METHOD FOR DETERMINING AND COMPARING USERS' PATHS IN A BUILDING

FIELD OF THE INVENTION

This invention relates to a method and system for determining a user's path. Further, this invention also relates to a method and system for determining the location of a user. More specifically, this invention relates to a method and system for tracking a user within an indoor or outdoor area, such as a hospital, a college campus, a sports arena or an airport This invention also relates to a method and system for determining a user's path for operational and planning purposes, and in particular to a method and system for determining the residence time of a user in a zone.

The invention also has application in providing real time information to passengers, as well as to the scheduling of services so that airport authorities can react to any build up of passengers in critical areas such as security screening, immigration checks, baggage and so on.

BACKGROUND OF THE INVENTION

In the past, airports have had difficulty getting historical and real-time information regarding the behaviour of passengers within and around an airport.

One solution to this problem is to use Bluetooth (Bluetooth is a registered trade mark of Bluetooth SIG, Inc, Washington, United States of America) or Radio Frequency Identification (RFID) tags. However these solutions have the following limitations:

- RFID tags are not typically carried by passengers and therefore cannot be used without specifically issuing them to passengers.
- Bluetooth is a short range protocol limited to small areas of the airport.
- Bluetooth is not commonly active in passenger smart telephone devices, thereby limiting the accuracy of any measurements.
- Bluetooth relies on Bluetooth Access Points in fixed locations. It is relatively complex and time consuming to relocate them if necessary.

Another solution is to use a WiFi triangulation method to track passenger smart telephones. WiFi uses a wireless connection between a user device and an access point to transfer data between the user device and access point. WiFi is a registered trade mark of Wi-Fi

Alliance, San Jose, United States of America. Usually, the access point has a wired connection to a local area network (LAN). However, a problem with this approach is that WiFi devices do not emit a continuous stream of data. This is because a device will only be detected when a user is actually using the airport WiFi infrastructure.

This means that for any given device, it may be detected only sporadically throughout the airport. For example, a device may be detected while a passenger is using their telephone in a café, or at a gate area, but not while walking from check in to security zones. This is of course problematic for live dwell time measurements because this sporadic data is not representative of what is actually happening in the airport.

Embodiments of the invention seek to address the above problems by using WiFi signals emitted through passenger smart telephones, and other devices, to provide location data which can be used to locate, track and measure the activities of passengers throughout the airport campus. The location data is processed to remove poor quality data and the remaining data is used to determine a passenger's path and associated dwell time information. This data can then be used to provide real time measurements for any section of the airport.

Embodiments of the invention, which may be referred to as and Indoor Anonymous Dwell Time Tracking system, are a multi component service that:

1. Allows airport staff to define arbitrary zones in the airport.
2. Locates devices using triangulation of WiFi signal strength
3. Associates these devices to a zone in an airport
4. Charts the path of devices in these spaces.
5. Maintains a live set of continuous device detections for devices detected in the airport
6. Uses this zone and device path data to determine the dwell time in any zones across the airport.

Embodiments of the invention improve on existing RFID systems because the passengers/consumers being tracked do not need to be given a RFID token to carry, and do not necessarily need to be informed that their movements are being tracked, which can subconsciously change behaviour.

Embodiments of the invention improve on Bluetooth systems because WiFi covers the entire airport campus, not just small specific areas. Therefore it is possible to provide sophisticated measurements such as "show current wait time for passengers in immigration who started in international arrivals". It also improves on Bluetooth systems because the zones being measured are arbitrary and are not tied directly to the location of access points. In this regard, in a Bluetooth system, if an airport wants to modify the zone being measured, it is necessary to physically move the Bluetooth sensors. In the present invention, the airport staff just need to configure the new zone using a Google Map application.

Embodiments of the invention improve on basic WiFi triangulation because it can maintain a live device path, storing all the previous zones a device passed through, and use this data to determine if the data is suitable or not for live dwell time measurements.

SUMMARY OF THE INVENTION

According to a first aspect of the present invention, there is provided a system for determining the path taken by a user through one or more zones. The system may comprise: a location server arranged to receive location data indicative of the location of a communication device associated with the user, the location data defining the position of the communication device at a plurality of different points in time, the location server further arranged to receive sequence data associated with the location data indicative of the order in which the location data was determined; and a path determining means for determining the path of the user through the zone, the user's path being defined by at least a portion of the received location data; and a comparator for comparing the determined path of the user with on or more predetermined user paths. The location server processes the received location data depending upon the result of the comparison. Preferably, the location server corrects the determined user path with the process location data.

