Today, the mobile industry is in the midst of a fundamental transformation. Circuit-switched TDM technology, which has been the mainstay of Analog/2G/3G networks, is evolving to or being replaced by all-IP networks with the advent of 4G/LTE. As part of the network evolution to IP Multimedia Subsystem (IMS) architectural framework for 4G/LTE, SS7 signaling, which has been the workhorse of TDM-based mobile and fixed networks for a very long time, is being replaced by newer and more efficient IP-based signaling protocols - SIP and Diameter. These protocols can handle the deluge of signaling traffic that is expected from smartphones, tablets and other mobile devices.

SIP and Diameter complement each other, and work in tandem to provide the complete signaling needs of 4G/LTE networks. SIP handles call control for establishing voice, video, messaging and IM sessions in 4G/LTE networks. For example, a Voice Over LTE (VoLTE) session is established using SIP signaling. Diameter, on the other hand, is responsible for data signaling. Diameter is used for signaling between policy servers, subscriber databases and charging systems to provide AAA (Authentication, Authorization and Accounting) functions in 4G networks.

Both Diameter and SIP are essential to the growing importance of the Mobile Internet, which is being driven by the BYOD trend. In fact, 51% of the total time spent online by U.S. users is via smartphones and tablets. By integrating mobile devices running across mobile networks to enable real-time communications for voice, video and collaboration, mobile operators can offer ubiquitous Unified Communications (UC) service to its subscriber base. Mobile UC utilizes SIP and Diameter signaling to authenticate subscribers, apply policies and establish/teardown sessions.

**Why Diameter is Important**

The growth potential of SIP signaling traffic is well understood and documented. This growth is the result of the widespread adoption of VoIP, UC and other IP-based real-time communications. However, what is less understood is the projected growth of Diameter signaling traffic. This growth is being driven primarily by the deployment of LTE networks worldwide. According to the GSA (Global mobile Suppliers Association), there will be 260 commercial LTE networks in 93 countries by the end of 2013. GSA reports that 499 mobile operators are investing in LTE/IMS network in 143 countries today. In every single LTE/IMS network, Diameter traffic flows through 75 different arteries.

**Key Takeaways**

- Growth expected in Diameter traffic is 50% CAGR over the next several years
- Mobile roaming revenues are anticipated to exceed US$80 billion by 2017
- SIP and SS7 expertise are important – Inter Working Function to remain important for the next several years
- Integrated SBC and Diameter Signaling helps drives differentiation at the edge
As more mobile operators begin to deploy 4G/LTE networks to meet the mobile broadband demand of smartphones and tablets, the number of Diameter signaling messages in 4G/LTE networks is expected to grow. Smartphones, for example, generate several Diameter signaling messages in the core network each time they access an application, download data, roam on a different network, and even when they’re simply turned on and off. Multiply dozens of Diameter signaling messages by millions of smartphones, and you suddenly have a large amount of Diameter signaling traffic in the network.

Some have likened the complexity of Diameter signaling to the problems originally presented by Signaling System 7 (SS7) in the first wave of mobile networks. Others have found a more recent parallel in the increase of SIP traffic that appeared with the popularization of VoIP. And just as the need to handle large amounts of SIP traffic led to the development of the Session Border Controller (SBC), the anticipated increase in Diameter signaling traffic has resulted in the introduction of a new product category, the Diameter Signaling Controller (DSC) and its subsets, the Diameter Routing Agent (DRA) and the Diameter Edge Agent (DEA).

