



TELEPHONE CALL ROUTING SYSTEM AND METHOD

The present invention relates to a telephone call routing system for routing a telephone call from a caller to one or more mobile resources, where a mobile resource is defined as any resource which is not confined to a specific location and which, due to the nature of its work, may often move from one location to another without returning to a specific central location. Some examples of such mobile resources are taxis, repair vehicles, police vehicles, doctors on-call, ambulances and utility service vehicles. More specifically, this invention relates to a system and method of routing a telephone call from a caller to a nearby mobile resource, so that the caller and operator of the mobile resource can engage in conversation for exchanging information, such as directions to each other's current location or a meeting time. It is proposed that such a system be known as "Zingo", for which there is presently a pending Community Trade Mark Application.

At the present time, when a caller wishes to contact a mobile resource to arrange a pickup or meeting, it is required that they telephone a call centre and speak to a call centre operator, who will record the caller's details, such as name, location and telephone number and then pass these details on to the operator of a mobile resource which the call centre operator considers to be available and close to the caller. An example is a caller booking a taxi, in which the caller telephones a call centre to give the call centre operator their name and location. This information is passed on to taxi drivers by radio, data messages or a mobile telephone call. The taxi drivers then "bid" for the booking, depending on their current availability and location relative to the caller. A further example is a caller requiring automobile breakdown assistance, in which the caller telephones a call centre and gives the call centre operator their name, location and breakdown problem. The call centre operator then passes this information to a breakdown engineer, who is generally remote from the call centre, but considered to be near the caller and available.

One problem with present systems and methods is that there is limited interaction between the caller and the mobile resource operator. The caller's details are passed to the mobile resource operator by the call centre operator, who may not know the exact availability of the mobile resource, the exact location of either the caller or the mobile resource, or other information, such as the amount of traffic or the presence of one-way



streets on route to the caller. Furthermore, at some stage in the passing of the caller's details to the mobile resource operator, there is the opportunity for incorrect information to be passed.

- 5 A further problem associated with present systems and methods is the high cost of the infrastructure. The cost of a call centre, employing many operators, can form a considerable proportion of an organisation's overheads. This cost is likely to be passed on to both callers and mobile resource operators. For example, in the case of a caller ordering a taxi, a booking fee may form a significant proportion of the overall cost to the caller,
- 10 whilst the taxi driver may also be subscribing to the syndicate or company providing the call centre. Furthermore, there are other associated high costs relating to the equipment which may have to be employed to pass information between the call centre operator and the mobile resource operator. For example there are several London based taxi booking and allocation services, which transfer information, such as directions to the caller, taxi
- 15 availability and acceptance or rejection of jobs, between a call centre and taxi drivers. Such services require complex and expensive terminals to be fitted into subscribing taxis.

- Yet a further problem associated with present systems and methods, particularly in relation to taxi drivers, is the amount of time spent looking for work. For example, in
- 20 London, currently up to forty percent of a taxi driver's time is spent searching for work. Often, there may be a potential customer in the vicinity of the taxi, but many potential jobs go unnoticed because there is currently no method for "hailing" a taxi without direct line of sight between the taxi driver and customer.

- 25 There are a number of technologies for locating the position of a mobile resource. Among these, the Global Positioning System (GPS) is well known in the art. The difference in time of arrival at a ground based receiver of signals arriving from a number of satellites orbiting the Earth can be used to locate the position of the receiver to within ten metres. The accuracy of the position depends on the quality of the signal, which may vary
- 30 due to environmental conditions, such as the presence of tall buildings or bad weather.

The existing infra-structure of mobile telephone networks can allow a call centre to determine the approximate location of callers on mobile telephones. One such method uses

a Cell of Origin (COO) technique to give an approximate location for a mobile terminal by examining which cell of a mobile network, the mobile device is currently registered to.

Another mobile telephone network location positioning system relies on a Time of Arrival (TOA) technique, which determines the location of the mobile terminal by calculating the

5 difference in the time of arrival of a signal from the mobile terminal at at least 3 base stations. Yet another mobile telephone location system, described in WO 97/11384, uses an Enhanced Observed Time Difference Method (E-OTD) to locate the position of a mobile terminal by using fixed Location Measurement Units (LMU) overlaid on the mobile network to act as reference beacons for determining the mobile terminal's location.

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Mobile telephone location systems, as described above, are used by mobile telephone network operators to maintain mobile telephone location databases, which store the location of mobile telephones on their networks. The location databases can be accessed remotely by third parties who are able to perform a reverse-lookup of the

15 telephone number of the caller's mobile phone, obtained using Caller Line Identification (CLI), to obtain an approximate grid reference for the location of the mobile telephone.

