopping center or mall, features in LBSs may be used to send Short Message Service (SMS) messages to him informing him of promotions or offers at certain shops in that shopping center or mall.

[0016] The present invention takes advantage of such capabilities of these LBSs in its method to determine the current position of a bus from a particular bus stop before calculating and returning an estimated arrival time. This is possible as the present invention makes use of a mobile device, such as a mobile telephone, that is specially installed onboard each bus, that can connect to the mobile telephone network. Each mobile device has their own unique International Mobile Equipment Identifier (IMEI) or International Mobile Subscriber Identity (IMSI) that may be used to identify each bus.

[0017] There are many advantages of the preferred embodiment of the invention. One advantage of the preferred embodiment is that an existing location-based service may be used. As such, there is no need to set up another locator system or use the less-than-ideal GPS. In addition, transmission of information between elements of the system makes use of wireless technology and existing mobile telephone services, further reducing costs.

[0018] A mobile telephone network comprises a network of cells, each served by a station that transmits and receives mobile telephone signals between mobile devices and the mobile telephone system. These stations may be augmented by relay stations to further increase their range of coverage. The system has to be able to keep track of the location of each active mobile telephone in the network as the system has to "hand over" the servicing of each mobile telephone between the cell or coverage of each station. This is to allow optimal signal strength between the mobile telephone and the stations as the mobile telephone user moves around from cell to cell. The method by which a mobile telephone system achieves locating the mobile telephone is essentially by triangulation of the mobile telephone's signal characteristics between the stations in several cells.

[0019] As the number of mobile telephones in a city or locale increases, the proportional cost of implementing and operating the system of the present invention will decrease, making the present invention attractive to operate as it rides on the existing location-based system of mobile telephone networks.

[0020] There are several advantages to making use of a mobile telephone network for location-based services. To overcome buildings blocking signals, a mobile telephone operator or service provider will have to install an adequate number of stations and relay stations around a city to ensure adequate coverage. In addition, there are back-ups, fail-safes in modern mobile telephone systems that minimize "down-time" and ensure reliability. For example, in a multi-band telephone such as that for GSM and PCN (or GSM 900/1800), when the signal for one waveband fails or is attenuated, the mobile telephone automatically switches to the alternative waveband.

[0021] Location-based systems take advantage of this capability of a mobile telephone network to keep track of the active mobile telephones in the system. An example of an LBS that may be used is the Siemens Location Enabling Server (LES). While the Siemens LES is used as an example, the present invention is not limited to this server and any other LBS may be used to practice the present invention.

[0022] Referring now to FIG.1, a functional block diagram of a system in accordance with the present invention is illustrated.

[0023] The system comprises three computer-based applications. The first is a location-based system **110** such as the Siemens LES. The next application is a data transmission application **120** to handle requests for bus arrival times by receiving and sending wireless signals, and to perform calculations for the arrival times. Another application is a database administration application **130** holding and processing information on bus service routes. While FIG. 1 shows these applications as being located separately in three computer servers for clarity, a person skilled in the art will appreciate that two or more of these applications may be combined to reside in, and be operated from, less than three servers. The person skilled

in the art will also appreciate that the three applications may be physically located in the same place or be alternatively disperse in several locations. This does not affect the working of the invention.

[0024] Other elements of the system of the present invention include a computer **142** and display unit **146** at each bus stop **140** in the system, and a plurality of buses, with each bus **152** equipped with a mobile device such as a mobile telephone **162**.

[0025] A location-based system such as the Siemens LES **110** is linked to a mobile telephone network and is capable of returning information such as the location or position of an active mobile telephone in a network. While the location is usually given as longitude and latitude co-ordinates, other formats of indicating geographical location may also be used. The Siemens LES, like other LBS, is also capable of calculating the distance between two points when given the co-ordinates of these two points.

