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Restricting Low Priority Data Access when Data Quality is Poor

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RESTRICTING LOW PRIORITY DATA ACCESS WHEN DATA QUALITY IS POOR

Abstract

A user equipment (UE) identifies situations in which a less-preferred radio access technology (RAT) camped on a network is unlikely to provide sufficient data throughput for one or more software applications executing at the UE. In such situations, the UE selectively represents the camped RAT as providing voice service only, even when data service is actually available. Alternatively, rather than a blanket prohibition on use of data services in this situation, the high-level operating system (HLOS) of the UE instead may identify software applications that require a data rate higher than that practicable for the less-preferred RAT under the current conditions and selectively bar these identified applications from using the PS data service provided by the less-preferred RAT, while allowing other software applications that have a sufficiently low data rate requirement to utilize the PS service. This prevents the user from attempting to utilize the poor data quality provided by the less-preferred RAT for an application that requires a higher data rate, thus avoiding unnecessary user frustration and excess power consumption from frequent data retransmissions resulting from attempted use of a poor data quality connection.

Background

Packet switching (PS) technologies and other data communication technologies such as General Packet Radio Services (GPRS), Evolution-Data Optimized (EVDO), High Speed Packet Access (HSPA), Long-Term Evolution (LTE), and Fifth Generation New Radio (5GNR), have increased the capacity and speed of wireless data networks and created a market for high-speed data applications, such as those widely used for browsing videos on various platforms. However, when a UE is unable to connect to a network using a more-preferred RAT that provides high-speed data, such as LTE or 5GNR, the UE typically falls back to using a lower-speed, less-

preferred RAT, such as Wideband Code Division Multiple Access (WCDMA), Global System for Mobile Communications (GSM), and the like. Such older-generation RATs generally have very low data rates, making them practically unusable for many current data use cases, such as streaming video.

Many wireless standards, such as those promulgated by the 3rd Generation Partnership Project (3GPP), do not enforce restrictions on using or not using a particular RAT based on the data rates necessary to support a corresponding use. At best, such standards provide for a Higher Priority Public Land Mobile Network (HPPLMN) or other network reselection after a certain time interval. While this can lead to the UE eventually connecting to a Radio Access Network (RAN) via a RAT that provides a sufficient data rate, during the time when the UE has not yet switched from the less-preferred, low-data-rate RAT, the UE will signal the availability of PS service to the user. As a result, the user may erroneously conclude that the user is free to use various software applications that rely on a relatively high PS service. Many such software applications are "greedy" from a data communication perspective and thus will attempt to operate using the less-preferred RAT that is unable to provide a data rate sufficient to support the software application. This leads to frequent data buffering, which in turn results in a high rate of data packet retransmission and a corresponding increase in power consumption.

These drawbacks manifest in particular when the signal quality of the less-preferred RAT is barely within the permissible range for attempting registration with the network. The data stalling and buffering resulting from signaling of PS service via a less-preferred RAT to support a software application requiring a higher data rate than can be supported by the less-preferred RAT under the circumstances often proves to be very frustrating to the user and results in a negative user experience.

Description

A less-preferred RAT of a UE may not provide a data rate sufficient to support satisfactory operation of one or more software applications of the UE and thus may frustrate the user. As described below, this situation can be mitigated using two approaches, individually or in combination. Both approaches generally involve either a blanket prohibition or selective prohibition on signaling PS service availability for use by some or all software applications when the UE is camped on a network using a less-preferred RAT, such as GSM, WCDMA, EVDO, etc. In a first approach, whenever the UE has acquired a network connection via a less-preferred data RAT, either due to reselection from the network or due to unavailability of the more-preferred RATs, and assuming the UE has a prefetched database of the public land mobile networks (PLMNs) (or other networks) or countries/regions in which the data quality of the camped RAT is insufficient, then the UE attempts a combined attach to a network while restricting the PS service to the user by only indicating voice capability or other circuit-switched (CS) service to the application processor of the UE. As part of this process, in the event that the UE was previously camped on a more-preferred RAT (such as LTE or 5GNR), the UE can also terminate any pending dormant public data network (PDN) or packet data protocol (PDP) connections previously established with the more-preferred RAT.

With this approach, the user will be notified of voice connection capability only (that is, the PS capability will be obfuscated while the CS capability is announced) and thus the user will be allowed to make voice calls, send simple message service (SMS) messages, or employ other software operations that rely on CS services only. With this configuration, software applications will not be able to run data communication operations in the background, which will reduce power consumption at the UE due to reduction or elimination in the retransmission and buffering

of data packets that otherwise would occur. Alternatively, rather than a blanket prohibition on use of data services in this situation, the high-level operating system (HLOS) of the UE instead may identify software applications that require a data rate higher than that practicable for the less-preferred RAT under the current conditions and selectively bar these identified applications from using the PS data service provided by the less-preferred RAT, while allowing other software applications that have a sufficiently low data rate requirement to utilize the PS service. For example, if a GSM connection is established, the UE may bar video streaming applications from utilizing the PS service provided by the GSM connection while allowing certain other low-data-rate applications, such as multimedia messaging service (MMS) applications or other basic messenger applications, email applications, and the like, to utilize the PS service provided by the GSM connection.

