June 25, 2019

Service-Oriented Mobile Network Tracking and Guiding

Jim Sun

Aaron Lee

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Abstract:

This publication describes techniques for a User Equipment device (UE) (*e.g.*, a mobile device, a tablet, a wireless-communication device) to guide a user to an area with a requested network service. Mobile device users often encounter situations where the wireless network they are connected to does not provide a requested network service. With no other available means to find a wireless network with the requested network service, users will often wander in attempt to access the network services they desire. Thus, a wireless-connection network manager (WCNM) that can aid the user by guiding them to a physical location where the user previously received access to a requested service is desirable.

Keywords:

Network service, service unavailable, not available, mobile network, cellular network, network coverage, no service, connection, global positioning system (GPS), guide, network selection/reselection, cell identity, mobile device, user equipment (UE), notification

Background:

In a cellular communication system, a user device can communicate with one or more base stations through wireless communication links. Through a wireless communication link, a cellular communication network can provide a network service to a connected user device. Examples of network services include: Emergency Communications Center (ECC) services (*e.g.*, emergency call services); Circuit Switch (CS) voice services (*e.g.*, normal voice call services); Packet Switch

(PS) voice services (*e.g.*, Voice over Long-Term Evolution (VoLTE) call services, Wi-Fi Calling (WFC) services); Mobile Data Call (MC) services (*e.g.,* mobile data); Rich Communication Service (RCS) messaging services; and IP Multimedia Subsystem (IMS) services.

In a cellular communication system, a user device can measure the wireless network quality of surrounding network cells and connect to the best measured cells by following, for instance, Public Land Mobile Network (PLMN) cell selection/reselection specifications defined in the 3RD Generation Partnership Project (3GPP). Different base stations to which a user device has access may provide different network services. For example, a first base station may provide CS voice services and MC services; a second base station may provide a full service including all CS/PS and mobile data capabilities; and a third base station may only provide a limited service which includes ECC services. Thus, while following the 3GPP PLMN cell selection/reselection specifications a user device may connect to the wireless network (*e.g.*, cell) with the highest signal strength, but the connected wireless network may not necessarily provide network services to which the user device needs access.

When a user's device cannot connect to a requested service, a user will oftentimes wander about hoping to find a spot where the user device can connect to the network service needed. With no direction or guidance, this task of locating a better network service region can be quite difficult. In fact, a wireless network providing the requested network service may be hundreds of yards or even miles away from the user's current location. Stumbling upon a wireless network with the requested services is unlikely, but returning to a previous location where the user device had access to a network service that provided the requested services can satisfy the user's network service desires. However, the user may not know of or recall a previous time when a wireless network that provided desired services was connected to the device.

Therefore, it is desirable for a user to be guided back to a physical location where the user previously had access to the requested network service via an on-device wireless-connection network manager (WCNM).

Description:

This publication describes techniques to guide a user to a physical area where the user previously had access to a requested network service. A User Equipment device (UE), such as a smartphone or a wireless-communication device, includes a wireless-connection network manager (WCNM). The UE archives the mobile device's service states. Examples of network services include: Emergency Communications Center (ECC) services (*e.g.*, emergency call services); Circuit Switch (CS) voice services (*e.g.*, normal voice call services); Packet Switch (PS) voice services (*e.g.*, Voice over Long-Term Evolution (VoLTE) call services, Wi-Fi Calling (WFC) services); Mobile Data Call (MC) services (*e.g.,* mobile data); Rich Communication Service (RCS) messaging services; and IP Multimedia Subsystem (IMS) services. Additionally, the UE device archives time stamps, geolocation information, and cell identities (*e.g.*, a physical cell identity assigned to and transmitted by a base station to which the mobile device connected) under the direction of the WCNM. In addition, the WCNM performs analyses of the various cell identities and their respective service states to determine the optimal location for the user to perform the desired task(s). Finally, the WCNM can calculate the path necessary to reach the optimal location from the user's current location.

Figure 1, below, illustrates a UE and the elements of the UE that support the WCNM to perform its tasks.