[0026] The data transmission application **120** receives requests initiated from the computer **142** at each bus stop **140**. These signals may be sent by the computer **142** at regular intervals, or may triggered by passengers waiting at the bus stops. While these signals may be relayed from the bus stops to the data transmission application **120** server by wired means under the present invention, the preferred embodiment of the present invention utilizes mobile telephone transmissions for these signals. This preferred embodiment thus reduces the cost of implementation by obviating the need to lay communication wires between the bus stops and the data transmission application.

[0027] In the preferred embodiment, the server in which the data transmission application **120** resides is equipped with a suitable communications means such as a mobile telephone modem card or mobile telephone that suits the mobile telephone system (eg PCN, GSM, CDMA) used in that city or locale. The computer **142** at the bus stop may communicate with the data transmission application **120** server by Short Message Service (SMS) transmissions or through a Java-enabled application such as the Java 2 Platform, Micro Edition (J2ME) application

over General Packet Radio Service (GPRS). Similarly, use of a mobile telephone modem will also allow passengers to request for information via SMS or GPRS. There presently exists land-line telephone units that users can utilize to send and receive SMS messages. Such telephone units may also be used to request for information under the present invention. In response, the data application server is able to return the requested information to the passenger by return SMS or GPRS message.

[0028] The data transmission application also has software providing the capability of calculating and determining the estimated arrival time of a particular bus to a specific bus stop, among other related capabilities. A person skilled in the art will appreciate that this capability may be provided in a number of different means, coded by a number of different programming languages, or be provided by customizing a suitable commercial software package.

[0029] Most public transport system operators and/or relevant government bodies maintain city road map directory information. Such information, together with data concerning the bus stop identities or names, and routes of each bus service, the registry of individual buses and their IMEI or IMSI, and other pertinent information, reside in the database administration application 130. An example of such an application is a database management system (DBMS) like the Microsoft SQL Server on a Windows operating system, or any other suitable server with an appropriate operating system and DBMS.

[0030] The database administration application 130 is preferably a web-based application so that any updates or changes to a database linked to it, may be readily performed by the authorized administrator of the database securely logging into the application from another computer. Such changes may include changes in bus routes, or locations of new bus stops.

[0031] The next group of elements in the system of the present invention comprises the computer 142 and display 146 at each bus stop 140. As indicated earlier, this computer 142 may be linked to the data transmission application 120 by wired means but wireless mobile telephone means are

preferred. The computer required does not need to be big or computationally powerful, only sufficiently rugged for all-weather, outdoor public use. This computer **142** may be adequately protected by a suitable tamper-proof case or housing for this purpose.

[0032] With the rapid advances in computing power of Personal Digital Assistants (PDAs), it is envisaged that a PDA equipped with a suitable mobile telephone modem card, or a "smart phone", will suffice for this application. As the electrical power requirements for PDAs are low, the computer at each bus stop may be powered by batteries charged by solar cells on the roof of the shelter and governed by an intelligent power management sub-system. Alternatively, power may be drawn or tapped from the bus stop shelter's existing electrical power supply.

[0033] The display **146** for this computer may be a "ruggedized" liquid-crystal display (LCD) screen with a touch screen function, or a simple keyboard, for passengers to request for information. Other display means, such as a board with light-emitting diodes (LEDs) may also be used. Alternatively, the display and computer may be integrated into one unit by use of a tablet notebook computer with a touch screen function.

[0034] The computer at each bus stop operates software that allows it to accept requests for the bus arrival times for the buses serving that bus stop. The computer will also receive the information on bus arrival times from the data transmission application and display the information on the display screen.

[0035] The elements of the system at the bus stop will be sufficiently protected against the elements and vandals, and are toughened for repeated public use.

[0036] The last group of elements in the system of the present invention comprises the elements in the buses. Each bus **152** in the system is equipped with a mobile device, preferably a mobile telephone **162**. As mentioned above, each mobile telephone is identified by its own unique International Mobile Equipment Identifier (IMEI) or International Mobile Subscriber Identity (IMSI).

