US 20110217964A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2011/0217964 A1

(43) Pub. Date: Sep. 8, 2011

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(54) SYSTEM AND METHOD FOR PROVIDING TO A WIRELESS COMPUTING DEVICE THE PRICING AND DYNAMICALLY-PREDICTED SIGNAL STRENGTH OF LOCALLY-AVAILABLE RADIO SERVICES

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(21) Appl. No.: **13/042,307**

(22) Filed: **Mar. 7, 2011**

Related U.S. Application Data

(60) Provisional application No. 61/311,237, filed on Mar. 5, 2010.

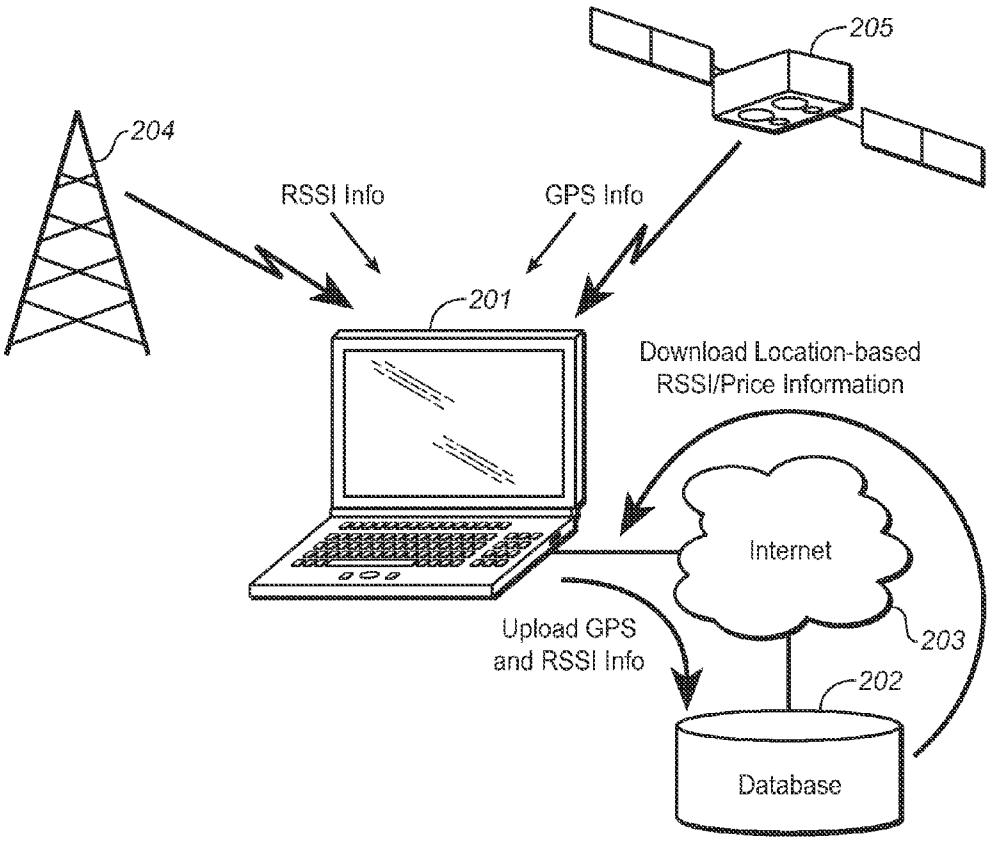
Publication Classification

(51) **Int. Cl.**
H04W 4/02 (2009.01)

(52) **U.S. Cl.** **455/414.2**

(57) **ABSTRACT**

A system and method for providing to a mobile computing device the carrier identity, expected connection quality and pricing information related to each radio service available in the location where the mobile computing device is attempting to make a radio communications connection. This location-specific connection quality information for each carrier is provided by a system that gathers real connection quality information for each wireless carrier operator's signal in a given location, as reported to the system by mobile computing devices operating in that given location, thus creating a database of connection quality information that is automatically updated over time. This system also links the identity and usage pricing structure information of each radio carrier operator to each location. Preferably, this system makes the aggregated map of information available to a mobile computing device via a data communications connection in real time, so a mobile computing device could download a current 'map' and use it immediately, or store it for future use in the same, or other locations. By looking up the information available in the map for its own current location, a mobile computing device can make an informed decision as to which carrier is the most appropriate for a connection at that location. The determination of the mobile device's current location can be obtained via an internal or linked GPS receiver, or by other mechanisms or methods.