In a second approach, whenever the UE has acquired a connection via a less-preferred data RAT either due to reselection from the network or due to unavailability of a more-preferred RAT because of poor signal quality or signal strength (but sufficient to register to the network), the UE measures the signal strength or other measurement indicative of signal quality and predicts, based on the signal quality, whether the required throughput can be achieved for sustaining one or more identified software applications executing at the UE. If so, then the UE is configured to indicate availability of PS services on the less-preferred RAT. If not, then the UE is configured to restrict the application processor and the user from accessing the PS service by refraining from signaling availability of a PS service so that the user does not attempt to access a software application that utilizes a data connection and, as a result, avoids the user being subjected to buffering and reload messages on the user interface (UI).

Figure 1 below illustrates the interaction between an application processor of the UE and a modem processor (also referred to as a communication processor or CP) of a modem of the UE. As shown, the modem processor signals the status of various services, including PS services and CS services, via corresponding service status indicators. Thus, to implement either or both approaches outlined above, the modem processor can selectively refrain from signaling the availability of a PS service via a corresponding service status indicator in instances whereby a less-preferred RAT is utilized and is providing a data rate insufficient to support some or all of the software applications a user is attempting to operate at the UE. With the absence of a PS service signaled to the application processor (or only selectively signaled for certain low-data-rate software operations), the user is not made aware of PS connectivity and thus assumes no connection is available. As such, the user avoids the frustration of attempting to use a software application on a data connection insufficient to adequately support the software application.

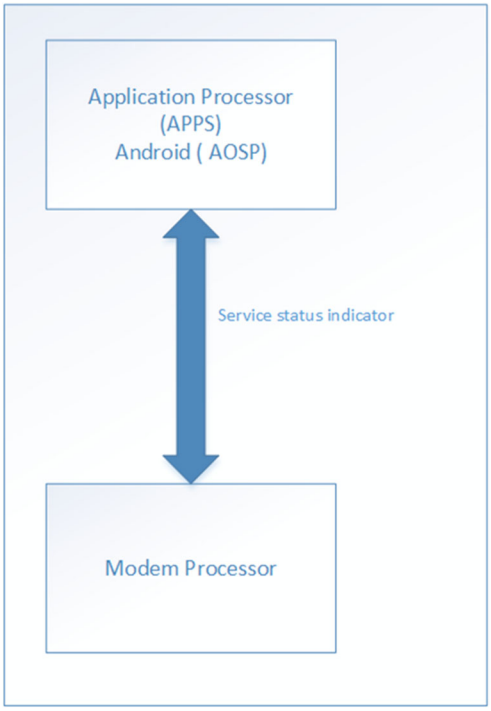

Figure 1 – Interaction between Application Processor and Modem Processor

Figure 2 below illustrates an example method for disabling access to PS capability by the application processor of the UE or a user when a database of poor data rates on a per-network or per-region basis is available. When a service is acquired, the modem processor determines whether the RAT used for the connection is a more-preferred RAT or a less-preferred RAT. If a more-preferred RAT, the modem processor provides a service status indicator indicating the same PS service status as that actually acquired. If the RAT is a less-preferred RAT and the service is not full service, the modem processor provides a service status indicator indicating the same PS service status as that actually acquired. If the RAT is a less-preferred RAT and the service status is full service and the service domain for the connection is both CS and PS services then the modem processor accesses an entry of the database based on a PLMN match or a region match and determines from the entry whether the RAT and PLMN on which the UE is camped have poor data quality (that is, a data rate lower than an identified threshold). If not, then the modem processor provides a service status indicator indicating the same PS service status as that actually acquired. If the RAT and PLMN have poor data quality, then the modem processor updates the service domain to voice only (e.g., CS service only) and does not announce the availability of PS service. The modem processor then determines whether a more-preferred RAT that was previously and recently connected has a pending active or dormant PDP/PDN connection and, if so, deactivates any such previous connections. The modem processor then provides a service status indicator to the application processor, the service status indicator indicating that there is no data service available on the camped RAT and PLMN.