The location of a caller making a telephone call from a fixed line telephone can be determined by performing a reverse-lookup on a central directory of fixed line telephone

20 numbers, to obtain a grid reference for the caller. In the United Kingdom, this database is known as OSIS and is provided by British Telecommunications Plc.

Automated call centres for handling telephone calls, without the presence of an operator, are already known in the state of the art. The call centre may use a Computer

25 Telephony Integration (CTI) system, which can automatically route telephone calls to appropriate devices or persons. An Interactive Voice Response (IVR) server may be used to interpret touch-tones from the caller's handset to allow interaction with a database.

Computer Telephony Integration (CTI) and caller location systems which

30 automatically provide callers with contact information for nearby fixed resources are already known in the art. In one such system, known as FindMe[®], provided by the UK mobile telephone network operator, mmO₂, a caller dials into an IVR server to receive contact information for nearby selected resources by Short Message Service (SMS) on their

mobile telephone. The call centre determines the location of the caller by performing a reverse-lookup of the caller's mobile telephone number on mmO₂'s database of mobile telephone locations, obtained by using COO techniques. In such a system, the resources are at fixed locations and the procedure for contacting a resource is in three stages. Firstly, a
5 caller has to call the call centre on a mobile telephone to request details of their desired resource. Secondly, following the call, the call centre transmits an SMS message with contact details for the mobile resource back to the caller's mobile telephone. Finally, the caller has to note down the contact details and make a second telephone call to connect with the resource. Thus, the procedure for contacting a resource is slow and inefficient. The
10 call centre has no ability to determine if a resource is available or to track resources which are not at fixed locations.

Therefore, what is required is a solution to the frustrating problem of contacting a local mobile resource, which is available, but may not be in the direct line of sight of a
15 potential customer.

In view of the foregoing and in accordance with the present invention, there is provided a telephone call routing system for routing a telephone call from a caller to a mobile resource, comprising:
20 caller location means for determining a location of a caller;
mobile resource location means for determining a location of one or more mobile resources; and
a coordinator for receiving location information from the caller location means and location information from the mobile resource location means,
25 wherein the coordinator processes the location information and routes the telephone call to a local mobile resource with respect to the caller.

In a preferred embodiment of the present invention, the coordinator routes the telephone call to a mobile telephone located in the local mobile resource.
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Preferably, the mobile resource is a vehicle, such that the conversation between the caller and mobile resource operator facilitates a meeting of the mobile resource and the caller.

Preferably, the vehicle is a taxi and the mobile resource operator is a taxi driver.

Preferably, the telephone call routing system further comprises a status monitor to
5 determine the availability of the mobile resource.

Preferably, each mobile resource contains mobile resource location means for
transmitting the location of the mobile resource to the coordinator across a wireless data
link.
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Preferably, the status monitor transmits the availability of the mobile resource to the
coordinator across a wireless data link, such that the coordinator can route the telephone
call to a mobile phone in a nearby available mobile resource.

15 Preferably, the mobile resource includes a payment terminal which transmits
payment transaction data to the coordinator across a wireless data link.

Preferably, the mobile resource location means is contained in the payment
terminal.
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Preferably, data can be transmitted from the coordinator to the mobile resource
across a wireless data link.

Preferably, the mobile resource location means comprises a Global Positioning
25 System (GPS) receiver.

Preferably, the mobile resource includes a multifunctional antenna for receiving and
transmitting data across a wireless data link, receiving and transmitting mobile telephone
signals from a mobile telephone and receiving GPS signals.
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In a preferred embodiment of the present invention, the telephone call originates
from a mobile telephone.

Preferably, the caller location means determines a location for the caller using a cell of origin of the second mobile telephone.

In another preferred embodiment of the present invention, the caller location means
5 determines a location for the caller by calculating a difference in time of arrival of a signal from the mobile telephone to at least three base stations whose locations are known.

In another preferred embodiment of the present invention, the caller location means determines a location for the caller by calculating a difference in times of arrival at the
10 mobile telephone and at additional receivers, whose locations are known, of signals from at least three base stations.

In yet another preferred embodiment of the present invention, the telephone call originates from a fixed line telephone.
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Preferably, the caller location means determines a location for the caller by looking up a location of the fixed line telephone using the fixed line telephone number.

In another preferred embodiment of the present invention, the coordinator includes
20 an interactive voice response server to allow the caller to interact with the coordinator and to route telephone calls from the caller to a mobile resource.