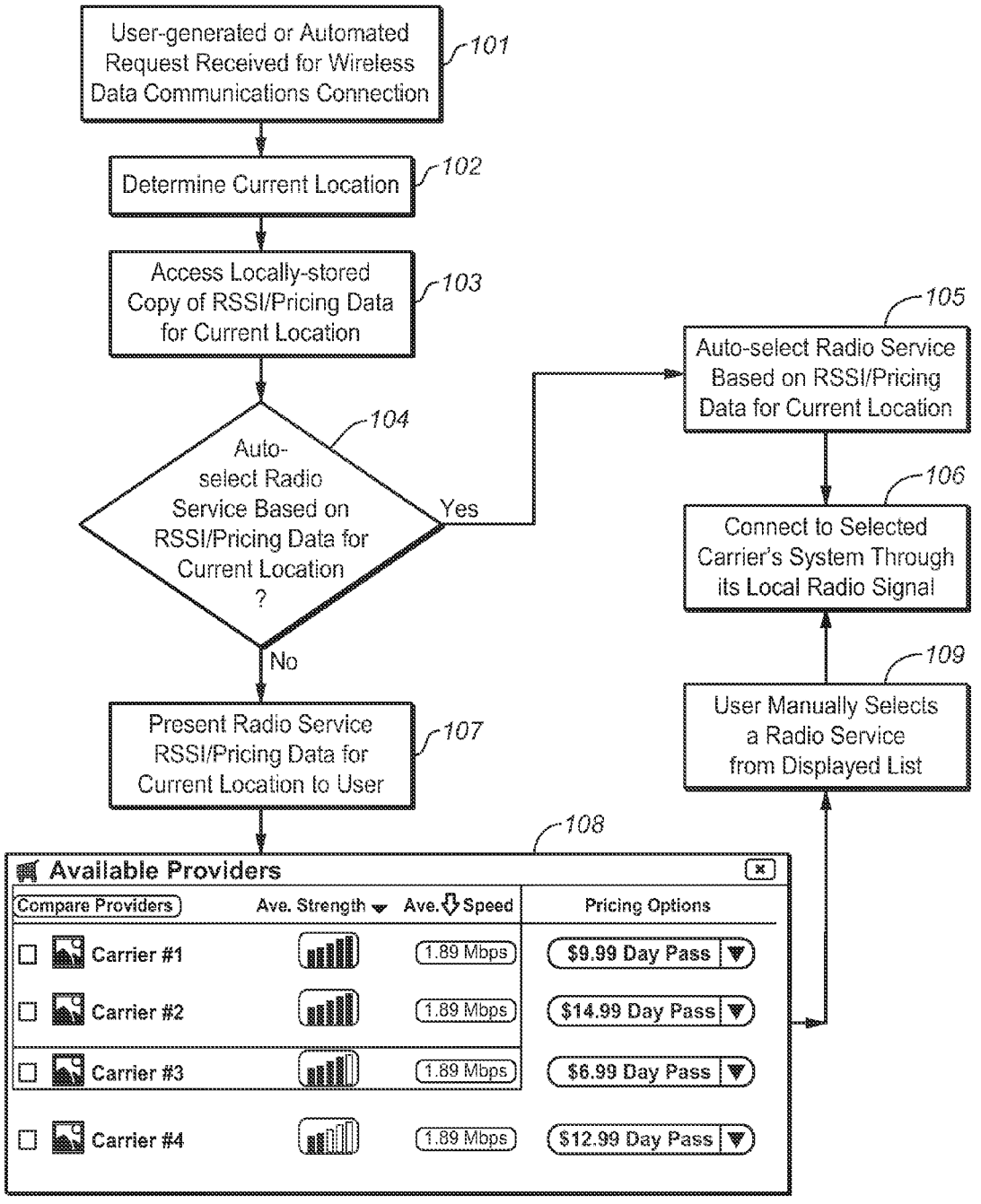

User-generated or Automated Request Received for Wireless Data Communications Connection
101
Determine Current Location
102
Access Locally-stored Copy of RSSI/Pricing Data for Current Location
103
Auto-select Radio Service Based on RSSI/Pricing Data for Current Location ?
104
Yes
No
Auto-select Radio Service Based on RSSI/Pricing Data for Current Location
105
Connect to Selected Carrier's System Through its Local Radio Signal
106
User Manually Selects a Radio Service from Displayed List
109
Present Radio Service RSSI/Pricing Data for Current Location to User
107
108
Available Providers
Compare Providers
Ave. Strength
Ave. Speed
Pricing Options
Carrier #1
1.89 Mbps
$9.99 Day Pass
Carrier #2
1.89 Mbps
$14.99 Day Pass
Carrier #3
1.89 Mbps
$6.99 Day Pass
Carrier #4
1.89 Mbps
$12.99 Day Pass