[0037] The mobile telephone **162** may be modified such that as the driver of the bus logs on for the day, the direction of route is also entered. An open source mobile telephone operating system such as Symbian will allow this modification to be easily implemented by a person skilled in the art. Similarly, when the bus reaches its destination or terminus in one direction of the route and starts on route in the opposite direction, this information is also captured by the system when the driver indicates so via the mobile device. This is to prevent confusion when two buses with the same route service number are in the same area of a bus stop **140** from where a passenger has requested for information via the computer **142** at that bus stop.

[0038] The notification of change of direction of the bus may effected by SMS message to the data transmission application **120** server. Alternatively, this change in direction of the service may be automatically noted by the applications of the present invention when the bus reaches its terminus. This is possible as the data transmission application **120** can be programmed to automatically track the bus periodically and to note the switch in direction after the bus arrives at the terminus.

[0039] It will be appreciated by one skilled in the art that the various software applications mentioned above may be easily obtained by customization of commercially available software packages. Alternatively, these programs maybe written or coded in a variety of programming languages by a competent programmer. In addition, a person skilled in the art will also appreciate that the hardware setup mentioned above may also be easily implemented in a variety of ways to practice the present invention.

[0040] The method of the present invention is illustrated in the flowchart of FIG. 2 and explained as follows.

[0041] A request for bus arrival information is first initiated from each bus stop **210** to the data transmission application **120**. The preferred means of initiating is by the computer **142** at intervals, (eg every 30 seconds or so during peak hours). This automatic feature need not be active during off-peak hours. When this automatic feature is not enabled, passengers may

initiate the request from the bus stop. This may be done by passengers touching the display screen at the bus stop or pressing the keys at the keyboard if a touch screen is not provided.

[0042] Alternatively, passengers may request for information from their telephones **150** for the bus stop where they intend to wait for their bus even before they reach the bus stop, if they know the identification number of the bus stop. The user may do this by sending an SMS message in an acceptable format to the data transmission application of the present invention. This format may comprise bus stop identification number that will be prominently displayed at the bus stop. Apart from using SMS, other means of requesting of bus arrival information may be used. An example is that of the J2ME application on telephones which provide for a graphical user interface to the user. Other alternative systems such as the Symbian and Embedded Linux systems on smart phones may also be used.

[0043] Another alternative may be possible, depending on the computational and processing power of the data transmission application. The application may be programmed to periodically send bus arrival times to various heavily-used bus stops at peak hours without the need for any requests to be initiated by the bus stop computer **142** or by any passenger.

[0044] To calculate and determine the bus arrival times for a particular bus stop, the data transmission application **120** will first retrieve the unique bus stop identification number **220** from the database administration application **130**. As each computer at the bus stop **140** is a wireless-equipped computer **142** in the network of the system, this unique identification number is preferably based on the network Internet Protocol (IP) address of the computer. The data transmission application will also retrieve from the database linked to itself, all the bus service numbers servicing that particular bus stop. Another category of information that the data transmission application will retrieve from the database administration application are the identification numbers (ie IMEI or IMSI) buses plying that direction of the route **230**, **240**. While other information may be retrieved depending on the sophistication of the processor used and the capabilities

of the system desired, these three categories of information are the minimum required for the invention to function.

[0045] Request for location information on the identified buses will then be sent by the data transmission application **120** to the location-based application **110**, either by wired or wireless means. The location-based application will then return the location information, preferably as longitude and latitude co-ordinates **250**.

[0046] Now, the returned data will comprise all the buses serving that particular bus stop. As such, the present invention will have to sift this information to determine the nearest buses of each bus service number serving that particular bus stop **250**. This is done by sending the co-ordinates of all the buses and that of the bus stop to the location-based application **110**. The location-based application will then calculate **260** and return distance information to the data transmission application of the present invention.

[0047] By considering only the nearest bus for each bus service number to the particular bus stop, the data transmission application will calculate an estimate time of arrival **270** for each bus service number to the bus stop where the information will be displayed **280**.

