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Self-taught Camp on Criteria

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SELF-TAUGHT CAMP-ON CRITERIA

Abstract

A self-taught mechanism enables a user equipment (UE) device to learn suitable camped-on criteria for itself. By using a cell measurement result and a connection establishment result, the UE device tunes a model to answer an advanced cell judgment query. In addition to cell selection procedures, the UE device also applies the self-taught mechanism to other mobility procedures, such as measurement reporting and cell reselection. In some cases, the UE device also considers radio link failure, target non-access stratum (NAS) procedure, or services for the self-taught mechanism.

Background

A UE device follows cell selection criteria to perform a cell selection procedure in scenarios such as initial cell selection, redirection, connection to idle mode and out of service, etc., to obtain service required by the UE device. When camping on a suitable cell, the UE device may receive system information for non-access stratum (NAS) or access stratum (AS) information, may receive paging or notification messages from the public land mobile network (PLMN) and may initiate a transfer to connected mode. The UE device selects a selectable cell based on idle mode measurements and cell selection criteria. The cell selection criterion S in normal coverage is fulfilled when the cell selection RX level value (Srxley) is greater than zero and the cell selection quality value (Squal) is greater than zero (see, e.g., Third Generation Partnership Project (3GPP) specifications, Long-Term Evolution (LTE): 36.304, New Radio (NR) 38.304, etc.).

However, in many network (NW) scenarios, the NW may provide improper cell selection criteria to the UE. For example, the NW may provide a criteria setting that is too challenging, such as specifying that the actual value specified for the minimum required received signal power (RX) level in the cell (Qrxlevmin) is -130 dBm and the specified minimum required quality level in the cell (Qqualmin) is -34dB. In other cases, the NW only configures RX level criteria and does not specify a quality criterion, in which case the UE device applies the value of negative infinity. Such improper cell selection criteria negatively impact the UE device chipset's lower layer/hardware performance abilities, which may differ between platforms.

When the cell selection criteria are not matched to the UE device's practical performance capabilities, the UE device may suffer serious performance problems such as camping on a cell but not completing the connection establishment procedure. Furthermore, if there are several cells nearby with similar conditions, the UE device may remain in cells with low-quality signals in low coverage for an extended time.

Description

To enable a UE device to camp on cells with higher quality signals, the UE device includes a self-taught criteria module to learn suitable camped-on criteria to perform a mobility procedure such as cell selection, measurement reporting, or cell reselection, etc. The criteria are based on various measurement results, such as cell measurement results, connection establishment results, radio link failure, target non-access stratum (NAS) procedure or services results, etc.

When a candidate cell is found and the mobility procedure has been triggered, the UE device continues receiving master information block (MIB)/system information block1 (SIB1) information from a network and estimates cell signal quality of the candidate cell. After the

MIB/SIB1 and cell signal quality estimate results are received, a radio resource control (RRC) layer of the UE device performs the mobility procedure and camps on the cell if the cell passes both specification (SPEC) defined criteria and self-taught criteria. The SPEC-defined criteria are criteria such as S criteria, cell barring check, etc. For advanced cell judgment, several parameters such as reference signal received quality (RSRQ), signal-to-interference-plus-noise ratio (SINR), band, carrier, and purpose, etc. are input to the self-taught criteria module to determine if the cell passes the criteria. If the cell passes both the SPEC-defined criteria and the self-taught criteria, the UE device camps on the cell. Otherwise, the UE device selects the next candidate cell.

The UE device sends feedback to the self-taught criteria module regarding successful connection with the cell or failure to establish a connection under a poor signal scenario with the cell, determined by predefined thresholds. The feedback enables the self-taught criteria module to adjust the cell selection criteria accordingly. In some cases, the self-taught criteria module adjusts the cell selection criteria using a convergence function or a deep learning technique.

One example of a method for the UE device to use a self-taught criteria module to learn suitable camped-on criteria to perform a mobility procedure is shown below in Figure 1. In the example method, a cell selection procedure is triggered, after which a candidate cell is found. The UE device receives MIB/SIB1 information from the network and estimates the cell signal quality of the candidate cell. Once the results of the cell signal quality estimate results are received, the method proceeds to cell judgment. In judging the cell, the UE device applies SPEC criteria judgment and self-taught criteria judgment by referencing the self-taught criteria module. The self-taught criteria judgment includes inputting an advanced cell judgment query to the self-taught criteria module, testing several parameters such as reference signal received quality (RSRQ), signal-to-interference-plus-noise ratio (SINR), band, carrier, and purpose, etc. The self-

taught criteria module responds with an indication of whether the cell passes or fails the advanced cell judgment query. If the cell passes both the SPEC-defined criteria judgment and the self-taught criteria judgment, the UE device camps on the cell. If the cell does not pass both the SPEC-defined criteria judgment and the self-taught criteria judgment, the UE device selects the next candidate cell and the method flow continues back to the point where a candidate cell is found.