FIG. 1

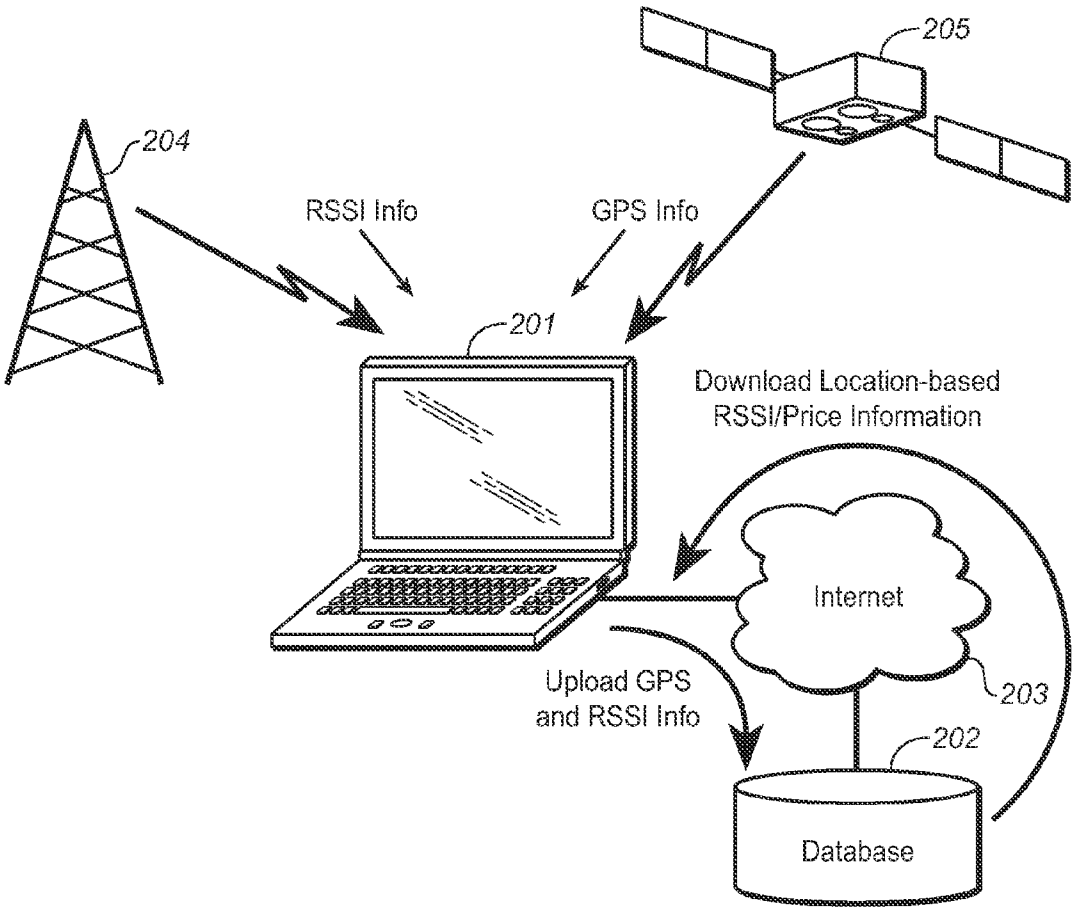

205
204
RSSI Info
GPS Info
201
Download Location-based
RSSI/Price Information
Internet
203
Upload GPS
and RSSI Info
202
Database

