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Estimating Probability of Stable Service for a Successful Voice Call Origination

Mahesh Telang

Rukun Mao

Qin Zhang

Shivank Nayak

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Abstract

A user of a device is provided with a notification indicating an estimate of a probability of success of a call on a cellular network prior to originating the call. With this notification the user may be aware that the device is in an area where the call may not be successfully connected, or the call may be disconnected due to the signaling conditions. The user then may elect to either continue attempting to establish the call, or to delay the call until the user is in a location more likely to lead to successful call origination.

Background

Whenever a user equipment (UE) transitions from In Service (IS) to Out of Service (OOS), radio access stratum layers such as Radio Resource Control (RRC) may indicate a service loss via an indication (e.g., a Loss of Coverage indication) to upper layers such as Non Access Stratum (NAS) layers, which then perform a loss of service recovery procedure and system selection. When a NAS module receives the service loss indication, it may perform a Public Land Mobile Network (PLMN) selection procedure (e.g., as discussed in the 3rd Generation Partnership Project (3GPP) specification 23.122) and initiate a PLMN SEARCH to acquire service. In this procedure, the UE attempts to search for cells from PLMN lists included in the 3GPP specification. If the UE is unable to locate any service, then a call processor (CP) may indicate "No Service" to an application processor (AP). When the CP goes out of service, it is not necessary that the AP be informed of the "No Service" status immediately. In many cases the CP may perform Loss of Coverage recovery and then inform the AP of the "No Service" status. When the CP is performing Loss of Coverage recovery, the AP will still be In Service. Thus,

when a user attempts to originate the call, the AP may allow the call and forward a call request to the CP, which in many cases fails when the CP is in Loss of Coverage recovery.

There may exist a scenario in which the user is in an area where the signal is not stable, and there are some spots in which the UE will be "In Service" and some spots in which the UE will be in "No Service." For example, this situation has been observed in high-rise buildings and cities with tall buildings obstructing the path of cellular towers. In this scenario as well, the CP may be toggling in and out of service frequently, and whenever the user attempts to originate a call in this marginal coverage there is a high probability of the call failing after initially being established, potentially causing an adverse user experience.

Description

As discussed below, a modem operating in a cellular network may predict whether a user of a UE is likely to successfully conduct a call in current network conditions. If the modem predicts that the UE is currently in network conditions where the voice call success probability is determined as being low, it sends an indication to an AP indicating the low probability for voice call success. A user interface (UI) of the AP then provides an indication to the user when, for example, the user dials the number from the keypad. This indication may include a displayed message that the UE is in an area where a probability of voice call success is low over the cellular network. An example technique for predicting the low probability of success for a voice call is discussed below.

As shown below, Figure 1 is a flowchart for an example technique for predicting the low probability of success for a voice call, based at least on a first timer and a second timer, and a counter that tracks a number of times (e.g., a cardinality of times) the UE has transitioned from "In Service" to OOS in a time indicated by the first timer. For example, the first timer is started

after service is lost for the first time after acquiring the service for a predetermined period of time. The first timer may be reset as long as the UE is transitioning in and out of service during the prediction period. The first timer may be stopped once the UE is in stable service for the prediction period.

Whenever the RRC layer reports a loss of coverage to the NAS layer or the OOS recovery module, a second timer is started (the second timer indicating the time for which the UE was OOS for this instance before recovery was successful), and a counter is incremented. For example, the counter tracks a number of times (e.g., a cardinality of times) the UE has transitioned from "In Service" to OOS in a time indicated by the first timer.

The total time in OOS in one period of the first timer is determined. The first timer is allowed to run a first threshold number of times before a decision is determined to provide an indication of low success for a voice call. A second threshold represents a threshold value for the time the UE will be in service so that the modem will not provide an indication of low success for a voice call (e.g., by not sending the indication to the AP).

The NAS/Out of Service recovery performs a loss of coverage recovery and starts searching for other PLMNs. If the Service is acquired then the second timer is used to update the sum of OOS time, and then reset. This example technique may be performed whenever the Lower layers report a loss of coverage (No service).

