Building a Signaling Gateway Using Emerson Network Power xTCA and SpiderWare® SG Products

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Executive Summary

Signaling gateways are critical network elements enabling the convergence of circuit switched (PSTN or POTS) and IP networks. They can be configured in many different ways depending on the specific function required by the network operator. This application note introduces the basic terminology and describes common gateway configurations. It then outlines potential gateway architectures using commercial off-the-shelf xTCA hardware and Emerson’s standards-based signaling gateway software, SpiderWare®SG. Finally, performance requirements and benchmarks demonstrate the benefits of these standards-based architectures.
What is a Signaling Gateway?

There is an on-going integration of circuit networks and IP networks. Network operators are designing and implementing all-IP networks for fixed line and mobile services. In order to leverage legacy circuit switched networks (PSTN or POTS) within an IP network, the IP networks must provide support for Signaling System 7 (SS7) protocols.

WHAT IS SS7?

SS7 is a means by which elements within a telephone network exchange information. For example, picking up a fixed line telephone and dialing a number generates SS7 protocol traffic that sets up, routes and tears down call resources.

In order to route a telephone call from a circuit network through an IP network, there must be a method to transparently exchange SS7 information between circuit and IP networks. This is where a signaling gateway comes into play.

Signaling gateways provide what is commonly known as SS7 over IP, which is the function of transparently transporting SS7 protocol messages over an IP network.

Signaling gateway protocols (signaling transport or SIGTRAN), can be used to transport SS7 protocol messages between IP and circuit networks, but also between signaling points in an all IP network.

SS7 consists of a number of protocol layers: three core message transfer layers; and a number of higher level protocols which work above the message transfer layers.

- **Physical Layer (MTP-1)**
  MTP-1 defines the physical electrical characteristics of the SS7 network signaling links.

- **Message Transfer Part – Level 2 (MTP-2)**
  MTP-2 is responsible for link level functionality, providing error checking, flow control, and sequence checking functions.

- **Message Transfer Part – Level 3 (MTP-3)**
  MTP-3 provides network layer functionality, such as node addressing, routing, alternate routing and congestion control. The address of an SS7 node is known as a point code, and is used by MTP-3 for routing.

The higher level SS7 protocols are Signaling Connection Control Part (SCCP), Global Title Translation (GTT), ISDN User Part (ISUP), Transaction Capabilities Application Part (TCAP).

These protocols are transported over MTP-1/2/3, and provide application functions to the telephone network, but are not covered in detail in this application note.

WHAT IS SIGTRAN?

SIGTRAN (signaling transport) is a family of protocols specifically developed to transport SS7 signaling over IP.

Initial SIGTRAN implementation relied on either UDP (Unreliable Datagram Protocol) or TCP (Transmission Control Protocol) for the transport layer. Both of these transport layers have inherent reliability issues, and are not suitable for signaling transfer.

A new protocol, Stream Control Transport Protocol (SCTP), was developed specifically to be used as the transport layer within signaling gateways.

A number of user adaptation layers (UA) run above SCTP, and present MTP2 and MPT3 interfaces – for example:

- M3UA <-> MTP3
- SUA <-> MTP3
- M2UA <-> MTP2
- M2PA <-> MTP2

Note that SUA is not covered in the application note.

Benefits of Signaling Gateways

Listed below are some of the benefits of SIGTRAN and IP based communication networks.

- **Network Expansion**
  Signaling gateways are transparent to SS7 networks, enabling future expansion without disrupting the existing network. The flexibility of a core IP network allows service providers to offer a variety of value added services.

- **Capital Expenditure**
  There is no need for further expensive investments in legacy signaling elements.

- **Efficiency and Bandwidth**
  SIGTRAN over an IP network doesn’t require E1/T1 over synchronous digital hierarchy (SDH). Technologies such as IP over SDH and IP over fibre, for instance, can achieve much higher throughput. The IP network is much more flexible than the TDM-base legacy network. IP does not constrain to link capacity, as is the case in the SS7 network.

The following section highlights the most common gateway configurations with a brief description of where they are used.
Common Signaling Gateway Configurations

M3UA SIGNALING GATEWAY

The M3UA Signaling Gateway is the most common configuration. M3UA is the SIGTRAN equivalent of SS7’s routing layer, MTP3. The M3UA layer provides an equivalent set of functions to MTP3, and is suitable for transport messages of any MTP3 user part (SCCP/TCAP, etc.). In Figure 1, the MTP3-User on the SS7 node accesses services offered by the application server process, via the signaling gateway. The MPT3-User is unaware that the application server resides on a remote IP network.

The M3UA gateway has a SS7 point code, and can therefore, be used to route to other gateways/nodes on an IP or SS7 network. M3UA is the SIGTRAN equivalent of SS7’s routing layer, MTP3.

M2UA SIGNALING GATEWAY

The M2UA signaling gateway is the simplest configuration, and provides a gateway between an E1/T1/J1 PSTN network and an application server on an IP network. M2UA is the SIGTRAN equivalent of SS7’s transport layer, MTP2.

The M2UA signaling gateway configuration does not have a point code and therefore cannot route to other gateways/nodes on a network. It is a point-to-point connection.