FIG. 2

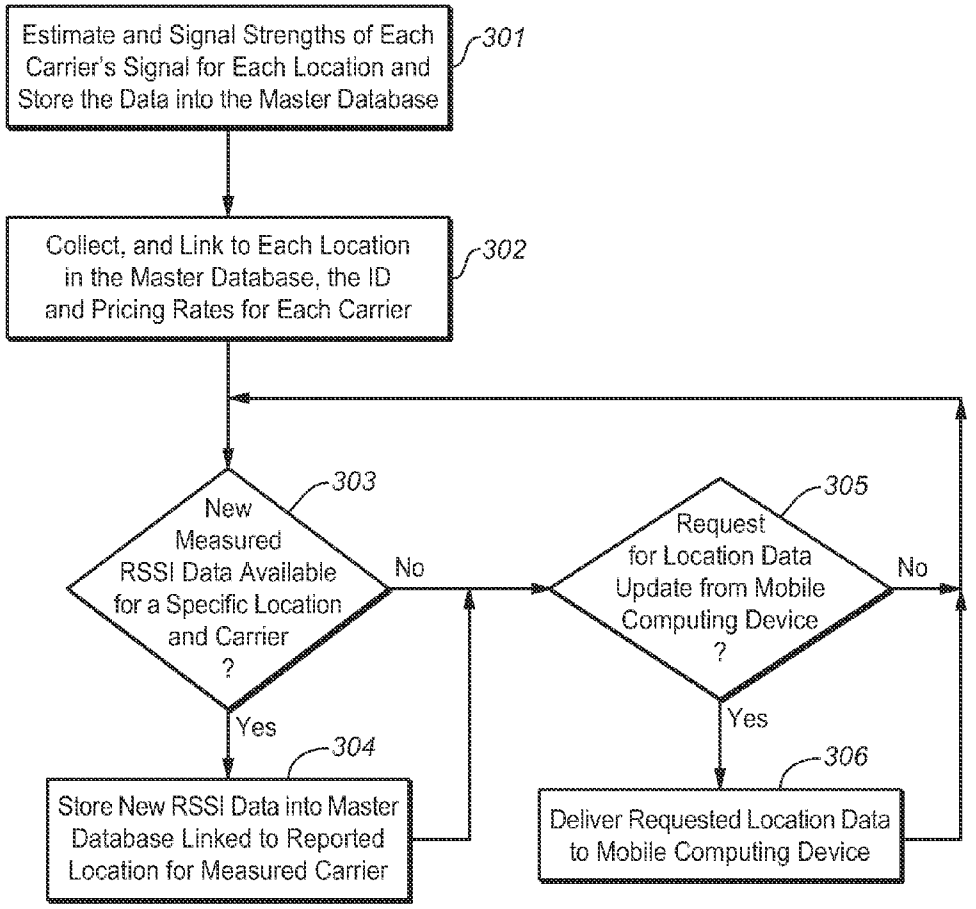

Estimate and Signal Strengths of Each Carrier's Signal for Each Location and Store the Data into the Master Database
301
Collect, and Link to Each Location in the Master Database, the ID and Pricing Rates for Each Carrier
302
New Measured RSSI Data Available for a Specific Location and Carrier ?
303
No
Yes
Request for Location Data Update from Mobile Computing Device ?
305
No
Yes
Store New RSSI Data into Master Database Linked to Reported Location for Measured Carrier
304
Deliver Requested Location Data to Mobile Computing Device
306

FIG. 3

SYSTEM AND METHOD FOR PROVIDING TO A WIRELESS COMPUTING DEVICE THE PRICING AND DYNAMICALLY-PREDICTED SIGNAL STRENGTH OF LOCALLY-AVAILABLE RADIO SERVICES

CROSS REFERENCES TO RELATED APPLICATIONS

[0001] The present application claims the benefit of U.S. Provisional Patent Application Ser. No. 61/311,237, filed Mar. 5, 2010 (Mar. 5, 2010).

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

THE NAMES OR PARTIES TO A JOINT RESEARCH AGREEMENT

[0003] Not applicable.

INCORPORATION-BY-REFERENCE OF MATERIAL SUBMITTED ON A COMPACT DISC

[0004] Not applicable.

BACKGROUND OF THE INVENTION

[0005] 1. Field of the Invention

[0006] The present invention relates generally to computers using radio telecommunications, and more specifically to a method of providing to a mobile computing device the usage pricing structure and expected connection quality (including, inter alia, received signal strength indication and/or average download speed) for each radio carrier signal available at the location from which the mobile computing device is attempting to make a wireless connection.

[0007] When a mobile computing device is attempting to wirelessly connect to a network, a connection manager (either the device user him- or herself, or an automated function residing in the mobile computing device) can select from any available radio service configured to connect computers or devices to a network and operating on a radio frequency and with a communications protocol that are compatible with the capabilities of the mobile computing device. This is predicated, of course, on first having obtained authorization to use the service from the radio service operator (e.g., carrier).

[0008] In order to make the best decision about which service to use, the connection manager must have certain important information about the specific location from which the connection will be attempted. This information includes the expected connection quality and usage pricing structure of each locally-available wireless network. The connection quality information is important because it directly correlates to data quality and throughput in a wireless system. When a received signal is weak, data errors increase and generate more error correction activity, thus requiring retransmission of more data. The retransmission of data reduces the overall data bandwidth of the path. Thus, when high throughput (data transfer rate) is required, the best available connection quality is an important factor in the decision to select a carrier.