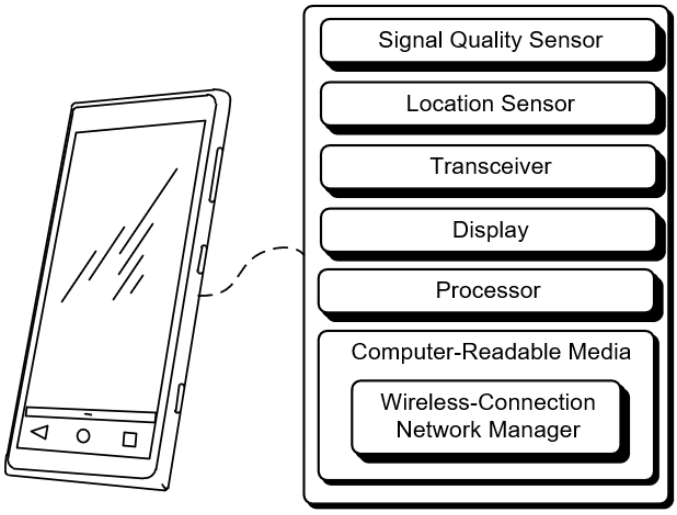

Figure 1

As illustrated, the UE is a smartphone. However, other wireless-communication devices (*e.g.*, wireless-communication device, a tablet, a laptop computer, a mobile device) can also support the WCNM's operations. The UE includes a signal quality sensor (*e.g.*, signal strength detection circuitry), a location sensor (*e.g.*, a global positioning system (GPS) sensor), a transceiver(s) (*e.g.*, a 4G LTE transceiver, a 5G NR transceiver) for transmitting data to, and receiving data from, the access point of the wireless network), and a display (*e.g.*, a light emitting diode (LED) display or liquid crystal display (LCD)). The UE also contains a processor. The UE also includes a computer-readable medium (CRM) storing executable instructions of a WCNM. The CRM may include any suitable memory or storage device, such as random-access memory (RAM). The WCNM, when executed by the processor of the UE, causes the UE to perform operations described within this document.

Figure 2 demonstrates an example method, implemented by a UE, of tracking and recording relevant network data. The method may use components of the UE presented in Figure 1.

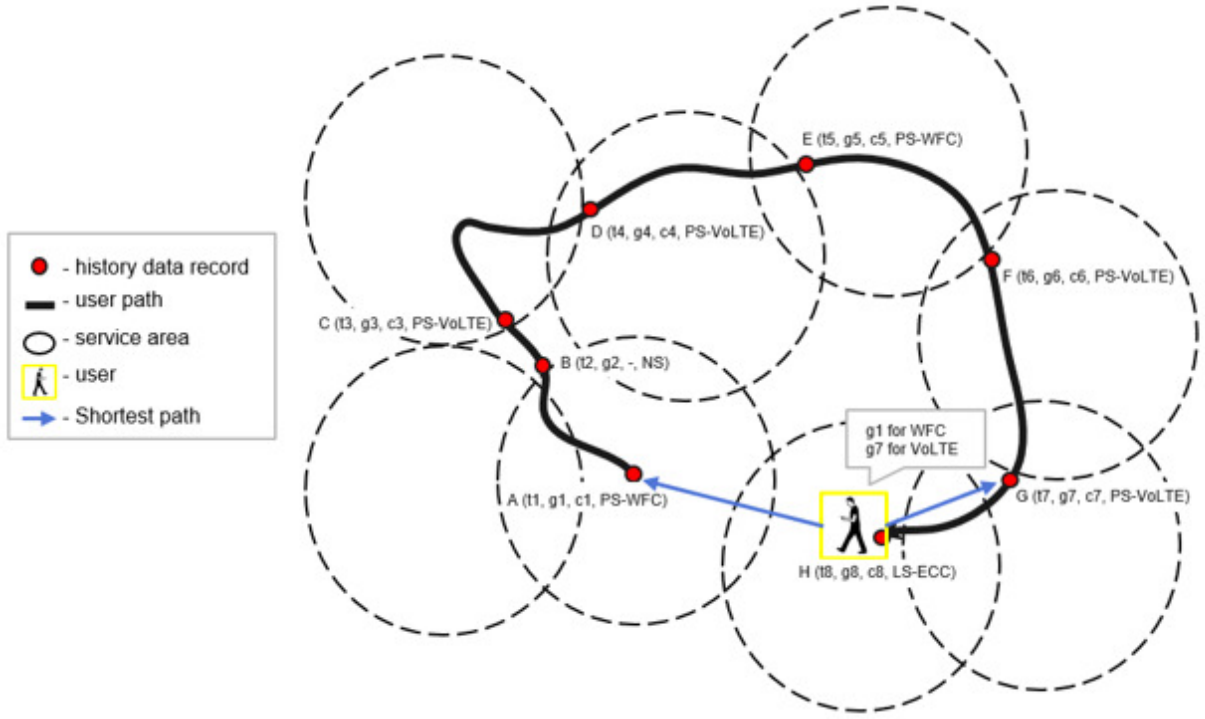

Figure 2

In Figure 2, a user is carrying a UE. The UE records that the user initially began his journey at location A and followed the path, as illustrated, to location H. During the travels of the user, the UE encountered a few different cellular communication networks, also known as base stations or, simply, cells, which are represented as dotted line circles. Some cells in Figure 2 afforded the user VoLTE call services (*e.g.*, at locations C, D, F, G), while others provided WFC services (*e.g.,* at locations A, E), ECC services only (*e.g.*, at location H), or no service (NS) (*e.g.*, at location B).