Preferably, the coordinator comprises a communications server for receiving location data from mobile resources.
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Preferably, the coordinator comprises an application server for interpreting and administering the data from the communications server and the interactive voice response server and for responding to requests from the interactive voice response server.

30 Preferably, the coordinator comprises a database server for storage of caller, mobile resource and operations data.

In another preferred embodiment of the present invention, the caller has one or more preferred mobile resources, such that the coordinator routes the telephone call to a mobile telephone located in a nearby preferred mobile resource, with respect to the caller.

5 Preferably, each mobile resource has secondary mobile resources, which are preferred by the mobile resource, such that if a caller's preferred mobile resource is unavailable, the coordinator routes the telephone call to a nearby secondary mobile resource, with respect to the caller.

10 Further, in accordance with the present invention, there is provided a telephone call routing system comprising:

 caller location means adapted to produce a caller location signal corresponding to a location of a caller making a telephone call;

 mobile resource location means adapted to produce a resource location signal
15 corresponding to a location of at least one mobile resource; and

 a coordinator which can receive and process the caller location signal and the resource location signal and route the telephone call to the mobile resource most conveniently proximate to the caller.

20 Further, in accordance with the present invention, there is provided a method for routing a telephone call from a caller to one or more mobile resources, comprising the steps of:

 determining the location of the caller;

 determining the location of one or more mobile resources; and

25 routing the telephone call from the caller to a nearby mobile resource, with respect to the caller.

 Preferably, the step of determining the location of one or more mobile resources, includes:

30 receiving updates, at varying intervals, of the current time, the location, the speed and the heading of the mobile resource; and

extrapolating a predicted location for the mobile resource between updates, by considering the location, speed and heading of the mobile resource at the previous update and the time elapsed since the last update.

- 5 Preferably, one or more of the mobile resources transmits updates only when the location of the mobile resource is outside an uncertainty circle surrounding the predicted location of the mobile resource.

10 Preferably, a call centre routes the telephone call from the caller to a nearby mobile resource, with respect to the caller.

Preferably, a radius of the uncertainty circle is controlled by the call centre, depending on the location of the mobile resource and/or the time of day.

- 15 Preferably, the predicted location is calculated in both the mobile resource and the call centre.

Further, in accordance with the present invention, there is provided a method for selecting a nearby mobile resource having a known location, with respect to a caller having
20 a known location, comprising the steps of:

- determining an uncertainty circle for the location of each mobile resource;
- selecting a group of available mobile resources having circles of uncertainty lying entirely within a certain distance from the caller; and
- selecting a mobile resource having a circle of uncertainty with a centre closest to the
25 caller from the group of available mobile resources.

In another preferred embodiment of the present invention, a mobile resource is selected by considering the size of at least one of the uncertainty circles of the taxis in the catchment area.

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A specific embodiment of the present invention is now described, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is an overview of the telephone call routing system according to the present invention;

Figure 2 is a diagram showing the caller connecting to the call centre on a mobile telephone;

5 Figure 3 is a diagram showing the caller connecting to the call centre on a fixed line telephone;

Figure 4 is an diagram of a taxi being used as a mobile resource according to the present invention;

Figure 5 is diagram of the call centre according to the present invention;

10 Figure 6 is a diagram illustrating how the taxi terminal updates the call centre with the location of the taxi; and

Figure 7 is a diagram illustrating how a nearby taxi is selected.

Referring to figure 1, a caller (10) telephones a call centre (11) to hail a taxi from a
15 group of taxis (12). The taxis (12) transmit, at varying intervals, updates of their location, speed, heading and availability across the wireless data link (13) to the call centre (11). The call centre (11) determines a location (14) for the caller (10) and establishes which taxis (12) are nearby. The call centre (11) then selects a nearby available taxi (15) and routes the telephone call to a mobile telephone in the nearby available taxi (15). If the
20 mobile telephone in the taxi (15) is unavailable, for example if it is engaged or out of service, then the call centre (11) routes the call to another nearby available taxi (16). The caller can then speak directly with a driver of the taxi (16) to pass their location (14) for pickup or, at the taxi driver's request, move to a more convenient pickup point.

25 Referring to figure 2, the caller (10) is shown using a mobile telephone (20) to hail the taxi from the group of taxis (12). The mobile telephone (20) is registered to a mobile telephone base station (BTS) (21) in a cell (22). Caller location means (23) determines a location (14) of the caller using COO (Cell of Origin), TOA (Time of Arrival) or E-TOA (Enhanced Time of Arrival) techniques. The location (14) of the caller is periodically
30 updated in a caller location database (24). The caller (10) makes a telephone call to the call centre (11), which determines the mobile telephone number of the caller using Caller Line identification (CLI) and looks up the location (14) of the caller by passing the mobile

telephone number (25) to the caller location database (24). The location (14) of the caller is returned to the call centre (11) as a longitude/latitude and a radius of uncertainty.