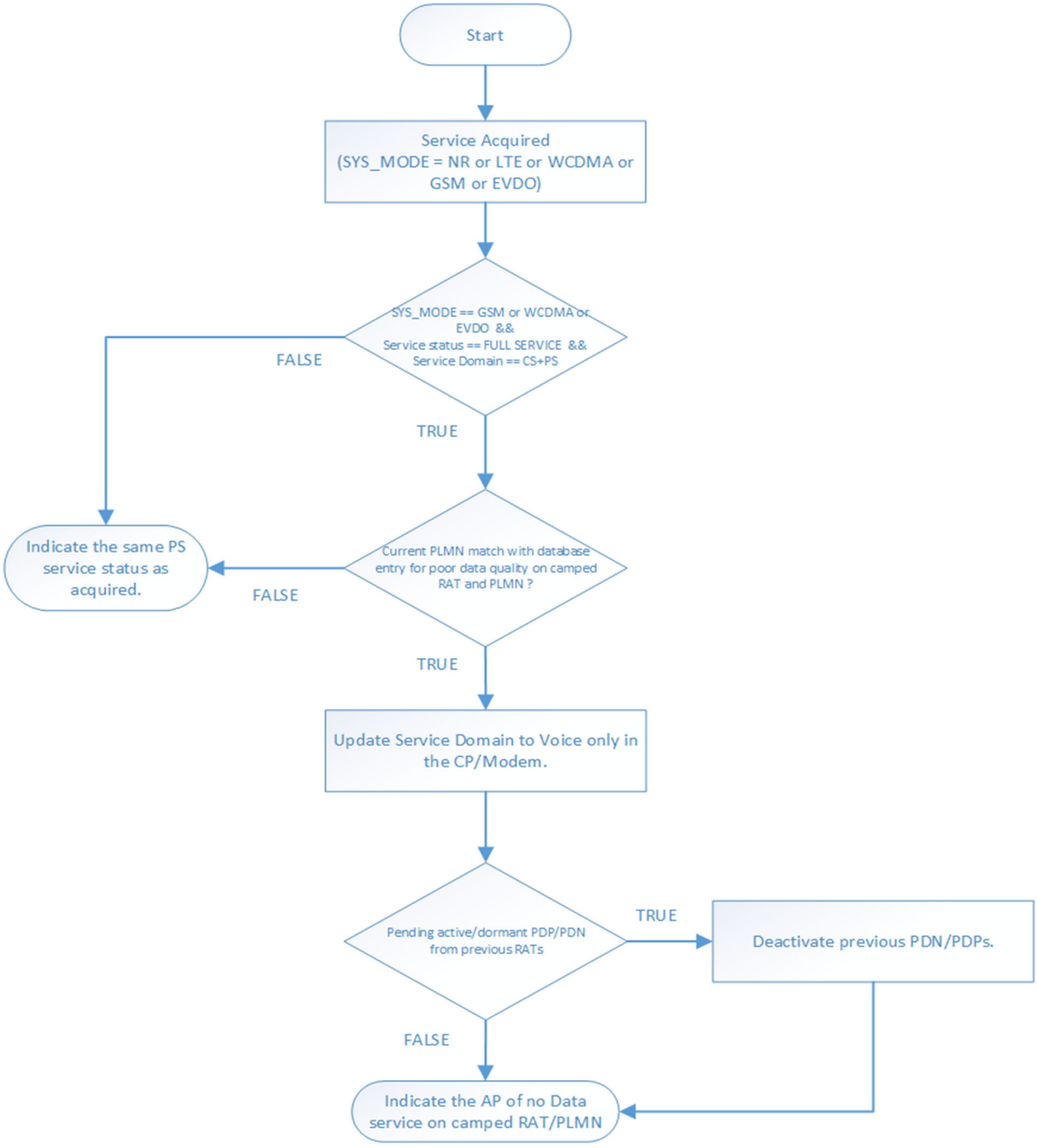

Figure 2

Figure 3 below illustrates an example method to disable access to PS capability by the application processor or user when the signal quality of a less-preferred RAT is below a

threshold for allowing data use. As with the previous method, when a service is acquired, the modem processor determines whether the RAT used for the connection is a more-preferred RAT or a less-preferred RAT. If a more-preferred RAT, the modem processor provides a service status indicator indicating the same PS service status as that actually acquired. If the RAT is a less-preferred RAT and the service is not full service, the modem processor provides a service status indicator indicating the same PS service status as that actually acquired. If the RAT is a less-preferred RAT and the service status is full service and the service domain for the connection is both CS and PS services, then the modem processor measures the signal strength or other indicator of signal quality. From this measurement the modem processor predicts a corresponding data throughput and then determines if this data throughput is above a specified minimum data rate threshold needed to support the operation of certain software applications. If so, the modem processor provides a service status indicator indicating the same PS service status as that actually acquired. If not, the modem processor updates the service domain to voice only (e.g., CS service only). The modem processor then determines whether a more-preferred RAT that was previously and recently connected has a pending active or dormant PDP/PDN connection and, if so, deactivates any such previous connections. After deactivating any such connections, the modem processor provides a service status indicator to the application processor, the service status indicator indicating that there is no data service available on the camped RAT and PLMN.