M2PA SIGNALING GATEWAY

M2PA is a SIGTRAN protocol for transporting SS7 MTP Level 2 user part signaling messages over IP using the Stream Control Transmission Protocol (SCTP). Unlike M2UA, M2PA is used to support full MTP Level 3 message handling and network management between any two SS7 nodes communicating over an IP network. IP signaling points function as traditional SS7 nodes using the IP network instead of the SS7 network. Each switched circuit or IP signaling point has an SS7 point code. The M2PA protocol layer provides the same set of services as MTP Level 2 provides to MTP Level 3. Like M3UA, M2PA is becoming a popular gateway, as it can be used to directly link IP signaling points on a network (as illustrated in Figure 3).

M2UA <> M3UA CONVERTER GATEWAY

While Figure 4 illustrates a custom configuration, it is becoming a more common option. M2UA was the first SIGTRAN layer to be written, hence, a lot of early gateways are based on this layer. Over time, M3UA has become a more popular gateway configuration, as it allows the node to have an SS7 point code, thus providing the option of routing between signaling points in an IP or SS7 network. This configuration acts a converter between M3UA gateways and a M2UA gateways, allowing network providers to leverage legacy equipment.
Building a Signaling Gateway Using Emerson Network Power xTCA and SpiderWareSG Products

Product and Application
SpiderWareSG, Emerson’s standards-based signaling gateway software, is capable of supporting the common gateway configurations described. While sold as a standalone system, it can be integrated into existing gateway setups. SpiderWareSG software can be configured to act as an SS7 Node (STP).

HIGHLIGHTS OF UPGRADING TO SPIDERWARESG:
- Standards based SIGTRAN/SS7 protocol layers
- High capacity/performance E1/T1/J1 interfaces
- Reduced system footprint
- Enhanced system performance
- Enhanced HA support
- Detailed debug support

APPLICATION
SpiderWareSG software provides APIs for each protocol layer, allowing easy integration with existing systems, higher level applications, such as management and SS7 transport protocols. Additionally, the gateway can be managed via SNMP, providing MIBS and event traps for each layer.

Effectively, SpiderWareSG provides a “tool box” allowing a customer to add their own value add applications.

BENCHMARKS AND PERFORMANCE REQUIREMENTS
Performance forms an important part of the requirement for a signaling gateway. This is either stated in terms of line utilization, or Busy Hour Call Attempts (BHCA).

- **Busy Hour Call Attempts (BHCA)**
  BHCA is an engineering measurement used to evaluate and plan capacity for telephone networks. BHCA is the number of telephone calls attempted at the busiest hour of the day. The higher the BHCA, the higher the stress on the network processors.

- **Line Utilization**
  Line utilization refers to the percentage utilization of the bandwidth of an E1/T1/J1 line at maximum system throughput. This figure depends on a number of factors, including message size. Small message sizes reduce line utilization. An example line utilization is shown in Figure 5.

![Figure 5—PM8560 128 Links Performance](image_url)
**PERFORMANCE FIGURES**

These performance figures are based on the following configuration:

- 1 X PM8560 (E1/T1/J1 Module)
- 8 X E1/T1/J1 Lines
- 16 X Links per line

As illustrated by the performance data in Figure 6, Message Signal Unit (MSU) size is the key factor in determining both throughput, and line utilization. Therefore, it is vitally important to know the type of traffic that will be sent over a signaling gateway, as this determines the typical MSU size.

It is possible to work out BCHA based on the performance figures above, as long as the expected average number of MSUs per call and typical MSU size are known.

**EXAMPLE**

In order to work out system capability in terms of BCHA, it is necessary to know, the number of MSUs per call, and the average MSU size. Based on 100 & 160 bytes per call, the system is capable of the following performance, calculated using the performance data from Figure 6.

- 100 bytes per call  BHCA  6,750,000
- 160 bytes per call  BHCA  4,500,000

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**Customer Benefits**

Emerson’s SpiderWareSG software offers a number of important benefits.

**HIGH PERFORMANCE**

SpiderWareSG is a highly optimized software platform, delivering high data throughput.

**FIELD-HARDENED SOLUTION**

Emerson’s signaling gateway solutions and protocols are widely deployed in the network.

**ATCA CARRIER GRADE HARDWARE PLATFORM**

SpiderWareSG software is capable of running on a number of different hardware platforms including AdvancedTCA®, CompactPCI® and MicroTCA™. In the example, it runs on a KatanaQP (ATCA blade), PM8560 (8 port E1/T1/J1 PTMC module) in a two-slot ATCA chassis (Centellis™ 2000).

The Centellis 2000 platform supports high availability through the use of redundant functions, and the ability to hot-swap key system components. When combined with the SpiderWareSG HA software, this provides an extremely robust and reliable system.

The use of standards based hardware allows for future expansion (higher performance hardware), without major changes to the overall platform.

**STANDARDS BASED PROTOCOL LAYERS AND HARDWARE PLATFORM**

The protocols are based on the latest specifications, and are regularly tested against other implementations during official plug-tests.

SpiderWareSG software will interoperate with the majority of signaling gateways/SS7 deployed in the network.

**HA SOFTWARE/5NINES AVAILABILITY**

These types of gateways are vital network elements—unscheduled downtime has a direct impact on revenue, as it prevents subscribers from making calls, or disrupts billing systems. Therefore, redundancy is vitally important for network providers in order to protect revenue streams.

SpiderWareSG HA software implements 5NINES availability via multiple blade configurations and HA services software. Reliable and redundant transport between blades is provided by SCTP, the same transport used within SIGTRAN. Blades can be geographically distributed, supporting mated pair configurations.

Redundant blades allow systems to be taken down for maintenance, without disrupting service.
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