Referring to figure 3, the caller (10) is shown using a fixed line telephone (30) to
5 hail a taxi from a group of taxis (12). The location (14) of a caller's fixed line telephone (30) is stored in a caller location database (34) for future reference. The caller (10) places a telephone call to the call centre (11), which determines the fixed line telephone number of the caller using Caller Line Identification (CLI) and looks up the location (14) of the caller by passing the fixed line telephone number (35) to the caller location database (34). The
10 location (14) of the caller is returned as a grid reference (14a).

Referring to figure 4, a GPS (Global Positioning System) receiver (40a) in the taxi (16) determines a location, speed and heading for the taxi (16) by receiving GPS signals (40b) through a multi-functional antenna (45) from satellites (40c). A taxi terminal (42a)
15 monitors and controls the GPS receiver (40a) and passes, at varying intervals, samples of the location, speed and heading of the taxi to a radio-pad (41a), which also receives data from a taxi panic button (42b). The taxi terminal (42a) also monitors the availability of the taxi (16) from a taxi hire sign (42c) and/or a taxi meter (42d). The location, speed, heading and availability of the taxi is transmitted by taxi terminal (42a) from the radio-pad (41a)
20 over a wireless data link (41b) through the multi-functional antenna (45). Additionally, the taxi terminal (42a) may process credit and debit card payments by transmitting and receiving payment transaction data across the wireless data link (41b).

The wireless data link (41b) may use an X25 packet radio network. Other
25 implementations may use General Packet Radio Service (GPRS), Universal Mobile Telecommunications Service (UMTS), Cellular Digital Packet Data (CDPD) or Short Message Service (SMS) based services (see glossary). The taxi (16) is also fitted with a mobile telephone (44a) and an associated hands-free kit (44c), which may also transmit and receive mobile telephone data signals (42b) through the multi-functional antenna (45). The
30 GPS receiver (40a) may be built into the radio-pad (41a). The taxi terminal (42a) and the GPS receiver (40a) may also receive other data, such as charging rates for the taxi meter and region parameter data from the call centre (11) across the wireless data link (41b).

Referring to figure 5, a computer telephony integration system (50), acting as a coordinator, is the key to the call centre (11) and includes an interactive voice response (IVR) server (51), an application server (52), a communication server (53), a database server (54) and a transaction server (55). There may also be a web server (56), connected
5 externally to the Internet through a firewall and intrusion detection system (57). An incoming telephone call from a caller (10) arrives at the interactive voice response (IVR) server (51), which determines the telephone number of the caller and may respond with an appropriate welcoming message. The interactive voice response (IVR) server may also check whether the telephone number of the incoming telephone call is on a barred phone
10 list and can select a dedicated account for the caller using the telephone number of the caller (10) or an account number entered by the caller (10).

The application server (52) interprets, administers and responds to requests from the interactive voice response server (51). On receipt of an instruction from the interactive
15 voice response server to locate the caller (10), the application server (51) checks whether the telephone call originates from a mobile or fixed line telephone. If the telephone call originates from a mobile telephone, the mobile telephone network operator is determined. Depending on whether the telephone call originates from a mobile or a fixed line telephone, the telephone number is passed to an external mobile telephone database (24) or fixed line
20 caller location database (34) to perform a reverse lookup of the location (14) of the caller.

The application server (52) also interprets and administers messages from the taxis (12), including storing location updates and availability and predicting locations for the taxis (12). The application server (52) may also log taxi drivers, vehicles and other
25 equipment in and out of the system, as well as alert a call centre operative if a taxi panic button (42b) is pressed and bar equipment from being used if a taxi or other equipment is stolen. Other functions of the application server (52) may include managing caller, taxi driver and/or corporate information, registering new taxi drivers, handling complaints and feedback and administering operations team applications, such as the quality of service,
30 system degradation, call centre systems resources and expansion and equipment installation and misuse.

Furthermore, the application server (52) may allow individual callers (10) to connect with preferred taxi drivers. The interactive voice response server (51) can recognise a caller (10), either from the telephone number of the caller or an account number, entered by the caller (10). Additionally, individual taxi drivers may allocate a group of preferred colleagues to their customers, such that if a caller's preferred taxi driver is busy, then the caller's telephone call is routed to another nearby taxi driver, which has been recommended by the caller's normal taxi driver.

