Integrated Diameter and SS7 Protocol Routing

Migrate from SS7 to Diameter While Protecting Capital Investment

Sonus

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Introduction

In recent years, the move to Long-Term Evolution (LTE)/Evolved Packet Core (EPC)/Diameter, Voice over IP (VoIP), Voice over LTE (VoLTE) and IP Multimedia Subsystem (IMS) networks has accelerated. Understandably, network service providers want to focus on the new LTE/EPC network build-out and implementation to support new revenue-generating services; however, a major obstacle is blocking the path forward. Since all networks, services and subscribers cannot be migrated to new technologies overnight, how do we address the legacy SS7 network while maintaining the forward momentum to LTE/EPC/Diameter-based networks?

This paper will focus on the challenges of and solutions to maintaining a legacy (SS7 signaling) network while moving rapidly to build out the new LTE/EPC network. These challenges include:

- Major reductions in Signaling Transfer Point (STP) vendors
- STP vendors announcing product
  - End of Life (EoL)
  - End of Support (EoS)
- STP vendors announcing large, costly upgrades required to retain support.

Market Drivers and Business Challenges

Why should we worry about legacy SS7 networks when LTE/EPC networks are being deployed at a rapid pace? To answer this question you must analyze data from several different sources, including:

- Global mobile Suppliers Association's (GSA) publication, "Evolution to LTE Report"
- Intelligence from GSMA—an association representing mobile operators' interests worldwide
  - The number of mobile connections
  - The number of unique mobile subscribers

As of the second quarter of 2014, the GSMA Intelligence reports that there were 3.6 billion unique mobile subscribers worldwide.

The Global mobile Suppliers Association's "Evolution to LTE Report" cites the number of commercially launched LTE Networks to be 360 in 124 countries, with 373 million LTE subscriptions globally. If we are to assume that these LTE subscriptions are unique subscribers, then 373 million subscribers out of a total 3.6+ billion subscribers are LTE. Simply stated, approximately 10% of the mobile subscribers worldwide are LTE/EPC/Diameter-based, leaving the remaining 90% to be 2G/3G SS7-based. If the subscriptions provided in the LTE report are a combination of unique subscribers and connections, then the LTE penetration rate percentage could be much less.

LTE Market Status

GSA's Evolution to LTE report - January 7, 2015

- **611 Operators investing in LTE in 174 countries**
  - 566 operator commitments in 166 countries
  - 45 pre-commitment trials in 8 more countries
- **360 commercially launched LTE networks in 124 countries**

Includes 48 LTE TDD (TD-LTE) networks in 30 countries

- **GSA forecasts 450+ commercially launched LTE networks by end 2015**
- **2,218 LTE user devices announced (Oct 14, 2014)**
- **373 million LTE subscriptions globally: Q3 2014**

Another data point regarding longevity of the SS7 network arises in the *FierceWireless* article, "Updated: Verizon Wireless to Sunset 2G and 3G CDMA Networks by 2021." It states that Verizon would keep its 2G/3G networks in place until at least 2021.

These two facts, coupled with the vast mobile growth in emerging countries, imply that 2G/3G/SS7-based networks will play a major role in mobile telecommunications for years to come. Considering this, the integrity of the SS7 network must be maintained.

History

In the search for a solution to the dilemma of supporting both the LTE/EPC/Diameter network and the legacy SS7 network, it is important to understand the evolution from SS7 to Diameter and the similarities of protocol concepts and network routing. Let's start by dividing the SS7 protocol into three parts: transport part, call setup and teardown part, and the transaction part. Each part will be discussed in terms of function, evolution and synergies with LTE/EPC/Diameter–based networks.

Signaling Transport – SS7 & Diameter

In the initial stages of SS7, Message Transfer Parts (MTPs) 1, 2 and 3 were responsible for the physical transport of the protocol (MTP 1), the point-to-point delivery of messages (MTP 2) and the Network management, respectively.

As we moved forward in the evolution of the transport capabilities of SS7, the need arose to have higher bandwidth for the SS7 links. This additional bandwidth requirement was addressed by transporting SS7 over Asynchronous Transfer Mode (ATM) or Annex A links. The Annex A links utilized either a non-channelized E-1 or T-1 facility as a single signaling data link.

The final stage in SS7 transport evolution came when the industry decided to use Internet Protocol (IP) methodology to transport SS7. SigTran provided increased bandwidth and transport cost reductions. However, before the SigTran protocol could be implemented in an IP networ, one important issue had to be addressed.