[0048] This may be done by comparing historical data for the buses arrival times and historical traffic conditions for that time of day stored in the database administration system. Historical data on the bus speed may be obtained by customizing the database administration application **130** such that the application will periodically sample the time taken by buses to move from one point, such as a bus stop, to another point, such as another bus stop. As the distances between the bus stops are known, the speeds of the buses may be calculated and stored. The sampling of the bus speeds need not be done for the entire route but only for stretches of the route known to be congested at various times of the day such as peak hours.

[0049] The method of the present invention may also moderate this estimate by taking into account the instantaneous speed of the vehicle in real time. This may be done by interfacing a simple computer to the

odometer or speedometer of the vehicle and to the mobile device. Data may then be transmitted wirelessly by SMS or GPRS messages to the data transmission application 120.

[0050] Alternatively, with the in-built self-diagnostic capabilities of modern vehicles, the data output from the bus's speedometer or odometer may be linked to a small computer installed in each bus that determines the instantaneous speed of the bus instead of just transmitting raw distance or speed. This computer can broadcast, via SMS messages on the bus's mobile telephone, its instantaneous speed to update the data transmission application 120. In such cases, calculations for the speed by the data transmission application need not be done.

[0051] A person skilled in the art will appreciate that such means to determine the bus's real time speed is achievable with minimal hardware setup and without the need for undue experimentation. Such a capability may be achieved at the present through the use of computing devices such as PDAs with mobile telephone capabilities, or smart phones. As such, mobile device on the bus can be a PDA-mobile phone that can receive and transmit data such as its odometer or speedometer reading to the data transmission application 120,

[0052] After the arrival time of each bus service has been determined, this information may be transmitted to the computer at each bus stop and displayed 280, or relayed to the telephone from which a passenger has initiated a request for the information via the SMS. This will allow the passenger to better time his arrival at the bus stop so as to minimize his waiting time there.

[0053] The estimated times of arrival of the buses to a particular may also be moderated by a number of factors such as traffic and weather conditions. The input of such information may be entered either manually, or captured automatically by the data transmission application or database administration application, depending on the sophistication desired by the user of the present invention.

[0054] It will be appreciated by one skilled in the art that the present invention can overcome or at least alleviate some problems in similar inventions of the prior art. In the present invention, a location-based system already present in a mobile telephone system at a locale or city may be used without having to invest heavily in installing radio broadcast devices or rely on GPS signals.

[0055] The present invention may be implemented at the present with products utilizing existing technology such as computers, wireless-capable computers and mobile devices such as mobile telephones. However, the present invention may also be implemented with products using emerging technologies such as vehicles with self-diagnostic and self-reporting capabilities, and smart phones, without departing from the scope of the present invention.

[0056] A person skilled in the art will also appreciate that the present invention is not limited to displaying estimated arrival times for public transport vehicles such as buses. Logistics companies and their clients tracking shipments may also utilize such a system to determine where their trucks are, and be notified of the estimated times of arrivals at their intended destinations.

[0057] The present invention may also be used to keep track of users carrying mobile phones or vehicles in a large area such as the whereabouts of police officers and patrol vehicles in a locale. By knowing the location of the officers and the location of their destination, an estimate of their arrival time at the scene of an emergency may be obtained from the present invention. In this case, the display is no longer at a bus stop but at the police dispatch center.

[0058] The present invention may also be more sophisticated as computational power of the computers used increases. For example, if previously displayed arrival times are changed due to say, breakdown of the vehicle, the passengers notified via the display at each bus stop. Another example of increasing sophistication within scope of the present is

that of automatically tracking changes in bus route directions after a bus has reached its terminus without further human intervention.

[0059] The present invention therefore provides a system and a method for determining and displaying arrival times of vehicles that overcome, or at least alleviate, the problems of the prior art.

[0060] It will be appreciated that although one preferred embodiment has been described in detail, various modifications and improvements can be made by a person skilled in the art without departing from the scope of the present invention.