The communications server (53) receives data from the taxis (12) across the wireless data link (41b) and decodes the data into messages. If the message is payment transaction data, then it is sent to the transaction server (55). If the message is a taxi location update, then it is sent to the application server (52).

The web server (56) acts as a user interface for the interactive voice response (IVR) server (51) and the application server (52). Access to the web server (56) can either be internal to the call centre by call centre operatives or be remote to the call centre across the Internet through a firewall and intrusion detection system (57) by customers or taxi drivers.

The transaction server (55) receives payment transaction data from the communications server (53) and connects to an acquiring bank (58) when authorisation is required. Payment transaction confirmation messages are then passed back to the communications server for transmitting to a taxi (16) or handling by the application server (52). Credit or debit card transactions may be received on the taxi terminal and transmitted to transaction server (55) via the communications server (53) across the wireless data link (41b). The transaction server connects to the acquiring bank when authorisation is required under the agreed terms. The transaction method may be APACS29 or APACS30 (see glossary).

The database server (54) passes stored data to and from the application server (52), and manages data access, as well as data recovery in the case of failure.

Other business processes, such as billing and account management, may take place remote from the call centre (11), such that data from the database server (54) can be

accessed and processed offline. The entire computer telephony integration system (50) may be housed remote from the call centre (11) in a secure, dedicated location, where servers may be pre-configured with Internet connections and also include regulated power, security and support. Call centre operatives, managers, taxi drivers and customers may
5 then access the computer telephony integration system through a web browser across the Internet.

Referring to figure 6, the taxi terminal (42a) nominally reads data from the GPS receiver (40a) once per second and averages the readings to produce a first sample (60)
10 comprising the time of day and the location, speed and heading of the taxi. The first sample (60) is transmitted to the call centre (11). Both the taxi terminal (42a) and the application server (52) in the call centre (11) extrapolate predicted locations (62) for the taxi at anytime after transmission of the first sample (60). Further samples (63) are produced by the taxi terminal (42a) and a second sample (64) is only sent to the call centre
15 (11) if the location of the taxi has moved outside an uncertainty circle (65), surrounding the predicted locations (62) and defined by a distance (A). The uncertainty circle (65) is therefore related to the frequency of transmission of data from the GPS receiver (40a).

The taxi terminal (42a) and the application server (52) extrapolate predicted
20 locations (62) for the taxis by considering the last sample transmitted from the taxi terminal (42a) or last sample received at the call centre (11). By taking account of the location, speed and heading of the taxi, as given in the sample, a predicted location can be calculated at both the taxi (16) and the call centre (11). The call centre (11) uses predicted locations and specified uncertainty circles (65) for each of the taxis (12) as the basis for selecting a
25 nearby taxi (16) for a caller. The taxi (16) uses the predicted locations and associated uncertainty circles (65) to decide when to send a new sample of the "real" location, speed and heading of the taxi to the call centre (11). Therefore, for accurate position tracking of the taxis (12), excessive, and therefore costly, transmissions do not need to be sent continuously.

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The distance (A), can be updated over the wireless data link (41b) from the call centre (11), depending on the location of the taxi and time of day. Thus, the call centre has control over how often data is transmitted across the wireless data link (41b). The distance

(A) is defined for a particular parameter region at a particular time of day and can be changed, for example, if the time of day is rush hour or if the taxi is in an urban area. Other parameter region data which can be changed and sent to the taxi terminal (42a) from the call centre (11), depending on the location of the taxi and time of day, may include: the
5 number of readings taken to form a sample, the interval between taking readings from the GPS receiver (40a), and absolute minimum and maximum update intervals. The latter two parameters override the conditional transmission of data to the call centre (11), so that data transmission either does not occur too often or does not occur at all, for example when the taxi is out of range for using the wireless data link (41b).

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The speed of the taxi (16) has an effect on the transmission rate to the call centre (11). A parked and unavailable taxi may not need to send any updates. However, as soon as a taxi (16) becomes available, an update should be sent immediately. Stationary or slow moving taxis are likely to send infrequent updates. A normal speed taxi, which may be
15 defined as moving at between 12.8 and 20.8 km / h, send the highest number of updates, compared to taxis, which may be moving at high speed, which is defined as moving greater than 30.4 km / h. For different ranges of speed, there may be different methods for predicting the location of taxis, both at the taxi terminal (42a) and at the application server (52), as well as different methods for selecting a taxi (16) for allocation to a caller (10). As
20 an example, the frequency of transmission of location updates to the call centre (11), may be up to twice per minute.