**Synergies between SIP and Diameter**

In many ways, a DSC handles Diameter the way that an SBC handles SIP: by routing messages more efficiently, preventing network overloads, providing security, and interworking different variations of Diameter signaling between devices. Instead of a complex mesh of Diameter signaling messages flowing between dozens of IMS/4G network elements, a DSC acts as a central mediator that streamlines the flow of Diameter signaling messages in the network. Beyond reducing the amount of Diameter signaling traffic in the core network, DSCs (like SBCs) provide a variety of other benefits to the network including:

- Provide load balancing of Diameter signaling traffic to prevent network element overload or service interruptions
- Interwork Diameter and MAP protocols for LTE interoperability with 2G/3G networks
- Further secure the network border through IPsec encryption, DoS protection, network topology hiding, etc.
- Enforce Diameter interoperability through manipulation of Attribute Value Pairs (AVPs)
- Simplify the provisioning of Diameter elements
- Enforce business logic through message manipulation and intelligent routing
SS7 Heritage Matters

Signaling in pre-4G networks (2G/3G) is based on SS7. Commercial 2G and 3G networks worldwide make extensive use of SS7 signaling both within their own network and between networks. 2G/3G (especially 3G) networks will continue to exist and be used in conjunction with 4G/LTE networks until all the networks fully migrate to 4G/LTE in the long term. In fact, 2G will represent half of all mobile connections through 2017 (source: https://gsmaintelligence.com/analysis/2012/11/half-of-all-mobile-connections-running-on-3g-4g-networks-by-2017/359/). According to a press release issued by Juniper Research on October 3, 2013, mobile roaming revenues are expected to be over US$80 billion by 2017.

Interworking between SS7 and Diameter will be very important to the smooth operation of these dual technology networks, and to ensure a high quality of experience for the subscribers. Reliability and security of the signaling networks are critical since any failure can disrupt roaming operations, leading to revenue losses. Support for roaming between 3G and 4G/LTE networks will be required for the foreseeable future.

SIP Legacy Matters

Mobile operators will start to deploy VoIP and other SIP based communications at scale for the first time in their 4G/LTE networks. Meanwhile, the wireline community has been deploying and running SIP based VoIP networks for a decade or more. The Enterprise IP-PBX was launched more than 10 years ago, and service providers such as SoftBank launched VoIP service 10 years ago (in 2002 for SoftBank). There are many lessons to be learned from wireline networks when deploying real time SIP based communication in mobile networks. Some of them include: the need and ability to optimize the network to maximize quality of service (QoS), the need to provide robust security at scale for SIP communications, and support for intelligent policy and routing mechanism that will enforce routing policies on a per-session basis. Experience in deploying and optimizing large scale SIP-based VoIP networks is particularly important since 4G/LTE networks are expected to have a large volume of active subscribers. Vendors, such as Sonus, that have deployed and optimized SIP-based VoIP in some of the largest networks for over a decade, have a significant advantage in this regard.

Simplifying 4G/LTE Signaling at The Edge

![Diagram](image)

*Figure 4: Exploiting SIP and Diameter synergies at the Edge*
Both the Diameter Edge Agent (DEA) and Session Border Controller (SBC) are the first point of entry for inbound interconnect traffic, and the exit point for outbound interconnect traffic. There are a set of functions that are common to both elements, such as security, interworking, policy based routing, and network management system. An integrated SBC/DEA solution makes it possible to realize operational efficiencies and performance improvements by making common some functions.

The concept of NFV (Network Function Virtualization) is gaining interest from IMS and 4G/LTE core networks, according to some industry analysts. As these networks evolve to a software-based NFV (Network Function Virtualization) architecture, the integrated SBC/DEA approach will become even more appealing. In such an integrated NFV architecture, it becomes possible to introduce new functionality that is common to both SBC and DEA, such as a robust policy engine that supports both SIP and Diameter, in a short time frame.

In summary, an integrated approach to SIP and Diameter signaling at the network edge is one that offers many advantages over a separate multi-box approach, both in the short term, and in the long term as networks evolve to a virtualized software environment.

**Steps To Take**

- Mobile operators should consider an integrated signaling solution at the network edge that supports both SIP and Diameter.
- Mobile operators should deploy an interworking function that supports 4G to 3G/LTE roaming (Diameter and SS7 roaming).
- When deploying a robust mobile UC solution, mobile operators must consider implementing DRA and SBC in their network.
- Fixed and Interconnect Service Providers who support IMS and LTE traffic should consider deploying an edge SBC/DEA solution.