The letters A through H represent eight instances when the WCNM on the UE recorded service metrics related to network services available to the wireless-communication. The WCNM may record (as service records) service metrics upon cell registration, cell exit, and/or cell identity change. The WCNM may also record service metrics periodically. In the example illustrated in Figure 2, each one of the service records include a time stamp (t), a geolocation stamp (g), a cell identity (c), and a service state, which the WCNM acquired from an internal clock, the location

sensor, the transceiver(s), and the signal quality sensor respectively. For example, the service record for F was generated because of cell exit of c5 and the WCNM recorded a time, geolocation, the new cell identity, and the available network service of VoLTE.

In a first example, if the user later desires to make a Wi-Fi call and a suitable network service (*e.g.*, PS voice services) is not available, the UE, by means of the WCNM, will guide the user to location A, by the shortest route possible to the nearest area which was known to previously support Wi-Fi calling services. In a second example, if the user desires to make a call through VoLTE and a suitable network service (*e.g.*, PS voice service) is not available, the UE, by means of the WCNM, will guide the user to the nearest area which was previously known to support VoLTE service, location G.

In the above examples, the location sensor could generate geolocation data (*e.g.*, geolocation data provided by a global positioning satellite (GPS) receiver) relating to the location of the user throughout all parts of his traveling. In some cases, for instance when the user is inside a building, geolocation data may not be accessible. Figure 3 illustrates an example of a wireless-communication device recording relevant network metrics without use of geolocation data.

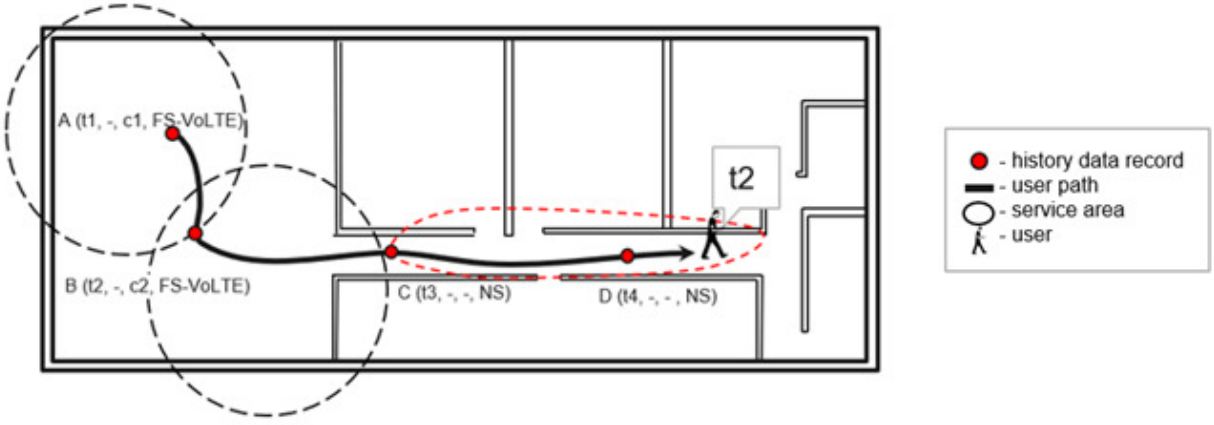

Figure 3

In this example, the UE lost location sensor service and instantly made a new service record at C. As demonstrated in Figure 3, the user continued on without location sensor service, thus a service record was generated at D after a certain time. The service record at D contains time and service state information. Since the UE is not connected to a cell and no geolocation data is available, the service record contains no information for these two slots. Under such circumstances, if the user desired to make a call utilizing VoLTE service, he would be notified that there would be an available network service cell if he traveled back to the location when time t2 was recorded.

The above example demonstrated procedures that may occur when location information is unavailable; if other sensors lose contact with their respective sources, or any combination thereof, a new service record may be generated immediately. If the user desires a network that will enable him to do a specific task, but no records indicate a service match, the user can be notified so that he does not have to keep wandering about trying to connect to a cell that is not present.

The following flow chart, Figure 4, portrays the order of operations the WCNM evaluated in Figure 2 and 3 to determine when to create a new service record.

