Tekelec EAGLE® 5 Integrated Signaling System

SIGTRAN User Guide

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Patents

This product is covered by one or more of the following U.S. and foreign patents:
U.S. Patent Numbers:
5,732,213; 5,953,404; 6,115,746; 6,167,129; 6,324,183; 6,327,350; 6,456,845; 6,606,379; 6,639,981; 6,647,113; 6,662,017; 6,735,441; 6,745,041; 6,765,990; 6,795,546; 6,819,932; 6,836,477; 6,839,423; 6,885,872; 6,901,262; 6,914,973; 6,940,866; 6,944,184; 6,954,526;6,954,794; 6,959,076; 6,965,592; 6,967,956; 6,968,048; 6,970,542; 6,987,781; 6,987,849; 6,990,089; 6,990,347; 6,993,038; 7,002,988; 7,020,707; 7,031,340; 7,035,239; 7,035,387; 7,043,000; 7,043,001; 7,043,002; 7,046,667; 7,050,456; 7,050,562; 7,054,422; 7,068,773; 7,072,678; 7,075,331; 7,079,524; 7,088,728; 7,092,505; 7,108,468; 7,110,780; 7,113,581; 7,113,781; 7,117,411; 7,123,710; 7,127,057; 7,133,420; 7,136,477; 7,139,388; 7,145,875; 7,146,181; 7,155,206; 7,155,243; 7,155,505; 7,155,512; 7,181,194; 7,190,702; 7,190,772; 7,190,959; 7,197,036; 7,206,394; 7,215,748; 7,219,264; 7,222,192; 7,227,927; 7,231,024; 7,242,695; 7,254,391; 7,260,086; 7,260,207; 7,283,969; 7,286,516; 7,286,647; 7,286,839; 7,295,579; 7,299,050; 7,301,910; 7,304,957; 7,318,091; 7,319,857; 7,327,670
Foreign Patent Numbers:
EP1062792; EP1308054; EP1247378; EP1303994; EP1252788; EP1161819; EP1177660; EP1169829; EP1135905; EP1364520; EP1192758; EP1240772; EP1173969; CA2352246

Ordering Information

Your Tekelec Sales Representative can provide you with information about how to order additional discs.

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Chapter 1

Introduction

Topics:

This chapter provides a brief description of Tekelec's SS7-over-IP using SIGTRAN feature of the EAGLE 5 Integrated Signaling System. The chapter also includes the scope, audience, and organization of the manual; how to find related publications; and how to contact Tekelec for assistance.

About this manual

An SS7-over-IP network consists of a traditional SS7 network that utilizes an IP network. This document describes SS7-over-IP networks that use the Signaling Transport (SIGTRAN) protocol suite as an enabler to access IP networks. IP-enabled or all-IP networks are growing in popularity for both wireline and wireless operators as they promise higher bandwidth at a lower cost, higher efficiency, and access to an exploding number of revenue-generating services. Participation in such services becomes increasingly difficult because of the high bandwidth required and the link restriction imposed by the traditional SS7 network.

A first step to IP success is an SS7-over-IP or SIGTRAN converged network to make reliable signaling over IP possible without replacing the entire network. The goal is to eventually move from the converged TDM/IP network to an all-IP network to take advantage of bandwidth, redundancy, reliability, and access to IP-based functions and applications. Tekelec is prepared to take customers through this process at their own pace by offering expertise and tested products that will assist in achieving this goal.

Figure 1: Transition from SS7 to IMS

This document examines the reasons for transitioning to an SS7-over-IP (SSoIP) network, the considerations that go into planning and dimensioning, and helpful information for implementing the network. This document does not attempt to provide a beginning-to-end solution for such a transition; contact your Tekelec Sales Representative to discuss your specific needs.

Audience

The audience for this document is Tekelec departments affected by the development, sale, or service of SIGTRAN-related products, as well as Tekelec customers that require an overview of SS7-over-IP networks, SIGTRAN, and other products that are part of the Tekelec solution.

Updates for this Release

Two new EAGLE 5 ISS features for Release 41.0 affect SS7-over-IP: 6-Way Loadsharing on Routesets and Support for IPSG M3UA and SCTP Graceful Shutdown.

6-way Loadsharing on Routesets

The 6-Way Loadsharing on Routesets feature allows loadsharing across all 6 routes to a destination or exception route. This feature requires a FAK, but no new hardware.

Support for IPSG M3UA and SCTP Graceful Shutdown

The Support for IPSG M3UA and SCTP Graceful Shutdown feature consists of two aspects:

- M3UA Graceful Shutdown

  The `ipsg` application is updated to increase the shutdown timer to 2 seconds, which allows the ASP to deplete all the messages from its queue before the ASP is brought down. The M3UA software is also enhanced to progress the shutdown when a designated response is received from a peer.

- SCTP Graceful Shutdown

  SCTP functionality of the `ipsg` application is updated to allow manual initiation of graceful shutdown for an M3UA association.

There are no feature control requirements identified for this feature. M3UA and SCTP shutdown is performed on only E5-ENET cards running the `ipsg` application.

For more details on these features , see the *EAGLE 5 ISS Release 41.0 Feature Notice*. For more information on the commands that are enhanced to support these features, refer to the *Commands Manual* for the EAGLE 5 ISS Release 41.0 documentation set.

Manual organization

The manual is organized into these chapters:

- *Introduction* on page 1 provides the purpose of this document, the targeted audience, how the manual is organized, and Tekelec contact information.
- *SS7-over-IP Networks* on page 11 describes the concept of an SS7-over-IP network and the protocols it uses, the opportunities it provides now and what it means for future directions. This section takes the reader from current TDM limitations, to the role of SIGTRAN, to the reasoning of why and when to transition to an SS7-over-IP network.
- *Tekelec Solutions* on page 23 describes how Tekelec products are a part of the SS7-over-IP solution. This section describes the EAGLE 5 Integrated Signaling System (ISS) function as a gateway to internet networks; and the Integrated Application Solution (IAS) , which provides several network management and performance tools including IP traffic monitoring through the Integrated Message Feeder (IMF).
- *Transition Planning* on page 27 provides a guideline on how to prepare for transition to an SS7-over-IP network.
- *Dimensioning* on page 33 describes dimensioning issues and calculations required to maximize the efficiency of the new network. This section addresses scalability, redundancy schemes, throughput calculations for both normal and failover mode, LAN/WAN considerations, and retransmission concepts.
- *Implementation* on page 61 provides hardware information, high-level configuration steps for the IPLIMx and IPGWx applications, how to refine timers and parameters after the installation, and high-level system verification steps.

- *Troubleshooting* on page 83 offers troubleshooting procedures based on symptoms occurring in the network.
- *Additional Deployment Scenarios* on page 89 provides other possible deployment scenarios.
- *References* on page 99 lists external and Tekelec internal references used in this manual. Customers requiring access to Tekelec internal references should contact their Sales Representative to obtain equivalent information. This section also provides the location of customer documentation on the Tekelec Customer Support site.

Manual conventions

Several conventions are used in this document. While certain acronyms are standard in the telecom industry and are understood by most readers, this document treats network components and feature name as proper names and spells out their names to improve the reading of this document.

For some process descriptions, figures or tables are displayed at the beginning of the process to allow the reader to follow most of the process on the same page. This convention is identified with each process.

Where “end points” are mentioned, the full range is included: Service Switching Points (SSPs), Signaling Control Points (SCPs), Home Locator Registers (HLRs), and Short Message Service Centers (SMSCs).

Documentation Admonishments

Admonishments are icons and text throughout this manual that alert the reader to assure personal safety, to minimize possible service interruptions, and to warn of the potential for equipment damage.

Table 1: Admonishments

	**DANGER**: (This icon and text indicate the possibility of *personal injury*.)
	**WARNING**: (This icon and text indicate the possibility of *equipment damage*.)
	**CAUTION**: (This icon and text indicate the possibility of *service interruption*.)

Customer Care Center

The Tekelec Customer Care Center is your initial point of contact for all product support needs. A representative takes your call or email, creates a Customer Service Request (CSR) and directs your requests to the Tekelec Technical Assistance Center (TAC). Each CSR includes an individual tracking number. Together with TAC Engineers, the representative will help you resolve your request.

The Customer Care Center is available 24 hours a day, 7 days a week, 365 days a year, and is linked to TAC Engineers around the globe.

Tekelec TAC Engineers are available to provide solutions to your technical questions and issues 7 days a week, 24 hours a day. After a CSR is issued, the TAC Engineer determines the classification of the trouble. If a critical problem exists, emergency procedures are initiated. If the problem is not critical, normal support procedures apply. A primary Technical Engineer is assigned to work on the CSR and provide a solution to the problem. The CSR is closed when the problem is resolved.

Tekelec Technical Assistance Centers are located around the globe in the following locations:

Tekelec - Global

Email (All Regions): support@tekelec.com

- **USA and Canada**

  Phone:

  1-888-FOR-TKLC or 1-888-367-8552 (toll-free, within continental USA and Canada)

  1-919-460-2150 (outside continental USA and Canada)

  TAC Regional Support Office Hours:

  8:00 a.m. through 5:00 p.m. (GMT minus 5 hours), Monday through Friday, excluding holidays

- **Central and Latin America (CALA)**

  Phone:

  USA access code +1-800-658-5454, then 1-888-FOR-TKLC or 1-888-367-8552 (toll-free)

  TAC Regional Support Office Hours (except Brazil):

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    0-800-555-5246 (toll-free)

  - **Brazil**

    Phone:

    0-800-891-4341 (toll-free)

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  Phone:

  1230-020-555-5468

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- **Dominican Republic**

  Phone:

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  1-888-367-8552 (1-888-FOR-TKLC)

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In the event of a critical service situation, emergency response is offered by the Tekelec Customer Care Center 24 hours a day, 7 days a week. The emergency response provides immediate coverage, automatic escalation, and other features to ensure that the critical situation is resolved as rapidly as possible.

A critical situation is defined as a problem with an EAGLE 5 ISS that severely affects service, traffic, or maintenance capabilities, and requires immediate corrective action. Critical problems affect service and/or system operation resulting in:

- A total system failure that results in loss of all transaction processing capability
- Significant reduction in system capacity or traffic handling capability
- Loss of the system's ability to perform automatic system reconfiguration
- Inability to restart a processor or the system
- Corruption of system databases that requires service affecting corrective actions
- Loss of access for maintenance or recovery operations
- Loss of the system ability to provide any required critical or major trouble notification

Any other problem severely affecting service, capacity/traffic, billing, and maintenance capabilities may be defined as critical by prior discussion and agreement with the Tekelec Customer Care Center.

Related Publications

For information about additional publications that are related to this document, refer to the *Related Publications* document. The *Related Publications* document is published as a part of the *Release*

Documentation and is also published as a separate document on the Tekelec Customer Support Site.

Documentation Availability, Packaging, and Updates

Tekelec provides documentation with each system and in accordance with contractual agreements. For General Availability (GA) releases, Tekelec publishes a complete EAGLE 5 ISS documentation set. For Limited Availability (LA) releases, Tekelec may publish a documentation subset tailored to specific feature content or hardware requirements. Documentation Bulletins announce a new or updated release.

The Tekelec EAGLE 5 ISS documentation set is released on an optical disc. This format allows for easy searches through all parts of the documentation set.

The electronic file of each manual is also available from the Tekelec Customer Support site (*support.tekelec.com*). This site allows for 24-hour access to the most up-to-date documentation, including the latest versions of Feature Notices.

Printed documentation is available for GA releases on request only and with a lead time of six weeks. The printed documentation set includes pocket guides for commands and alarms. Pocket guides may also be ordered separately. Exceptions to printed documentation are:

- Hardware or Installation manuals are printed without the linked attachments found in the electronic version of the manuals.
- The Release Notice is available only on the Customer Support site.

Note: Customers may print a reasonable number of each manual for their own use.

Documentation is updated when significant changes are made that affect system operation. Updates resulting from Severity 1 and 2 PRs are made to existing manuals. Other changes are included in the documentation for the next scheduled release. Updates are made by re-issuing an electronic file to the customer support site. Customers with printed documentation should contact their Sales Representative for an addendum. Occasionally, changes are communicated first with a Documentation Bulletin to provide customers with an advanced notice of the issue until officially released in the documentation. Documentation Bulletins are posted on the Customer Support site and can be viewed per product and release.

Locate Product Documentation on the Customer Support Site

Access to Tekelec's Customer Support site is restricted to current Tekelec customers only. This section describes how to log into the Tekelec Customer Support site and locate a document. Viewing the document requires Adobe Acrobat Reader, which can be downloaded at www.adobe.com.

1. Log into the Tekelec **new** Customer Support site at *support.tekelec.com*.

   Note: If you have not registered for this new site, click the **Register Here** link. Have your customer number available. The response time for registration requests is 24 to 48 hours.

2. Click the **Product Support** tab.

3. Use the Search field to locate a document by its part number, release number, document name, or document type. The Search field accepts both full and partial entries.
4. Click a subject folder to browse through a list of related files.
5. To download a file to your location, right-click the file name and select **Save Target As**.

Chapter 2

SS7-over-IP Networks

Topics:

This chapter describes the concept of an SS7-over-IP network and the protocols it uses, the opportunities it provides now, and what it means for future directions. It takes the reader from current TDM limitations, to the role of SIGTRAN, to the reasoning of why and when to transition to an SS7-over-IP network.

SS7-over-IP networks overview

An SS7-over-IP network consists of a traditional SS7 network that can integrate IP-enabled or all-IP devices with protocols defined by the Internet Engineering Task Force (IETF) standards organization.

SS7-over-IP signaling primarily addresses the transport aspect of SS7. Call-control services and other types of services, therefore, can continue to be offered and deployed without concern for the method of interconnection. The method of service implementation, however, remains dependent on the particular network element chosen to support the service rather than the transport chosen.

This section looks at the limitations of the traditional SS7 network and its network components, the role of SIGTRAN protocols, the purpose of SS7-over-IP networks, the advantages of transitioning to this network, and when it is time to consider transitioning.

SS7 limitations

SS7 is a signaling network (data traffic) protocol used to send and receive signaling messages between Signaling End Points over dedicated signaling links. Operators deploy SS7 services over a dedicated network of 56- or 64-kbps Time Division Multiplexed (TDM) lines, or utilize high-speed T1 (1.5 Mbps) or E1 (2.048 Mbps) lines. SS7 uses centralized databases and services, achieves reliable connections through network management, and is secure because of its isolation from end users through the dedicated network. SS7 signaling is mature, with standards and a rich feature set, and offers these advantages to both wireline and wireless services.

However, SS7 limitations in scalability, bandwidth, and network availability slow network growth and opportunities to participate in new IP services:

- Scalability is limited by 16-link linksets consisting of 64 kbps transport

  Up to 16 links may be grouped into one circuit, or linkset. Adjacent network elements, such asSignal Transfer Points (STPs) and Service Control Points (SCPs), may be connected by no more than one linkset. The protocol further recommends that links and linksets are configured to no more than 40% of their maximum capacity, so that the alternate path can carry the full load of messages during failover.

- Bandwidth

  A traditional SS7 message size is limited to about 272 octets. E1/T1 links allow the transmission of larger messages, but not without originating, routing, or end points supporting either large messages or message segmentation.

  A bandwidth of 56 kbps or 64 kbps per link and dedicated links reduce flexibility and increase cost significantly when creating sufficient bandwidth for new service applications. In a TDM network, entire transmission segments must be reserved for each call, even if the TDM connection is idle.

TDM-based SS7 is continuing to evolve, but slowly. Instead, wireline and wireless operators are looking to IP solutions.

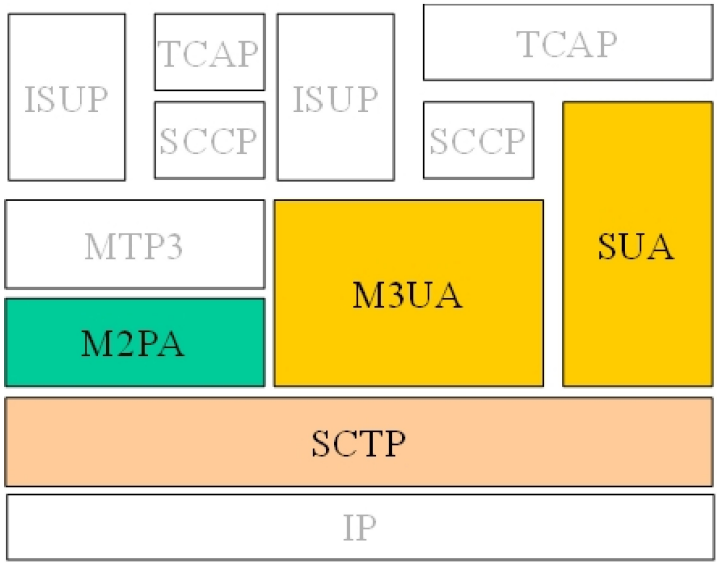
Role of SIGTRAN

SIGTRAN is a working group of the IETF, addressing packet-based Public Switched Telephone Network (PSTN) signaling over IP networks. A set of signaling transport protocols has been developed out of the group's work. For the purposes of this document, the protocols are collectively called the "SIGTRAN" protocols or suite.

The SIGTRAN architecture used by Tekelec includes the following protocols. The figure shows their location in the protocol stack:

- Stream Control Transmission Protocol (SCTP); RFC 4960
- MTP2 User Peer-to-Peer Adaptation Layer (M2PA) protocol; RFC 4165
- MTP3 User Adaptation Layer (M3UA) protocol; RFC 4666
- SCCP User Adaptation Layer (SUA) protocol; RFC 3868

Figure 2: SIGTRAN protocols used by Tekelec



SCTP (Stream Control Transmission Protocol)

SCTP is a new reliable transport protocol that operates on top of a connectionless packet network such as IP, and operates at the same layer as TCP. It establishes a connection between two endpoints, called an association, for transmission of user messages. To establish an association between SCTP endpoints, one endpoint provides the other with a list of its transport addresses (one or more IP addresses in combination with an SCTP port). These transport addresses identify the addresses that will send and receive SCTP packets. SCTP was developed to eliminate deficiencies in TCP and offers acknowledged, error-free, non-duplicated user data transport.

IP signaling traffic is usually composed of many independent message sequences between many different signaling endpoints. SCTP allows signaling messages to be independently ordered within multiple streams (unidirectional logical channels established from one SCTP end point to another) to ensure in-sequence delivery between associated end points. By transferring independent message sequences in separate SCTP streams, it is less likely that the retransmission of a lost message will

affect the timely delivery of other messages in unrelated sequences (called head-of-line blocking). Because TCP does enforce head-of-line blocking, the SIGTRAN Working Group recommends SCTP rather than TCP for the transmission of signaling messages over IP networks.