According to another aspect of the present invention, there is provided a system for processing user location data comprising: a location server arranged to receive location data of a communication device associated with the user, the location data defining the position of the communication device at a plurality of different points in time, the location server further arranged to receive sequence data associated with the location data indicative of the order in which the location data was determined; path determining means for determining the user's path defined by the received location data and the associated sequence data; and a comparator for comparing the determined path of the user with one

or more predetermined user paths. Each predetermined path is preferably defined by further location data and associated sequence data indicative of the order of the further location data. The location server is configured to process the received location data depending upon the result of the comparison. Usually, the location data is determined based on signal strength data which is usually received by an access point from a mobile device.

In yet a further aspect of the present invention, a method for processing user location data is provided. The method comprises receiving, with a receiver, location data of a communication device associated with the user, the location data defining the detected position of the communication device at a number of different points in time, and receiving, with the receiver, sequence data associated with the location data indicative of the order in which the location data was determined; determining, using a processor, the user's path passing through points defined by the received location data and the associated sequence data; and comparing, using the processor, the determined path of the user with one or more predetermined user paths; and processing, using the processor, the received location data depending upon the result of the comparison. Preferably, the determined user path is corrected or updated with the processed location data.

BRIEF DESCRIPTION OF THE DRAWINGS

Embodiments of the invention will now be described, by way of example only, and with reference to the accompanying drawings, in which:

Figure 1 is a schematic representation of the main functional components embodying the invention;

Figure 2 is a screen shot of a zone editor embodying the invention which may be used to select, create, edit or delete different zones in the airport to track a user's device;

Figure 3 is a screen shot of an editor embodying the invention in which a high quality device path in the airport is visualised in a particular zone;

Figure 4 is a screen shot of an editor embodying the invention in which a lower quality device path in the airport is visualised in a particular zone;

Figure 5 is a histogram showing live dwell time data obtained by embodiments of the invention; and

Figure 6 is a flow diagram showing the main steps performed by an embodiment of the invention.

The following description is of a system for use in the aviation industry, but this is exemplary and other applications of the invention will also be discussed. For example, the system may be used in any indoor or outdoor area where a user carries a WiFi enabled device, such as a hospital, a college campus, a sports arena and so on.

Referring now to figure 1, this shows a schematic representation of a system 100 according to an embodiment of the invention. Operation of the various components will be explained in further detail below.

The system 100 may be directed towards the tracking of users in an airport 101 having a plurality of WiFi access points 101a – 101d providing at least part of a WiFi infrastructure in the airport 101. Each access point 101a - 101d may be positioned at a different location in the airport 101.

The WiFi infrastructure may use Real-time Locating System (RTLS) triangulation to locate a passenger's smart telephone or other mobile communication device as will be known to the skilled person.

In the embodiment shown in figure1, a location server 107 is communicatively coupled to the airport WiFi infrastructure 101a – 101d. The location server 107 may be coupled to the airport infrastructure via a wireless link or a wired link. The sever 107 may run in an airport data centre or as a cloud service over a number of servers, which are usually positioned in different locations.

The server 107 may communicate with the airport network by means of an Application Programming Interface, API, that is provided by a WiFi vendor or provider. The server 107 may use a particular provider's API to obtain the raw location data from the airport.

The location server 107 may comprise a historical data store 103 for storing the determined movement of devices in the airport. The historical data store may be provided as part of the location server as a hard disk or solid state memory or other local storage means. Alternatively the historical data store 103 may be a separate store located in a different position to the location server 107, such as a hard disk or solid state memory or other remote storage means. The historical data store may store both historical reference data and also data identifying devices belonging to airport staff or infrastructure. In either case, the historical data store 103 is communicatively coupled a zone data component 102 which may be part of the location server 107. This may be using a wired or wireless connection. A

zone refers to a spatial area in the airport in which dwell time measurements are to be made. Examples of zones are: Security, Baggage, Immigration, Retail, or Check in.

The zone data component 102 may store a definition of the zones of interest in the airport, for example: airside, landside, security, baggage, retail and so on. The data component 102 may store the zone definitions on a hard disk or solid state memory or in other storage means. The airside part of the airport is usually the part of the airport that is accessible only after a passenger has gone through boarding card and x-ray security checks. The landside part of the airport is usually the part before a passenger has gone through boarding card and x-ray security checks. It is also useful to note that arriving passengers emerges from the baggage hall into the Landside area.