[0009] If available, the connection quality information can be used by an automated connection manager to select the optimum network with which to connect, or the information can be provided to the end user so that the user can make the best cost-benefit decision.

[0010] Under current business practices in the wireless computing industry, this important information is not made readily available to the connection manager of a mobile computing device at the time the connection attempt is being made. This is because network operators have no incentive to share information about their radio network coverage quality with competitors. Even if there were a motivation to share this information, there is no currently known method or system available for carriers to use for sharing this information or to provide it to mobile computing devices.

[0011] In consequence, the end users of wireless computing connections currently must make connection decisions with limited information, which in turn may lead to a less than optimum overall user experience. Under these circumstances, the user may frequently unknowingly make a decision to connect to a carrier whose signal strength is not the best for the location, or whose price is higher than an another carrier with equivalent signal strength at the same location.

[0012] One approach to solving this problem is for the mobile computing device briefly connect to (and sniff) each local wireless network to obtain connection quality and network operator information. This solution has disadvantages that include an unacceptably long lead time required for the initial measurement of the received signal strength of each available carrier signal before being able to automatically connect using the information or display it to the user. This makes for an even worse user experience, because in order to obtain usage pricing information, the user is required to manually connect to multiple networks, read, and remember the rate information before having sufficient information to make an informed choice of which network to use.

[0013] Another solution is for the mobile computing device to contain (or access) a database of location-specific predicted connection quality information. This information could be downloaded from a source where a mapping of location to predicted signal strength is accomplished through existing methods for predicting wireless signal strength in a certain location. These methods include Gaussian, raw measurement, predictive propagation, and static prediction calculation techniques. This approach still requires the user to manually compare the predicted signal strengths for the current location downloaded from multiple carrier operators. The user must also look up pricing information for each carrier available at the location and then attach a price structure to each carrier's predicted signal strength so that an informed decision can be made.

[0014] This second solution has other limitations, including the limited connection quality prediction accuracy due to variables such as location of walls, buildings, people, or landscape. Additionally, the connection quality information for a location is not easily obtained or provided from every available carrier. There is currently no available method for aggregating this information for efficient presentation to an end user or automated connection manager.

[0015] Discussion of Related Art including information disclosed under 37 CFR §§1.97, 1.98: Known relevant art includes U.S. Pat. No. 7,110,768, to Bridges, et al, which purports to teach an apparatus and system for accurately predicting and evaluating cellular system performance before an actual system is installed at a site. The system uses a portable measurement and antenna placement (MAP) tool to evaluate quality determinative system parameters at varied locations in relation to a planned cell site, before the cell site is installed. A user can measure the radio coverage area of cells by viewing a bar graph display that shows the range of acceptable signal levels for the system, and by listening for an audible warning tone that signals the user when the cell 'edge'

has been exceeded. This prediction and evaluation tool provides only a static snapshot of predicted coverage of a wireless site. It does not automatically update the predicted or measured connection quality information over time.

[0016] U.S. Pat. No. 6,678,525, to Baranger, teaches a process for predicting radio signal propagation in indoor environments, useful only as a method for static prediction of in-building signal coverage. The method could be used by each carrier to provide (for its own network) an RSSI prediction for each location within a building. However, the method provides no process for aggregating coverage information with the predicted RSSI information for other carriers' signals for the same location. Additionally, the prediction data created using this method are static. Updating this data requires recalculating the radio coverage using updated building structure and content information. There is no method described for automated updating of the data.

[0017] U.S. Pat. Appl. Ser. No. 2003/0087657, by Wilborn, discloses a method and apparatus for predicting RSSI in a wireless mobile receiver. The predicted signal strength is used to set the mobile receiver amplifier gain to a desired level and for automatically updating the predicted RSSI information. However, the updated the predicted RSSI information is not sent to an external system for aggregation with other information from other radio receivers for the same location.

[0018] In a paper entitled, "Gaussian Processes for Signal Strength-Based Location Estimation," by Ferris, US Robotics Proceedings, 2006, there is described a method for improved estimation of the location of a mobile device based on wireless signal strength. This paper shows how Gaussian processes can be used to generate a likelihood model for signal strength measurements, wherein parameters of the model, such as signal noise and spatial correlation between measurements, can be learned from data via hyperparameter estimation. This is an example of the use of prediction techniques for estimating the location of a mobile transmitting device. This can be useful for informing the device about its location. A superior alternative to this technique is to use a Global Positioning System (GPS) receiver linked to (or integrated into) the mobile device. In this manner, the device can obtain location information through its GPS receiver logic.