Security

SCTP provides certain transport-related security features, such as resistance against blind denial of service attacks, masquerades, or improper monopolization of services.

SIGTRAN protocols do not define new security mechanisms, as the currently available security protocols provide the necessary mechanisms for secure transmission of SS7 messages over IP networks.

Tekelec deviations

The following sections summarize the most important deviations from the IETF RFCs that Tekelec has made. Refer to the Tekelec protocol compliance matrices for details; see *Tekelec internal references* on page 100. Contact your Sales Representative for access to the information contained in these documents.

SCTP multiple streams

There are several architectural issues regarding the use of multiple streams as described in the SCTP protocol. The issues include:

- Synchronization between data streams
- Synchronization from control stream to data streams
- Load-sharing implementation based on SLS across streams, either within a connection or across all the connections in an Application Server

  Since the underlying SS7 network is connectionless, a stringent requirement for mis-sequenced messages has been set because it is often easier to recover from the loss of a message by a time-out than from one message delivered out-of-sequence. The Message Transfer Part (MTP) is able to maintain a high probability of message sequencing. This is ensured by the MTP user, which generates a value for a Signaling Link Selection (SLS) field as a parameter for each message. As the message is routed through the network, wherever there is a choice to be made between alternate routes, the link selection is made based on the SLS value in the message.
- Connection behavior when a stream becomes congested

A lack of consensus on the IETF SIGTRAN mailing list regarding these issues resulted in Tekelec supporting a maximum of two streams: a control stream and a data stream.

SCTP timer

Based on experiences in the field, Tekelec has deviated from some RFC-recommended timer settings, especially related to retransmission, to better accommodate signaling networks.

The Tekelec default mode for the retransmission timer (RMODE) is linear, whereas the RFC-recommended timer setting is exponential. Tekelec makes both settings available through configuring an association to use either the Linear (LIN) or the exponential (RFC) method. For more information about both modes and the timer settings, see *SCTP timers* on page 56.

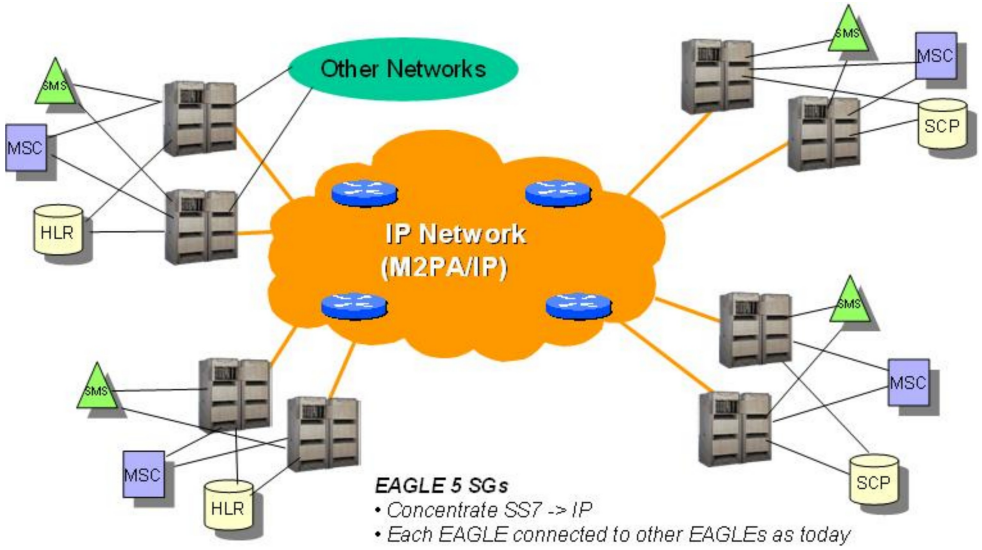
M2PA (MTP2 User Peer-to-Peer Adaptation Layer) protocol

M2PA is used primarily to replace B-, C-, and D-links. When used with A-links, M2PA connects to Service Switching Points, Signaling Control Points, Home Locater Registers and other endpoints. M2PA is a direct replacement for channelized TDM circuits because it has specific controls for assurance of in-sequence delivery of messages. As such, M2PA is needed to connect points that pass call-related data that is time-sensitive, such as ISUP calling data.

Congestion procedures conform to those specified by the ANSI/ITU standards. The M2PA protocol can coexist in a linkset with other link types such as low-speed links and ATM high speed links. When using other link types, the throughput will always match the lowest-speed link in the linkset.

Tekelec implemented the M2PA protocol through its IPLIMx application. For more information on the IPLIMx application, see *IPLIMx, IPGWx and IPSG applications* on page 25.

Figure 3: M2PA network



M3UA (MTP Level 3 User Adaptation Layer) protocol

M3UA seamlessly transports SS7 MTP3 user part signaling messages over IP using SCTP. M3UA-connected IP endpoints do not have to conform to standard SS7 topology, because each M3UA association does not require an SS7 link; there are no 16-link-per-linkset restrictions. Each M3UA-connected IP endpoint can be addressed by an SS7 point code unique from the signaling gateway's point code. Tekelec offers two types of topologies M3UA: IPGWx using routing keys, and IPSG using IPSG-M3UA links.

Note: A-links for nodes requiring in-sequence delivery of messages should be configured on the IPLIMx card using M2PA; M3UA does not have sequence numbers to support lossless changeover/changeback. For more information on the IPLIMx application, see *IPLIMx, IPGWx and IPSG applications* on page 25.

A routing key defines a set of IP connections as a network path for a portion of SS7 traffic, and is the IETF Signaling Gateway equivalent of a Signal Transfer Point's SS7 route. Routing keys are supported by the M3UA protocols to partition SS7 traffic using combinations of Destination Point

Code (DPC), Origination Point Code (OPC), Service Indicator (SI), Network Indicator (NI), SS7 Subsystem Number (SSN), and/or Circuit Identification Code (CIC) message fields.

Using IPGWx, M3UA-connected IP endpoints do not have to conform to standard SS7 topology, because each M3UA association does not require an SS7 link; there are no 16-link-per-linkset restrictions. Each M3UA-connected IP endpoint can be addressed by an SS7 point code unique from the signaling gateway's point code.

In release 38.0, M3UA can also be implemented using IPSG, supports routing keys in the form of SS7 Routes referencing IPSG M3UA linksets, rather than as distinct 'routing key' managed elements. Instead, it performs similarly to the M2PA protocol. Each M3UA association is viewed as a link by the core EAGLE, and each IPSG card can have up to 32 associations/links per card. MTP Origin-Based Routing cannot be used with adjacent point codes.

M3UA does not have a 272-octet Signaling Information Field (SIF) length limit as specified by some SS7 MTP3 variants. Larger information blocks can be accommodated directly by M3UA/SCTP without the need for an upper layer segmentation or re-assembly procedure as specified by the SCCP and ISUP standards. However, a Signaling Gateway will enforce the maximum 272-octet limit when connected to a SS7 network that does not support the transfer of larger information blocks to the destination.

At the Signaling Gateway, M3UA indicates to remote MTP3 users at IP end points when an SS7 signaling point is reachable or unreachable, or when SS7 network congestion or restrictions occur.

Note: IPGW and IPSG M3UA links cannot be in the same link set at the same time. However, the EAGLE allows IPGW and IPSG-M3UA link sets to have separate routes to the same AS, aiding in cutover.

SUA (SCCP User Adaptation) protocol

SUA transports any SS7 SCCP signaling messages over IP using SCTP, and is used between a Signaling Gateway and a signaling end point or between signaling end points.

SUA is used to direct queries to the correct IP-based Application Server Process. It replaces the SCCP layer with its own SUA layer and is used when source and destination are both IP.

A Signaling Gateway can determine the "next hop " using the Global Title Translations delivered in the Called Party Address of the Message Signaling Unit (MSU) .

Note: A-links for nodes requiring in-sequence delivery of messages should be configured on the IPLIMx card using M2PA; SUA does not have sequence numbers to support lossless changeover/changeback. For more information on the IPLIMx application, see *IPLIMx, IPGWx and IPSG applications* on page 25.

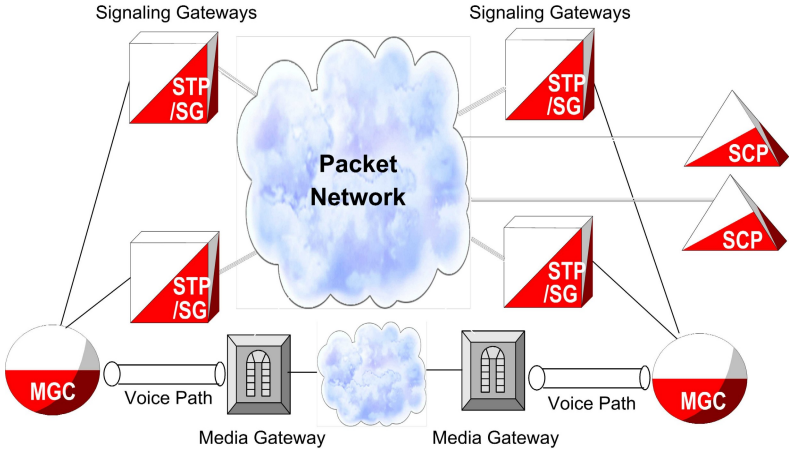
Routing keys are supported by the SUA protocol as in M3UA. Routing key parameters include DPC, OPC, SI, and SSN.

IPSG does not support SUA.

SS7-over-IP signaling transport

SIGTRAN protocols connect IP-based or IP-enabled Media Gateway Controllers (MGCs) , Signaling Gateways (SGs) , switches, databases and other Next Generation signaling applications with traditional circuit-switched signaling architecture.

Figure 4: SS7-over-IP network.



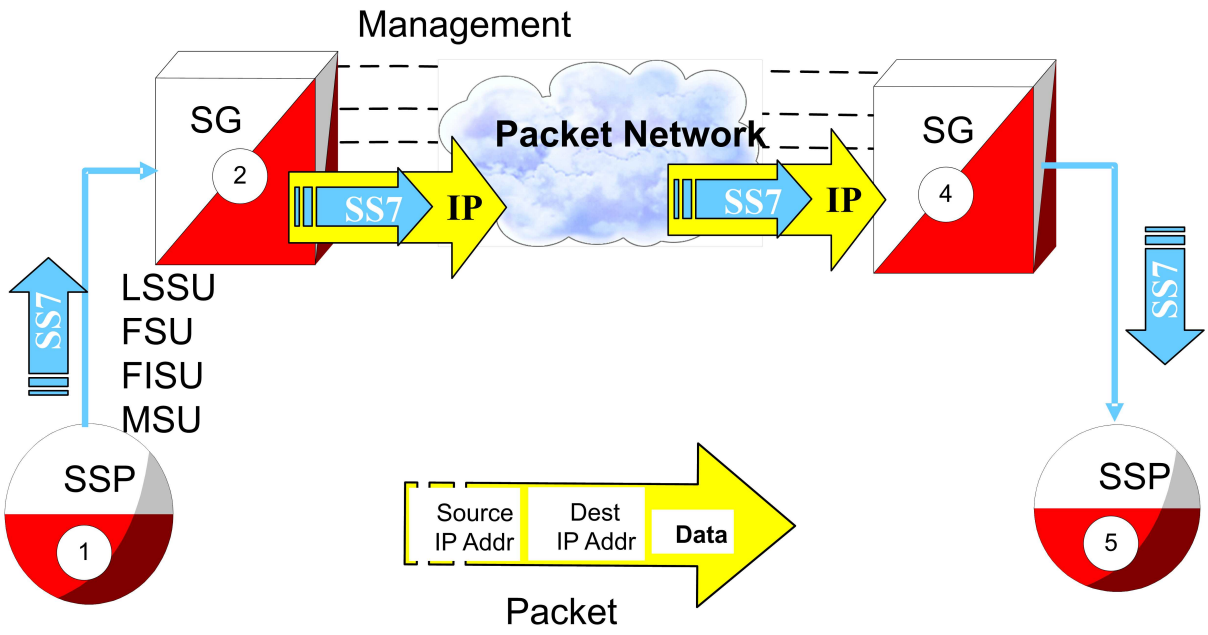
In SS7-over-IP networks, traditional SS7 signals from a telephone company switch are transmitted to a Signaling Gateway, which wraps the signals in an IP packet for transmission over IP to either the next Signaling Gateway or to a MGC, other Service Control Points, or Mobile Switching Centers (MSCs). SIGTRAN protocols define how the SS7 messages can be transported reliably over the IP network; see also *Role of SIGTRAN* on page 13.

The Signaling Gateway has a critical role in the integrated network and is often deployed in groups of two or more to ensure high availability. The Signaling Gateway provides transparent interworking of signaling between TDM and IP networks. The Signaling Gateway may terminate SS7 signaling or translate and relay messages over an IP network to a Signaling End Point (SEP) or another Signaling Gateway, which may be separate physical devices or integrated in any combination. For example, the EAGLE 5 ISS can perform the functions of a Signal Transfer Point in addition to those of a Signaling Gateway.

From SS7 message to IP packet

The following figure and description show how SS7 messages are encapsulated and sent over an IP network to a hostin another network.

Figure 5: Change from SS7 message to IP packet

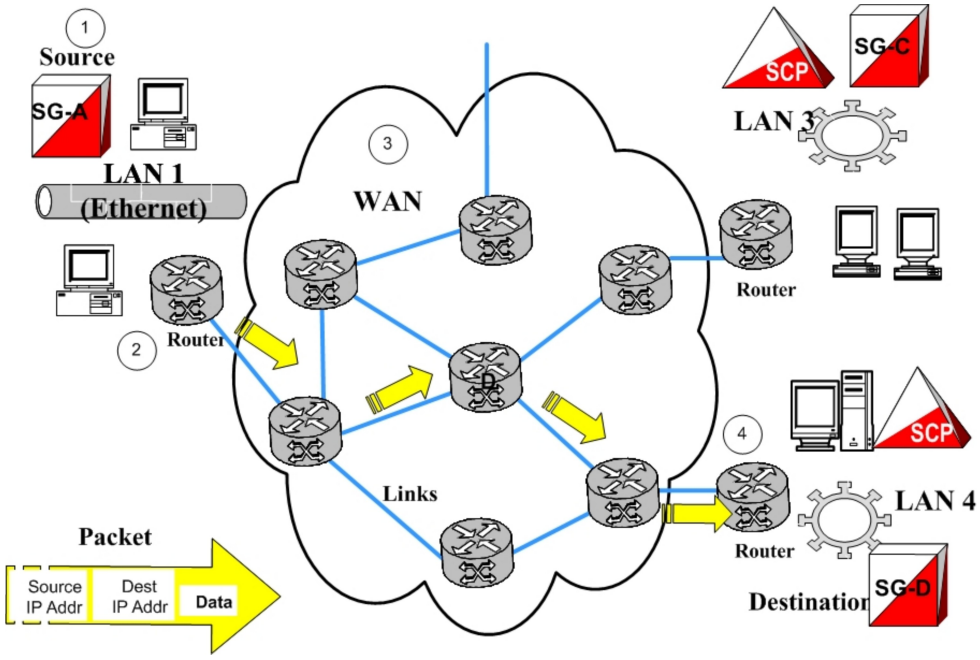


1. A signaling point issues an SS7 message, unaware that there is IP signaling in the network. The message contains Link Status Signaling Units (LSSU), Fill In Signal Units (FISU), Final Signal Units (FSU), and Message Signal Units (MSUs).
2. The Signaling Gateway receives the SS7 packet and encapsulates all necessary SS7 information into the data section of the IP packet. The packet includes the data, source and destination IP address.
3. The packet travels across the IP network. The network is unaware that it is delivering SS7 data. There is no need to modify the routers or gateways along the way.
4. The packet is delivered to the Signaling Gateway on the receiving network. The SS7 information is recovered from the IP packet.
5. A well-formed SS7 packet is sent to the destination Signaling Point.

Communication inside the Wide Area Network (WAN)

The following figure and description show the routing inside the Wide Area Network (WAN).

Figure 6: Communication inside the WAN



1. The Source Host (Signaling Gateway) builds a packet with a destination IP address.
2. A router on the LAN converts the packet to the WAN protocol and places it on the WAN.
3. Each router on the WAN looks at the destination IP address and determines the port to which it forwards the packet. Each router needs to know only how to get the packet closer to the destination.
4. The final router converts the packet to the local LAN format and delivers it to the Destination Host.

Reasons to transition to an SS7-over-IP SIGTRAN network

There are many reasons for transitioning to an SS7-over-IP network. The resulting network offers better cost effectiveness, increased capacity that can be further scaled as needed, a high Quality of Service (QoS) including redundancy and security, and efficient deployment using existing equipment.

Cost effectiveness

SS7-over-IP networks lower network capital and operational expenditures. SIGTRAN is based on the IP protocol; these networks use industry standard, off-the-shelf network interfaces, cables, switches, and software. Improvements in technology and reductions in cost found in the general computer industry can be applied readily in signaling applications. As an industry standard, SIGTRAN allows customers to interoperate in a multivendor environment.

Replacing long-haul point-to-point SS7 links between network elements with IP connectivity can reduce recurring signaling transport costs and the need for dedicated TDM lines. IP-based network monitoring and provisioning improve operation efficiencies.

Increased capacity

SS7-over-IP networks offer increased capacity. The bandwidt overall is greater, both due to inherent capacity and to dynamic bandwidth sharing. Data traffic including Short Message Service (SMS) can run more efficiently over SIGTRAN. For example, SMS data is saturating some SS7 networks. Using devices such as the Tekelec EAGLE 5 ISS with its gateway functions, operators can have a Short Message Service Center communicate directly to Home Location Registers (HLR) and Mobile Switching Centers (MSCs) using SIGTRAN.

Flexibility

SIGTRAN uses the packet IP network to define logical connections between devices. Because the network developers, planners, and installers are no longer tied to deploying fixed circuits for signaling, they have the flexibility to define the network as needs and demands change. Flexibility is key in adapting bandwidth on demand; redimensioning the SS7-over-IP network can be done completely through software. With legacy SS7, users are limited to either 56 or 64 kbps links.

There is also flexibility when adding capacity for new IP-based solutions and value-added services; future enhancements are more transparent.