The database server (54) may store parameter region data for different regions for different times of the day, thereby allowing optimal location tracking from the taxi terminal
25 (42a). As the taxi (16) moves from one region to another at a given time of day, the parameter region data can be changed by updating the taxi terminal (42a) from the call centre (11) across the wireless data link (41b). If there is no parameter region data stored for a given region and time of day, then the taxi terminal (42a) may continue to use the previously received parameter region data.

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The application server (52) may also analyse the samples received from the taxi terminals (42a) and determine the traffic density surrounding the taxis (12), so that, when selecting a given taxi (16) for a particular caller (10), intelligent automatic allocation may

be performed. This way, taxis which may be close to a given caller (10), but which are in heavy traffic, are not allocated. Instead, a taxi moving freely, but, which is further away from the caller, (10) may be selected.

5 Referring to figure 7, the application server (52) selects a nearby taxi (16) to route a telephone call to by defining a catchment area (70) around the caller (10). A nearby taxi (16) is selected from a group of available taxis having uncertainty circles (65) and contained entirely within the catchment area (70).

10 In one embodiment of the present invention, the taxi (16) having it's centre of uncertainty circle (70) closest to the caller (10) is selected. In other embodiments of the present invention, a taxi, having it's centre of uncertainty circle (70) further away from the caller (10) than other taxis in the catchment area (70), may be selected by considering the size of some or all of the uncertainty circles of the taxis in the catchment area (70), the
15 direction of travel of the taxis in the catchment area (70) and the expected locations of the taxis (70).

To increase the chance that a selected taxi (16) is within a certain distance and hence time of the caller (10), the size of the catchment circle (70) can be reduced,
20 particularly if the location (14) of the caller becomes known with less accuracy. The size of the catchment circle (70) may be a parameter which can be varied depending on the location of the caller (14) and may be stored for different administrative regions.

GLOSSARY OF TERMS

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Association for Payment Clearing Services (APACS)

APACS29 or APACS30 is a payment transaction method for transmitting credit and debit card transactions to acquiring banks. "29" is a standard developed to settle credit card payments as a batch process, usually overnight. "30" is the specification for a credit
30 authorisation terminal to enable online (directly with the bank) secure authorisation of payment transactions. Once authorised the payment is guaranteed providing you have the card, cardholder present, and a signature from the cardholder during authorisation.

Cell of Origin (COO)

Cell of Origin (COO) identifies which cell a caller is in and looks up the location of the cell centroid in a geographical database. COO is a variable and not a very precise locator. Depending on the number of base stations in the search area, accuracy may be within one hundred meters of the target in an urban area or as far off as thirty kilometers away from the target where base stations are less densely concentrated.

Cellular Digital Packet Data (CDPD)

CPD is an analogue cellular packet data system, which is widely deployed across the USA. It may form the backbone for data communication, in the absence of a GPRS system, in the USA.

Computer Telephony Integration (CTI)

Computer Telephony Integration (CTI) refers to systems that enable a computer to act as a call center, accepting incoming calls and routing them to the appropriate device or person. The systems can handle all sorts of incoming and outgoing communications, including phone calls, faxes, and internet messages. Some of them also have the ability to authenticate callers, recognize voices, receive faxes and route them to the appropriate fax machines, and match the caller's number with their customer record and display it for reference.

Enhanced-Observed Time of Difference (E-OTD)

Enhanced Observed Time Difference (E-OTD) systems operate using reference beacons and Location Measurement Units (LMUs) overlaid on the cellular network. Each beacon has an accurate timing source and when a signal from at least three beacons is received by a mobile running E-OTD software and also by an LMU, the time differences of arrival of the signal from each beacon at the handset and at the Location Measurement Unit are calculated. The differences in time stamps are then combined to estimate the location of the handset.

E-OTD schemes offer greater positioning accuracy than cell of origin, between 50 and 125 metres, but have a slower speed of response, typically around five seconds, and require software modified handsets, which means that they cannot be used to provide location specific services to existing customer bases.

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General Packet Radio Service (GPRS)

General Packet Radio Service (GPRS) is a packet-based wireless communication service that promises data rates from 56 up to 114 Kbps and continuous connection to the Internet for mobile phone and computer users. GPRS is based on Global System for Mobile (GSM) communication and is seen as a "2.5G" technology, being a stepping-stone from second generation GSM to third generation UMTS .

In theory, a GPRS based service should cost users less than circuit-switched services since communication channels are being used on a shared-use, as-packets-are-needed basis rather than dedicated only to one user at a time. Indicative costs from Vodafone are £1/megabyte, which is an order of magnitude less than PRS. GPRS may eventually enable the present invention to operate across Europe (where there is no PRS coverage) and to generate floating car data (at affordable transmission cost).

