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Optimizing WLAN Access Point Scans for VOIMS

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OPTIMIZING WLAN ACCESS POINT SCANS FOR VOIMS

ABSTRACT

WLAN-to-WLAN handover decisions and WLAN-to-WWAN handover decisions for a portable user device conducting a VoIMS call typically are based on a scan list that lists identified WLAN APs and their detected signal quality characteristics. The conventional approach of periodically updating the scan list can result in an out-of-date listing of available WLAN APs and their signal quality characteristics, which can result in sub-optimal handover decisions and thus a sub-optimal voice call experience. The handover decision process is improved by using other triggers to initiate an updated WLAN AP scan, including using activation of a dialer GUI or other indication that a voice call is about to be placed, degradation of a WWAN connection supporting a current voice call, and the like. Through increases in the frequency of WLAN AP scans balanced against the power consumed by such scans, a more accurate and timelier WLAN AP scan list is made available for handover decisions, and thereby supporting a higher-quality voice call experience.

BACKGROUND

Cellular phones and other wireless-enabled portable user devices often utilize network connectivity provided by wireless local area network (WLAN) access points (APs) to communicate data. As the range of a WLAN AP is limited, procedures have been developed to facilitate the handovers of WLAN support for a portable user device between WLAN APs as the portable user device moves in and out of the ranges of a succession of WLAN APs. As a result of legacy considerations, the algorithms typically employed for inter-AP handover decisions are optimized for standard Internet traffic with the goal of reducing the number of handovers unless necessitated by poor connectivity. Moreover, conventional approaches to AP handovers typically seek to limit the frequency at which the portable user device conducts periodic WLAN AP scans to identify available WLAN APs as such scans increase power consumption at the portable user device.

However, with the advent of technologies that conduct voice calls at least partially over packet-switched networks, such as Voice over Internet Protocol Multimedia Subsystem (VoIMS) and, more particularly, Voice over WiFi (VoWiFi), conventional WLAN AP handover techniques that seek to minimize handovers and to minimize AP scans typically result in suboptimal voice call experiences for portable user devices conducting voice calls over a WLAN connection, particularly when the portable user device is highly mobile and crossing multiple WLAN access points (as often is the case in, for example, an office environment).

One contribution to the suboptimal voice call experience is the risk of the portable user device being attached to a suboptimal WLAN AP as a result of an AP scan list that is not up-to-date due to infrequent AP scanning. Thus, with an out-of-date scan list, the portable user device may attach to a WLAN AP with low-quality connectivity, and thus an impacted voice call quality, while another WLAN AP with higher-quality connectivity is available but unutilized as it was not identified during the last AP scan. Likewise, the decision to initiate an AP handover may be made on such out-of-date WLAN AP information resulting from infrequent AP scanning.

Yet another contributor to a suboptimal voice call experience is that the thresholds based on certain connection quality parameters, such as Received Signal Strength Indicator (RSSI), for standard WLAN-to-WLAN handovers for typical Internet traffic often are lower than the same thresholds for a WLAN-to-WWAN (wireless wide area network) handover. As a result, an out-of-date scan list can miss a high-connection-quality WLAN AP and thus trigger an unnecessary handover of the voice call from a WLAN connection to a WWAN connection.

DESCRIPTION

FIG. 1 below illustrates an example mobile cellular system 100 having a portable user device 102 (also commonly referred to as a user equipment or UE) having a variety of options for connecting to a packet data network (PDN) 104 (e.g., the Internet) in support of voice calling or other IMS services. The portable user device 102 can include any of a variety of electronic wireless communication devices, such as a cellular phone, a cellular-enabled tablet computer or cellular-enabled notebook computer, an automobile or other vehicle employing cellular services (e.g., for navigation, provision of entertainment services, in-vehicle mobile hotspots, etc.), and the like. One option for the portable user device 102 to connect with the PDN 104 includes establishing a WWAN connection with a base station 106 of a mobile network operator, which are also commonly referred to as “mobile carriers”, “carrier networks”, or simply “carriers.” Another option includes establishing a WLAN connection with a WLAN AP 108, such as with one of WLAN AP 108-1, 108-2, or 108-3 illustrated in FIG. 1. The WLAN APs 108 can implement any of a variety of WLAN access protocols, such as one of the Institute of Electrical and Electronics Engineers (IEEE) 802.11 protocols or combination of IEEE 802.11 protocols.

