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Recovery Of Server Identifiers In Response To Network Failure

Poying Chuang

Rayson Chou

RECOVERY OF SERVER IDENTIFIERS IN RESPONSE TO NETWORK FAILURE

Abstract

A user equipment (UE) can experience a server-identifier failure, wherein a network fails to provide the UE with one or more server addresses required by the UE to access network services. To reduce the impact of such a server-identifier failure, the UE can maintain a local database of previously received server identifiers. In response to a server-identifier failure, the UE uses the database to identify and communicate with the corresponding server via the network. The UE is thereby able to access network services, such as Domain Name System (DNS) services or Internet Protocol (IP) Multimedia Subsystem (IMS) services, in the event of a server-identifier failure, thereby improving the overall user experience with the UE.

Background

Modern UE devices, such as smartphones, wearable devices, mobile devices (e.g., a Wi-Fi router), or devices in the automotive or manufacturing industry, can perform a wide variety of operations. At least some of these operations require a UE to connect to a server via a network, such as a DNS server (so that the UE can browse the Internet) or a Proxy Call Session Control Function (P-CSCF) server (so that the UE can enable IMS services such as voice-call services, video-call services, and Short Message Service (SMS) over IMS services). However, under some circumstances, the network will fail to provide the UE with the requisite identifier for the server, resulting in a loss of functionality at the UE and a poor user experience.

Description

To reduce the impact of a server-identifier failure, such as when a network fails to provide a UE with a requisite server identifier, the UE can maintain a local database of

previously received server identifiers. In response to a server-identifier failure, the UE queries the database for the requisite identifier (e.g., a server address), and uses the identifier to communicate with the corresponding server via the network. The UE is thereby able to access network services, such as DNS services or IMS services, in the event of a server-identifier failure, thereby improving the overall user experience with the UE.

An example method of maintaining and using the local database of server identifiers is illustrated at FIG. 1.