[0019] Accordingly, in view of the limitations of the prior art, the need remains for a method of providing a mobile computing device with expected connection quality and pricing information related to each radio service available in the location where the computing device is attempting to make a radio communications connection. This information does not require the mobile computing device itself to scan all of the available local radio signals to determine the localized signal strengths. Rather, this location-based connection quality information for each carrier can be provided by a system that gathers real connection quality information for each wireless carrier operator's signal in a given location, as reported to the system by actual mobile computing devices operating in that given location, thus creating a database of connection quality information that is automatically updated over time. The system can gather the identity and pricing structure information of each radio carrier operator for each location (preferably automatically, but manual entry of this identity and pricing information is also possible). The system can store a record for each location, and link to that record the connection quality and pricing for each available carrier operator. Preferably, this system makes the aggregated map of carrier-specific and location-specific connection quality and pricing information available to a mobile computing device via a data communications connection in real time, so a mobile computing device can download a current 'map' and use it immediately, or store it for future use in the same or other locations (since the map can contain information about more locations than the mobile device's current location). By looking up the information available in the map for its own current location, a mobile computing device can make an informed decision as to which carrier is the most appropriate for a connection at that location. The determination of the mobile device's current location can be obtained via an internal or linked GPS receiver, or by other mechanisms or methods. These needs are met in the present invention as described herein.

[0020] The foregoing discussion sets out the current state of the art of which the present inventors are aware. This discussion is intended to aid in discharging Applicants' acknowledged duties of candor in disclosing information that may be relevant to the examination of claims to the present invention. However, it is respectfully submitted that none of the extant art in this field, nor references related thereto, disclose, teach, suggest, show, or otherwise render obvious, either singly or when considered in combination, the invention described and claimed herein.

BRIEF SUMMARY OF THE INVENTION

[0021] It is a first and principal object of the present invention to provide a system and method for providing to a mobile computing device the expected connection quality and pricing information related to each radio service available in the location where the computing device is attempting to make a radio communications connection.

[0022] Another object of the invention is that the determination of the mobile device's current location can be obtained via an internal or linked GPS receiver, or by other mechanisms or methods.

[0023] It is a further object of the present invention to eliminate the need of a mobile computing device itself to scan all of the available local radio signals to determine their localized signal strengths and to do so by providing access to the location-based connection quality information for each carrier that is stored in a system that gathers (from mobile computing devices operating in each location) the actual measured connection quality information for each wireless carrier operator's signal in each location. Note: in lieu of actual measured connection quality information for a given location, a predicted value can be used until actual measured values are reported.

[0024] It is still another object of the present invention to have the system database of connection quality information automatically updated over time as more mobile computing devices report local connection quality information for specific carriers' signals at specific locations.

[0025] Yet another object of the present invention is to provide a system that gathers the identity and pricing structure information of each radio carrier operator for each location.

[0026] An even further object of the present invention is to make an aggregated map of carrier-specific and location-specific connection quality and pricing information available to a mobile computing device via a data communications connection in real time.

[0027] Finally, the present invention is also intended to enable a mobile computing device to download a current 'map', and to store the 'map' information for future use (thereby eliminating the need to scan radio signals before making a decision regarding the carrier to select for connection at any given location).

[0028] The foregoing summary broadly sets out the more important features of the present invention so that the detailed description that follows may be better understood, and so that

the present contributions to the art may be better appreciated. There are additional features of the invention that will be described in the detailed description of the preferred embodiments of the invention which will form the subject matter of the claims appended hereto.

[0029] Accordingly, before explaining the preferred embodiment of the disclosure in detail, it is to be understood that the disclosure is not limited in its application to the details of the construction and the arrangements set forth in the following description or illustrated in the drawings. The inventive apparatus described herein is capable of other embodiments and of being practiced and carried out in various ways.