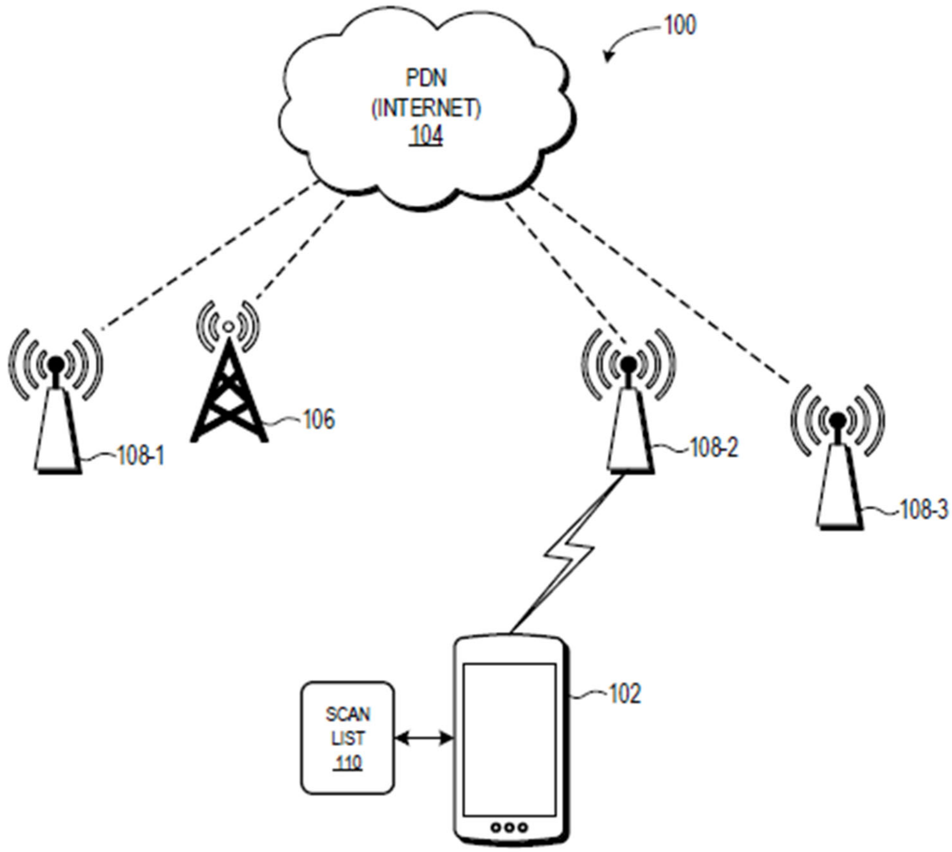

FIG. 1 – mobile cellular system employing adaptive WLAN AP scanning

In accordance with conventional operation, the portable user device 102 periodically conducts a WLAN AP scan to identify those WLAN APs 108 in which the portable user device 102 is within range, and for each WLAN AP 108 so identified, determine one or more parameter values representative of the potential connection quality. These parameter values can include, for example the aforementioned RSSI, signal to noise ratio (SNR), protocol or technology type (e.g., 802.11a vs. 802.11n), and the like. The information for each WLAN AP 108 identified in the most recent scan is maintained in a scan list 110. A similar process is performed to characterize the potential performance of the one or more base stations 106 within range.

Thereafter, the portable user device 102 utilizes the scan list 110 to make certain decisions regarding its connection to the PDN 104, such as whether to initiate a handoff from one WLAN AP 108 to another WLAN AP 108, to initiate a WLAN-to-WWAN handoff (that is, from a WLAN AP 108 to the base station 106) or, conversely, to initiate a WWAN-to-WLAN handoff (that is, from the base station 106 to a WLAN AP 108).

However, as briefly explained above, the conventional process of periodically performing the WLAN AP scan and updating the resulting scan list can result in an inaccurate representation of the WLAN AP options for the portable user device 102. To illustrate, at a time T1 an iteration of the WLAN AP scan can be performed, which results in the identification of WLAN AP 108-1 and WLAN AP 108-2. At time T2 following this scan and prior to the next scan, the portable user device 102 has entered the range of WLAN AP 108-3, which presents a higher-quality connection than either WLAN AP 108-1 or 108-2. However, as the current version of the scan list at time T2 does not identify WLAN AP 108-3, the portable user device 102 might make an ill-informed handoff decision based solely on the basis of WLAN AP 108-1 and 108-2.

Accordingly, to facilitate better-informed handoff decisions, the portable user device 102 employs an adaptive WLAN AP monitoring process as outlined by method 200 of FIG. 2 below.