The only transport protocols used in IP networks were not acceptable for the transmission of real-time telecommunication protocols. User Datagram Protocol (UDP) did not provide a reliable transport mechanism and Transport Control Protocol (TCP) had issues with both Head of Line Blocking and multi-homing, so it was not a candidate for SigTran protocol transport. To overcome these Transport over IP issues a new transport protocol was developed—Stream Control Transmission Protocol (SCTP). SCTP's connection-oriented methodology offered a solution to Head of Line Blocking by providing multiple streams. Additionally, SCTP was defined to provide error recovery and multi-homing to fulfill the reliability requirements needed for real-time telecommunications protocol transport. Understandably, these stages of transport evolution address the issues of SS7 transport over IP. What does this have to do with Diameter protocol used in LTE/EPC networks? The simple answer is that the SCTP protocol used in the SS7 SigTran environment is also used to transport Diameter in the LTE/EPC network.

Call/Session Setup and Teardown – SS7 & SIP

The ISDN User Part (ISUP) portion of SS7 is responsible for the setup and teardown of calls within the circuit-switched environment of the Public Switched Telephone Network (PSTN). As the telecommunications networks moved toward an all IP methodology, a new protocol had to be defined to set up and tear down calls and media sessions. Session Initiation Protocol (SIP) was defined by the Internet Engineering Task Force (IETF) to provide these evolutionary capabilities in Next Generation Networks such as IP Multimedia Subsystems (IMS) and Voice over LTE (VoLTE) networks.

Transaction Capabilities – SS7 & Diameter

In the SS7 environment the Transaction Capabilities Application Part (TCAP), and more specifically the Mobile Application Part (MAP), provided the ability to authenticate, authorize and account for usage in mobile networks. The equivalent capabilities needed to be provided in LTE/EPC networks. Standards bodies such as the IETF analyzed existing authentication, authorization and accounting (AAA) protocols to determine their applicability within the new networks. The predominant AAA protocol studied was Remote Authentication Dial-In User Service (RADIUS). They found that the RADIUS protocol was deficient in terms of:

- Reliability
- Security
- Scalability
- Flexibility

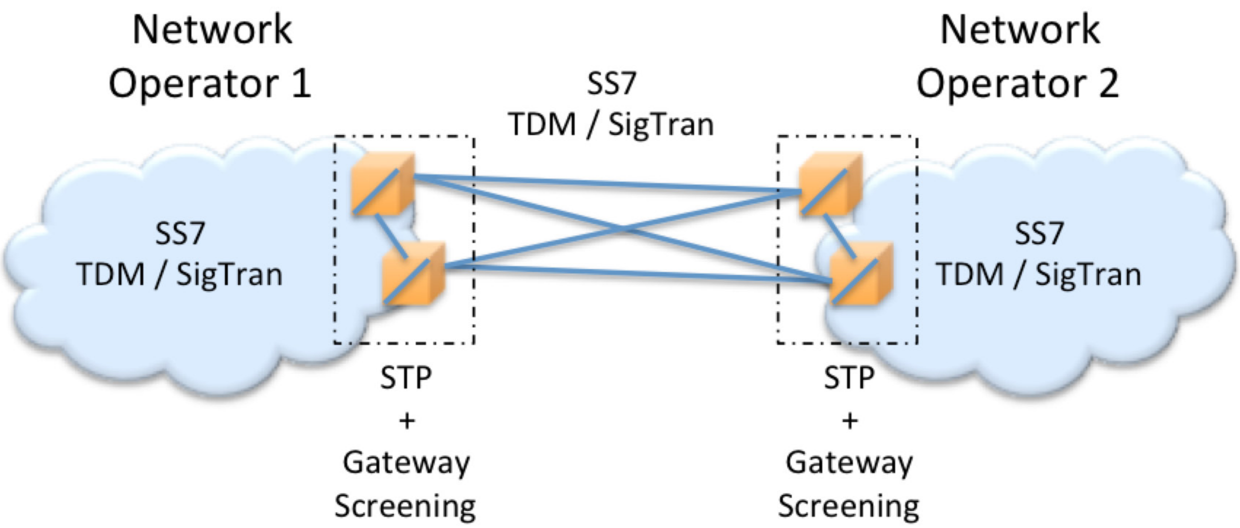
It was also determined that it would be too difficult to modify the existing RADIUS protocol; therefore a new AAA protocol had to be specified for use in next-generation networks such as LTE/EPC. The new protocol specified was the Diameter Protocol. As a baseline, the Diameter Protocol had to provide the equivalent capabilities as the SS7 TCAP/MAP protocol, with additional features to support new services in the LTE environment.