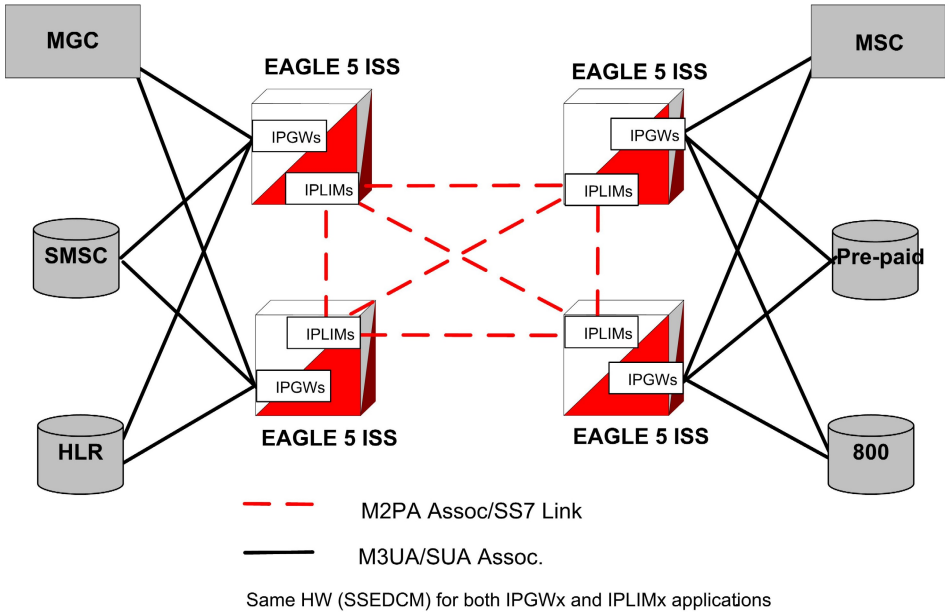
Integration

Enabling a network with IP does not require expensive investments or costly upgrades for existing end nodes; it enables migration to packet-based architecture without adding new point codes or reconfiguring the network.

For M2PA, there are no architectural changes. When using SIGTRAN, SS7 routing translations are the same for TDM or IP linksets.

An SS7-over-IP network is the first step to an all-IP network. The following figure shows the diversity of solutions that are possible using SIGTRAN protocols. For example, M3UA and SUA support an IP-enabled Short Message Service Center (SMSC) or Home Location Register (HLR). SS7-over-IP solves the throughput limitations that were inherited from the SS7 standards, thus allowing Short Message Service Center, Home Location Register, and other equipment to support heavy SS7 traffic needs.

Figure 7: Typical EAGLE 5 ISS SS7-over-IP deployment



Type of network change

When considering a transition, determine the type of change to make. Consider the advantages and disadvantages of a dedicated network versus a converged network. Does the equipment need to be phased out or will new equipment be added? Does the network require additional protection or supplier integration through diversity? All these issues should be considered in the initial planning because of their significant impact on the overall network architecture.

Dedicated network versus converged IP network

While a dedicated IP network offers inherent security and minimal routing, a converged network carrying both voice and data also will satisfy these needs at less cost, provided that the QoS attributes such as Round Trip Time (RTT) , Packet Loss, andJitter are satisfied. These attributes should always be given the highest priority on the IP network.

Implementing SS7-over-IP on an SS7 system creates a converged IP network that allows quick, cost-effective implementation of IP-based services using existing network elements. The Tekelec EAGLE 5 ISS with its Signaling Transfer Point and Signaling Gateway functions offers a reliable solution for this transition.

Decisions regarding the customization of the IP network are left up to the customer, but Tekelec Professional Services can provide recommendations based on their experiences with previous SIGTRAN deployments.

Replacement versus expansion

When transitioning to an SS7-over-IP network, consider these strategies:

- Replacement of out-phased (end of life) TDM equipment

- Gradual replacement, which means coexistence of the two technologies: there is no need to retire an existing switch if you are deploying purely for additional capacity
- Full accelerated replacement with a short transition period based on cost, efficiency, and fault management: even if complete transition is desired, it is unrealistic to expect to instantaneously cut over unless the subscriber base is very small.

  There is enormous leverage when one platform provides both TDM and SS7-over-IP. The issue is more than cost savings. A combined platform can support new multimodal voice, data and video services that utilize a combination of IP data with diverse messaging capabilities, location and presence information, voice connections, speech recognition and Intelligent Network control. Of course, not every application requires every capability, so flexibility is key
- Maintaining the existing PSTN network, and use Next Generation Network (NGN) equipment to satisfy growing demands: legacy switches have many features and services.
- Operators may have to wait until new switches support all required features and services.
- Out-of-region or in-region expansion Traditional services or new features

Diversity

Supporting businesses with critical operations such as banking requires strategies for predictable recovery, not only from regular network faults, but also from attacks on signaling networks. When planning to move to an SS7-over-IP network, the operator should consider diversity to assist in recovery.

The range of diversity will differ from customer to customer and it may include a multitude of factors:

- Entry diversity offers more than one cable entrance into a building
- Pair and cable diversity provides a local loop connection through multiple, nonadjacent pairs in more than one cable
- Path or route diversity provides end-to-end, physically or logically separate routes for a circuit
- Central office diversity provides local loops that terminate in more than one central office
- Site diversity provides alternative or backup locations

When to transition to an SS7-over-IP SIGTRAN network

Consider transitioning to an SS7-over-IP network if:

- Traffic-volume growth on the network is demanding additional capacity
- New networks are planned or IP services will be added to existing networks
- Traffic volume between signaling points is surpassing the bandwidth of 16-link linksets
- A data or voice-over-IP network is already present
- Signaling traffic is deployed over very high latency or lossier networks, such as satellite links

If signaling messages are transported over a private intranet, security measures can be applied as deemed necessary by the network operator.

Chapter 3

Tekelec Solutions

Topics:

This chapter describes how Tekelec products are a part of the SS7-over-IP solution - how the EAGLE 5 ISS functions as a gateway to internet networks; and describes the IAS, which provides several network management and performance tools including IP traffic monitoring through the IMF.

Overview

Tekelec has set the standard for ultra-reliable, high-performance, scalable signaling in wireless and wireline networks around the world. Advanced solutions optimize network efficiency and save customer capital and operational costs. Tekelec addresses network transition by providing the signaling bridge to seamlessly converge circuit and packet-switched technologies.

Operators can leverage existing TDM and ATM network resources as they transition at their own pace to new IP-based transport and services. Tekelec's innovative switching solutions create cost-effective, fully scalable networks with built-in flexibility, making it quick and easy to roll out high-margin multimedia services to business and residential customers.

Tekelec is the IP signaling leader and the first to recognize the value of IP Signaling by developing the TALI protocol (RFC 3094) in 1998. Tekelec was first to market with an IP Signaling solution (IPLIMx application) in 2000, and has years of IP signaling deployment experience.

There are a variety of Tekelec products available to implement a new IP network or upgrade an existing SS7 network.

EAGLE 5 ISS

The Tekelec EAGLE 5 ISS is a robust SS7-over-IP solution that delivers centralized signaling routing, and bridges the legacy circuit-switched and packet networks. It provides seamless interworking between TDM resources such as Service Control Points and IP-enabled elements such as Media Gateway Controllers and next-generation databases. With its packet-based technology, the EAGLE 5 ISS can handle signaling requirements of the most complex networks, delivering dynamic bandwidth sharing to support increases in signaling traffic without additional nodes. The same platform delivers full Signal Transfer Point capabilities and a complete portfolio of integrated applications.

Using the EAGLE 5 ISS to structure the network provides a predictable and reliable architecture with all required interfaces. It is easily scalable to cover huge core networks, with an independent control layer that allows expansion on different parts of the network independent of each other.

The EAGLE 5 ISS provides ease of database management for the SS7-over-IP architecture. Key benefits of using the Tekelec SS7-over-IP solution are:

- **Decreased network congestion**. Tekelec's packet-switched technology delivers dynamic bandwidth sharing to enable carriers to effectively expand their signaling networks and reduce network bottlenecks. By replacing TDM links with an IP interface, service providers can significantly increase signaling capacity to Service Control Points.
- **Reduced transport costs.** Replacing long-haul, point-to-point SS7 links between network elements with IP connectivity can reduce recurring signaling transport costs by 40% to 70%.
- **More efficient networks.** Transitioning to SS7-over-IP signaling does not require expensive equipment replacement or costly software upgrades for existing end nodes. With Tekelec solutions, carriers can streamline their networks while reducing administration, without service interruption during installation..
- **Migration to next-generation architecture**. The EAGLE 5 ISS can appear as an end office to the SS7 network by sharing its point code with the IP endpoints. This allows carriers to migrate

to a packet-based architecture without adding a new point code or reconfiguring the network. Tekelec's open, multi-protocol architecture (SS7, SCTP, M2PA, M3UA, and SUA) gives carriers the capability to grow and migrate their network and the independence to choose best-in-class products.

IPLIMx, IPGWx and IPSG applications

The EAGLE 5 ISS implements SIGTRAN with three applications:

- IPLIMx , which represents IPLIM for ANSI networks and IPLIMi for ITU-N and ITU-I networks
- IPGWx , which represents IPGWx for ANSI networks and IPGWi for ITU-N and ITU-I networks
- IPSG in Release 38.0, which represents a unified application for both ANSI and ITU links on a single association

The IPLIMx application uses SCTP with M2PA protocols to support B-, C-, and D- links; but it can also be used for A-links to connect to SEPs on other vendor equipment that have M2PA SIGTRAN specifications implemented. IPLIMx is fully compliant with RFC 4165.

IPLIMx is installed on either an SSEDCM card or an E5-ENET card. Based on the card type, IPLIMx allows up to 8 links per SSEDCM card and up to 16 links per E5-ENET card, each with one SCTP association per link. IPLIMx can be implemented with just one card and expanded to 100 cards per system.

The IPGWx application uses SCTP with M3UA and SUA protocols to provide user part support such as SCCP and ISUP over A-links to IP-resident network elements such as Service Switching Points, Mobile Switching Centers, Service Control Points and Home Location Registers using SIGTRAN. Since IPGWx applications use M3UA/SUA to replace MTP3 functions, it cannot be used in mixed linksets of both M3UA/SUA and MTP3, as the application will not participate in any changeover/changeback procedure. IPGWx supports statically provisioned routing keys by selecting IP connections based on DPC/OPC/SI/CIC/SSN. The application also supports the End Office mode where the EAGLE 5 ISS shares its point codes with IP-remote applications. However, A-links for nodes requiring in-sequence delivery of messages should be configured on the IPLIMx application using M2PA; M3UA/SUA does not have sequence numbers to support lossless changeover/changeback procedures.

IPGWx is installed on either an SSEDCM card or an E5-ENET card. IPGWx allows one link per card and up to 50 SCTP associations.The link terminates at a private adjacent point code. IPGWx is installed with just one card, and can be expanded to 125 cards per system.

The IPSG application uses SCTP with the M2PA protocol to support A-, B-, C-, D-links as previously mentioned for IPLIMx. It also uses SCTP with the M3UA protocol to support user part support as IPGWx above. IPSG supports routing keys in the form of SS7 Routes referencing IPSG M3UA linksets, rather than as distinct 'routing key' managed elements" or End Office capability as IPGWx does. IPSG is installed only on an E5-ENET card.

The IPSG feature provides conformant M3UA functionality that behaves more like other LIMs, providing the following benefits:

- The IPSG-application M3UA operational model equates Linkset (LS) and Application Server (AS). it equates Signaling Link (SLK) with an AS-ASP (Routing Context + Association) instance. This allows each AS-ASP instance to be administered as a signaling link.
- A new signaling link type, IPSG-M3UA, can be assigned to linksets having up to 16 signaling links. This is double the 8-link (and card) limitation of the current IPGWx linkset.
- Each IPSG card will host up to 32 signaling links.

- Each IPSG card will host up to 32 SCTP associations. A maximum of 16 IPSG-M3UA signaling links can be assigned to a single association.
- The adjacent point code (APC) of the IPSG-M3UA linkset is the point code assigned to the Application Server serviced by the linkset. The IPSG-M3UA linkset does not require a fake adjacent point code as the current IPGWx application does.
- Each IPSG-M3UA signaling link can have a single IP connection, unlike the current IPGWx signaling link which can have up to 50 IP connections.
- The state of the IPSG-M3UA signaling link will be based on the states of the assigned IP connection and AS-ASP instance. If the IP connection is unavailable for traffic, then the IPSG-M3UA signaling link will also be unavailable. If the AS-ASP instance is not available, then the IPSG-M3UA signaling link will also be unavailable.
- Multiple IPSG-M3UA signaling links (up to 16) can share one IP connection, as long as all of the IPSG-M3UA signaling links and corresponding IP connection are hosted by the same card. This enables multiple SS7 variant support across a single IP connection.

Tekelec Integrated Application Solutions (IAS)

The Tekelec IAS platform, integrated with EAGLE 5 ISS, provides tools to capture network traffic data and convert it into useful business intelligence for troubleshooting, managing traffic, roamers, services, and revenues. With its powerful and configurable filtering, IAS sorts through the data to create comprehensive dashboards and reports for all departments within the service-provider company. IAS includes a comprehensive array of performance- and revenue-management capabilities that provide reliable real-time or historical information based on network traffic.

The IAS is based on industry-standard network protocols, and provides one platform for all network technologies including Voice over Internet Protocol (VoIP) and IMS. It supports many different protocols including SS7, CLASS, SIGTRAN, IN, INAP, GSM, CDMA, CAMEL, WIN, MMS, SMPP, WAP, POP3, SMTP, FTP, and HTTP.

For more information on IAS, contact your Tekelec Sales Representative.

Integrated Message Feeder (IMF)

The IMF is an integrated site collector that provides integrated data acquisition in conjunction with the EAGLE 5 ISS. IMF connects to the EAGLE 5 ISS via Ethernet and monitors signaling links on the EAGLE 5 ISS including LSL, ATM HSL, SE HSL, M2PA and M3UA.

IMF allows remote access for administration and troubleshooting, and provides backup and upgrade capability, database management, and traffic management of captured signaling information.

IMF hardware supports NEBS 3 for central office environments. IMF provides a redundant LAN architecture for interface reliability and an N+1 server architecture in case of a single server failure within the managed subsystem.

For more information on IMF, contact your Tekelec Sales Representative.

Chapter 4

Transition Planning

Topics:

The purpose of transitioning from an existing traditional SS7 network to an SS7-over-IP SIGTRAN network is to access valuable IP services at a reasonable cost and within the desired time frames, without losing any current functionality. While the transition can occur in phases and at the desired pace of the customer, the transition must be well planned to minimize impact on existing operations. This chapter provides guidelines on how to approach such a transition and points to the detailed information provided in this document.

Transition guidelines

The transition guidelines consist of these major steps:

1. *Resolve high-level network design* on page 28
2. *Collect network information* on page 29
3. *Analyze data* on page 31
4. *Prepare configurations* on page 31
5. *Implement and test* on page 31
6. *Analyze data* on page 31

Resolve high-level network design

Determine any issues by looking at the current network design compared to the new network architecture. Consider the protocols to be used, specific Tekelec implementations, mated-pair redundancy and link engineering, unihoming versus multihoming, and IP redundancy.

General considerations about the overall network include the following topics:

- *Type of network change* on page 21
  - *Dedicated network versus converged IP network* on page 21
  - *Replacement versus expansion* on page 21
  - Diversity (see *Type of network change* on page 21)
- *Security* on page 14

SIGTRAN protocols were designed to support specific paths between signaling points. The main protocols are M2PA and M3UA, each of which is built on top of the SCTP protocol. Read about the role of the protocols:

- *SCTP (Stream Control Transmission Protocol)* on page 13
- *M2PA (MTP2 User Peer-to-Peer Adaptation Layer) protocol* on page 15
- *M3UA (MTP Level 3 User Adaptation Layer) protocol* on page 15
- *SUA (SCCP User Adaptation) protocol* on page 16

Be aware of Tekelec-specific implementations or deviations and how they will impact your new network. Read about these implementations:

- Protocol deviations
  - *SCTP timers* on page 56
  - *SCTP (Stream Control Transmission Protocol)* on page 13
  - *Multihoming* on page 52
  - *M3UA (MTP Level 3 User Adaptation Layer) protocol* on page 15
- *Overview* on page 24 of products
- *Scalability* on page 34
- *IPGW/M3UA deployment scenarios* on page 93, *IPLIM/M2PA deployment scenarios* on page 91, and *IPLIM/M2PA deployment scenarios* on page 90
- *IPGWx congestion management options* on page 51

- *IPGWx mateset* on page 54
- *Signaling Link Selection (SLS) routing* on page 55

Redundancy is achieved through linkset engineering, leveraging unihoming or multihoming, and IP network redundancy. Read about redundancy, links, linksets, and associations:

- *Redundancy and link engineering* on page 52
  - *Unihoming versus multihoming* on page 52
  - *Mated Signal Transfer Point redundancy* on page 53
  - *IPGWx mateset* on page 54
  - *Signaling Link Selection (SLS) routing* on page 55
- *Additional Deployment Scenarios* on page 89
- *Scalability* on page 34

Collect network information

Developing a physical and logical diagram of the network will help organize the information clearly. Detailed documentation should include:

- Hardware data of the infrastructure's physical structure
- Software data including the existence and configuration of protocols used on the network
- Logical organization of the network
- Name and address resolution methods
- The existence and configuration of services used
- Location of the network sites and the available bandwidth

The physical network diagram should present the following information about your existing network:

- Details of physical communication links, such as cable length, grade, and approximation of the physical paths of the wiring, analog, and ISDN lines
- Servers with name, IP address (if static), server role, and domain membership. A server can operate in many roles.
- Location of devices such as hubs, switches and routers that are on the network
- WAN communication links and the available bandwidth between sites (this could be an approximation or the actual measured capacity)

The logical network diagram should show the network architecture, including the following information:

- Domain architecture including the existing domain hierarchy, names, and addressing scheme.
- Server roles including primary and backup

IP addresses, subnet masks, default gateways and LAN parameters (e.g. Full/Half Duplex, 10/100 Speed, MAC Layer) will also be needed for implementation. Refer to the Database Administration - IP7 Secure Gateway Manual of the current EAGLE 5 ISS documentation for affected parameters and detailed information.

Before an association is established, the exact RTT is impossible to measure accurately because only the transmitter's SCTP will be able to measure the exact amount of elapsed time from each transmit until the acknowledgment. A good estimate can be gained using a number of ping requests

at different times of the day or from a network analyzer. Remember, however, that ping uses ICMP echo packets that are often given a lower QoS in IP networks.

To gather the information required to determine configuration parameters of the M2PA and M3UA association(s) between an EAGLE 5 ISS node and each Signaling End Point (SEP), a spreadsheet per EAGLE 5 ISS node can be very helpful. Every node connected by a SIGTRAN link should appear as a row in the spreadsheet, with the headings listed in the table along the top row.