[0030] As such, those skilled in the art will appreciate that the conception, upon which this disclosure is based may readily be used as a basis for designing and implementing other systems and methods for carrying out the several purposes of the present invention. It is important, therefore, that the claims are regarded as including such equivalent constructions as far as they do not depart from the spirit and scope of the present invention. Rather, the fundamental aspects of the invention, along with the various features and structures that characterize the invention, are pointed out with particularity in the claims annexed to and forming a part of this disclosure. For a better understanding of the present invention, its advantages and the specific objects attained by its uses, reference should be made to the accompanying drawings and descriptive matter in which there are illustrated the preferred embodiment.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0031] The invention will be better understood and objects other than those set forth above will become apparent when consideration is given to the following detailed description thereof. Such description makes reference to the annexed drawings wherein:

[0032] FIG. **1** is schematic flow chart showing the software of the inventive system running on a mobile computing device, according to a preferred embodiment of the present invention;

[0033] FIG. **2** is schematic block diagram showing an implementation of the preferred embodiment of the present invention;

[0034] FIG. **3** is a block-diagrammatic schematic flow chart showing tasks performed to populate and distribute data from a centralized server database according to the preferred embodiment of the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0035] Referring first to FIG. **1**, it can be seen that software (either system or application software) running on a mobile computing device starts in block **101**, wherein a user-generated or automated request is received for making a wireless data communications connection. Upon receiving this request, the software proceeds to block **102**, where the current location of the mobile computing device is determined. After this, the software proceeds to block **103**, where it accesses the connection quality/pricing data for each carrier, which may be locally stored, having a signal serving the mobile computing device's current location. After retrieving this information, the software proceeds to decision block **104**.

[0036] At decision block **104**, the software determines whether the mobile computing device is configured to automatically select the radio service. If the answer is yes, then the software proceeds to block **105**, where the software automatically selects the radio service based on the connection quality and pricing information of each available radio service for the location. The software then proceeds to block **106**, where the mobile computing device is connected to selected carrier's system through that carrier's local radio signal.

[0037] If, in decision block **104**, the software determines the answer is no, then the software proceeds to block **107**, where the software visually presents to the user at least the connection quality and pricing information of each available radio service for the location (see visual display **108**). The software may also display the average bit rate or data transfer rate or other signal or network operating characteristics. The user then manually selects one of the available carriers for the connection in block **109**, and the software then flows to block **106**, where the mobile computing device is connected to selected carrier's system through that carrier's local radio signal.

[0038] Referring now to FIG. **2**, it is seen that a mobile computing device **201** can be connected via the Internet **203** to centralized database **202**, where the aggregated signal quality indicator (e.g., signal strength, QoS, data throughput, or any other signal characteristic relevant to connection and/or data quality, as such the signal quality indicator may comprise a single signal characteristic or multiple signal characteristics as desired) and pricing are stored for each carrier for each location. With this connection, mobile computing device **201** can retrieve all, or a part of, the stored location information. Using the same connection path, mobile computing device **201** can report its current location; along with the signal quality indicator currently received at that location, for example signal strength, from the wireless carrier though which mobile computing device **201** is currently connected.

[0039] Still referring to FIG. **2**, GPS satellites **205** are used by mobile computing device **201** to determine its current location. Mobile computing device **201** combines this location information with the signal quality indicator (e.g., strength of the signal received) from the transmissions of wireless transceiver **204**, and reports it back to centralized database **202**, relating the to the carrier ID received from the transmissions of wireless transceiver **204**.

[0040] The mobile computing device and the centralized database may connect and communicate in several ways.

[0041] Initial Connection: In an embodiment, the mobile computing device may be pre-loaded with a partial database file at the factory or at another staging location. It is an increasingly common practice for retailers to remove PC OEM factory images and to replace those with their own image. This way the retailer can take advantage of freeware activation revenue that might otherwise flow to the PC OEM. Should this practice evolve or expand, it is possible that retailers may employ location-specific files loaded before sale. Likewise, the PC OEM may download a location-specific file as a final CTO (Configure to Order) step before shipping a pre-ordered number of units to a purchasing retailer location.

[0042] A full file of connection options may be pre-loaded onto PCs or mobile devices. On first boot up and as part of initialization, the PC or mobile device can activate its GPS unit and identify the general location of the PC or mobile device and remove all other locations.

[0043] The first connection the user makes need not be a wireless WAN. If the first connection is a wired connection at a home or office, a file can be downloaded with connection quality and location information before WWAN is activated.

[0044] Uploading Information to the Server: Once a connection between the mobile computing device and the centralized server is established (wired, wireless, wireless LAN,

WWAN, etc.), the system employs a mechanism to capture the signal quality indicator, such as connection quality, and location information from the actual network connection. In an embodiment, RSSI information, for instance, can be passed from the modem that interacts with the network to the software, where the software translates the RSSI to a signal strength display. Likewise, there are currently standard GTPS APIs that hook into the software, so the modem can transfer this information to the software.