In the example shown in figure 2, and described in further detail below, there are three terminals, T1, T2, and T3. Each terminal comprises a plurality of zones. For example, terminal T1 may comprise the following zones: Airside – First Floor, Airside - Ground Floor, and Landside zones. Terminal T2 may comprise Duty Free, Food, Retail, Airside, Check in, Landside-First Floor, and Landside – Ground Floor zones. Further, Terminal T3 may comprise Baggage and Check in zones, although the above definitions of which zones are associated with which terminal are exemplary only.

The zones are defined as are virtual spaces. A user may define each zone by dragging a polygon out on a map application, such as an internet browser map application running on an administration interface 106. One example of a suitable internet browser map application is a Google maps application. Defining a zone is similar to creating a polygon shape in Microsoft Powerpoint. Google is a registered trade mark of Google Inc., USA, and Microsoft and PowerPoint are registered trade mark of Microsoft Corporation, USA.

It is only necessary to define zones in a region of the airport where access points exist. However, one or more physical access points may be added to or removed from a particular zone without modifying the virtual zones. Furthermore, virtual zones may be redefined without having to modify any airport infrastructure. This addresses one of the problems with Bluetooth identified above in that embodiments of the invention may allow a change in the area being measured or monitored without physically moving access points.

In figure 1, the arrow labelled B pointing from the administration interface towards the zone data component schematically shows how the administration interface sends data defining a particular zone to the zone data component. The data defining each zone may be data

defining a polygon and preferably associated data defining the position of each access point in the polygon.

The server may also comprise an in-memory cache 104. The cache 104 stores data indicative of the current active devices that are being tracked in the airport, including their current position and zone. The cache may also store an in-memory representation of a path a device has taken as it moves thorough the airport. A path may be defined by the curve line or shape which links or joins a sequence of data points indicative of the position of the device. The sequence of the positional data is usually ordered in a chronological order.

An example of this representation is shown in figures 3 and 4 of the drawings, described in further detail below. Figure 3 is an example of a device path that is considered a high quality device path. There are plenty of device detections with good accuracy in the desired measurement zone. Figure 4 is an example of a device path that is considered low quality compared to the device path shown in figure 3. There are more infrequent detections than the higher quality device path shown in figure 4. The path shown in figure 4 is an example of the type of problematic data quality that the invention seeks to adderss.

The server 107 may also comprise an Application Programming Interface (API) 105. The API provides a way to access the data stored in the in-memory cache 104.

In the embodiment shown in figure 1, the API 105 is communicatively coupled to an administration interface 106 and the in-memory cache 104. The administration interface is described in further detail below. Further, the in-memory cache 104 is communicatively coupled to the zone data component 102 and to the API 105. Further, in the embodiment shown in figure 1, the zone data component 102 is communicatively coupled to both the historical data store 103 and the airport WiFi infrastructure 101.

The administration interface 106 uses the API 105 to access the memory cache data 104. The administration interface sends a request via the API 105 to access the memory cache data 104. The arrows E and F shown in figure 1 represent the memory cache data 104 being sent to the administration interface 106 in response to that request.

As previously described, the system 100 may comprise an administration interface 106 tool. This tool may be used to define the zones and to display the data returned from the API. The administration interface tool 106 is usually provided on a separate or different

server to the location server 107 however, they can in principle be provided on a single server. In either case, the administration interface 106 is communicatively coupled to the zone data component 102 and the API 105 within the location server 107.

The various steps performed by an embodiment of the invention will now be described in further detail below, referring to the flow diagram shown in figure 6. In some embodiments, not all of the steps shown in figure 6 will be performed, and the steps do not necessarily have to be performed in the order shown in figure 6.

At step 201, an airport operator uses the Administration Interface 106 to define the zones in the airport. A zone may be defined as a polygon having a plurality of lines joined by a number of vertices. Usually, the polygon is a closed shape so that a user has to cross one of the lines or zone boundary when leaving a zone.

The zone data may be stored in the Zone Data component 102. In addition, the zone data may also be stored offline in the Historical Data Store 103, but it is sufficient for the zone to be stored in a single storage means. An example of a baggage zone is shown in figure 2 as a filled black polygon area.