Table 2: M2PA and M3UA configuration parameter data

Heading Text	Explanation
Node Name	The unique network name for the node
Node ID	The unique network ID for the node
Site Name	The unique network name for the site in which the node resides
Node Type	STP, MSC, HLR, SMSC, IN, MSS, MGC, etc.
Connected SGW(s)	The EAGLE 5 ISS node connection to which this data refer
Total # SGWs	Total number of STPs to which this node connects
SIGTRAN Protocol	M2PA, M3UA or SUA
RTT to STP	Measured or estimated RTT between the two nodes
Jitter %	The percentage variation in RTT
Dim %	The normal designed maximum utilization of a link (20%, 40%, etc.)
Avg. MSU Size	The expected average MSU size between this node and the EAGLE 5 ISS
% SCCP Class 1	The percentage of SCCP Class 1 traffic expected to be sent to this node
Peak MSU/s	The planned number of MSU/s expected to be sent to this node from all EAGLE 5 ISSs in worst-case conditions
Max Assoc	The maximum number of associations that this node supports to this EAGLE 5 ISS

See also:

- *Configure the IPGWx application* on page 73
- *Configure the IPLIMx application* on page 72
- *Configure the IPSG application* on page 70
- *Database Administration - IP7 Secure Gateway Manual* of your current EAGLE 5 ISS documentation

Analyze data

Follow the guidelines in *Tekelec internal references* on page 100 (TR005007) to determine expected throughput from IPLIMx and IPGWx applications, and for details on other criteria to achieve these advertised capacities.

Additional information on card throughput (MSU/s) can be found in *Achieving IP Signaling Applications' Advertised Capacity* on page 38.

Tekelec has guidelines for implementing SS7-over-IP, which can be found at:

- *SIGTRAN engineering guidelines* on page 49
- *Calculate the number of cards required* on page 50

To determine association configuration parameters, see:

- *Define RTO parameter* on page 78
- *Configure Congestion Window Minimum (CWMIN) parameter* on page 60

Prepare configurations

Once card and association throughput are determined, they can be compared to the traffic dimensioning required for signaling end points (from customers) to determine the number of linksets to use, number of cards in a linkset, and number of associations per card. Consider other factors such as limitations enforced by the connected node (e.g., limits to the number of supported associations).

Note: Combining IP links and low-speed links in same linkset will limit bandwidth availability and scalability. Creating dedicated linksets for IP links and low-speed links also can cause load sharing issues (load sharing across more than two linksets).

Implement and test

- *Configuration* on page 70
- *Retransmission concept* on page 56
- *Define RTIMES association retransmits* on page 78
- *Define RTO parameter* on page 78
- *System verification* on page 79
- *Troubleshooting* on page 83

Refine timers and parameters

Refine timers and parameters on page 76

Chapter 5

Dimensioning

Topics:

This chapter describes dimensioning issues and calculations required to maximize the efficiency of the new network, addressing scalability, redundancy schemes, throughput calculations for both normal and failover mode, LAN/WAN considerations, and retransmission concepts.

About bandwidth, throughput, transaction units, and TPS

Bandwidth is the maximum amount of data that can pass through a network at any given time; it is the Advertised Capacity of a card.

Throughput is the amount of data that is actually transmitted in that given time. Throughput reflects an end-to-end rate, which is affected by various conditions during the transmission. Throughput is always lower than bandwidth.

Transactions versus transaction units and TPS

In SS7 signaling, a transaction is typically defined as one MSU transmitted and one MSU received, and assumes a worst-case scenario of that many MSUs both transmitted and received simultaneously per second.

IP signaling capacity is not usually constrained by the IP network (bandwidthbandwidth), but rather by the processing platform (CPU or memory). The cost of a given transaction varies based upon the feature set triggered by the transaction. Not all MSUs are the same, and not all configurations are the same. Rather than to continue to engineer product capacity for the worst case and thereby penalizing customers who are not using worst-case scenarios, Tekelec is providing the Transaction Unit (TU) modelto allow customers flexibility in how to use application or card capacity.

Under the TU model, a transaction unit indicates the relative cost of an IP signaling transaction; the base transaction unit is 1.0. Some transactions are more expensive than others in terms of IP signaling card capacity. A transaction that is less expensive than the base has a transaction unit less than 1.0, and a transaction that is more expensive is greater than 1.0. The total transaction units consumed by an MSU are the sum of the base transaction unit value and the additional transaction unit value. Transaction Units per Second (TPS) are then calculated with the total transaction unit value and the Advertised Card capacity.

For detailed information on how to calculate IP signaling TPS and the number of cards required to carry MSU traffic, see *How to calculate transaction units per second (TPS)* on page 42 and *Calculate the number of cards required* on page 50”.

Scalability

Scalability is the ability to increase total throughput under an increased load proportionally to added resources such as hardware or software. For example, to add traffic and to increase throughput in a current system, the operator can replace low-speed links with IP-based links; IP-based links are much more efficient than standard TDM links. This change requires at least one card that runs the IPGWx, IPLIMx or IPSG application.

Link equivalency

The figure shows that a single IPLIMx application can take the place of 52 to 80 56K DS0 low-speed links; a single application (M3UA) can take the place of 12 to 80 56K DS0 low-speed links.

Table 3: EAGLE Link Equivalency for IPLIMx/IPGWx

ATM <->Low speed link				**M2PA<-> ATM <->Low speed link**				**M3UA<-> ATM <->Low speed link**			
Avg. MSU size (MTP 2 + MTP 3)	Eagle ATM link Msu/ Sec	56K links ATM equiv-alent	64K links ATM equiv-alent	Eagle M2PA Msu/ Sec	ATM link equiv-alent	56K links IP equiv-alent	64K links IP equiv-alent	Eagle M3UA Msu/ Sec	ATM links Equiv-alent	56K links IP equiv-alent	64K links IP equiv-alent
20	2000	6	5	4000	2	12	10	4000	2	12	10
30	2000	9	8	4000	2	18	15	4000	2	18	15
40	**1800**	**11**	**9**	**4000**	**3**	**23**	**20**	**4000**	**3**	**23**	**20**
50	**1800**	**13**	**12**	**4000**	**3**	**29**	**25**	**4000**	**3**	**29**	**25**
60	1800	16	14	4000	3	35	30	4000	3	35	30
70	1800	18	16	4000	3	40	35	4000	3	40	35
80	1800	21	18	4000	3	46	40	4000	3	46	40
90	**1200**	**16**	**14**	**4000**	**4**	**52**	**45**	**4000**	**4**	**52**	**45**
100	**1200**	**18**	**15**	**4000**	**4**	**58**	**50**	**4000**	**4**	**58**	**50**
110	**1200**	**19**	**17**	**4000**	**4**	**63**	**55**	**4000**	**4**	**63**	**55**
120	**1200**	**21**	**18**	**4000**	**4**	**69**	**60**	**4000**	**4**	**69**	**60**
130	**1200**	**23**	**20**	**4000**	**4**	**75**	**65**	**4000**	**4**	**75**	**65**
140	**900**	**18**	**16**	**4000**	**5**	**80**	**70**	**4000**	**5**	**80**	**70**
150	900	20	17	4000	5	86	75	2800	4	60	53
160	900	21	18	4000	5	92	80	2800	4	64	56
170	900	22	20	4000	5	98	85	2800	4	68	60
180	900	24	21	4000	5	103	90	2800	4	72	63
190	720	20	18	4000	6	109	95	2800	4	76	67
200	720	21	18	4000	6	115	100	2800	4	80	70
210	720	22	19	4000	6	120	105	2800	4	84	74
220	720	23	20	4000	6	126	110	2800	4	88	77
230	720	24	21	4000	6	132	115	2800	4	92	81
240	600	21	18	4000	7	138	120	2800	5	96	84
250	600	22	19	4000	7	143	125	2800	5	100	88
260	600	23	20	4000	7	149	130	2800	5	104	91

ATM <->Low speed link				M2PA<-> ATM <->Low speed link				M3UA<-> ATM <->Low speed link			
270	600	24	21	4000	7	155	135	2800	5	108	95

Table 4: EAGLE Link Equivalency for IPSG

ATM <->Low speed link				M2PA<-> ATM <->Low speed link				M3UA<-> ATM <->Low speed link			
Avg. MSU size (MTP 2 + MTP 3)	Eagle ATM link Msu/ Sec	56K links ATM equiv-alent	64K links ATM equiv-alent	Eagle M2PA Msu/ Sec	ATM link Equiv-alent	56K links IP equiv-alent	64K links IP equiv-alent	Eagle M3UA Msu/ Sec	ATM links Equiv-alent	56K links IP equiv-alent	64K links IP equiv-alent
20	2000	6	5	5000	3	15	13	5000	3	15	13
30	2000	9	8	5000	3	22	19	5000	3	22	19
40	**1800**	**11**	**9**	**5000**	**3**	**29**	**25**	**5000**	**3**	**29**	**25**
50	**1800**	**13**	**12**	**5000**	**3**	**36**	**32**	**5000**	**3**	**36**	**32**
60	1800	16	14	5000	3	43	38	5000	3	43	38
70	1800	18	16	5000	3	50	44	5000	3	50	44
80	1800	21	18	5000	3	58	50	5000	3	58	50
90	**1200**	**16**	**14**	**5000**	**5**	**65**	**57**	**5000**	**5**	**65**	**57**
100	**1200**	**18**	**15**	**5000**	**5**	**72**	**63**	**5000**	**5**	**72**	**63**
110	**1200**	**19**	**17**	**5000**	**5**	**79**	**69**	**5000**	**5**	**79**	**69**
120	**1200**	**21**	**18**	**5000**	**5**	**86**	**75**	**5000**	**5**	**86**	**75**
130	**1200**	**23**	**20**	**5000**	**5**	**93**	**82**	**5000**	**5**	**93**	**82**
140	**900**	**18**	**16**	**5000**	**6**	**100**	**88**	**5000**	**6**	**100**	**88**
150	900	20	17	5000	6	108	94	5000	6	108	94
160	900	21	18	5000	6	115	100	5000	6	115	100
170	900	22	20	5000	6	122	107	5000	6	122	107
180	900	24	21	5000	6	129	113	5000	6	129	113
190	720	20	18	5000	7	136	119	5000	7	136	119
200	720	21	18	5000	7	143	125	5000	7	143	125
210	720	22	19	5000	7	150	132	5000	7	150	132
220	720	23	20	5000	7	158	138	5000	7	158	138

ATM <->Low speed link				M2PA<-> ATM <->Low speed link				M3UA<-> ATM <->Low speed link			
230	720	24	21	5000	7	165	144	5000	7	165	144
240	600	21	18	5000	9	172	150	5000	9	172	150
250	600	22	19	5000	9	179	157	5000	9	179	157
260	600	23	20	5000	9	186	163	5000	9	186	163
270	600	24	21	5000	9	193	169	5000	9	193	169

Hardware and software requirements

For SS7-over-IP networks, Tekelec uses two cards to achieve IP connectivity

- Single-slot EDCM (SSEDCM) card
- EPM-based Ethernet (E5-ENET) card

Either of these cards can be loaded with the IPLIMx or IPGWx application, but IPSG can be loaded only on the E5-ENET card:

- The IPLIMx application implements the M2PA protocol, which is used mainly for B-, C-, and D-links. Once either of the cards is loaded with the IPLIMx application, the card is referred to as the IPLIMx card.
- The IPGWx application implements the M3UA and SUA protocols, which are used for A-links. Once either of the cards is loaded with the IPGWx application, the card is referred to as the IPGWx card.
- The IPSG application implements the M2PA and M3UA protocols, which are used for A-links (IPSG-M3UA) and B-, C-, and D-links (IPSG-M2PA) signaling links. Once the card is loaded with the IPSG application, it is referred to as an IPSG card.

Each of these cards has a different maximum capacity for the number of TPSs that they will support. The older SSEDCM supports up to 2,000 TPS, while the E5-ENET card supports up to 4,000 TPS (5,000 TPS using IPSG). The number of MSU/s supported by each of these cards is dependent on various factors including MSU size, percentage of MSUs triggering the SCCP Class 1 sequencing feature, and the Integrated Monitoring feature.

System capacity

Each of the IP7 applications may have a unique set of TPS ratings based on the card type used. System capacity for the EAGLE is defined as 500,000 TPS with 160-byte average message size, including up to 150,000 Class-1 Sequenced SCCP TPS. This capacity is equivalent to 100 E5- ENET cards running the IPSG application (rated at 5000 TPS). While this limit is not enforced by the provisioning sub-system, the rated capacity of all IP7 applications running in an EAGLE must not exceed the available system capacity. Note that other features, such as Integrated Monitoring, will also require system capacity and must be considered when calculating the available system capacity.

The EAGLE system is engineered to support a system total capacity as defined above where:

- Each IPLIM-SSEDCM consumes 2000 TPS
- Each IPLIM-E5-ENET consumes 4000 TPS

- Each IPGW-SSEDCM consumes the minimum of the card's configured linkset TPS or 2000 TPS
- Each IPGW-E5-ENET consumes the minimum of the card's configured linkset TPS or 4000 TPS
- Each IPSG-E5-ENET consumes the total SLKTPS of the SLKs hosted by the card up to a maximum of 5000 TPS

Although IPSG is not supported on SSEDCM cards, the EAGLE allows mixing of E5-ENET and SSEDCM cards when SSEDCM is used for IPGW or IPLIM, and E5-ENET is used for IPGW, IPLIM or IPSG.

The system total depends on card limits. Table 3 "Card limits by Application per Node" list limits when combining cards and/or applications on a node

Table 5: Card limits by application per node

Application Type	Card Type		
	E5-ENET	SSEDCM	Mixed E5-ENET and SSEDCM
IPLIMx	100	100	100
IPGWx	125	125	*
Combined IPLIMx/IPGWx	100	225	*
IPSG	100	NA	NA
* Contact your Sales Representative for IPLIMx configurations at or over 100			

When considering other factors or additional configurations that impact the IMT, contact your Sales Representative for more information.

Achieving IP Signaling Applications' Advertised Capacity

A goal of properly engineered networks is to eliminate congestion. Advertised Capacity refers to the maximum TPS that can be sustained without congestion. Several factors affect TPS calculations and must be considered when calculating the expected throughput for the IPLIMx, IPGWx and IPSG applications.

The IPGWx application implements traffic flow control based upon the TPS value allocated to its signaling link, which is derived from the `iptps` parameter setting of its linkset. Presenting a load in excess of the signaling link TPS value will result in congestion.

Factors affecting advertised capacity

The following factors affect the IP application's Advertised Capacity:

- Host card

  Some cards have different performance characteristics than others. For example, the E5-ENET card has much more memory for buffering traffic than the SSEDCM card.

- CPU utilization

A wide variety of factors determine the processing resources required by IP applications to manage a given traffic load, and cause the processing of each MSU to be more expensive. For example, the EAGLE 5 ISS provides a feature that enables support of Class-1 Global Title traffic. When the feature is enabled and a triggering message is received by an IP signaling application, the application sends the MSU to an SCCP card for translation, and after translation, the MSU is sent back to the originating IP signaling card for post-translation routing. This extra IMT hop results in significant processing overhead in the receiving IP signaling card.

- Message buffers

  The amount of memory allocated for traffic buffers determines the maximum traffic rate and average message size that can be sustained for a certain network configuration. The buffer size is configurable through associations. For example, within the constraints of memory on the card, each association can have from 8 kb up to 400 kb of send-and-receive buffer space for SCTP.

- Card communication interfaces

  The capacity of the card's external interfaces can become a constraint for certain configurations. For example, the IMT interface capacity is affected by high-utilizing features, or the Ethernet interface configurable capacity is set to half-duplex (not 100Mb/sec full-duplex).

For detailed descriptions of factors that affect advertised card capacity, see *Tekelec internal references* on page 100.

Base transaction unit

The base IP signaling transaction unit involves an MSU sent and an MSU received, each having a Service Information Field (SIF) of less than or equal to 140 bytes, with the Data Feed feature disabled and a minimum set of features in use. A larger MSU, or an MSU that is monitored as part of the Data Feed feature, has a transaction unit cost of greater than 1.0.

The base Advertised Capacity of EAGLE 5 ISS IP signaling cards assumes an average transaction unit cost of 1.0, so a TPS rating of 2,000 = 2,000 Transaction Units per Second (TPS) , each having a cost of 1.0. If the average transaction cost increases above 1.0, then the Advertised Capacity (TPS rating) of the IP signaling card decreases proportionally.

The table shows the base Advertised Capacity for the SSEDCM and E5-ENET cards.

Table 6: Base Advertised Capacity

Card	Base Advertised Capacity (TPS)
SSEDCM	2,000
E5-ENET	5,000 for IPSG 4,000 for IPGWx/IPLIMx

Exceeding the Advertised Capacity may result in signaling congestion, and in combination with the Data Feed feature, may result in the application discarding Data Feed messages.

Base transaction unit rules

The base transaction unit rules are applied to establish the base transaction unit costs:

1. Sufficient IP TPS is assigned to the linkset to which the IPGWx signaling link is assigned. (IPGWx only)
2. The traffic is not monitored via the E5IS feature.
3. For IPGWx and IPLIMx. the percentage of received traffic that triggers the enabled EAGLE SCCP Class-1 Sequencing feature is less than or equal to 50%.
4. The IP packet loss rate is 25 per 100,000 or less.
5. IP connection message buffer memory is of a sufficient size on the IPGWx application and the peer network elements to sustain traffic for the network's RTT and worst-case packet loss.
6. The IP connection retransmission mode must be linear (RMODE=LIN) for SCTP associations.
7. The IP connection retransmit time-out is configured to a value that is appropriate for the expected network latency (RMIN for SCTP associations).
8. M2PA Timer T7 (Excess Delay in ACK) is configured to have a value appropriate for the expected network latency (IPLIMx only).
9. For IPSG, none of the received traffic triggers the enabled Eagle SCCP Class-1 Sequencing feature.

Base transaction unit costs

The base transaction unit cost is based on the configuration rules shown in *Base transaction unit rules* on page 39. Any additional configurations are applied to the adjusted transaction unit.

Table 7: Base transaction unit cost per MSU SIF size

MSU SIF	M2PA	M3UA	SUA
0..140	1	1	1.33
141..272	1	1.4	2
273..544	2	2	N/A
545..816	3	3	N/A
817..1088	4	4	N/A
1089..1360	5	5	N/A
1361..1632	6	6	N/A
1633..1904	7	7	N/A
1905..2176	8	8	N/A
2177..2448	9	9	N/A
2449..2720	10	10	N/A
2721..2992	11	11	N/A
2993..3264	12	12	N/A
3265..3536	13	13	N/A
3537..3808	14	14	N/A
3809..4080	15	15	N/A

MSU SIF	M2PA	M3UA	SUA
4081..4095	16	16	N/A

Adjusted transaction unit

The adjusted transaction unit is the value calculated and tested by Tekelec that represents additional cost per base transaction unit when the configuration deviates from the base configuration.

The table shows adjusted configuration scenarios and their TU values for IPGWx (M3UA), IPLIMx (M2PA) and IPSG (M3UA and M2PA). For more information on calculating throughput based on transaction units, see *How to calculate transaction units per second (TPS)* on page 42”.