[0045] Once this information is captured, it is automatically and periodically updated on an Internet-connected server, in a manner well known in the art.

[0046] Downloading Information from the Server: To update a connection quality and location file, the user can manually connect to a server on the Internet and download an executable file, which when executed will store the desired information on the mobile computing device. This method can be automated to bypass the need for manual steps. Alternatively, the server may act as a device management server to push periodic updates to the mobile connection devices via OMA DM or another standard.

[0047] Referring now to FIG. **3**, it can be seen that software operating in a centralized server (to which database **202** is connected) performs operations that enable the present invention. In block **301**, an initial estimate is made of the signal quality indicator (e.g., signal strengths) of each carrier signal for each location, and this information is stored in the master database. Following this, in block **302**, the server collects, and also links to each location in the master database, the ID and pricing rates for each carrier for each location. Note that the step of block **302** can be automated, or performed using manual data entry.

[0048] After the initial prediction values are stored, the software proceeds to decision block **303**, where it is determined whether a new report has been received with the signal quality indicator, such as signal strength, for a carrier's signal at a specific location. If so, then the software proceeds to block **304**, where the reported connection quality data is stored in the master database and linked to a reported location and the measured carrier. After this, the software proceeds to decision block **305**.

[0049] If, in block **303**, the answer is no, then the software also proceeds to decision block **305**, at which point the software determines whether a request has been received from mobile computing device **201** for a location data update. If so, the software proceeds to block **306**, where the server delivers the requested data to mobile computing device **201**, and then loops back to the entry of decision block **303**.

[0050] If, in block **305**, the answer is no, then the software also loops back to the entry of decision block **303**.

[0051] To generate an indication of the typical signal quality indicator (e.g., signal strength) information about a particular GPS coordinate, in an embodiment the central database calculates the mean (average) of signal strength information to create a representative typical signal quality indicator (e.g., signal strength). The system is inherently intelligent and self-learning, such that as more information becomes available and outlier data will diminish in significance. Additionally, as more information becomes available, the system becomes more accurate as smaller circles of physical area can be identified to obtain granular detail with respect to connection quality. In this manner, connection quality inside a building can be differentiated from connection quality outside the same building.

[0052] Finally, the database includes a time element to track this data, so that, for instance, at 7:00 a.m. connection quality may be better than connection quality at 9:00 a.m. when many users on a network might create a high load on the network that adversely affects average download speed.

[0053] In this manner, the centralized server creates and maintains an updated set of connection quality information for each carrier's signal at each location. The server also connects this information to the location and carrier, along with the carrier's rate structure for the location. The server makes this information available upon request.

[0054] The instant disclosure describes how to fashion and use various embodiments in accordance with the present invention, rather than to limit the true, intended, and fair scope and spirit thereof. Accordingly, the foregoing description is not intended to be exhaustive or to limit the invention to the precise form disclosed. Modifications or variations, such as described just above, and others, are possible in light of the above teachings. The embodiment(s) was chosen and described to provide the best illustration of the principles of the invention and its practical application, and to enable one of ordinary skill in the art to utilize the invention in various embodiments and with various modifications as are suited to the particular use contemplated. All such modifications and variations are within the scope of the invention as determined by the appended claims, as may be amended during the pendency of this application for patent, and all equivalents thereof, when interpreted in accordance with the breadth to which they are fairly, legally, and equitably entitled.

What is claimed as invention is:

1. A system for providing to a mobile computing device information relating to the identity, predicted received signal quality indicator, and pricing information for each radio service available in the location in which the mobile computing device is attempting to make a radio communications connection, comprising

a central database including storage means for storing the information in said central database; and

downloading means for downloading the information stored in said central database to the mobile computing device in real time.

2. The system of claim **1**, further including calculation means for using a predictive static model to calculate the predicted received signal quality indicator stored in said central database for each specific location, for each specific carrier.

3. The system of claim **1**, including information update means for updated the predicted received signal quality indicator stored in said central database for a specific location, and for a specific carrier, whenever a mobile computing device measures and reports a new received signal quality indicator for that specific location, while operating in that specific location and while connected to that specific carrier.

4. The system of claim **1**, including locating determining means, wherein a mobile application running on said mobile computing device, upon receiving a request for a wireless data connection, determines said mobile computing device's current location, and then accesses said predicted received signal quality indicator and pricing information for each carrier identified as having a signal at the current location of said mobile computing device.

* * * * *