

Mobile Networking

Purpose

The purpose of this white paper is to inform the reader about mobile networking technology. For further information, see www.mobilein.com.

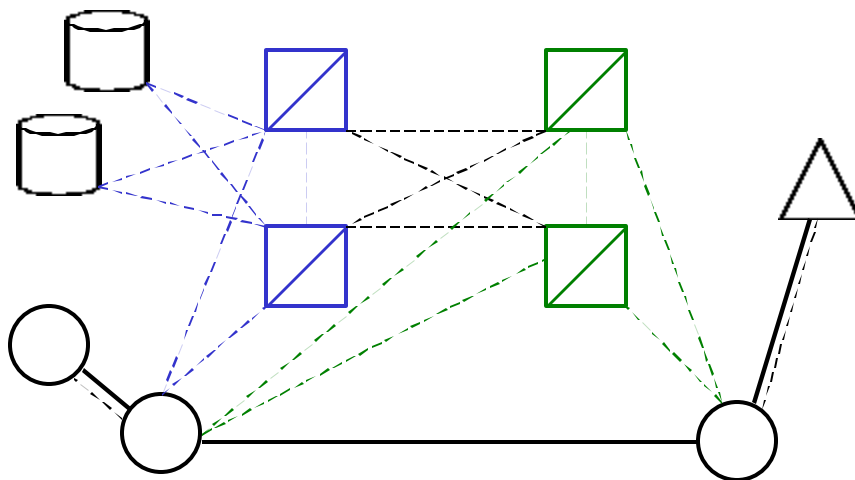
Mobile Network Signaling

Telecommunications signaling is the transmission of data for purposes of sharing information for network control and/or call control. The type of signaling used in a modern network is called Signaling System number Seven (SS7).

SS7 is a critical component of modern telecommunications systems. SS7 is a communications protocol that provides signaling and control for various network services and capabilities. Being a layered protocol, SS7 provides various protocol levels for connection oriented and connectionless (database) signaling in fixed and mobile networks.

SS7 is comprised of a series of interconnected network elements such as switches, databases, and routing nodes. Each of these elements is interconnected with links, each of which has a specific purpose. The routing nodes are the heart of the SS7 network and are called a Signal Transfer Point (STP). STPs are connected to Service Switching Points (SSP) that are switches equipped with SS7 control logic.

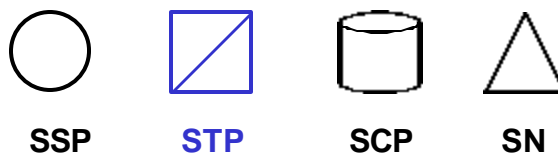
SS7 Network Architecture



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The above illustration depicts a SS7 network. The network elements are depicted below.

SS7 Network Elements



Each of these network elements have a specific role in the SS7 network.

- **Service Switching Point (SSP):** A telecommunications switch that contains the control logic (software) necessary to send/receive SS7 messages to other nodes in the network. If a Mobile Switching Center (MSC) has said control logic, it is by definition considered an SSP.
- **Signal Transfer Point (STP):** This is the "heart" of the SS7 network. STP routes messages between other network elements.
- **Service Control Point (SCP):** This is the "brain" of the SS7 network. The SCP is nothing more than a database. However, utilization of a SCP offers profound enhancements for service delivery and network control.
- **Service Node (SN):** Includes database functionality of the SCP along with additional capabilities such as voice interaction and control of voice resources. Generally speaking, SCPs work well with requirements that call for voluminous data transactions. SNs, on the other hand, are typically not designed for high volume data processing. Instead, SNs are best suited for special circumstance call processing involving voice resources and/or interaction.

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SS7 involves two different types of signaling: connection oriented signaling and connectionless oriented signaling. Connection oriented signaling refers to the establishment of switch-to-switch facilities referred to as inter-office trunks which are the bearer for voice (usually) and data communications. The ISDN User Part (ISUP) part of the SS7 protocol is utilized to establish trunks between switches. In contrast, the Transaction Capability Application Part (TCAP) is utilized for connectionless signaling which typically entails switch-to-database or database-to-database communications. An example of connectionless signaling is TCAP signaling of Home Location Register to Visiting Location Register discussed below.

Mobile Networking Standards

There are two major types of inter-system signaling for mobile communications: GSM Mobile Application Part (MAP) and ANSI-41. GSM MAP is the inter-system standard utilized for GSM and ANSI-41 is the standard for all other mobile networks including CDMA, D-AMPS (IS-136), and analog systems such as AMPS.

Although the two standards have their differences, both have certain key things in common. For example, both standards support three network elements that are required for mobile communications: MSCs, HLRs, and VLRs.

Mobile Switching Center

A Mobile Switching Center (MSC) is a telecommunications switch deployed in mobile communications networks, to provide call control, processing and access to the Public Switched Telephone (fixed) Network.