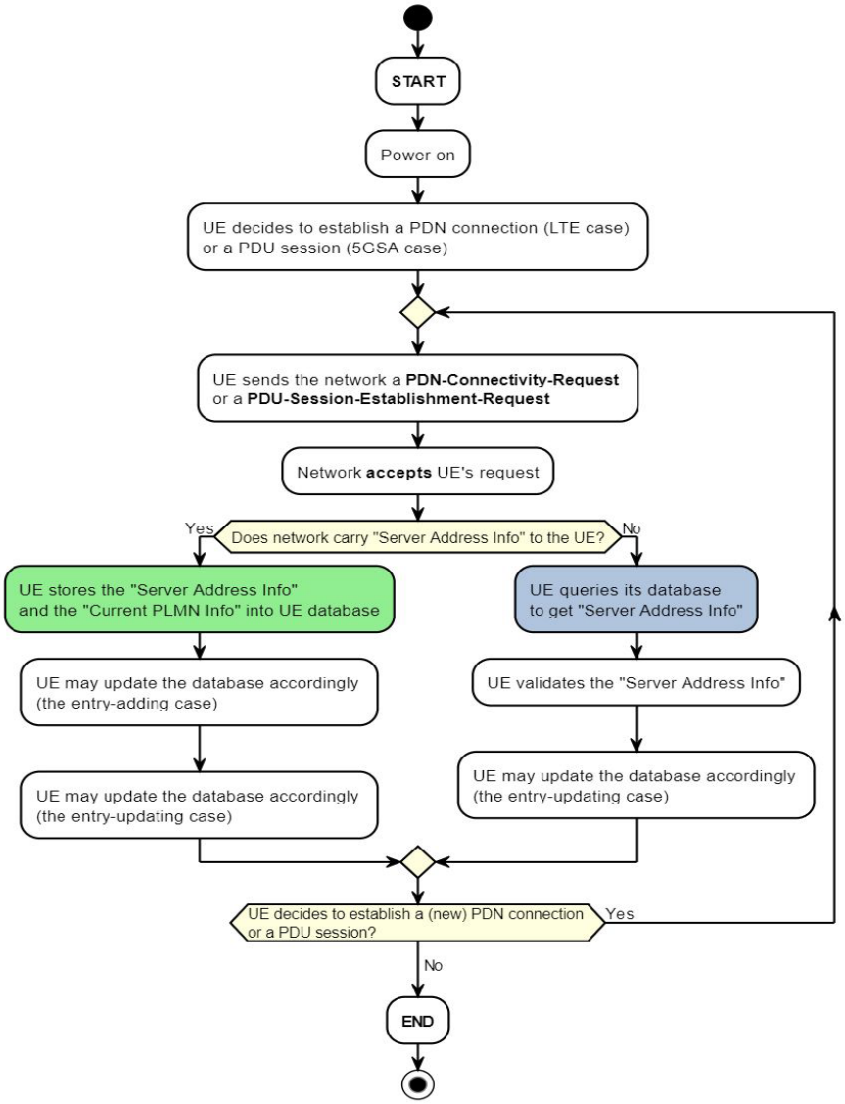

FIG. 1

As shown, the method begins with the user turning the UE on. In response, the UE determines to establish a public data network (PDN) connection (in the case of the UE connecting to a Long-Term Evolution (LTE) network) or a protocol data unit (PDU) connection (in the case of the UE connecting to a Fifth-Generation Standalone (5GSA) network). To establish the connection, the UE sends a PDN connectivity request (for an LTE network connection) or a PDU session establishment request (for a 5GSA network). The corresponding network then accepts the UE's request, thus establishing the network connection with the UE.

After the network connection is established, the UE expects the network to provide one or more server addresses, such as a DNS server address, a P-CSCF server address, or an evolved packet data gateway (EPDG) server address. Each address can be an IPv4 address, IPv6 address, ethernet address, an unstructured address, or an address associated with another addressing technique. In response to receiving the server addresses, the UE stores the server addresses at an entry of the local database, along with the current Public Land Mobile Network (PLMN) information. The PLMN information can be the Mobile Country Code (MCC) or PLMN-ID (the MCC + Mobile Network Code (MNC)) of the current network, or the MCC or PLMN-ID of the current Subscriber Identity Module (SIM) card. In some cases, the current PLMN information includes helper information to identify one or more specific records, such as current device information (e.g., the International Mobile Equipment Identity (IMEI) or Mobile Subscriber Integrated Services Digital Network (MSISDN) number of the SIM card) and time information (e.g., the current time or a timestamp). In some cases, the DNS server is public information, and therefore the UE does not need to store the DNS server address along with the specific PLMN info. In such cases, in order to add or update an entry in the database, the UE may use some wildcard characters to represent the "don't-care" portion of the PLMN information.

If the database already includes an entry associated with the current PLMN, the UE updates that entry with the received server addresses. If the database does not include an entry associated with the current PLMN, the UE creates a new entry in the database for the current PLMN. The UE then uses the received server address information to communicate with the corresponding servers and thereby use the corresponding network services, such as DNS services or IMS services.

If the UE does not receive an expected server address (that is, if a server-identifier failure occurs), the UE queries the database to get the stored server address information for the current PLMN. The UE then validates the retrieved server address information by communicating with the server directly. For example, in the case of a DNS server, the UE can query a specified domain name at the server address. For a P-CSCF server, the UE can try to register IMS services at the server address. For an EPDG server, the UE can attempt to register IMS services over a Wi-Fi connection with the server. If these attempts are successful, the UE uses the validated server address information to communicate with the corresponding servers via the network and thereby use the corresponding network services, such as DNS services or IMS services. Thus, in the event of a server-identifier failure, the UE is able to use the local database to determine the requisite server addresses and thereby use the corresponding network services.

In some cases, to make querying the database easier, the UE maintains information in the database indicating which entry or entries have been more recently used, and gives these entries a higher priority. Additionally, in some cases the UE removes entries from the database based on one or more of a variety of factors, such as the time an entry was created, when the entry was last accessed (so that, for example, the least recently used entries are periodically removed from

the database), and the rate at which the server address information for an entry is successfully validated.

In some cases, the UE periodically updates the local database with the address information for the servers currently being used by the UE. The trigger for updating the database can be expiration of a pre-defined timer, the occurrence of a session-specific event (e.g., a data/IMS session is setup or terminated, or a PDN connection is established or disconnected), or the occurrence of a PLMN-specific event (e.g., the UE moves to a different PLMN, the UE performs an LTE attach/tracking area update (TAU) procedure, or the UE performs an inter-radio-access-technology (inter-RAT) procedure, such as the UE moving from an LTE network to a 5GSA network).

Subsequently, if the UE decides to establish a new PDN connection or a new PDN session, the UE sends another connection request, and the method flow described above is repeated. Otherwise, the method ends.

It will be appreciated that the UE described herein refers to any device that may connect to and use LTE and/or 5GSA networks. Thus, the UE can be, for example, a mobile phone, a mobile device such as a Wi-Fi router, a device or module in the manufacturing or automotive industry, or a wearable device such as a watch, a smart bracelet, or a tracker.

References

1. 3rd Generation Partnership Projection (3GPP) TS 24.301 version 15.8.0 Release 15
2. 3GPP TS 24.008 version 15.9.0 Release 15
3. 3GPP TS 24.501 version 15.6.0 Release 15