At step 203, the Location Server 107 polls the Airport WiFi infrastructure via a third party server. Usually, the airport WiFi infrastructure is provided by a third party, and therefore the location server 107 polls a third party server which in turn requests data, such as location data associated with all devices which may have moved since the last poll request. Usually, the third party server polls the Airport WiFi infrastructure in a periodic or regular manner. The server may poll the WiFi infrastructure approximately every 15 seconds. However, although the polling may be periodic, the received location data of each device is usually irregular in nature. This is because the airport WiFi infrastructure does not have control as to whether it receives a signal from a device. For example, if a device is temporarily switched off, then no location data of that device will be received by the location server when the device is switched off.

The third party server performs triangulation of the devices as the devices use the WiFi network. The third party server does this by well known triangulation methods familiar to the skilled person. The third party server sends to the location server location data of each mobile device which has been detected by the third party server. This allows the location server 107 to receive data associated with all devices that have moved since the last poll

request. The arrow labelled A, shown in figure 1 represents this data being sent from the third party location server to the location server 105.

The quality of the data received from the third party server may be determined based on an accuracy value provided by the third party provider. Data quality may be determined based on the signal strength or, the number of access points which can see each device, or both.

In addition, the location data may be time-stamped. This provides additional data indicative of when the location data of a particular device was determined. The system may determine the frequency of detections by comparing the time stamp of sequential location data messages received by the location sever 107.

The third party server then sends raw, or in other words, unprocessed location data to the location server 107. The unprocessed location data may include absolute positional data of each device i.e. longitude and latitude of each device in an airport or in other words, the x and y coordinates of the devices. Usually, the received location data of each device does not depend upon the location of the access point which each device is communicating with. Accordingly, the received location data of each device may be independent of the position of each access point.

At step 205, the location server 105 receives from the third party triangulation server data determining the location of all mobile devices which are active within the airport. This may be performed every 15 seconds, but can be performed more frequently or less frequently than this. After the server has received the location data at step 205, the location server may determine the user's path defined by the received location data and the associated sequence data defining a plurality of points on the path, at step 207. At step 209, the location server compares the determined path of the user with one or more predetermined user paths. At step 211, the location server processes the received location data depending upon the result of the comparison. At step 213, the location server corrects or updates the determined user path based on the comparison.

In some embodiments, the raw data received by the location server 107 may be combined or associated with the Zone Data to give it context. This is done by determining whether or not each device is within the boundary defining a particular zone. If it is determined that a particular device is located in a particular zone, then the location data associated with that device is also associated with the zone in which the device is located.

For example, the location server 107 may compare the location data i.e. the coordinates of a device with the coordinates defining a zone. If a device is determined to be inside the boundary of a polygon defining the zone under consideration, then the location server 107 associates that zone with the data structure for each device.

The combined or associated data may be referred to as contextual data. The data is combined by the server 107 and then stored in an in-memory (and preferably database) data structure. There is a data structure for each device detected. This data structure contains the coordinates, for example the abscissa (e.g. x coordinate) and ordinate (e.g. y coordinate) of the device.

In other words, each device is associated with a zone at each detected location. Usually, a plurality of devices are associated with each zone. In the example shown in figure 3, there are 5522 device paths are found, ready for an operator to review.

For example, there may be many people waiting in security or baggage zones at peak time. If there are 100 people waiting, and the server receives data detecting around 10% of them, then there would be 10 devices active in security or baggage.

Although not essential to all embodiments, the contextual location data may be stored in the Historical Data Store 103.

The contextual location data may also be updated in the In Memory Cache 104, storing a real time representation of the movements of all devices in the airport, as shown in figure 3.

The contextual data may be stored in both store 103 and memory cache 104 so that a) any airport staff may be automatically identified during nightly processing because they are in the airport longer than is typical for passengers, and b) so that the airport can use the data for historical comparison..

Each time the data is polled, the live dwell time may be determined for each device within each zones. This is described in further detail with reference to a particular Live Dwell Time Algorithm below.

For each communication device, the dwell time may be determined by determining the time when a user was first detected within a zone, and the time when the user was last detected within a zone (before the user moved do a different zone). The dwell time may be

computed as the difference in time between the last detection time within a zone and the first detection time within a zone. In the histogram shown in figure 5, the number of devices within security is determined as function of wait or dwell time: 5 devices have a dwell time of less than one minute; 6 devices have a dwell time of 1 minute; a further 6 devices have a dwell time of 2 minutes; a further 6 devices have a dwell time of 3 minutes; 2 devices have a dwell time of 4 minutes; 2 further devices have a dwell time of 5 minutes; while finally, 2 devices have been determined to have a dwell time of 6 minutes in security. Steps 203, 205, 207, 209, 211, and 213 may be repeated as updated location data is received by the location server 107.