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Global Positioning System (GPS)

Global Positioning System (GPS) is a system of 24 satellites. By triangulation of signals from four of the satellites, a receiving unit can pinpoint its current location anywhere on earth to within a few meters. Speed and direction of motion can also be calculated directly from the GPS signal. However, the signal from the satellites is extremely weak and the need for direct line of sight to at least 4 satellites means that GPS systems can suffer from an "urban canyon" problem whereby they are unable to get a good fix under trees or close to tall buildings.

Interactive Voice Response (IVR)

Interactive Voice Response (IVR) is a software application in which a touch-tone telephone is used to interact with a database (pre recorded voice responses), to either acquire information from or enter data into it. IVR technology does not require human interaction
5 over the telephone as the user's interaction with the database is predetermined by what the IVR system will allow the user access to.

Mobile Telephone Generations (2, 2.5 and 3G)

The first generation of phones were analogue. In Europe, current digital phones are
10 thought of as "second generation", or "2G". General Packet Radio Service (GPRS) and High Speed Circuit Switched Data (HSCD) are considered "2.5G", while "3G", also known as Universal Mobile Telephone Service (UMTS) is the forthcoming system using Code Division Multiple Access (CDMA) modulation.

15 Packet Radio Service (PRS)

PRS is a virtual X25 data network operated by Vodafone in the UK (only). The system is cell-based the cells being somewhat larger than GSM cells (due to the lower frequency of the signal). Radio pads (PRS data modems) can operate in fixed, portable and mobile modes, although calls in progress cannot be handed from one cell to another. PRS
20 operates at 4800 bps, which is about half the rate of a fax machine or standard GSM data call.

Short Message Service (SMS)

Short Message Service (SMS) is a service for sending messages of up to 160
25 alphanumeric characters to mobile phones that use the GSM network, much like a pager system. However, SMS messages do not require the mobile phone to be active and within range, as the message will be held for a number of days until the phone is available.

Time of arrival (TOA)

The difference in time of arrival of a signal from a mobile device at three base stations is used to calculate location. In this scheme, however, there may be no overlay network used as the Location Measurement Unit (LMU). Instead, this functionality is provided by

5 synchronization of the cellular network, using GPS at each base station.

It will of course be understood that the present invention has been described by way of example only, and that modifications of detail can be made within the scope of the invention.

CLAIMS

1. A telephone call routing system for routing a telephone call from a caller to a mobile resource, comprising:
 - 5 caller location means for determining a location of a caller;
mobile resource location means for determining a location of one or more mobile resources; and
a coordinator for receiving location information from the caller location means and location information from the mobile resource location means,
 - 10 wherein the coordinator processes the location information and routes the telephone call to a local mobile resource with respect to the caller.
2. A telephone call routing system as claimed in claim 1, wherein the coordinator routes the telephone call to a mobile telephone located in the local mobile resource.
- 15 3. A telephone call routing system as claimed in claims 1 or 2, wherein the mobile resource is a vehicle, such that the conversation between the caller and mobile resource operator facilitates a meeting of the mobile resource and the caller.
- 20 4. A telephone call routing system as claimed in claim 3, wherein the vehicle is a taxi and the mobile resource operator is a taxi driver.
5. A telephone call routing system as claimed in any one of the preceding claims, further comprising a status monitor to determine the availability of the mobile resource.
- 25 6. A telephone call routing system as claimed any one of the preceding claims, wherein each mobile resource contains mobile resource location means for transmitting the location of the mobile resource to the coordinator across a wireless data link.
- 30 7. A telephone call routing system as claimed in any one of the preceding claims, wherein the status monitor transmits the availability of the mobile resource to the coordinator across a wireless data link, such that the coordinator can route the telephone call to a mobile phone in a nearby available mobile resource.

8. A telephone call routing system as claimed in any one of the preceding claims, wherein the mobile resource includes a payment terminal which transmits payment transaction data to the coordinator across a wireless data link.
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9. A telephone call routing system as claimed in claim 8, wherein the mobile resource location means is contained in the payment terminal.
10. A telephone call routing system as claimed in any one of the preceding claims, wherein data can be transmitted from the coordinator to the mobile resource across a wireless data link.
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11. A telephone call routing system as claimed in any one of the preceding claims, wherein the mobile resource location means comprises a Global Positioning System (GPS) receiver.
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12. A telephone call routing system as claimed in claim 11, wherein the mobile resource includes a multifunctional antenna for receiving and transmitting data across a wireless data link, receiving and transmitting mobile telephone signals from a mobile telephone and receiving GPS signals.
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13. A telephone call routing system as claimed in any one of the preceding claims, wherein the telephone call originates from a mobile telephone.
14. A telephone call routing system as claimed in 13, wherein the caller location means determines a location for the caller using a cell of origin of the second mobile telephone.
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15. A telephone call routing system as claimed in 13, wherein the caller location means determines a location for the caller by calculating a difference in time of arrival of a signal from the mobile telephone to at least three base stations whose locations are known.
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16. A telephone call routing system as claimed in 13, wherein the caller location means determines a location for the caller by calculating a difference in times of arrival at the