Table 8: Additional IPLIMx/IPGWx Transaction Units for Advanced Configurations

MSU SIF Size	Adapter	Monitored by E5IS	Number of Open Conns	SLAN or SCCP Conversion	Base TU	TU Adjustment	Total TU	Max MSU/s 2000	Max MSU/s 4000
0..140	M3UA	Yes	<= 8	No	1.0	0.43	1.43	1400	2800
0..140	M3UA	Yes	<= 8	Yes	1.0	0.67	1.67	1200	2400
0..140	M3UA	Yes	> 8	No	1.0	0.82	1.82	1100	2200
0..140	M3UA	Yes	> 8	Yes	1.0	1.00	2.00	1000	2000
141..272	M3UA	Yes	<= 8	No	1.43	0.80	2.22	900	1800
141..272	M3UA	Yes	<= 8	Yes	1.43	1.24	2.67	750	1500
141..272	M3UA	Yes	> 8	No	1.43	1.65	3.08	650	1300
141..272	M3UA	Yes	> 8	Yes	1.43	1.91	3.33	600	1200
0..140	M2PA	Yes	<= half max per card	No	1.0	0	1.00	2000	4000
0..140	M2PA	Yes	<= half max per card	Yes	1.0	0.38	1.38	1450	2900
0..140	M2PA	Yes	> half max per card	No	1.0	0.11	1.11	1800	3600
0..140	M2PA	Yes	> half max per card	Yes	1.0	0.54	1.54	1300	2600
141..272	M2PA	Yes	<= half max per card	No	1.0	0.54	1.54	1300	2600

MSU SIF Size	Adapter	Moni-tored by E5IS	Number of Open Conns	SLAN or SCCP Conver-sion	Base TU	TU Adjust-ment	Total TU	Max MSU/s 2000	Max MSU/s 4000
141..272	M2PA	Yes	<= half max per card	Yes	1.0	1.00	2.00	1000	2000
141..272	M2PA	Yes	> half max per card	No	1.0	0.67	1.67	1200	2400
141..272	M2PA	Yes	> half max per card	Yes	1.0	1.11	2.11	950	1900

Table 9: IPSG Additional Transaction Units for Advanced Configurations

Configuration Attribute	Average MSU SIF Size	Transaction Unit Adjustment (per MSU with attribute)	Transaction Unit Cost (per MSU with attribute)
More than 16 active SLKs	0..272	0.135	1.35
SCCP Class-1 Sequencing feature	0..272	0.2	1.2
SLAN or SCCP conversion	0..140	0.2	1.2
IMF	141..272	0.4	1.4
IMF	0..140	1.0	2.0
IMF	141..272	1.4	2.4

How to calculate transaction units per second (TPS)

Refer to *Table 10: Calculating TPS* on page 43 to follow the process:

1. Determine which application will carry the traffic (IPGWx, IPLIMx or IPSG).
2. Determine the type of card that will host the application (SSEDCM or E5-ENET).
3. Determine the adapter protocol type of the association(s) that will carry the traffic (in the table, the adapter is always M3UA).
4. Determine how many distinct categories of traffic will be carried by the card. Characteristics that distinguish categories include:
   - Average SIF size (1)
   - Whether or not the traffic is monitored (in the table, all rows have monitoring by E5IS)
   - How many connections per card will carry the traffic (2)
   - Whether Signal Transfer Point SLAN or SCCP Conversion is applied to the traffic (3)

Distinct traffic categories are identified by rows in the table (A), (B).

5. Select the TU value that applies to each distinct category of traffic. (6)
6. If the total bi-directional MSU rate of each category ((A7), (B7)) is known in advance, then the:
   - Total TU rate for a category = MSU rate x TU value ((A7) x (A6))
   - Total TU rate to be carried by the card = Sum of all TU rates of the traffic categories ((A6) x (A7) + (B6) x (B7))

   Then compare that value to the Base Card Capacity (7).
7. If you know the fraction of total traffic that applies to each category, then you can determine maximum total MSU rate, that is, the actual Advertised Capacity, by dividing the Base Advertised Capacity (7) by the total TU value of the traffic mix (6).

Table 10: Calculating TPS

	1 MSU SIF Size	2 # of Open Conns	3 Conver-sion	4 Base TU	5 Adjust-ment	6 Total TU	7 Max MSU/s 2000	Max MSU/s 4000	Max MSU/s 5000
A	0..140	<=8	No	1.0	0.43	1.43	1400	2800	3500
	0..140	<=8	Yes	1.0	0.67	1.67			
	0..140	>8	No	1.0	0.82	1.82			
	0..140	>8	Yes	1.0	1.00	2.00			
	141..272	<=8	No	1.43	0.80	2.22			
B	141..272	<=8	Yes	1.43	1.24	2.67	750	1500	1875
	141..272	>8	No	1.43	1.65	3.08			
	141..272	>8	Yes	1.43	1.91	3.33			

Calculation example

Refer to *Table 10: Calculating TPS* on page 43 to follow this calculation:

- The signaling link is being monitored by E5IS (Data Feed) (A3, B3).
- Fail traffic uses M3UA adapter (A2, B2).
- Eight IP connections are open and allowed (A4, B4).
- Eighty percent of traffic involves ISUP MSUs having a SIF size less than or equal to 140 bytes (80% of A8).
- Twenty percent of traffic involves SCCP-converted MSUs having a SIF size greater than 140 bytes and less than or equal to 272 bytes (20% of B8).

```
(Base Advertised Capacity) =
((0.80 * (1.43)) + (0.20 * (2.67)) * (Actual Advertised Capacity)=
(1.14 + 0.53) * (Actual Advertised Capacity)=
```

```
1.67 * (Actual Advertised Capacity)

(Actual Advertised Capacity)= (Base Advertised Capacity) / (1.14 + 0.53)=
4000 / 1.67 = 2395
```

Once the needed throughput is established, calculate the number of cards required to support this need (see *Calculate the number of cards required* on page 50).

Rules for Integrated Datafeed using STC cards

Tekelec internal references on page 100 contains additional rules related to Integrated Datafeed (for IMF using STC cards).

Follow the guidelines and consult the tables in *Tekelec internal references* on page 100:

- Effects of different Integrated Monitoring configurations
- Association buffer sizes
- Throughput per association
- Congestion Window Minimum size

Functionality of configurable SCTP buffer sizes per association

The amount of memory allocated for traffic buffers determines the maximum traffic rate and average message size that can be sustained for a specific network configuration. Memory is a constraint in achieving advertised capacity due to queuing, message storing and packet retention for retransmission over the Ethernet physical transport. As a general rule, the greater the Round Trip Time (RTT) for a packet, the greater the need for memory to store the unacknowledged packets being sent to the peer. Since each card has a finite amount of memory, the allocation is spread across all the links or connections on the card. This means that as a card's hosted-association(s) buffer sizes increase, the maximum number of associations that can be hosted by the card decrease.

The SCTP buffer size is configurable per association. Within the constraints of memory on the card, each association can have 8 kb to 400 kb of send-and-receive buffer space for SCTP.

The table lists the maximum memory available for SCTP buffers on each card type

Table 11: SCTP Buffer Space per Connection, Card and Application

Application	Card	Max # Conns	Default Conn Buffer	Max Conn Buffer	Max Total Buffer
IPLIMx	SSEDCM	8	200KB	400KB	1600KB
IPLIMx	E5-ENET	16	200KB	400KB	3200KB
IPGWx	SSEDCM	50	16KB	400KB	800KB
IPGWx	E5-ENET	50	16KB	400KB	3200KB
IPSG	E5-ENET	32	200KB	400KB	6400KB

Note: No card or application combination supports the maximum number of connections with each connection having the maximum buffer size.

System constraints affecting total IP Signaling capacity

Previous sections focused on the Maximum and Advertised Capacity of particular applications on particular cards for various configurations. This section focuses on constraints involved in using multiple IP signaling cards and applications.

Table 12: IPLIMx and IPGWx connectivity data

Feature	IPLIM (SSEDCM/ E5-ENET)	IPGWx (SSEDCM/ E5-ENET)	Notes
Cards per system	100	125	Worst-case inter-shelf IMT utilization is a key factor. Total number of E5-ENET cards for IPLIMx cannot exceed 100.
Link connectivity type	Point to point (1 connection per link)	Point to multipoint	---
Link type replacement	Any	A	---
Typical application	Interconnect transfer point	Interconnect a front-end SS7 gateway to a backend service element	---
Links per card	8/16	1/1	Worst-case inter-shelf IMT utilization is a key factor. Virtual signaling link. Terminates SS7 network (IPGWx)
Links per link set	16	8	Assumes unmated configuration. Link set defines the scope of a mateset/SG. If mated, then only one link is allowed in the link set.
Supports combined link sets	Yes	No	---
IP connections per system	4000	4000	---
IP connections per card	8/16	50/50	SCTP associations
Routing keys per system	---	2,500	---
IP connections per routing key	---	16	---

Feature	IPLIM (SSEDCM/ E5-ENET)	IPGWx (SSEDCM/ E5-ENET)	Notes
Application Servers per system	---	250	---
Associations per Application Server	---	16	---
Ethernet interfaces per card	2	2	Unihomed connection on either interface, multihomed using both interfaces
EAGLE 5 ISS Hardware Redundancy Model	2N	2N	---
Capacity (TPS)	2000/4000 MSU/s	2000/4000 MSU/s	2.5/5K is the goal
Failure mode (80%)	1600/3200 MSU/s	1600/3200 MSU/s	Capacity growth required at this point
Multihoming support	Yes	Yes	---
Connection model	Peer to peer	Server	---
SS7 routing	Traditional least-cost based	Two-step traditional SS7 least-cost plus route keys	---
Supports lossless	Yes	No	IPGWx relies on SCTP changeover for sequencing
Supports network management	Yes	Yes	---
Number of DTA Point Codes	1	1	Implies one IPGWx mateset if DTA PC route involves IPGWx link set
Number of internal point codes per network	1	1	Implies one IPGWx mateset per network domain for end-office mode of operation
IPTPS for System	---	Purchase quantity	Total pool of capacity distributed by user across IPGWx link sets
IPTPS per IPGWx link set	---	System IPTPS	---
IPTPS per IPGWx signaling link	---	Link set IPTPS	---

Feature	IPLIM (SSEDCM/ E5-ENET)	IPGWx (SSEDCM/ E5-ENET)	Notes
IMT Inter-Shelf Capacity, each bus, ring topology	1 Gb/sec	1 Gb/sec	Full-Duplex

Table 13: IPSG Connectivity Data

Feature	M2PA	M3UA	Notes
Cards per system	100	100	Worst-case inter-shelf IMT utilization is a key factor. Total number of E5-ENET cards for IPLIMx cannot exceed 100.
Link connectivity type	Point to point (1 connection per link)	Point to multipoint	---
Link type replacement	Any	Any	---
Typical application	Interconnect transfer point	Interconnect a front-end SS7 gateway to a backend service element	---
Links per card	32	32	Worst-case inter-shelf IMT utilization is a key factor. Virtual signaling link. Terminates SS7 network (IPGWx)
Links per link set	16	16	Assumes unmated configuration. Link set defines the scope of a mateset/SG. If mated, then only one link is allowed in the link set.
Supports combined link sets	Yes	Yes	---
IP connections per system	4000	4000	---
IP connections per card	32	32	SCTP associations
Routing keys per system	---	---	---
IP connections per routing key	---	---	---

Feature	M2PA	M3UA	Notes
Application Servers per system	---	---	---
Associations per Application Server	---	---	---
Ethernet interfaces per card	2	2	Unihomed connection on either interface, multihomed using both interfaces
EAGLE 5 ISS Hardware Redundancy Model	2N	2N	---
Capacity (TPS)	5000 MSU/s	5000 MSU/s	2.5/5K is the goal
Failure mode (80%)	4000 MSU/s	4000 MSU/s	Capacity growth required at this point
Multihoming support	Yes	Yes	---
Connection model	Server	Server	---
SS7 routing	Peer to peer	Traditional least-cost based	---
Supports lossless	Yes	No	---
Supports network management	Yes	Yes	---
Number of DTA Point Codes	1	1	---
Number of internal point codes per network	1	1	---
IPTPS for System	---	---	Total pool of capacity distributed by user across IPSG link sets
IPTPS OR M3UA link set	---	System IPTPS	---
IPTPS Signaling link	---	Link set IPTPS	---
IMT Inter-Shelf Capacity, each bus, ring topology	1 Gb/sec	1 Gb/sec	Full-Duplex

SIGTRAN engineering guidelines

This section provides general SIGTRAN engineering guidelines with examples of normal and failover scenarios and resulting MSU calculations. Some overall guidelines to keep in mind include:

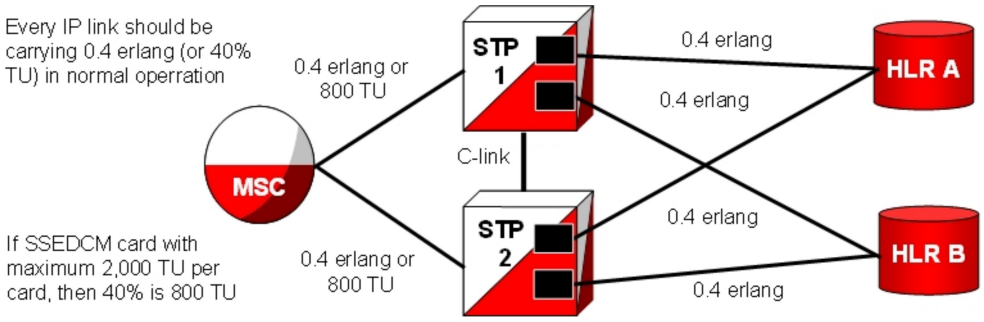
- Perform SIGTRAN engineering like TDM links
- Utilize Transaction Unit (TU/MSU) mapping
- For an IPGWx, IPLIMx or IPSG card, the total capacity per card is considered one erlang

  Erlang is a statistical measure of the volume of telecommunications traffic. Traffic of one erlang refers to a single resource being in continuous use, or two channels being at 50% use, and so on.
- In a normal scenario, run the card at a maximum of 40% total capacity or 0.4 erlang
- In failover scenarios, the card runs at 80% of total capacity or 0.8 erlang

The IPx (IPGWx, IPLIMx, and IPSG) applications can be configured as either an IPLIMx or IPSG supporting M2PA B-, C-, and D-Links; or as an IPGWx or IPSG card supporting A- and E-Links (see the note under *M3UA (MTP Level 3 User Adaptation Layer) protocol* on page 15 for more information about A-links).

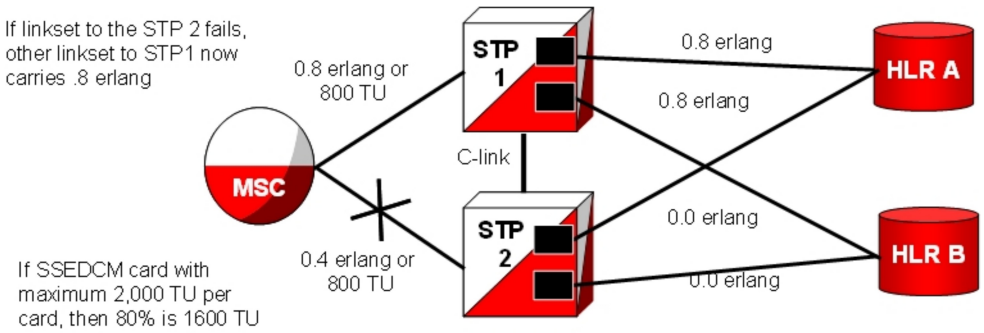
Every IP link should carry 0.4 erlang (or 40% TU) in normal operation. For an SSEDCM card with a maximum of 2,000 TU per card, 40% is 800 TU.

Figure 8: SIGTRAN: Every IP link at 0.4 erlang



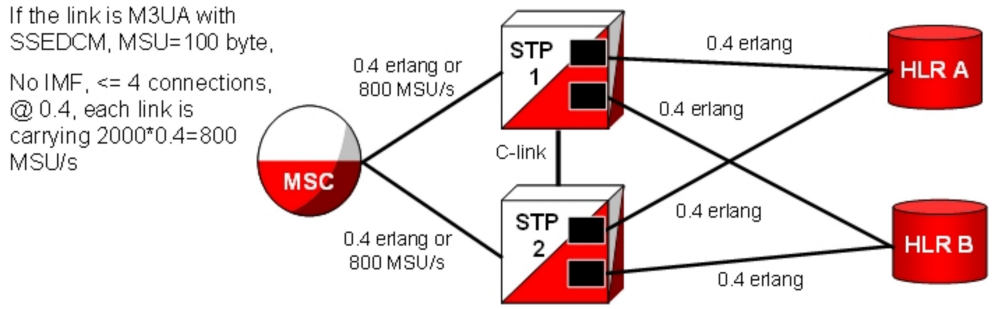
If the linkset to STP2 fails, another linkset to STP1 now carries 0.8 erlang. For an card with a maximum of 2,000 TU per card, 80% is 1,600 TU.

Figure 9: SIGTRAN: Failover at 0.8 erlang



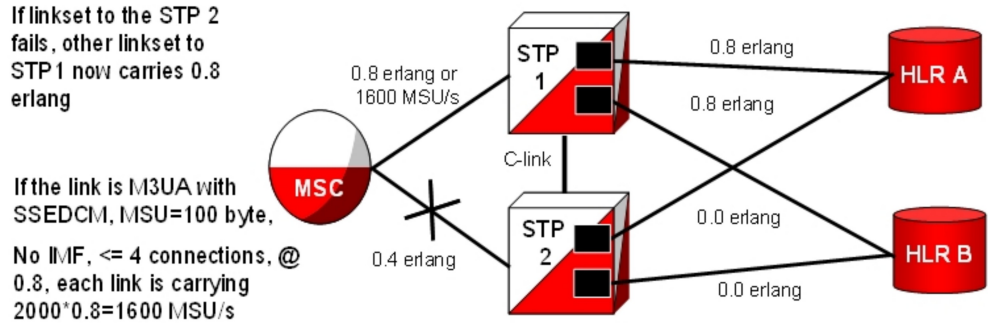
If the link is IPGWx M3UA with an SSEDCM, a 100-byte MSU, no IMF, and 4 or less connections at 0.4 erlang, each link carries 800 MSU/s (2000*0.4).

Figure 10: SIGTRAN: Every link at 0.4 erlang and 800 MSU/s



If the linkset to STP2 fails, another linkset to STP1 now carries 0.8 erlang. If the link is IPGWx M3UA with an SSEDCM, a 100-byte MSU, no IMF, and 4 or less connections at 0.8 erlang, each link carries 1600 MSU/s (2000*0.8).