The dwell time is the amount of time that passengers spend in a particular area (i.e. a Zone) of the airport. This term is interchangeable with Wait Time. Dwell Time is used in areas of an airport that a passenger wants to be in for example retail, food hall. Wait Time is used in areas of an airport that a passenger doesn't want to be in, for example check in, security, baggage collection.

The data may be made accessible to 3rd parties via the API. In other words, 3rd parties may access the data stored in the historical data store 103 (and the in memory cache 104). This live data is in stored in memory 104, while the historic data is stored in historical data store 103. The data (both real time or historical or both) may be viewed using the Administration Interface 106, as shown in figure 4, although this step is in fact optional.

The processing, using an algorithm, of the raw WiFi positional data of each mobile device within the airport will now be described in further detail. The algorithm uses the received positional data to determine live dwell time of each mobile device within the airport. This algorithm may be performed every time the location server 107 refreshes the location of devices in the Airport.

When measuring the live dwell time for a given zone such as security, it is necessary to factor in the following data quality problems:

1. Staff and static WiFi devices (e.g. staff personal computers (PCs)) in the security should be filtered out.
2. The sporadic and periodically inaccurate nature of WiFi data means that devices that are passing near to, but not through, the Security zone may be incorrectly reported as being in Security.
3. The number, accuracy and frequency of detections will vary for devices.

Embodiments of the invention address these data quality problems in a number of different ways.

Handling staff devices

The Location Server 107 maintains a dynamic list of staff and infrastructure at the airport (Historic Data 103 above). This list is automatically generated by monitoring for devices that are in the airport for a long time which may be typical of a staff member working there, or are frequently in the airport which may be typical of airport staff working 5 days a week.

Devices in the Security zone are then compared with this list and filtered out from the results.

Handling inaccurate or partial paths

Inaccurate WiFi data can be smoothed out or eliminated by using the typical path of a departing passenger through the airport. The following example refers to a departing passenger because it is described in conjunction with a security area, and only departing passengers pass through security. Nevertheless, the processing steps equally apply to other passenger types such as arriving passengers.

The device path can be used to profile the passenger as a Departing, Arriving or Transfer passenger. In addition the device path can be profiled as Airport Staff, or a welcoming agent also known as a Meeter/Greeter.

The typical path of a departing passenger is given by the following sequence of zones:

LANDSIDE CHECK IN SECURITY AIRSIDE RETAIL GATE AREA

That is, a passenger arrives at the airport in the LANDSIDE zone, then CHECKS IN, then passes through SECURITY to the AIRSIDE zone. The passenger will typically dwell in the RETAIL area until ready for boarding and then go to the GATE AREA.

For the purposes of measuring dwell time in security, any paths that contain LANDSIDE or CHECKIN in the past, and do not contain AIRSIDE/RETAIL/GATEAREA can be considered good representative paths.

Examples of inaccurate paths caused by the sporadic nature of the WiFi data are:

1. SECURITY [SLEEP] GATE AREA

This would be an example of a path where a device is first detected in the SECURITY area, then enters SLEEP mode where it is no longer detected by the WiFi infrastructure, and after a long period of time detected in GATEAREA. This is a bad path because a) It is not known how long the device was in SECURITY before it was first detected and b) because it entered a SLEEP mode and was undetected, it is not known how long it remained there before going AIRSIDE.

1. AIRSIDE GATE AREA BAGGAGE SECURITY LANDSIDE

This is an example of an arriving passenger who has arrived at AIRSIDE in the GATEAREA, and walked to BAGGAGE to collect their bags. Before going LANDSIDE, the passenger is briefly (and incorrectly) detected in the SECURITY zone because of poor WiFi quality. This device path will therefore have to be eliminated from the dwell time measurements.