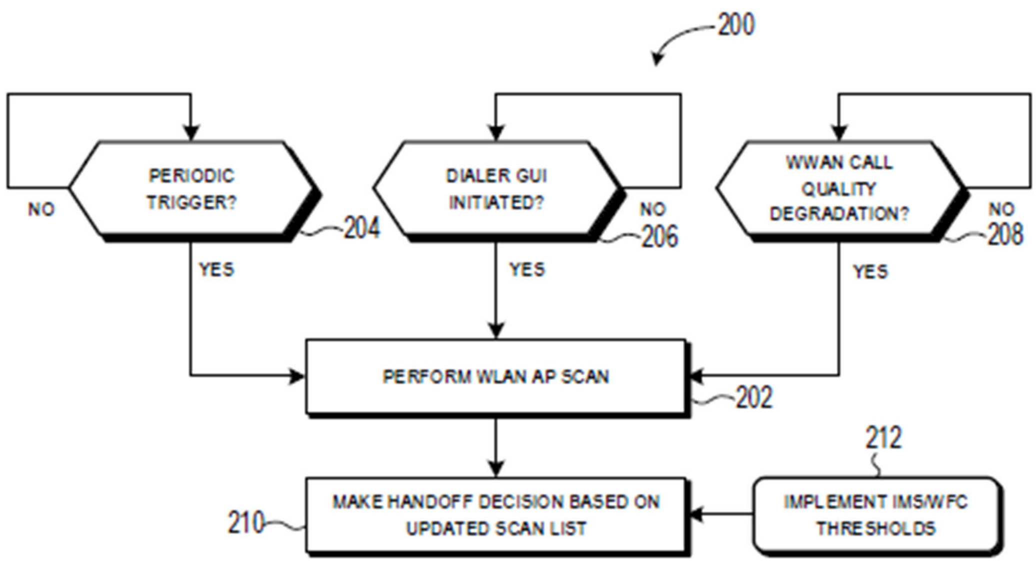

FIG. 2 – adaptive WLAN AP monitoring process

As illustrated by method 200, in addition to triggering the performance of the WLAN AP scan process (as represented by block 202) in response to a periodic trigger (represented by block 204) as is performed in conventional approaches, the portable user device 102 utilizes additional adaptive triggers to maintain a more up-to-date WLAN AP scan list 110. As represented by block 206, one such trigger is an indication from a user that a voice call is about to be attempted. This indication can include, for example, the user interacting with a touchscreen or other user input/output (I/O) to bring up a dialer graphical user interface (GUI) or other dialer application used to receive user input indicative of a phone number or other call destination identifier. Further, this trigger may also rely on an indication that an IMS service is then registered on a WLAN. Alternatively, this indicator can include a voice command from the user indicating an instruction to initiate a voice call, input from another device indicating initiation of a voice call (e.g., input from a smartwatch wirelessly tethered to the portable user device 102), and the like.

Further, in instances where a voice call has been established over a WWAN link (e.g., via the base station 106), the portable user device 102 monitors the link quality and in response to trigger caused by detection of degradation of the WWAN connection (and before the call becomes unsustainable)(represented by block 208), an instance of the WLAN AP scan process is initiated. Note that because this is a conditional scan based on the quality of the WWAN radio access technology (RAT) connection, a balance is provided between call quality and power consumed in order to perform the WLAN AP scan.

The triggering of a WLAN AP scan responsive to indication of initiation of a voice call or responsive to degradation of the quality of a WWAN call already in progress, in addition to the conventional approach of periodically performing a WLAN AP scan, results in a more up-to-date and accurate scan list 110 when a handoff decision process (represented by block 210) is initiated due to, for example, detection of signal quality degradation in the current wireless link used by the portable user device 102. As such, a better informed handoff decision can be made, thus frequently resulting in maintenance of the highest quality wireless link available for supporting the voice call. As represented by block 212, the algorithm utilized for handoff decisions can be informed, at least in part, on the IMS or WiFi Calling (WFC) thresholds utilized when IMS is registered on WiFi/WLAN. That is, rather than utilize the default WLAN-to-WLAN handoff thresholds (e.g., RSSI handover threshold) that are lower than the typical WLAN-to-WWAN handoff thresholds, the WLAN-to-WWAN handoff thresholds can be employed as the WLAN-to-WLAN handoff thresholds as well. This can mitigate the potential for an unnecessary handover of a voice call to a WWAN even when neighboring WLAN APs have satisfactory RSSI based on VoWiFi criteria.