Figure 11: EAGLE 5 ISS: Failover at 0.8 erlang and 1600 MSU/s



Calculate the number of cards required

Below are examples of calculations to determine how many cards are needed. These are somewhat simplified; precise calculations require data about the specific network and the traffic running over it.

Example (without monitoring)

Assumptions:

- Mated pair of Signal Transfer Points
- Customer needs 10,000 MSU/s from Mobile Switching Center to Signal Transfer Point
- Average MSU size is 100 bytes/MSU over M3UA
- Less than 5 connections per IP SSEDCM card
- No monitoring is required

Calculation:

- During normal operation, each Signal Transfer Point should handle 5000 MSU/s
- During failover operation, each Signal Transfer Point should handle 10,000 MSU/s

- Each SSEDCM over M3UA with up to 4 connections and 100 byte/MSU without monitoring can support 2000 MSU/s

So 2,000 is 1 erlang

@40% = 800 MSU/card

To support 5,000 MSU/sec @ 40% rate, we need 7 cards per Signal Transfer Point.

Example (with monitoring)

Assumptions:

- Mated pair of Signal Transfer Points
- Customer needs 10,000 MSU/s from Mobile Switching Center to Signal Transfer Point
- Average MSU size is 100 bytes/MSU over M3UA
- Less than 5 connections per IP SSEDCM card
- Monitoring is required

Calculation:

- During normal operation, each Signal Transfer Point should handle 5000 MSU/s
- During failover operation, each Signal Transfer Point should handle 10,000 MSU/s
- Each SSEDCM over M3UA with up to 4 connections and 100 byte/MSU with monitoring can support 1400 MSU/s

So 1,400 is 1 erlang

@40% = 560 MSU/card

To support 5,000 MSU/sec @ 40% rate, we need 9 cards per Signal Transfer Point.

IPLIMx linksets are permitted up to 16 links or, if one link per card, 16 cards. linksets are permitted up to 8 links; at one per card, 8 cards are allowed. An Application Server (i.e., in M3UA, a point code) is not permitted to span linkset boundaries, so the prescribed traffic rate would require a different architecture. For example, two Application Servers with different point codes could be used, one with 4 cards and one with 5 cards. A better solution, however, would be to segregate the traffic by type prior to reaching the SS7-over-IP cards, using smaller multiple servers and smaller linksets.

IPGWx congestion management options

There are two options for congestion management: either discard new messages (which is how MTP3 congestion is handled) or fail a connection.

The IPGWx application is designed to match MTP3 congestion procedures. With this option, the connection congestion status is not shared, and altering routing strategy based on congestion events is stopped. Instead, new messages destined to the congested connection are discarded, a new measurement is pegged, and response-method Transfer Controlled (TFC) messages are generated. This routing strategy only changes due to adapter state events.

A configurable timer (False Connection Congestion Timer) sets the maximum amount of time that a connection can remain congested before it is failed. This timer is similar to the MTP3 False Link Congestion timer (T31).

This Match MTP3 Congestion Procedures option has several advantages: it is simple to implement, prevents mis-sequencing during connection congestion, and notifies the originator of a discarded MSU due to the congestion. The primary disadvantage is that MSUs may be discarded that otherwise may have been transmitted (which is the same as for link congestion).

The configurable UA Parameter Set (UAPS) Timer 'False Connection Congestion Timer' allows the user to specify the maximum amount of time an association can remain congested before it is taken out of service. The default setting for the timer is 3,000 ms, the minimum is 0 ms, and the maximum setting (enforced by the IPGWx L2 software, not by the `chg-uaps` command) is 30,000 ms.

Redundancy and link engineering

A properly designed SS7 network always provides at least two physically separate ways to transmit user data. To provide the same level of redundancy using the IP-based solution, node and card redundancy can be used.

The EAGLE 5 ISS can be deployed with completely redundant IP network paths, each of which must be capable of sustaining the worst-case traffic load; or a redundancy model that relies on a mate Signal Transfer Point for IP path redundancy, although this option is less robust (and less expensive).

Unihoming versus multihoming

The EAGLE 5 ISS can be deployed with completely redundant IP network paths, each of which must be capable of sustaining the worst-case traffic load. Either of these two methods can be applied, depending on the application used:

- Unihomed links (for M2PA links)
- Multihomed links (for M2PA, M3UA and SUA links)

Unihoming

For unihoming , a set of IPLIMx or IPSG cards, which are configured for worst-case traffic load, hosts one signaling link per linkset. Each signaling link is assigned to a unihomed SCTP association, where half of the associations are assigned to one independent IP network path, and the other half are assigned to another independent IP network path. Each network path must have dedicated bandwidthsufficient to sustain the worst-case traffic load.

Multihoming

For multihoming , a set of IPLIMx or IPSG cards, which are configured for worst-case traffic load, is hosting one signaling link per linkset. Each signaling link is assigned to a multihomed SCTP association, which is mapped to an IP network having at least two completely redundant paths. Each network path must have dedicated bandwidth sufficient to sustain the worst-case traffic load.

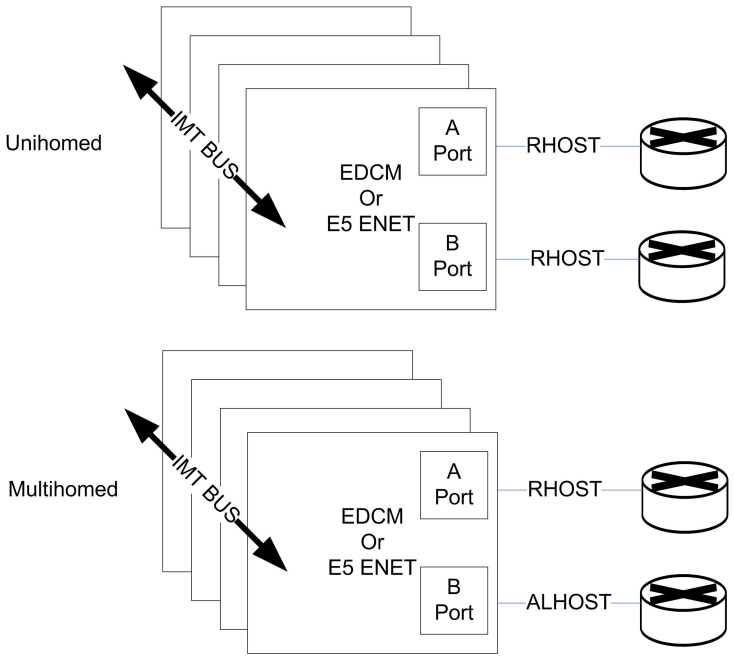
Multihoming is very important for M3UA and SUA connections because it is the only means of lossless handover in the event of a path failure.

Multihoming provides network-level resilience for SCTP associations by providing information on alternate paths to a signaling end point for a single association.

SCTP multihoming supports only communication between two end points, of which one or both are assigned with multiple IP addresses on possibly multiple network interfaces. Each IPx card maintains a single static IP route table, utilized by both Ethernet interfaces or ports. By checking the destination address in this IP route table, the router determines the port from which the message is transmitted by the IPx card.

This means that it is not possible to have a route to a single destination from both ports of an IP card – it must be one port or the other. SCTP multihoming does not support communication ends that contain multiple end points (i.e., clustered end points) that can switch over to an alternate end point in case of failure of the original end point.

Figure 12: Unihoming versus multihoming



Choosing a redundancy method for M2PA links

Unihoming is simpler to configure but more expensive than multihoming, in terms of computational power and network bandwidth to handle worst-case failure. Unihoming requires change-over procedures and rerouting if a network path is interrupted, whereas a multihomed SCTP association will simply switch to the alternate network path.

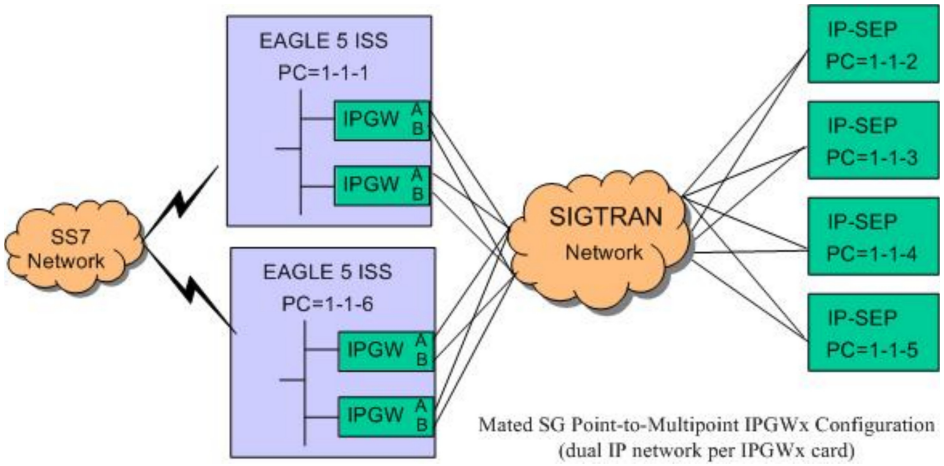
SCTP multihoming in general is less mature than MTP3 change-over procedures. In addition, the lack of ARHOST configurability in the EAGLE 5 ISS can result in asymmetrical traffic on a multihomed connection when both paths are available, which may be undesirable for the operator.

The EAGLE 5 ISS fully supports both options for M2PA, but Tekelec recommends unihoming.

Mated Signal Transfer Point redundancy

If a completely redundant IP network path is not available, then a redundancy model that relies on a mate Signal Transfer Point for IP path redundancy is supported by Tekelec. This model is less robust but also less expensive.

Figure 13: Mated Signal Transfer Point redundancy



Mated SG Point-to-Multipoint IPGWx Configuration
(dual IP network per IPGWx card)

IPGWx mateset

An IPGWx mateset is an IPGWx card linkset configuration with two mutually exclusive settings:

- Mated: Two IPGWx or IPSG linksets are allowed in a mateset by using the `matelsn` linkset parameter. The limitation of this approach is that each linkset can have only one card. This configuration for IPGWx is supported to be backward compatible with previous EAGLE 5 ISS software versions.

IPGWx status sharing

Each IPGWx and IPSG card supports up to 50 IP connections, each of which can be available or unavailable for SS7 traffic. Expanding the number of cards in a mateset also means that the worst-case number of status messages to be communicated during run-time grows by the square of the number of cards. The exponential increase in status messages can have a significant impact on IMT bus utilization.

IP destination status

Proper implementation of SS7 network management on behalf of IP-based point codes requires that the cards comprising an IPGWx linkset have a common view of destination availability. Destination availability status is based upon the availability of IP connections assigned to various routing keys. Each card must know which other cards in the linkset have connections available for a given destination. When the total count of available connections for a destination changes from 0 to 1, then a Transfer Allowed (TFA) needs to be generated. When the total count changes from 1 to 0, then a Transfer Prohibited (TFP) needs to be generated.

SS7 network status

IPGWx cards within a mateset must maintain a shared view of SS7 network status and inform IP Signaling Points of changes in this shared view. There are three kinds of SS7 network status:

- SS7 destination availability
- Route congestion status
- User part unavailability

Signaling Link Selection (SLS) routing

A Signaling Link Selection (SLS) value is a 5- or 8-bit integer (ANSI) or 4-bit integer (ITU) that is used to identify the linkset and link to which a message is to be transported.

The SLS value is included in the SLS field, which is part of the MSU's MTP routing label. The SLS is used to evenly distribute traffic across routes and links, assuming that the SLS values are randomly distributed by the originating node.

The Tekelec SS7-over-IP solution follows standard SLS load sharing with IPLIMx. With IPGWx, SLS values are distributed over the associations in the Application Servers.

LAN/WAN considerations

The operational characteristics of the LAN/WAN need to be quantified. Following is a list of general rules for the LAN/WAN environment devoted to SS7-over-IP traffic.

- Keep the number of nodes per LAN subnet as low as possible.

  The number of nodes attached to a LAN segment is a major influence in overall LAN performance. As the number of nodes increases on a LAN segment, the performance will tend to decrease due to contention for the LAN resource. For optimal performance, this number should be kept as low as possible.
- Be aware of all the node and traffic types on the LAN.
- Dedicate sufficient bandwidth to your IP Signaling traffic.

  From the SS7-over-IP perspective, there are two types of nodes: SS7-over-IP-related nodes (which are IP-equipped nodes involved in the overall signaling solution, such as the EAGLE 5 ISS, IP Service Control Points, Media Gateway Controllers and Media Gateways, and any management platforms doing work directly related to the SS7-over-IP solution); and non-SS7-over-IP nodes. Non-SS7-over-IP nodes are any other devices that could be on the LAN using LAN bandwidth, such as file servers or other hosts not directly involved in the signaling solution. If non-SS7-over-IP nodes are deployed on the same LAN as SS7-over-IP nodes, then the nodes will have to share the LAN resources.
- Restrict, or severely limit, the number of non-SS7-over-IP nodes.

  If non-SS7-over-IP nodes are on the network, their LAN throughput needs to be well understood, and the worst-case traffic from these sources needs to be considered. Normally it is easier to monitor (baseline) and predict network behavior when the nodes are similar. This is an important factor that will influence network performance.
- Plan for and allocate LAN capacity to handle worst-case scenarios.

  Consider all traffic sources and compute worst-case numbers that estimate LAN throughput, including failure scenarios that may switch traffic from one LAN to another. The evaluation of throughput should always be based on the worst-case traffic for each device.
- Monitor LAN performance and make adjustments as necessary.

  Once the network is implemented, the LAN throughput and utilization should be monitored for a period of time sufficient to fully understand the traffic on that LAN. Measure the LAN

utilization over time and ensure that it is always at an acceptable limit (<= 35 percent of maximum LAN throughput).

- Once the network is implemented, the RTT should be checked.

  Confirm that the RTT is appropriate to achieve the maximum desired throughput, and that the RTT is acceptable from the viewpoint of the applications that are originating the traffic.

IP network planning must be executed carefully to realize the benefits of SS7-over-IP deployments. Tekelec can assist with characterizing your LAN/WAN QoS parameters and engineering an SS7-over-IP solution. Contact your Tekelec Sales Representative for more information related to this Professional Service.

Retransmission concept

The Tekelec-recommended IP network environment for signaling traffic has:

- RTTs set according to traffic (see *Refine RTO parameter* on page 78)
- Minimal errors (< 0.01%)
- Minimal jitter

A transport protocol provides transport reliability through two mechanisms:

1. Explicit Data Acknowledgements: the sending side retains transmitted data until the receiving side explicitly acknowledges its receipt
2. Retransmission Timer: the sending side maintains a timer, and if the timer expires prior to receiving an acknowledgement for the transmitted data, then the sender will "retransmit" the data to the receive end

Retransmissions and destination status

When transmitting data on a multihomed association, the initial transmission is made to the primary address on the primary path. If the initial transmission times out, then the first retransmission is made to an alternate destination in a round-robin, consecutive fashion. The SCTP layer will continue to send the initial transmission of new data arriving for transmission from upper layers on the primary path.

If a unihomed SCTP endpoint is not in contact after RTIMES errors, the end point address is marked as unreachable. For multihomed associations, if an endpoint's address is not in contact after RTIMES/2 errors, the address is marked as unreachable.

An error is a failure to Selectively Acknowledge (SACK) a transmitted packet or acknowledge a heartbeat within a Retransmission Time Out (RTO). Alternate paths exchange heartbeats as a means of confirming connectivity, and failure to acknowledge heartbeats would cause an alternate destination to be marked as unreachable.

SCTP timers

Tekelec provides two retransmission modes: RFC and Linear. The SCTP retransmission control feature allows the tailoring of retransmissions to detect a network fault in a timely fashion through these configuration parameters:

- RMODE: Selects desired retransmission mode (RFC or LIN)
- RTIMES: Maximum number of retransmits attempted before the connection is declared lost (3 to 12); the default is 10
- RTO: Time to wait before the current retransmit attempt is declared a failure. This time is dynamic because it is a moving average of the network.
- RMAX: Upper bound of calculated RTO (10 ms to 1,000 ms); the default is 800; Tekelec suggests 3 * RMIN
- RMIN: Lower bound of calculated RTO (10 ms to 1,000 ms). The default is 120; Tekelec suggests the greater of (1.2 * average RTT) or (10 ms + average RTT).
- CWMIN: Minimum Congestion Window Size (1,500 to 192K); the default is 3K

RFC timer setting

With an exponential timer setting, the RTO value is doubled for each retransmit attempt. When transmitting a packet, the RTO has to expire before attempting to retransmit. With the second attempt, the last RTO value is doubled (RTO * 2) before retransmitting; with the third attempt, the last RTO value is doubled again (RTO * 4); and so on. This method significantly increases the time to determine that a link is lost.

For example, if data is being transmitted for five retransmits, the time to determine a lost link is:

```
RTO.min * Path.Max.Retransmits (or 1 + 2 + 4 + 8 + 16 + 32) = 63 sec
```

The table shows RFC timers and their RFC and Tekelec-recommended default values.

Table 14: CTP Configuration Data Descriptions for Tekelec EAGLE 5 ISS

RFC Name	Description	RFC Recommended Default Value	Tekelec Default Value	Tekelec Configurable?	Tekelec Ranges
RTO.initial	Initial RTO Value	3 seconds	120 ms	Yes Assoc RMIN parameter	1-1000 ms
RTO.max	Upper limit of RTO	60 seconds	800 ms	Yes Assoc RMAX parameter	1-1000 ms
RTO.min	Lower limit of RTO	1 second	120 ms	Yes Assoc RMIN parameter	1-1000 ms
Max.Init. Retransmits	Maximum Initial Retransmit Attempts	8 attempts	10 attempts	Yes Assoc RTIMES parameter.Not configurable independently	1-12

RFC Name	Description	RFC Recommended Default Value	Tekelec Default Value	Tekelec Configurable?	Tekelec Ranges
				of Assoc.max. retrans	
Association. max. retrans	Maximum Association Data Retransmit Attempts	10 attempts	10 attempts	Yes Assoc RTIMES parameter	1-12 ms
Path.max. retrans	Maximum Data Retransmit attempts per Destination (used for multi-homing only)	5 attempts	5 attempts	Indirectly ½ of the assoc RTIMES parameter	1-6 ms
Acknowledge-ment timer	SACK Transmit	User Configurable not to exceed 500 ms	½ RTO or 200 ms, whichever is less	Indirectly RTO is bound by the assoc RMIN and RMAX parameters	5-200 ms
T3-rtx	Timer Data Retransmit	RTO (see RTO.initial for initial value)	RTO (see RTO.initial for initial value)	Yes RTO is bounded by the assoc RMIN and RMAX parameters	10-1000 ms
T1-init	Timer Init retransmit timer	Initially 3 seconds RTO thereafter	Initially 1 second, RTO thereafter	No for initial value Indirectly thereafter via RMIN/RMAX bounding of RTO	10-1000 ms
HB.Interval	Heart Beat Interval	30 seconds	500 ms	No	500 ms
Shutdown timer	Shutdown timer t2	RTO	RTO	Indirectly	10-1000 ms

RFC Name	Description	RFC Recommended Default Value	Tekelec Default Value	Tekelec Configurable?	Tekelec Ranges
				RTO is bound by the assoc RMIN and RMAX parameters	
Cookie Timer	Cookie-t1 – Cookie Echo retransmit timer	Initially 3 seconds RTO thereafter	Initially 1 second RTO thereafter	No for initial value Indirectly thereafter via RMIN/RMAX bounding of RTO	10-1000 ms
Cookie life	Cookie Life	60 seconds	5 seconds	No	5 seconds

LIN timer setting

Tekelec has implemented a more aggressive timer method called Linear (LIN), in which the RTO between attempts is constant. Tekelec recommends this setting to detect a failure more quickly than the RFC method.