Because the full device path is maintained in memory, it is possible to filter or remove these bad quality paths by specifying filter criteria in the algorithm. The filter criteria vary according to the zone being measured, and therefore must be configurable for the zone in question. The following is an example of the filter criteria for two zones:

1. Security Zone

a. Device must be in Security Zone, or device must have just transitioned out of Security into AIRSIDE

b. Device must never have been AIRSIDE

c. Device must have previously been LANDSIDE

d. Device path must match profile for Departing Passenger

2. Baggage Zone

a. Device must be in Baggage Zone, or device must have just transitioned out of Baggage into LANDSIDE

b. Device must never have been LANDSIDE

c. Device must have previously been AIRSIDE

d. Device path must match profile for Arriving Passenger

Handling number, accuracy & frequency of detections

The live dwell time algorithm may factor in the number, accuracy & frequency of detections to determine the quality of any given device path for use. These three factors are important because:

1. In general, the more detections that of a particular device path, the better quality of that device path. Closely related to this is the accuracy and frequency of these detections.
2. The accuracy can vary from detection to detection, caused by environmental factors at the airport. The higher the accuracy, the more reliable the data.
3. The frequency of detections varies along the device path (typically due to whether the passenger is using the device or not). Infrequent detections is a problem because if a device has not been detected for, say 2 minutes, it is not possible to tell if the device is still in Security or has moved out of Security. Figure 2 and 3 show examples of device paths with high and low frequency.

The algorithm factors in these three parameters when assigning a quality value to the path. Of particular importance are the frequency and accuracy of detections as the device transitions from CHECKIN to SECURITY and from SECURITY to AIRSIDE. If a determination can be made with a high degree of accuracy when a device moves into/out of SECURITY, then embodiments of the invention can determine with a high degree of accuracy how long the device spent in SECURITY.

The device path has to meet a quality threshold to be usable for zone dwell time measurement.

Accordingly, embodiments of the invention combine an arbitrary zone definition, device path profiling, device path filtering by history and device detection quality profiling such that that the variable and sporadic nature of WiFi signals can be processed. This allows live (as well as historic) dwell times of a user in any part of an airport to be determined.
In some embodiments, a system for processing user location data is provided. The system comprisises

a. a location server arranged to receive location data of a communication device associated with the user, the location data defining the detected position of the communication device at a number of different points in

time, the location server further arranged to receive sequence data associated with the location data indicative of the order in which the location data was determined;

b. path determining means for determining the user's path passing through points defined by the received location data and the associated sequence data; and

c. a comparator for comparing the determined path of the user with one or more predetermined user paths;

wherein the location server processes the received location data depending upon the result of the comparison.

In some embodiments, a method for processing user location data is provided. The method comprises:

a. receiving, with a receiver, location data of a communication device associated with the user, the location data defining the detected position of the communication device at a number of different points in time, and receiving, with the receiver, sequence data associated with the location data indicative of the order in which the location data was determined;

b. determining, using a processor, the user's path passing through points defined by the received location data and the associated sequence data; and

c. comparing, using the processor, the determined path of the user with one or more predetermined user paths; and

processing, using the processor, the received location data depending upon the result of the comparison.

CLAIMS

1. A system for determining a user's path comprising:
    a. a location server arranged to receive location data of a communication device associated with the user, the location data defining the detected position of the communication device at a number of different points in time, the location server further arranged to receive sequence data associated with the location data indicative of the order in which the location data was determined;
    b. path determining means for determining the user's path passing through points defined by the received location data and the associated sequence data; and
    c. a comparator for comparing the determined path of the user with one or more predetermined user paths;
    wherein the location server processes the received location data depending upon the result of the comparison and corrects the determined user path with the processed location data.

2. A system according to claim 1 in which the location server is further configured to smoothen the determined path or eliminate one or more points on the determined path or interpolate between points on the path based on the result of the comparison.

3. A system according to claim 1 in which the location server is further configured to determine the accuracy of the received location data based on the result of the comparison.

4. A system according to claim 1 in which the location server is further arranged to track the location of user at a point in time on the path based on real time or cached location data.

5. A system according to claim 1 in which the location server is configured to receive location data comprising timestamp data indicative of when the location of the device was determined.

6. A system according to claim 1 in which the location server is further configured to determine the user's dwell time at a particular location or within a zone based on the processed location data.

7. A system according to claim 1 in which the location server is further configured to determine the number points on the determined user path, and preferably to compare the determined number points with a predetermined threshold stored in a storage means.

8. A system according to claim 7 in which the location server is further configured to determine the user dwell time only if the number points on the determined user path is greater than the predetermined threshold.

9. A system according to claim 1 in which the location server is configured to process the location data to eliminate location data associated with an inaccurate path.

10. A system according to claim 1 in which the location server is further configured to determine that a path is inaccurate if the determined user path does not correspond to the predetermined user path.