When the first timer expires, a buffer is updated with the current values of the total time in OOS in this period of the first timer, and with the counter that tracks the number of times the UE has transitioned from "In Service" to OOS in this period of the first timer. A total of the buffered counters and a total of the buffered time on OOS values for a last predetermined time period is determined. The modem may determine whether the device is in a "Low Success for voice call"

network condition or not based, at least, on whether the total of the buffered counters exceeds the first threshold, or the total of the buffered time on OOS values exceeds a predefined threshold value associated with OOS time, and further, whether the UE is not in stable service for the last period exceeding the second threshold. For example, the buffer may include an indexed buffer. If these conditions are met, a "Low Success for voice call" indication is sent to the AP.

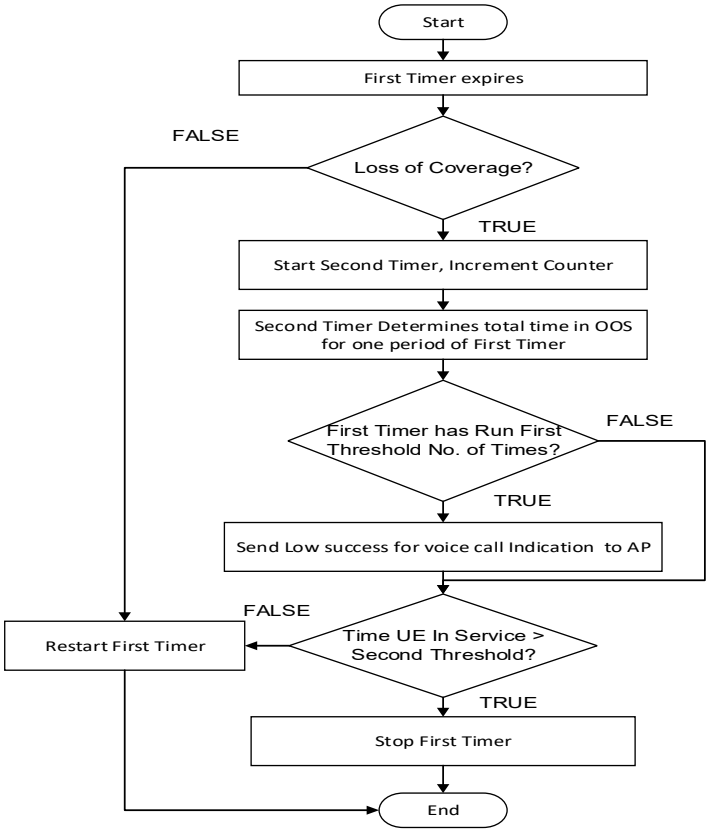

Figure 1

The Lower Layers (RRC) may also perform a low signal estimate based on the signal quality, (e.g., Reference Signal Received Power (RSRP), Received Signal Strength Indicator (RSSI), Signal-to-Interference-plus-Noise Ratio (SINR), Path loss, etc.), and determine whether the UE is currently in the "low signal" state or not. When there is an update regarding signal strength, the example technique may check RSRP, Reference Signal Received Quality (RSRQ), and Carrier-to-Interference-plus-Noise Ratio (CINR). If any one of them is lower than respective thresholds, this signal strength update is determined as an instance of a low signal. In order to handle possible signal fluctuations, there may be a low signal count threshold to satisfy before reporting a low signal indication to the AP. Thresholds for RSRP, RSRQ, CINR, and low signal count may be configurable.

When Transmission Time Interval (TTI) bundling is enabled, the UE may repeat transmission several times to increase the robustness of the radio link. In this case, corresponding thresholds for RSRP and other factors may be lower. For example, if the UE is in a low signal state then the modem may also send a "Low Success for call" indication to the AP with the trigger event or cause as "Low Signal." Further, if the UE has transitioned out of "Low Signal," then the modem may send another indication to reset the trigger event/cause "Low Signal" that was sent previously.

The modem may send an indication with a trigger event as an event indicating frequent in-and-out-of-service plus low signal if the UE is continuously transitioning in and out of service and if the signal is also low. If the UE is in stable service for a predefined period, then the first timer is stopped; if not, the first timer may be reset.

References (incorporated herein):

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