With the LIN timer setting, the time to declare the association down is at least

```
RMIN * RTIMES
```

For very high throughput associations, RTIMES (and if possible, RMIN) should be lowered and CWMIN increased. CWMIN is the parameter that sets the minimum size of the congestion window, which determines the number of packets that can be sent without having received the corresponding ACK packets.

On the far end, the LIN mode can coexist with RFC mode, but in contrast to the Signaling Gateway, the far-end may experience congestion in the ASP-to-SGP direction because of network impairments.

Jitter effects

Since the RTO is a moving average of network RTT samples, as the jitter range increases, bounding the lower limit of the RTO at or near the average will cause the amount of unnecessary retransmissions to increase, since for each transmission that takes longer than the current RTO to acknowledge a retransmission will occur, wasting bandwidth.

If the lower limit of the RTO is bounded to the upper end of the jitter range to minimize retransmits, then connection failure detection time is similarly increased.

So, minimizing jitter in the network translates into a small range for network RTT, and the RTO can be bounded to minimize retransmissions while being able to detect a loss of connection in a timely fashion.

Configure Congestion Window Minimum (CWMIN) parameter

The CWMIN parameter is important in managing traffic flow and retransmissions under varying network conditions. Changing the congestion window by setting CWMIN to a higher value affects how long it takes to recover from the retransmit event. This limits how far the window gets closed in a retransmit-event condition. In the extreme case, one could set CWMIN to the configured buffer size, which allows the entire buffer bandwidth to be used. As a general rule, setting CWMIN to a value equal to half of the traffic rate in an RTT interval should allow adequate retransmit-recovery time while preventing excessive load to the peer:

```
CWMIN = (Bytes/Sec * RTT) / 2 bytes
```

Note: Setting CWMIN to a value much higher than MTU will result in periodic intermediate node overloads. CWMIN can't be set less than 3K and should normally be set to ~64K or greater. The specific value chosen for the sender should take into account network latency, configuration, packet loss, capacity, and traffic characteristics. It is important that RMIN be set to a value greater than the expected average RTT to minimize false retransmissions.

Chapter 6

Implementation

Topics:

This chapter provides hardware information, high-level configuration steps for the IPLIMx and IPGWx applications, how to refine timers and parameters after the installation, and high-level system verification steps.

Hardware requirements

Some of the hardware requirements specific for a Tekelec SS7-over-IP network are described here. However, for a full list customized for your planned network, contact your Sales Representative.

EAGLE 5 ISS

An EAGLE 5 ISS fully configured for SS7-over-IP consists of at least one IPLIMx, IPLIMx, or IPSG application. The applications can be installed on either an SSEDCM (if IPLIMx or IPGWx) or an E5-ENET card.

A HIPR card is required in shelves equipped with E5-ENET cards. If a HIPR card is installed, all other shelves must be equipped with either all HMUX cards or all HIPR cards in one shelf; no shelf can contain a mix of HMUX and HIPR cards.

The table shows the cards and their Advertised Capacity in TPS. Also, review *Table 5: Card limits by application per node* on page 38.

Table 15: EAGLE 5 ISS IP signaling maximum capacities by card and application

EAGLE 5 ISS Card Name	IPLIMx Capacity	IPGWx Capacity	IPSG Capacity
Single-Slot Enhanced Database Communication Module (SSEDCM)	2,000	2,000	N/A
EAGLE 5 ISS Ethernet (E5-ENET)	4,000	4,000	5,000

The capacities listed in this table are achieved when the traffic carried by the application involves no feature or network attribute that requires excessive CPU, memory, or transport capacity. Rates in excess of the values shown will result in signaling link or IP connection congestion.

Integrated Message Feeder (IMF)

When monitoring IPx links using IMF, Tekelec requires that HIPR cards and at least one STC card are configured on the same shelf as the IPx cards. Only M2PA links that are RFC 4165 compliant can be monitored. A minimum of two STC cards are required per system to turn on the monitoring feature in the EAGLE 5 ISS.

When monitoring M2PA, M3UA and SUA links, the Data Feed or monitoring subsystem requires a significant amount of CPU and memory resources from the IPx cards. When enabled, this capability causes the of the IPx applications to drop well below the maximum capacity of the platform. For a detailed analysis of IP7 throughput for provisioning purposes, refer to *Tekelec internal references* on page 100.

Installation of the SS7-over-IP system includes both hardware installation and software provisioning, and is detailed in the EAGLE 5 ISS customer documentation.

Converting non-IPSG-M2PA Linksets to IPSG-M2PA Linksets

IPSG-M2PA signaling links can reside in a linkset with other non-IPGWx, non-IPSG-M2PA links. Having non-IPSG-M2PA links in a IPSG-M2PA linkset is supported to allow non-IPSG-M2PA linksets to be converted to IPSG-M2PA linksets, and should be a temporary condition. In the case of IPSG-M2PA linksets that contain other link types, the non-IPSG-M2PA links will not be subject to the configured SLKTPS. The `rept-stat-iptps` command will not report any link IP TPS data or raise link IP TPS alarms for the non-IPSG links that are not reporting IP TPS information.

Steps to convert an existing non-IPSG-M2PA linkset to an IPSG-M2PA linkset are:

1. Existing linkset (`LINKSETA`) with `IPGWAPC=NO` and `IPSG=NO` (i.e. contains links of any type except IPGW or IPSG)
2. Enter `chg-ls:lsn=LINKSETA:ipsg=YES:slktps=XXXX`
3. Provision new IPSG cards and M2PA associations
4. Add new IPSG-M2PA links to linkset and remove non-IPSG-M2PA links from linkset, soaking modifications as required

To back out the above conversion:

1. Remove IPSG-M2PA links from linkset and add original non-IPSG-M2PA links to linkset
2. Enter `chg-ls:lsn=LINKSETA:ipsg=NO`

Converting IPGWx M3UA Application Servers to IPSG-M3UA Linksets

IPGWx links and IPSG-M3UA links cannot co-exist in the same linkset for the following reasons:

- IPGWx linksets require provisioning of Routing Keys and Application Server (AS) table entries in the EAGLE to communicate with M3UA ASs; IPSG-M3UA linksets require only SS7 routes since the IPSG-M3UA linkset defines the scope of the AS.
- The M3UA AS's point code is a non-adjacent route accessed by a provisioned EAGLE Routing Key for an IPGWx linkset; this point code is the adjacent point code of an IPSG-M3UA linkset. This results in significant differences in network management behavior between IPGWx and IPSG-M3UA.
- IPSG implements IP TPS control with subtle differences from IPGWx that result in incompatibilities.

IPGWx M3UA AS must have the following attributes to qualify for conversion to IPSG-M3UA linksets:

- The Routing Key(s) used by the M3UA AS must be DPC-only; or the use of DPC-only Routing Key(s) would not degrade current or planned capability
- M3UA AS-Pending procedure using a non-zero value for T(recovery) must not be a critical function provided by the Signaling Gateway
- M3UA ASP Failure notifications must not be a critical function provided by the Signaling Gateway

- The number of IPGWx-M3UA Application Servers to be converted to IPSG-M3UA linksets must not result in the total EAGLE link or linkset limits being exceeded. A maximum of 2,000 links and 1,024 linksets are supported in EAGLE 5 ISS 38.0.
- IPGWx cards that will be redeployed as IPSG cards MUST be E5-ENET.

The method by which a customer migrates from existing IPGWx M3UA deployments to IPSG-M3UA deployments will vary based primarily on the following:

- The number of Routing Keys and ASs provisioned on the IPGWx linkset being converted
- The IPGWx redundancy model used
- The connected AS's reliance on AS procedures
- The connected AS's maximum supported number of connections and attached Signaling Gateways

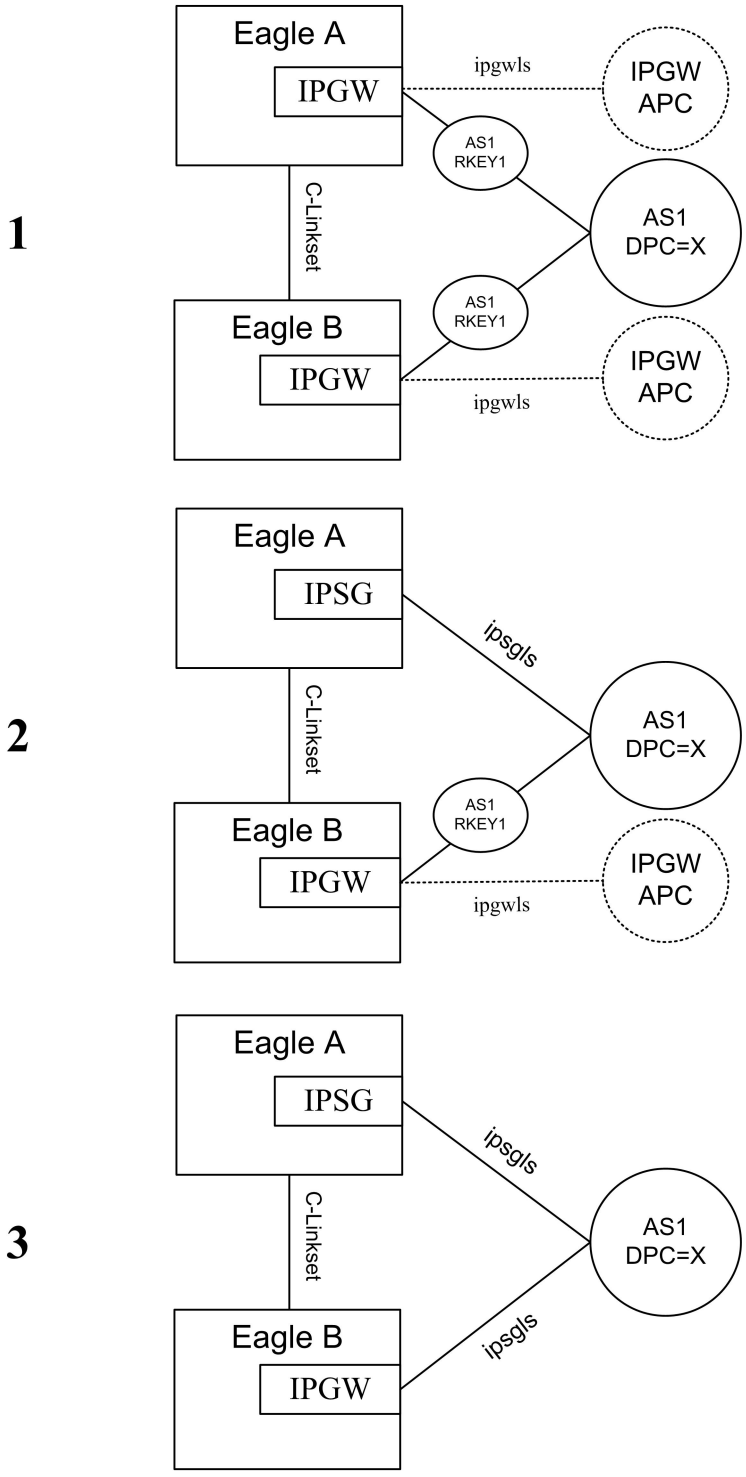
Examples of typical deployments and possible conversion strategies are listed below, but contact your Tekelec sales representative to assist in planning an actual conversion.

Since this feature does not initially provide any automated IPGWx-to-IPSG conversion functionality, it is highly recommended that ProComm scripts or other automated EAGLE provisioning functionality be used to further mitigate risk.

IPGWx to IPSG-M3UA Conversion Example 1

Figure *Figure 14: IPGWx to IPSG-M3UA Conversion Strategy Example 1* on page 64 depicts one strategy to convert a simple IPGWx deployment to IPSG-M3UA.

Figure 14: IPGWx to IPSG-M3UA Conversion Strategy Example 1



The IPGWx deployment shown in #1 of *Figure 14: IPGWx to IPSG-M3UA Conversion Strategy Example 1* on page 64 has the following attributes:

- Each STP in the mated pair of STPs utilizes a single IPGWx card to provide connectivity to AS1

- Each IPGWx card hosts a single M3UA association referenced by AS1
- AS1 is referenced by a single DPC-only Routing Key with DPC=X in each STP

The configuration shown in #2 of *Figure 14: IPGWx to IPSG-M3UA Conversion Strategy Example 1* on page 64 is a result of the following steps:

- The IPGWx signaling link in the top EAGLE is gracefully removed from service
- The Routing Keys for AS1/DPC=X and AS1 are deleted from the EAGLE database
- The M3UA association settings are recorded for use when the association is re-entered on the IPSG card
- The M3UA association is deleted from the EAGLE database
- The SS7 routes to DPC X and the IPGWx APC are deleted from the EAGLE database
- The IPGWx Signaling Link and Linkset is deleted from the EAGLE database
- The IP-CARD, IP-LNK, and IP-RTE settings for the IPGWx card are recorded. These settings are not preserved when the IPGWx card is deleted.
- The IPGWx card is deleted from the EAGLE database and entered as an IPSG card (assumes that there is an E5-ENET card in the slot)
- The IP-CARD, IP-LNK, and IP-RTE entries are updated in the EAGLE database for the new IPSG card with the setting recorded for the IPGWx card prior to its deletion
- An M3UA association is entered into the EAGLE database and is updated with any non-default settings recorded for the IPGWx association prior to its deletion
- A new IPSG-M3UA linkset with APC=X is provisioned in the EAGLE database with the appropriate SLKTPS
- A single IPSG-M3UA SLK is added to the IPSG-M3UA linkset referencing the M3UA association that is hosted by the IPSG card
- An SS7 route to DPC X over the IPSG-M3UA linkset is entered into the EAGLE database. The relative cost of this route is determined by the customer's requirements and approach to proving and soaking the IPSG-M3UA link. Initially, it may be desirable for the cost of the route over the IPSG-M3UA linkset to be higher than the cost of the route over the C-linkset; however, it should be noted that this approach will not prevent the AS from sending SS7 traffic over the IPSG-M3UA link once the IPSG-M3UA link becomes IS-NR.
- The IPSG-M3UA association is opened and SCTP connectivity is confirmed. The state of the IPSG-M3UA SLK should be `OOS-MT-DISABLED`. The state of the AS-ASP instance should be ASP-INACTIVE, assuming the ASP is not administratively blocked at the AS.
- The IPSG-M3UA SLK is activated; it's state should become IS-NR. The state of the AS-ASP instance should be ASP-ACTIVE, assuming the ASP is not administratively blocked at the AS.
- The cost of the SS7 route to DPC X in EAGLE A is adjusted as appropriate to allow/prevent EAGLE A from using the IPSG-M3UA linkset to deliver MSU traffic destined for DPC X

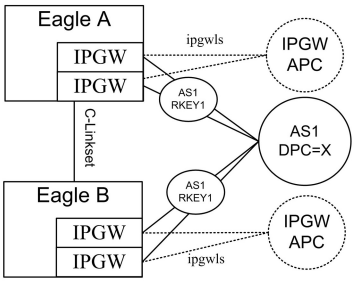
The configuration shown in #3 of *Figure 14: IPGWx to IPSG-M3UA Conversion Strategy Example 1* on page 64 is a result of utilizing the same steps used in EAGLE A to convert the IPGWx linkset in EAGLE B to IPSG-M3UA.

IPGWx to IPSG-M3UA Conversion Example 2

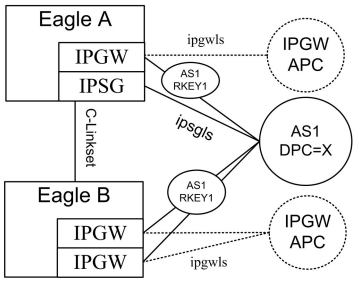
Figure 15: IPGWx to IPSG-M3UA Conversion Strategy Example 2 on page 66 depicts one strategy to convert a more complex IPGWx deployment to IPSG-M3UA.

Figure 15: IPGWx to IPSG-M3UA Conversion Strategy Example 2

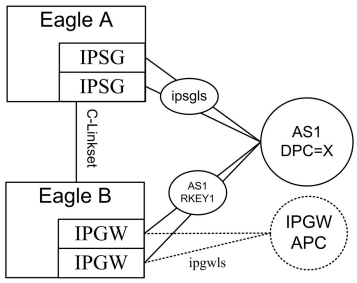
1



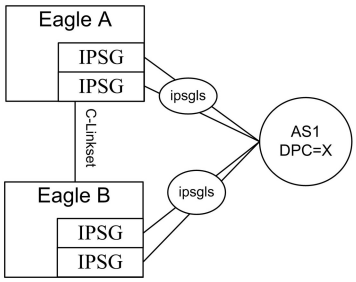
2



3



4



It should be noted that the IPGWx deployment shown in #1 of *Figure 15: IPGWx to IPSG-M3UA Conversion Strategy Example 2* on page 66 has the following attributes:

- Each STP in the mated pair of STPs utilizes two IPGWx cards to provide connectivity to AS1
- Each IPGWx card hosts a single M3UA association referenced by AS1
- AS1 is referenced by a single DPC-only Routing Key with DPC=X in each STP

The configuration shown in #2 of *Figure 15: IPGWx to IPSG-M3UA Conversion Strategy Example 2* on page 66 is a result of re-provisioning one of the IPGWx cards in EAGLE A to be a single-link IPSG-M3UA linkset with an APC of X, while leaving one of the original IPGWx links in place. From the M3UA AS's perspective, provisioning the IPSG-M3UA link in EAGLE A while the remaining IPGWx links in EAGLE A and EAGLE B are still provisioned may be viewed as:

- Effectively connecting a third Signaling Gateway to the AS; this will be true if the AS relies on AS Notifications to operate correctly, since EAGLE treats AS1 over IPGWx linkset as a separate AS than AS1 over the IPSG-M3UA linkset.