The UE device refines the self-taught criteria judgment by providing feedback to the self-taught criteria module. The UE device attempts to establish a connection with a cell. If the UE device successfully establishes a connection with the cell, the UE device provides feedback to the self-taught criteria module indicating that a connection was successfully established. If the UE device does not successfully establish a connection with the cell, the UE device determines whether the UE is receiving a poor signal. If the UE device is receiving a poor signal, the UE device provides feedback to the self-taught criteria module indicating that a connection was not successfully established and that the cell has a poor signal.

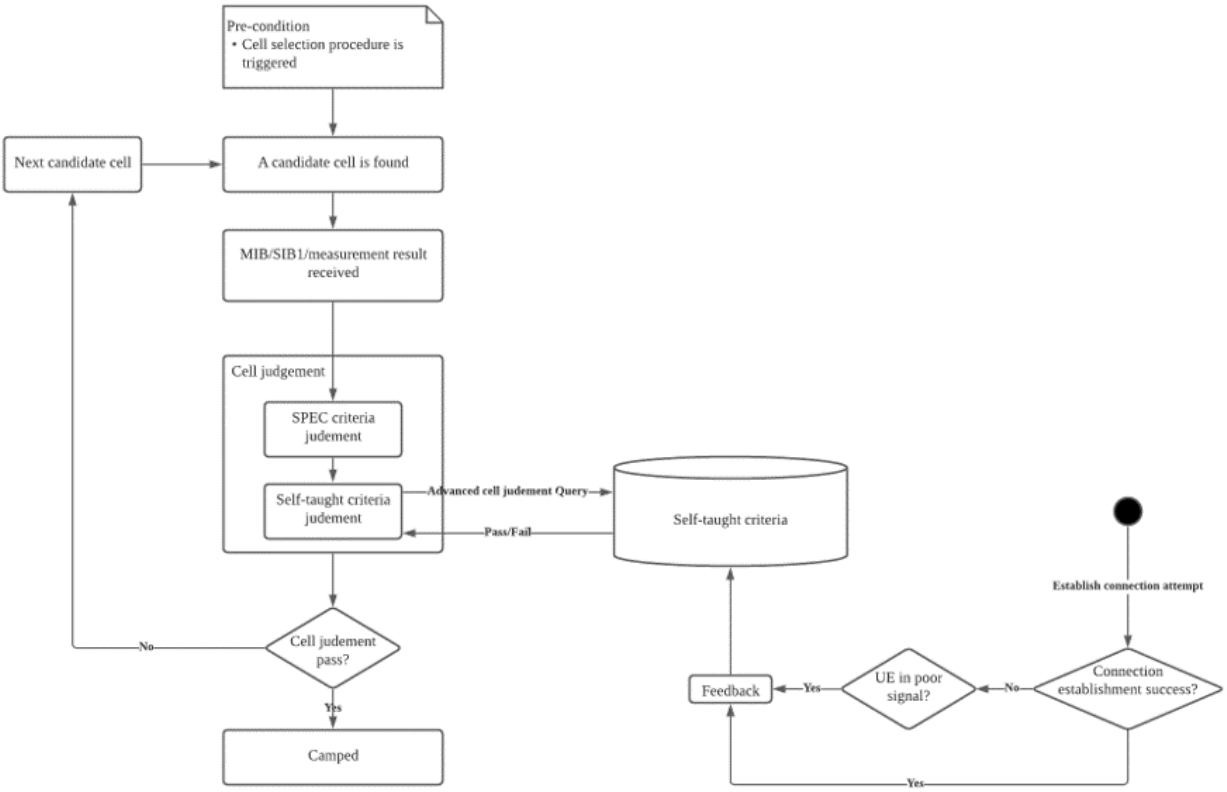

FIG. 1

References

1. U.S. Patent Application No. 2019/0246325, entitled “Method and Device of Reselecting Cell by Terminal,” and filed on April 15, 2019, the entirety of which is incorporated by reference.
2. U.S. Patent Application No. 2011/0165909, entitled “Cell Reselection Method and Terminal,” and filed on April 14, 2009, the entirety of which is incorporated by reference.
3. ETSI Technical Specification 138 304 V15.0.0 (2018-09), the entirety of which is incorporated by reference.