11. A system according to claim 1 in which location server is further configured to determine whether the communication device is associated with a staff member or infrastructure located within a zone or whether the communication device is stationary for a substantial period of time.

12. A system according to claim 1 in which the location server is further configured to process the location data to eliminate location data associated with a staff member or infrastructure or location data of a device which has been stationary for a substantial period of time.

13. A system according to claim 6 in which the location server determines that the device is associated with a staff member if the determined dwell time is greater than a predetermined threshold.

14. A system according to claim 1 further comprising a storage means for storing a plurality of predetermined user profiles, for example, a departing passenger profile or an arriving passenger profile or a transfer passenger profile or an airport staff profile, or welcoming staff profile or non-passenger user profile based on the determined user path.

15. A system according to claim 1 further comprising an administration interface for defining a plurality of zones within a region such as an airport.

16. A system according to claim 1 in which the location server is further configured to determine zone data, from the received location data, indicative of which of a plurality of zones the communication device is located in at each point in time.

17. A system according to claim 16 in which the location server is further configured to associate the determined zone data with the determined location data.

18. A system according to claim 1 in which the location server is further configured to profile the user as a departing passenger or an arriving passenger or a transfer passenger or airport staff, or welcoming staff or non-passenger user based on the comparison of the determined user path and the predetermined user path.

19. A system according to claim 14 in which each predetermined user profile is defined by the zone sequence data defining the order in which a user passes though a plurality of zones or the order in which the location data is detected.

20. A system according to claim 19 in which the location server is further configured to profile the user by comparing the sequence of zones of the predetermined user profile with a determined sequence of zones associated with the determined path.

21. A system according to claim 1 in which the location server is further configured to rank the determined user path data based on the number of points which the determined user path passes through or based on the accuracy of the processed location data or based on the frequency of the processed location data.

22. A system according to claim 1 in which the location server is further configured to determine a boundary of one or more zones.

23. A system according to claim 1 in which the location server is further configured to determine a first frequency of location detections when the user device within a first predetermined distance from a zone boundary and a second frequency of location detections when the user device is further away from the zone boundary.

24. A system according to claim 23 in which the location server is further configured to rank the path based on the first and second frequency of detections.

25. A system according to claim 1 in which the location server is further configured to receive location data of a plurality of communication devices and to determine the path of each device and to compare the determined path of each user with one or more predetermined user paths and to processes the received location data depending upon the result of the comparison and to correct each determined user path with the processed location data depending upon the result of the comparison.

26. A system according to claim 1 in which the location server is further configured to determine a first frequency of location detections of a first path when the user device within a first predetermined distance of a zone boundary and a second frequency of location detections of a second path when a further user is within a corresponding predetermined distance from the zone boundary.

27. A system according to claim 26 in which the location server ranks a path with more location detections within the predetermined distance of a zone boundary higher than a path with fewer location detections within the predetermined distance of the zone boundary.

28. A system according to claim 1 further comprising storing means for storing the determined user path.

29. A system according to claim 1 in which the location data of the communication device is determined based on signal strength data received by an access point.

30. A system according to claim 1 in which the location data is received from a third party server arranged to determine the location of the communication device based on signal strength data received by the third party server.

31. A system according to claim 1 wherein the received location data comprises location data defining the detected position of the device at three or more points in time, and wherein the location data is received in a non-periodic or irregular or sporadic manner.

32. A system according to claim 1 in which the location data is determined using a wireless communications system, particularly a wireless communications system employing a wireless protocol according to the Institute of Engineering and technology 802.11 standard.

33. A system according to claim 1 wherein each predetermined path is defined by further location data and associated sequence data indicative of the order of the further location data.

34. A method for determining a user's path comprising:

a. receiving with a location server location data of a communication device associated with the user, the location data defining the detected position of the communication device at a number of different points in time, receiving, using the location server, sequence data associated with the location data indicative of the order in which the location data was determined;

b. determining with a path determining means, the user's path passing through points defined by the received location data and the associated sequence data; and

c. comparing, using a comparator, the determined path of the user with one or more predetermined user paths; and
processing with the location server the received location data depending upon the result of the comparison and correcting, using the location server, the determined user path with the processed location data.

35. A method according to claim 34 in which the location server smoothens the determined path or eliminates one or more points on the determined path or interpolates between points on the path based on the result of the comparison.