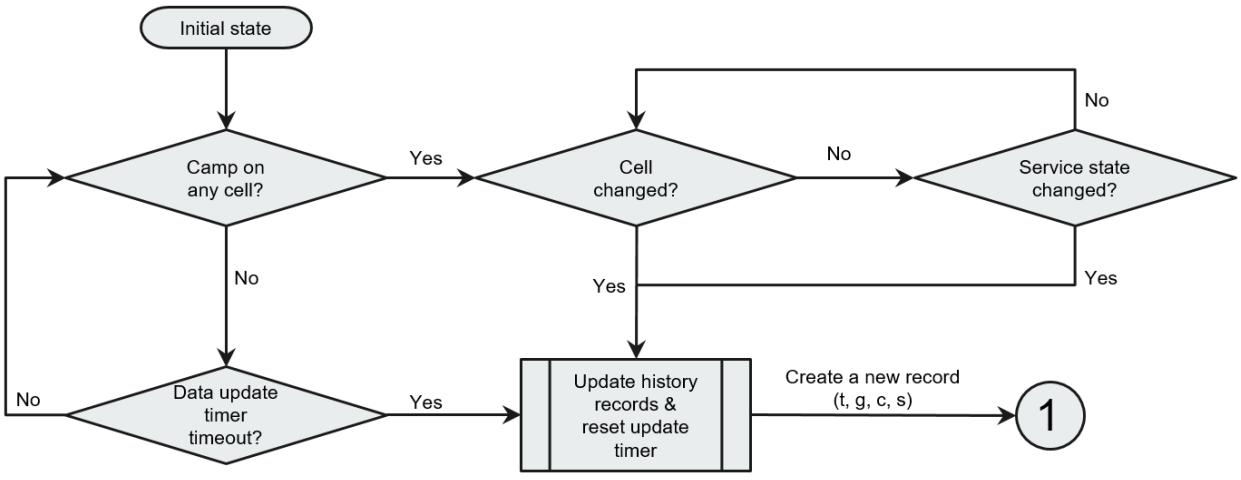

Figure 4

The WCNM checks to see if the UE is connected to (*e.g.*, camped on) a wireless network (*e.g.*, cell). If the device is not connected to a cell, then the WCNM will determine if a data update timer has timed out; if not, it will repeat the process, otherwise, it will update the service (history) records, reset the data update timer, and create a new service record. If the device is connected to a cell, then the WCNM will determine if the cell has changed. If the cell has not changed, then it will determine if the service state has changed; if not, then it will repeat back to determining if the cell has changed. If the service state has changed or the cell has changed, then it will update the service records, reset the data update timer, and create a new service record.

The guiding mechanism is initiated by the UE's request to use certain services. The WCNM determines if the service state of the current cell will provide the requested services. If the current service state can provide the requested services then it will end, otherwise it will analyze the record data gleaned from the output (1) in Figure 4 and isolate cell identities with service states that may provide the requested services. For example, if the user desires to explore the internet on their mobile device, then the WCNM will find service records with FS or MC services. After collecting all service records that provide the requested services, the WCNM will calculate the nearest wireless network (*e.g.*, cell) to the user's current location utilizing known map service tools or math methods (*e.g.*, Pythagorean Theorem, vector formula). Finally, the WCNM will guide the user to the closest area with a cell that provides the requested services. Once the user returns to the designated location, the original service record associated with the reentered cell could assist in the acceleration of the modem network reselection process. Once the user reenters a cell region under the guidance of the WCNM, a service-oriented cell selection process will be performed.

The process described in this document could further be implemented in a service-oriented cell selection policy for speeding up (*e.g.*, utilizing cell identity information within history data) a modem cell selection/reselection for specific service requirements. This process will speed up modem cell selection for specific service requirements. The WCNM will then check to see if the connected cell fulfills the user request; if not, the WCNM will iterate through the service-orientated cell selection process until it selects the cell that fulfills the user's request. Once the appropriate cell has been selected, the process will end. If a UE encounters an unidentified cell—a cell not found in the history data—that satisfies the user's request, then the guiding mechanism will terminate. Otherwise, the guiding mechanism will continue guiding the user to the best cell location. For example, in the RRC_IDLE cell selection and reselection process described in 3GPP TS 36.304 V15.3.0 (2019-03), a service-oriented cell selection policy could be utilized with respect to the stored information cell selection procedure, the cell selection procedure when leaving connected mode, or the cell reselection evaluation process.

In conclusion, a WCNM can assist a user by guiding the user to a physical location where the UE previously received access to a currently desired network service. Such assistance and guidance are currently absent for all mobile device users.

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