mobile telephone and at additional receivers, whose locations are known, of signals from at least three base stations.

17. A telephone call routing system as claimed in any one of claims 1 to 12, wherein the
5 telephone call originates from a fixed line telephone.

18. A telephone call routing system as claimed in claim 17, wherein the caller location means determines a location for the caller by looking up a location of the fixed line telephone using the fixed line telephone number.

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19. A telephone call routing system as claimed in any one of the preceding claims, wherein the coordinator includes an interactive voice response server to allow the caller to interact with the coordinator and to route telephone calls from the caller to a mobile resource.

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20. A telephone call routing system as claimed in any one of the preceding claims, wherein the coordinator comprises a communications server for receiving location data from mobile resources.

20 21. A telephone call routing system as claimed in claim 20, wherein the coordinator comprises an application server for interpreting and administering the data from the communications server and an interactive voice response server and for responding to requests from the interactive voice response server.

25 22. A telephone call routing system as claimed in any one of claims any one of the preceding claims, wherein the coordinator comprises a database server for storage of caller, mobile resource and operations data.

23. A telephone call routing system as claimed in any one of claims any one of the
30 preceding claims, wherein the caller has one or more preferred mobile resources, such that the coordinator routes the telephone call to a mobile telephone located in a nearby preferred mobile resource, with respect to the caller.

24. A telephone call routing system as claimed in claim 23, wherein each mobile resource has secondary mobile resources, which are preferred by the mobile resource, such that if a caller's preferred mobile resource is unavailable, the coordinator routes the telephone call to a nearby secondary mobile resource, with respect to the caller.

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25. A telephone call routing system comprising:

caller location means adapted to produce a caller location signal corresponding to a location of a caller making a telephone call;

mobile resource location means adapted to produce a resource location signal
10 corresponding to a location of at least one mobile resource; and

a coordinator which can receive and process the caller location signal and the resource location signal and route the telephone call to the mobile resource most conveniently proximate to the caller.

15 26. A method for routing a telephone call from a caller to one or more mobile resources, comprising the steps of:

determining the location of the caller;

determining the location of one or more mobile resources; and

routing the telephone call from the caller to a nearby mobile resource, with respect
20 to the caller.

27. A method as claimed in claim 26, wherein the step of determining the location of one or more mobile resources, includes:

receiving updates, at varying intervals, of the current time, the location, the speed
25 and the heading of the mobile resource; and

extrapolating a predicted location for the mobile resource between updates, by considering the location, speed and heading of the mobile resource at the previous update and the time elapsed since the last update.

30 28. The method as claimed in claim 27, wherein one or more of the mobile resources transmits updates only when the location of the mobile resource is outside an uncertainty circle surrounding the predicted location of the mobile resource.

29. The method as claimed in claim 28, wherein a call centre routes the telephone call from the caller to a nearby mobile resource, with respect to the caller.
30. The method as claimed in claim 29, wherein a radius of the uncertainty circle is controlled by the call centre, depending on the location of the mobile resource and/or the time of day.
31. The method as claimed in any one of claims 29 or 30, wherein the predicted location is calculated in both the mobile resource and the call centre.
32. A method for selecting a nearby mobile resource having a known location, with respect to a caller having a known location, comprising the steps of:
determining an uncertainty circle for the location of each mobile resource;
selecting a group of available mobile resources having circles of uncertainty lying entirely within a certain distance from the caller; and
selecting a mobile resource having a circle of uncertainty with a centre closest to the caller from the group of available mobile resources.
33. The method as claimed in claim 32, wherein a mobile resource is selected by considering the size of at least one of the uncertainty circles of the taxis in the catchment area.
34. A telephone call routing system, substantially as hereinbefore described with reference to the accompanying drawings.
35. A method for routing a telephone call from a caller to one or more mobile resources, substantially as hereinbefore described with reference to the accompanying drawings.
36. A method for selecting a nearby mobile resource, substantially as hereinbefore described with reference to the accompanying drawings.