Network Routing Devices – STP, DSC, SBC

The discussion on network routing devices will be limited to those functions that are similar across all devices. This discussion is not meant to be an exhaustive explanation of all functionalities.

Signal Transfer Point (STP)

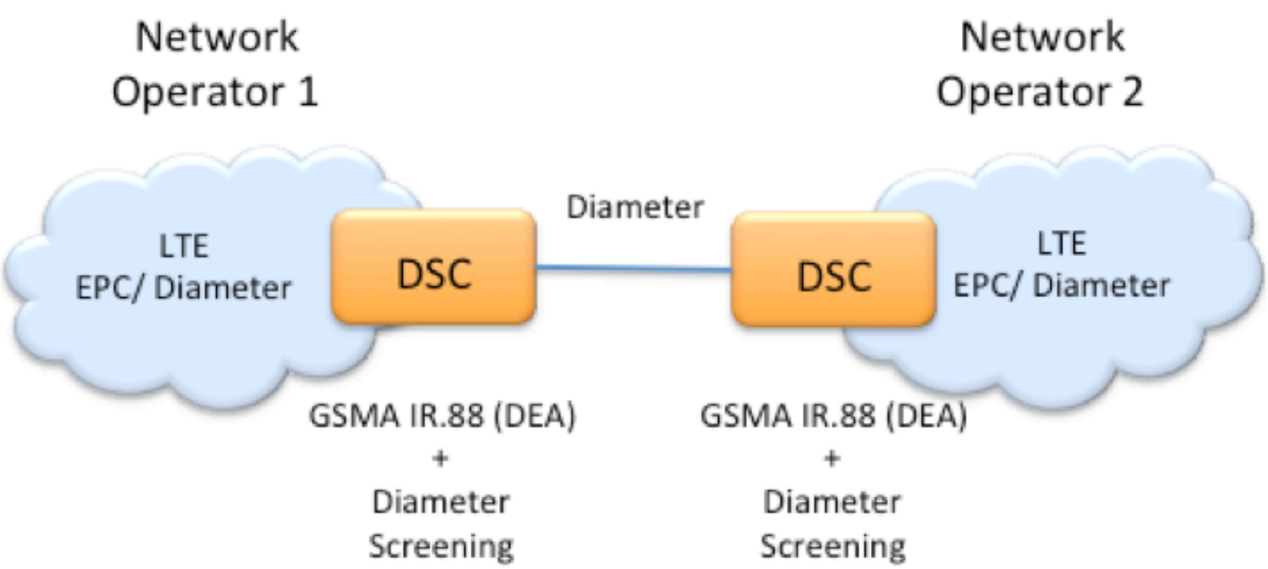
STPs are packet switches that provide SS7 message routing between network elements of different types. STPs placed on the boundaries between two networks are configured with a feature referred to as Gateway Screening. These STPs provide a firewall and admission control over messages that are allowed into the network.



Diameter Signaling Controller (DSC)

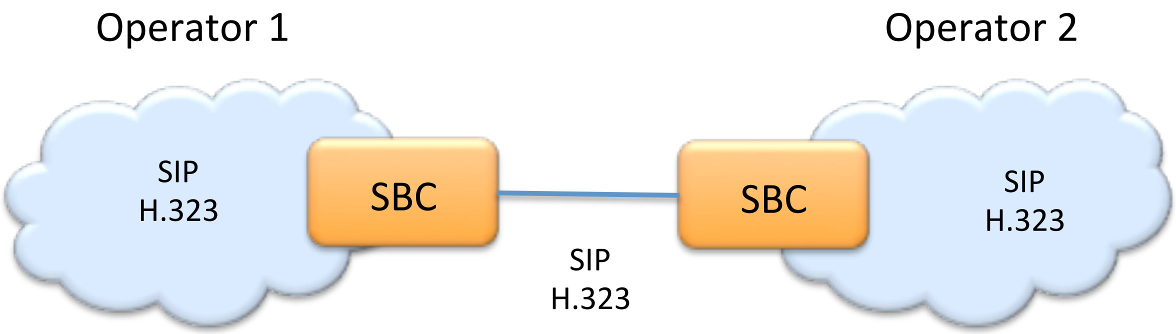
Diameter Signaling Controllers (DSCs) are key elements in LTE/EPC networks, and are used for routing and securing Diameter messages. Diameter Signaling Controllers provide routing, traffic management, load balancing and session binding.