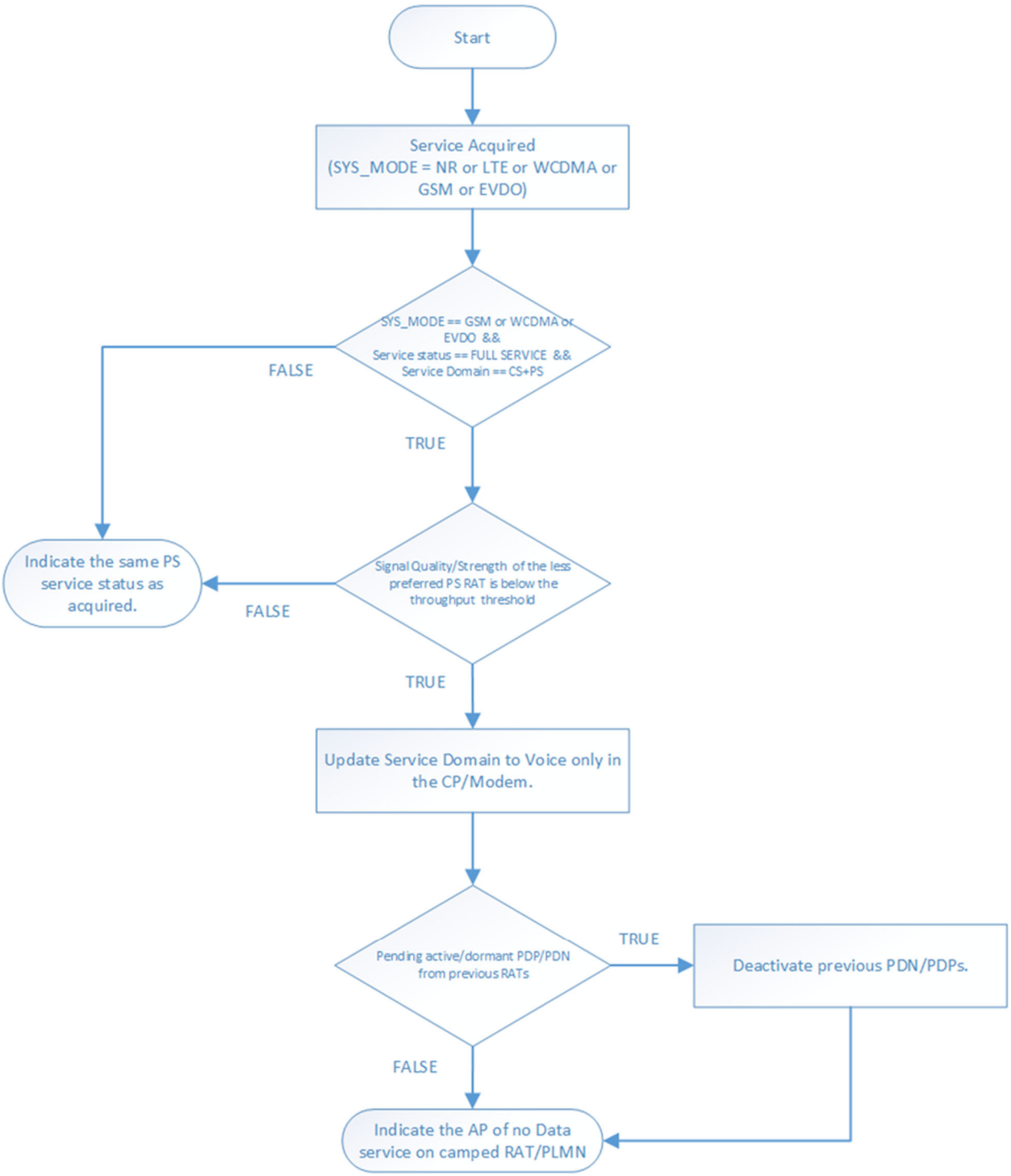

Figure 3

Further, a combination of the methods of Figures 2 and 3 can be employed. In this approach, when there is either or both of an indication of poor data quality based on a database entry

matching the PLMN or the region, or a prediction of a data throughput below a threshold based on measured signal quality, the modem processor acts to update the service domain to voice only, deactivate any previous PDN/PDP connections, and signal to the application processor that no data connections are available.

Use of the approaches outlined above, individually or in combination, provides for an improved user experience because the UE will avoid indicating availability of data service to the user when the data quality is poor. This prevents the user from attempting to use a poor data quality connection to support operation of a high-data-rate software application. Moreover, by allowing the UE to be registered with both PS and CS services but only indicating CS service to the user and the application processor, data access attempts, and consequentially data retransmissions, are avoided when the data quality is unable to sufficiently support an application, thereby reducing power consumption by the UE.

References

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