36. A method according to claim 1 in which the location server determines the accuracy of the received location data based on the result of the comparison.

37. A method according to claim 34 in which the location server tracks the location of user at a point in time on the path based on real time or cached location data.

38. A method according to claim 34 in which the location server receives location data comprising timestamp data indicative of when the location of the device was determined.

39. A method according to claim 34 in which the location server determines the user's dwell time at a particular location or within a zone based on the processed location data.

40. A method according to claim 34 in which the location server determines the number points on the determined user path, and preferably compares the determined number points with a predetermined threshold stored in a storage means.

41. A method according to claim 40 in which the location server determines the user dwell time only if the number points on the determined user path is greater than the predetermined threshold.

42. A method according to claim 34 in which the location server processes the location data to eliminate location data associated with an inaccurate path.

43. A method according to claim 34 in which the location server determines that a path is inaccurate if the determined user path does not correspond to the predetermined user path.

44. A method according to claim 34 in which location server determines whether the communication device is associated with a staff member or infrastructure located within a zone or whether the communication device is stationary for a substantial period of time.

45. A method according to claim 34 in which the location server processes the location data to eliminate location data associated with a staff member or infrastructure or location data of a device which has been stationary for a substantial period of time.

46. A method according to claim 39 in which the location server determines that the device is associated with a staff member if the determined dwell time is greater than a predetermined threshold.

47. A method according to claim 34 further comprising storing in a storage means a plurality of predetermined user profiles, for example, a departing passenger profile

or an arriving passenger profile or a transfer passenger profile or an airport staff profile, or welcoming staff profile or non-passenger user profile based on the determined user path.

48. A method according to claim 34 further comprising defining, using an administration interface, a plurality of zones within a region such as an airport.

49. A method according to claim 34 in which the location server is further configured to determine zone data, from the received location data, indicative of which of a plurality of zones the communication device is located in at each point in time.

50. A method according to claim 49 in which the location server associates the determined zone data with the determined location data.

51. A method according to claim 34 in which the location server profiles the user as a departing passenger or an arriving passenger or a transfer passenger or airport staff, or welcoming staff or non-passenger user based on the comparison of the determined user path and the predetermined user path.

52. A method according to claim 47 in which each predetermined user profile is defined by the zone sequence data defining the order in which a user passes though a plurality of zones or the order in which the location data is detected.

53. A method according to claim 52 in which the location server is further configured to profile the user by comparing the sequence of zones of the predetermined user profile with a determined sequence of zones associated with the determined path.

54. A method according to claim 34 in which the location server ranks the determined user path data based on the number of points which the determined user path passes through or based on the accuracy of the processed location data or based on the frequency of the processed location data.

55. A method according to claim 34 in which the location server determines a boundary of one or more zones.

56. A method according to claim 34 in which the location server determines a first frequency of location detections when the user device within a first predetermined

distance from a zone boundary and a second frequency of location detections when the user device is further away from the zone boundary.

57. A method according to claim 56 in which the location server ranks the path based on the first and second frequency of detections.

58. A method according to claim 34 in which the location server receives location data of a plurality of communication devices and determines the path of each device and compares the determined path of each user with one or more predetermined user paths and processes the received location data depending upon the result of the comparison and corrects each determined user path with the processed location data depending upon the result of the comparison.

59. A method according to claim 34 in which the location server determines a first frequency of location detections of a first path when the user device within a first predetermined distance of a zone boundary and a second frequency of location detections of a second path when a further user is within a corresponding predetermined distance from the zone boundary.

60. A method according to claim 59 in which the location server ranks a path with more location detections within the predetermined distance of a zone boundary higher than a path with fewer location detections within the predetermined distance of the zone boundary.

61. A method according to claim 34 further comprising storing, in storing means, the determined user path.

62. A method according to claim 34 in which the location data of the communication device is determined based on signal strength data received by an access point.

63. A method according to claim 34 in which the location data is received from a third party server arranged to determine the location of the communication device based on signal strength data received by the third party server.

64. A method according to claim 34 wherein the received location data comprises location data defining the detected position of the device at three or more points in

time, and wherein the location data is received in a non-periodic or irregular or sporadic manner.

65. A system according to claim 1 in which the location data is determined using a wireless communications system, particularly a wireless communications system employing a wireless protocol according to the Institute of Engineering and technology 802.11 standard.

66. A method according to claim 34 wherein each predetermined path is defined by further location data and associated sequence data indicative of the order of the further location data.