Claims

1. A system for determining and displaying the estimated times of arrival of vehicles at a particular stop, the system comprising:
 - a location-based application;
 - a data transmission application;
 - a database administration application;
 - a plurality of stops, each stop being equipped with at least one computer and at least one display;
 - a plurality of vehicles; and
 - a plurality of mobile telephones, each of the plurality of mobile telephones installed in each of the plurality of vehicles;

wherein the location-based application is for determining the location of the plurality of mobile telephones which correspond to the location of the plurality of vehicles.

2. The system according to Claim 1, the data transmission application capable of communicating with the computers of the plurality of stops.
3. The system according to Claim 2, wherein the data transmission application communicates with the plurality of stops via wireless means.
4. The system according to Claim 1, the data transmission application capable of determining the estimated time of arrival of a vehicle at a particular stop in response to a request for information, the determining based on information from the location-based application and the database administration system.

5. The system according to claim 4, wherein the requesting of information originates from a passenger using the computer at the particular bus stop.
6. The system according to claim 4, wherein the requesting of information originates automatically from the computer at the particular bus stop.
7. The system according to claim 4, wherein the requesting of information originates from a passenger not at the particular bus stop.
8. The system according to claim 7, wherein the requesting of information originating from a passenger not at the bus stop is sent via land telephone lines.
9. The system according to claim 7, wherein the requesting of information originating from a passenger not at the bus stop is sent via a mobile telephone.
10. The system according to Claim 1, the database administration application is linked to at least one database.
11. The system according to claim 10, wherein the database further comprising data on identification of vehicles based on the mobile telephone installed in the vehicles, vehicle routes, and stop identification information.
12. The system according to Claim 1, the location-based application, data transmission application and the database administration system further residing in three separate computers.
13. The system according to Claim 1, the location-based application, data transmission application and the database administration system further residing in fewer than three computer servers.

14. The system according to Claim 1, wherein the at least one computer and the at least one display of each of the plurality of computers further comprises a combined computer and display unit.
15. The system according to Claim 1, wherein the stops further comprising bus stops.
16. The system according to Claim 1, wherein the vehicles further comprising buses.
17. A method for determining and displaying the estimated times of arrival of vehicles at a particular stop, the method comprising the steps:
 - receiving a request for arrival information;
 - retrieving stop identity;
 - retrieving list of vehicles serving the particular stop;
 - retrieving identities of vehicles serving the particular stop;
 - determining positions of vehicles serving the particular stop;
 - computing distance information of nearest vehicles to the particular stop;
 - computing arrival times of the nearest vehicles to the particular stop; and
 - displaying arrival times of nearest vehicles to the particular stop;wherein the step of determining positions of vehicles serving the particular stop further comprises the steps:
 - providing the identities of vehicles to a location-based system linked to a mobile telephone system, and
 - obtaining the positions of a mobile telephone installed in each of the vehicles thereby obtaining the positions of the vehicles.
18. The method according to Claim 17, the receiving a request comprising receiving request from a computer at the particular stop.
19. The method according to Claim 18, the receiving a request comprising receiving a request from a telephone not from the particular bus stop.

20. The method according to Claim 17, the retrieving stop identity further comprising retrieving information from at least one database.
21. The method according to Claim 17, the retrieving list of vehicles serving the stop further comprising retrieving information from at least one database.
22. The method according to Claim 17, the retrieving identities of vehicles further comprising retrieving information from at least one database and where the identities of the vehicles further comprising information relating the unique identification of at least one mobile device onboard each vehicle.
23. The method according to Claim 17, the computing of distance information of nearest vehicles nearest the particular stop further comprising:
providing the position of vehicles and the position of the particular stop to a
location-based system;
obtaining the distances of the vehicles from the particular bus stop; and
determining the nearest vehicles based on the distances returned by the
location-based system.
24. The method of Claim 17, the computing of arrival times of the nearest vehicles to the particular stop based on information further comprising:
distance of the nearest vehicles from the particular stop;
speeds of the vehicles;
historical data;
traffic conditions; and
weather conditions.

25. The method of Claim 17, the displaying further comprising transmitting the arrival times back to the point from which the request for arrival information was received, and displaying the arrival information.