Home Location Register

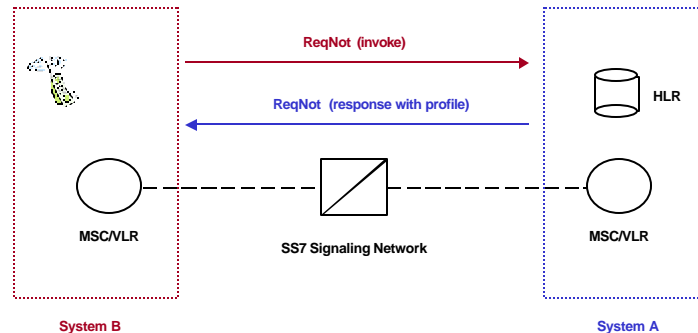
The Home Location Register (HLR) is a database that is maintained by a user's home carrier or the mobile operator from whom the user has initiated service. The HLR stores information about the user, including the user profile (preferences), account status, features and capabilities.

Visiting Location Register

The Visiting Location Register (VLR) is another database and is used by the serving carrier system to manage service requests from mobile users who are away from their home system.

The interaction between the MSC, HLR, and VLR is best understood by walking through the registration process.

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In the above figure, the mobile user's home system is depicted as System A and the mobile user is currently roaming in System B, the visited or serving system.

Step One: Detecting a Potential User

The first step involves the serving system (B) detecting the mobile phone. This occurs over the radio interface. Each mobile phone emits a unique identification that is detected by the radio frequency (RF) equipment of the serving system. The fact that the mobile phone is "powered on" triggers system B's RF equipment to inform system B's switching equipment of the mobile's presence. The switching equipment performs translations to determine whether the mobile is in its "home" area or whether it is a "visitor". In this context, visitor means that the mobile user is not in its normal home location (the city/country of service origination). These translations involve analysis of the International Mobile Station Identifier (IMSI) of the mobile phone to determine its home network and assignment of a point code for routing to the appropriate HLR.

Step Two: Exchanging the Appropriate Information about the User

The second step involves database interaction to determine appropriate handling of call requests. If you are in your home area, the Home Location Register (HLR) provides information necessary to handle requests for either call origination (making a call) or termination (being called). If you are not in your home area, a Visiting Location Register (VLR) must request information from the HLR so that the visited (serving) system can process calls appropriately.

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Communication between the VLR in the serving system and the HLR of the home area is facilitated by mobile networking protocols and signaling based on SS7. In GSM networks, the GSM MAP protocol rides on top of SS7, allowing VLR to HLR (and HLR to VLR) communications. In GSM networks, the SS7 signaling network employs a procedure called Global Title Translations (GTT) to determine the appropriate HLR to handle the request for information.

To perform this signaling, the MSC sends a query to an alias point code. STPs in the SS7 network perform GTT on the alias point code to retranslate the address into the actual address of the home HLR in system A. Once the STP performs the GTT and routes the query to system A, the HLR can then respond to the query by addressing a message to the originating point code from system B (which corresponds to the VLR).

This signaling and database communications typically occurs before any call is either placed or received, allowing the serving system to know exactly how to handle calls when a call is placed/received.

Step Three: Handling Calls

By the time the user either places or receives a call, this database interaction has occurred. The serving system now knows whether the mobile phone is associated with an account in good standing, user feature/service subscription, and the location of the user so that calls placed to the user may be delivered.

Placing a call

Upon detecting a request for a mobile phone user to originate a call, the serving system reviews the VLR record (established in Step Two above) to determine appropriate treatment. This allows the serving system to determine if the call is allowed and if any additional features/services should be made available. Once this investigation occurs (in a fraction of a second), the switch processes the call attempt as appropriate.

Receiving a call

When someone calls a mobile phone user, the home switch reviews the HLR. If the user is in the home area, the call is delivered immediately. If the mobile user is in another serving area (called "roaming"), the HLR record indicates which VLR is currently maintaining the mobile user's records. The HLR uses SS7 and the appropriate mobile networking protocol to request delivery instructions from the VLR. The VLR provides these instructions to the HLR, allowing the home switch to deliver the call to the serving switch and seamlessly terminate the call to the mobile phone as if the user were in the home area.

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Mobile Networking and Applications

GSM MAP supports various applications including basic services such as call waiting and conference calling. This support is provided in the form of profile updates between the serving system (VLR) and the home system (HLR). The HLR updates the VLR regarding subscriber services, allowing the serving system to provide the appropriate services to the visitor. GSM MAP also allows for value-added services such as those enabled by short messaging service. These services include Subscriber Identity Module (SIM) based prepay. The SIM Toolkit, employed in many GSM phones today, also enables more advanced services such as mobile banking and location based services.

A discussion of these applications is beyond the scope and purpose of this white paper. See www.mobilein.com for more information about roaming, intelligent networks and applications.

Summary

This white paper is an introduction to mobile networking. For more details, see www.mobilein.com and the book [*Wireless Intelligent Networking*](#).