The GSMA has specified a Diameter Agent in GSMA IR.88. This agent is referred to as a Diameter Edge Agent (DEA). DEAs are placed on the boundaries between networks to eliminate the export of network topologies. With the addition of Diameter Screening on the DEA a firewall can be implemented, further increasing inter-network security.



Session Border Controller (SBC)

A Session Border Controller (SBC) controls a network by admitting (or not admitting) and then directing communications between two end devices on the network. The SBC understands, parses and encodes SIP or H.323 packets onto a UDP or TCP-layer 3 to create a VoIP or VoLTE call between two devices. These communications are called sessions. The SBC does this session controlling at the point where traffic is handed off from one network to another (called the border).



Historical Conclusion

Thus far, everything has followed a normal evolutionary path; we have investigated the evolution of SS7 protocols to include:

- SigTran Protocol
- Stream Control Transmission Protocol (SCTP)
- Session Initiation Protocol (SIP)
- Diameter Protocol

We have also examined the similarities between the STP used with SS7 Protocol, the Diameter Signaling Controller used with the Diameter Protocol, and the Session Border Controller used with the SIP.

Since the ISUP portion of SS7 is simply carried by the transport mechanisms and routed at the MTP 3 level, its involvement in overall SS7 routing is limited. Therefore, in the remainder of this paper we will focus specifically on two protocols and two routing components—SS7/STPs and Diameter Signaling Controllers.

What has happened in the SS7 network to make its support such an issue?

Today, the number of STP suppliers has dwindled to four or five, some of which are quite small. This attrition in the STP market and the need to maintain the integrity of the SS7 network are causing major concern to service providers. Some STP vendors have announced EoL or EoS for their products. Some vendors announcing EoL are also significantly increasing the price of support to discourage the continued use of EoL products. Other vendors have announced that a major upgrade is required in order for support to continue on their STPs.

How can the legacy SS7 network support issues be cost-effectively addressed while maintaining the forward momentum toward LTE/EPC/Diameter networks?

Solution

Having investigated the evolution of the SS7 Protocol to the Diameter Protocol and the similarities between the STP used for SS7 routing and the DSC for Diameter routing, the solution to the SS7/Diameter issue seems quite evident: Place the STP and DSC on the same signaling routing platform. This simple yet elegant solution to the dilemma of supporting the legacy SS7 network while migrating to LTE/EPC/Diameter networks protects network service providers' capital investment, eases the transition to next-generation networks, reduces operational impact, and provides support for the SS7 network as long as required.

This solution is predicated on finding a telecommunications routing vendor whose products allow STP and DSC capabilities to coexist on the same signaling platform.

What to Look for in SS7/DSC Solutions

IP-Centric Design for Both Diameter and SS7 Routing

One of the most important architectural issues to be addressed is the IP switching capability of the selected STP/DSC. If internal IP switching is not provided within the STP/DSC platform, external IP switches have to be installed, provisioned and maintained for Diameter and SS7-over-IP (SigTran) deployments, causing an increased burden on implementation and capital budgets.

Consistent Routing Engine

Another important architectural issue to be considered in the selection of an STP/DSC is whether or not the internal software design is based on universal protocol switching and routing concepts.

These concepts can give service providers the assurance that as new protocols are defined and implemented within the network, the switching equipment can evolve to meet the needs of next-generation network requirements.

Plug and Play Solution for Diameter and SS7 on Same Platform

It goes without saying that the platform for DSC/ STP has to allow SS7 routing and Diameter routing to coexist, but each must be segmented on the same platform. As the telecommunications network evolves to LTE/EPC/Diameter, the platform should allow the SS7 routing capabilities to be decreased as Diameter routing capabilities are increased.

SDN and NFV

The DSC should include the capabilities of Software Defined Networks (SDN) and Network Functions Virtualization (NFV) to meet network operators' desire to reduce costs and use commercial off-the-shelf (COTS) servers.

Common User interface

The implementation of any new technology, such as Diameter, within the telecommunications network requires that the support and operations personnel be capable of ongoing maintenance and support of the network. The inclusion of a consistent web-based intuitive user interface across both SS7 and Diameter routing reduces the training, operational impact and operational costs.

Experience in Telecommunications Signaling SS7 and Diameter

In order to provide solutions that span the evolutionary stages of telecommunications signaling (SS7 to Diameter), it is imperative that the solutions vendor has experience in the concepts of both SS7 and Diameter Signaling. The experience in the legacy SS7 Protocol and its associated network provides the STP/DSC vendor with the unique knowledge of issues and concerns that occurred within legacy networks. This knowledge allows the vendor to provide solutions that mitigate these issues in new networks and protocols, such as LTE/EPC/Diameter.

Independence – Specializing in Network Signaling & Routing

There will always be differences in the implementation and interpretation of specifications when any network or protocol is deployed. These differences can cause catastrophic problems within networks and across the boundaries between different networks. A network equipment vendor that specializes in protocols and routing can provide mediation capabilities that solve the protocol inconsistencies, and thus eliminate their network impact.

Sonus DSC 8000 Advantage

Sonus DSC 8000 IP Advantage

The Sonus DSC 8000 is designed to be a mere extension of the IP network. The internal architecture of DSC 8000 platform includes intelligent IP backplanes for both internal and external communications. Also included in the design are integrated, five-nines reliable, gigabit Ethernet switches. The inclusion of the carrier-grade Ethernet switches reduces the requirement for an expensive, external Ethernet switch or IP router ports.

Sonus DSC 8000 "Distributed Routing Engine"

The internal design of the DSC 8000 utilizes Sonus' advanced Distributed Routing Engine. The DRE concept includes instances of the DRE on each routing processor and intercommunications between these instances, providing reliability and scalability of routing across the entire platform. An additional advantage for the DRE is its registration capabilities, supporting both SS7 and Diameter.

Sonus DSC 8000 Plug-and-Play

The Sonus DSC 8000 and its innovative Distributed Routing Engine allows the STP functionality or DSC functionality or a combination of STP and DSC functionality to be active on the same DSC 8000 platform. As the network evolves from SS7 to Diameter, the SS7 capacity can be diminished and the Diameter capacity increased. This capability protects the capital expenditure of network operators deploying the DSC 8000 as combination STP/DSC.

Sonus DSC SWe (Software edition)

The DSC SWe delivers the same advanced features and functionality of Sonus' hardware-based Diameter Signaling Controller (DSC) in a virtualized platform, delivering greater deployment flexibility for network operators. SDN and network NFV play an increasingly critical role in today's next-generation and Cloud networks. Building upon its strategy to virtualize the field-proven code base of its industry-leading hardware platforms, Sonus separated its Diameter software from the DSC 8000 hardware and architected it to operate on industry-standard COTS servers. For customers looking to leverage new and existing platforms to support NFV functionality, the DSC SWe allows them to deploy a fully-featured DSC co-resident with other applications.

Sonus DSC 8000 Common Interface

The DSC 8000 is designed with the end user in mind. An intuitive, easy-to-navigate, graphical, web-based user interface with pull-down menu selectors assists operations personnel with the configuration, operations and support of both the system and the network. These user interface methodologies are consistent across both the Diameter and SS7 environments. This consistent approach to the user interface helps to reduce operations impacts and costs.

Sonus' History in Telecom Signaling

Sonus is uniquely positioned to provide independent signaling and routing solutions to the telecommunications industry. Sonus' extended history in delivering SIP solutions, coupled with its acquisition of Performance Technologies (PT), enables Sonus to expand and diversify its portfolio to both SS7 and Diameter products/solutions. This vast experience in all aspects of telecommunications signaling, from SS7 to SIP to Diameter, enables Sonus to deliver solutions over the broad spectrum of telecommunications signaling, resulting in more efficient, scalable, secure and cost-effective networks.

Specializing in Telecommunications Signaling and Routing Solutions

Sonus' focus on signaling and routing solutions, combined with its expertise in SS7, SIP and Diameter protocols, provides the objectivity required to deliver the most efficient SS7, SIP and Diameter interworking capabilities in the industry. These interworking functions ensure that multi-vendor networks perform at their peak and removes the need to constantly upgrade network elements due to protocol inconsistencies.

About Sonus Networks

Sonus enables and secures real-time communications so the world's leading service providers and enterprises can embrace the next generation of SIP and 4G/LTE solutions including VoIP, video, instant messaging and online collaboration. With customers in more than 50 countries and nearly two decades of experience, Sonus offers a complete portfolio of hardware-based and virtualized Session Border Controllers (SBCs), Diameter Signaling Controllers (DSCs), policy/routing servers and media and signaling gateways. For more information, visit www.sonus.net or call 1-855-GO-SONUS. Sonus is a registered trademark of Sonus Networks, Inc. All other company and product names may be trademarks of the respective companies with which they are associated.

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