  OR

- No configuration change; this will be true if the AS does not rely on AS Notifications to operate correctly. In this case, AS notifications sent by EAGLE A are ignored by the AS and the IPSG-M3UA link is simply used as a path to the SS7 network if it is ACTIVE. The fact that the AS notifications sent by EAGLE A are not scoped across the IPGWx and the IPSG-M3UA linkset is not applicable. For ASs with this attribute, it may be desirable to disable AS notifications on the IPSG-M3UA linkset by setting the `asnotif` linkset parameter to NO.

Similar to the earlier example, the relative cost of the route to DPC X over the IPSG-M3UA linkset in #2 of *Figure 15: IPGWx to IPSG-M3UA Conversion Strategy Example 2* on page 66 is dependent on the customer's cutover strategy. It is important to note here again that the AS may begin sending SS7 traffic over the IPSG-M3UA link once the ASP becomes ACTIVE and the IPSG-M3UA link becomes IS-NR regardless of the relative cost of this route in the EAGLE.

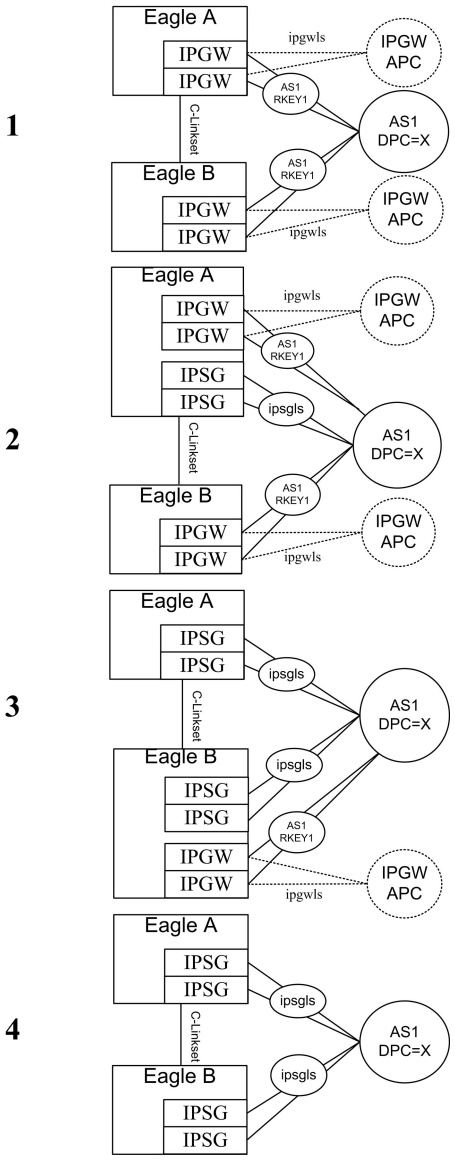
The configuration shown in #3 of *Figure 15: IPGWx to IPSG-M3UA Conversion Strategy Example 2* on page 66 is a result of re-provisioning the remaining IPGWx card in EAGLE A to be an IPSG card hosting a single IPSG-M3UA link and adding the link to the existing IPSG-M3UA linkset connected to AS1. From the AS's perspective, this change may be viewed as 1) reducing the number of connected Signaling Gateways back to the original two OR 2) no change. In either case, once the second IPSG-M3UA link is brought into service in EAGLE A, conversion activities are complete for EAGLE A.

The configuration shown in #4 of *Figure 15: IPGWx to IPSG-M3UA Conversion Strategy Example 2* on page 66 is a result of performing the same steps in EAGLE B as described for EAGLE A in steps #2 and #3.

IPGWx to IPSG-M3UA Conversion Example 2A

Figure 16: IPGWx to IPSG-M3UA Conversion Strategy Example 2A on page 68 depicts an alternative strategy to convert the IPGWx configuration from example 2 above to IPSG-M3UA.

Figure 16: IPGWx to IPSG-M3UA Conversion Strategy Example 2A



The strategy shown *Figure 16: IPGWx to IPSG-M3UA Conversion Strategy Example 2A* on page 68 in can be used to minimize risk and increase the flexibility in switching traffic between the IPGWx and IPSG-M3UA links and is dependent on: •

- The customer's willingness and ability to provision new E5-ENET cards and associated cabling and network connectivity for the IPSG links while leaving the existing IPGWx cards and associated cabling and network connectivity in place during the soak period
- The AS's ability to support the configuration shown in #2 and #3 of *Figure 16: IPGWx to IPSG-M3UA Conversion Strategy Example 2A* on page 68. As described earlier, the IPSG-M3UA linksets may be viewed by the AS as additional Signaling Gateway instances or simply additional M3UA connections to the SS7 network.

In #2 and #3 of *Figure 16: IPGWx to IPSG-M3UA Conversion Strategy Example 2A* on page 68 above, the SS7 route cost for the routes to DPC X over the IPGWx linkset, the IPSG-M3UA linkset, and the C-linkset provides maximum control over which path is used to deliver MSUs destined for

DPC X to the M3UA AS. It should be noted that multiple-link IPGWx linksets were not designed to be in combined linksets (i.e having SS7 routes to the connected ASs with equal cost to other SS7 routes in the same EAGLE) and so there exists the potential for the loadsharing across associations in a multiple link IPGWx linkset to be uneven when the IPGWx and IPSG-M3UA route costs are the same, especially if one or more SLKs or connections is not IS-NR.

Configuration

This section describes the configuration sequence for the IPLIMx, IPGWx and IPSG applications.

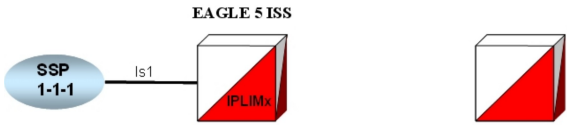
Configure the IPSG application

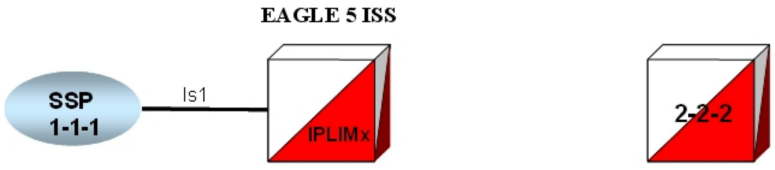
This section provides a basic overview of the steps involved to provision the IPSG application for M3UA. For detailed procedures, see the *Database Administration Manual - IP7 Secure Gateway* of your current EAGLE 5 ISS documentation suite.

1. Declare the E5-ENET card application to be ipsg (ent-card).
2. Define the IP settings for the Ethernet port (chg-ip-lnk):
   a) Declare what card and port you are defining with this command
   b) Associate an IP address to that card and port
   c) Set the Ethernet settings for the card and port
3. Associate an IP address to a host name that will be used in configuring the Association (ent-iphost).

   This step sets up a static IP address Host Table, which associates Domain Names to IP addresses so that the computer can look up Domain Names and place the corresponding IP address in the packet header. The alternative is to use a DNS server.
4. Enter an Application Server Process and bind an SCTP association with it (ent-assoc).

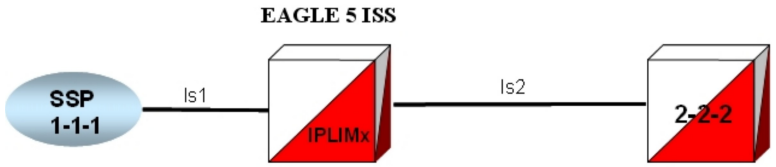
   This command configures the SCTP association in the Internet Protocol Application Socket (IPAPSOCK) table. This command permits the association to transport protocol data units and adaptive layer peer messages. Each association is connected to a process at the far end. The IPAPSOCK table is used to associate the Local Host/Local Port to a Remote Host/Remote Port.
5. Define the Site ID (chg-sid).
6. Enter adjacent point code (ent-dstn)..





7. Define capacity and use alarm (ent-ls).

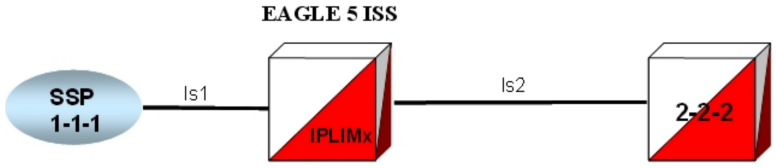
   ent-ls:lsn=ls1201:apc=10-10-10:lst=a:adapter=m3ua:ipsg=yes:rcontext=1:slktps=100



8. Tell the EAGLE 5 ISS that this is a SIGTRAN M3UA link (ent-slk).
9. Enter route (ent-rte).

SS7 Routing Table

DPC	lsn	rc
1-1-1	ls1	10
2-2-2	*ls2*	*10*



10. Allow and open the SCTP association (chg-assoc).
11. Activate signaling link (act-slk).

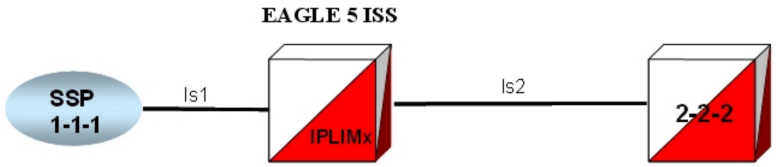
Configure the IPSG Application on the Same Card

The following series of commands may be used to provision an IPSG-M2PA link on the same card, assuming the card, IP addresses and hosts are already configured.

1. Enter an Application Server Process and bind an SCTP association with it (ent-assoc).
2. Enter adjacent point code (ent-dstn).
3. Define capacity and use alarm (ent-ls).
4. Tell the EAGLE 5 ISS that this is a SIGTRAN M2PA link (ent-slk).
5. Enter route (ent-rte).

SS7 Routing Table

DPC	lsn	rc
1-1-1	ls1	10
2-2-2	*ls2*	*10*

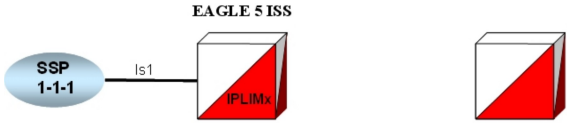


6. Allow and open the SCTP association (chg-assoc).
7. Activate signaling link (act-slk).

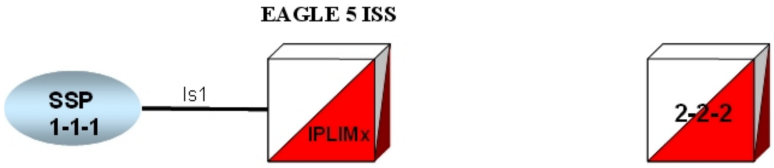
Configure the IPLIMx application

This section provides a basic overview of the steps involved to provision the IPLIMx application for M2PA. For detailed procedures, see the *Database Administration Manual - IP7 Secure Gateway* of your current EAGLE 5 ISS documentation suite.

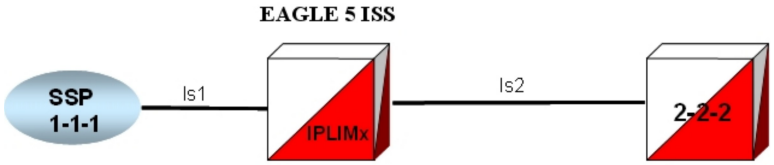
1. Declare the DCM to be iplim or iplimi (ent-card).



2. Enter adjacent point code (ent-dstn).



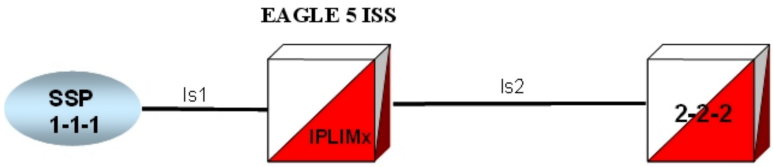
3. Define capacity and use alarm (ent-ls).



4. Tell the EAGLE 5 ISS that this is a SIGTRAN M2PA link (ent-slk).
5. Enter route (ent-rte).

SS7 Routing Table

DPC	lsn	rc
1-1-1	ls1	10
2-2-2	*ls2*	*10*



6. Define the IP settings for the Ethernet port (chg-ip-lnk):
   1. Declare what card and port you are defining with this command
   2. Associate an IP address to that card and port
   3. Set the Ethernet settings for the card and port
7. Associate an IP address to a host name that will be used in configuring the Association (ent-ip-host).

   This step sets up a static IP address Host Table, which associates Domain Names to IP addresses so that the computer can look up Domain Names and place the corresponding IP address in the packet header. The alternative is to use a DNS server.

8. Define the network devices that the DCM card will access, for example, DNS or router (chg-ip-card).
9. Define routes through routers other than the default router defined in the ent-ip-rte command (optional).

   Limits:

   - 64 routes per card
   - 1,024 routes per EAGLE 5 ISS

10. Enter an Application Server Process and bind an SCTP association with it (ent-assoc).

    This command configures the SCTP association in the Internet Protocol Application Socket (IPAPSOCK) table. This command permits the association to transport protocol data units and adaptive layer peer messages. Each association is connected to a process at the far end.

    The IPAPSOCK table is used to associate the Local Host/Local Port to a Remote Host/Remote Port.

11. Allow card (alw-card).
12. Activate signaling link (act-slk).

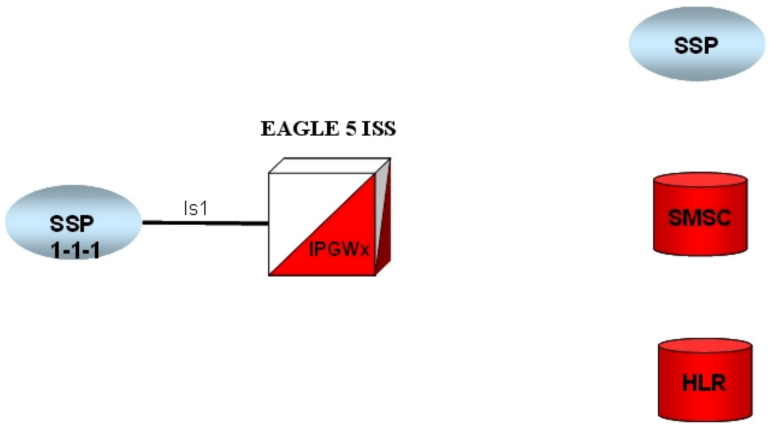
Configure the IPGWx application

This section provides a basic overview of the steps involved to provision the IPGWx application for M3UA. For detailed procedures, see the *Database Administration Manual - IP7 Secure Gateway* of your current EAGLE 5 ISS documentation suite

1. Enable the feature with the part number and feature access key (FAK) (enable-ctrl-feat).

   IPGWx IP TPS implies a true system limit. Each IPGWx linkset will have a configurable "linkset IP TPS", and the total of all the provisioned linkset IP TPS values must be less than or equal to the IPGWx system IP TPS.

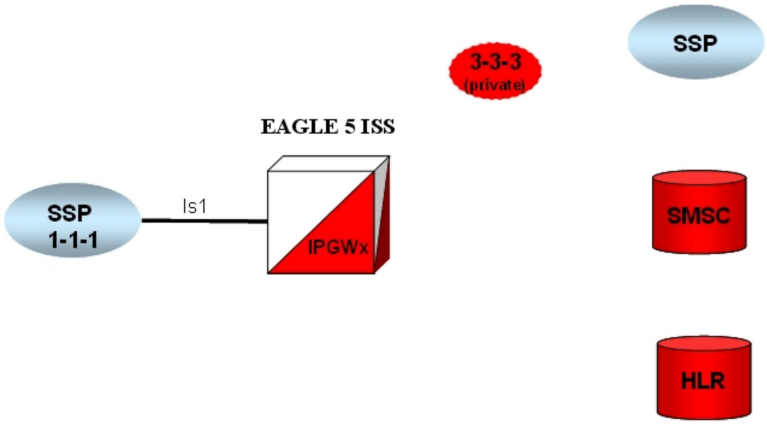
2. To help manage IPGWx system IP TPS, view the system wide IP TPS usage (rept-stat-iptps).
3. Declare the DCM to be ipgwx (ent-card).



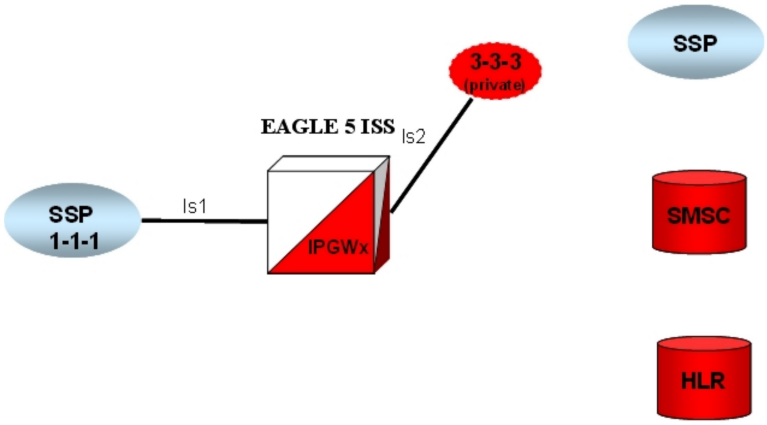
4. Enter the virtual point code (ent-dstn).

   To create a virtual IPGWx SS7 link, first create an SS7 linkset and an Adjacent Point Code (APC).

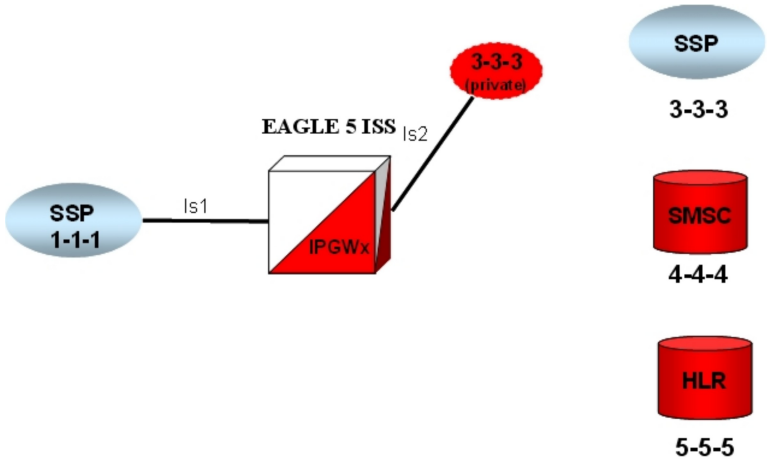
The adjacent node functionality for an IPGWx linkset is performed by the IPGWx software to provide SS7-to-IP interworking. For this reason, IPGWx APCs are referred to as "adjacent" point codes. Syntaxes that are normally not allowed for point codes, such as 0-0-1, are allowed for virtual adjacent point codes to minimize depletion of point code space. In addition, beginning with EAGLE 5 ISS 34.0, private point codes can be utilized (and are recommended by Tekelec) for IPGWx APCs. Private point codes are used for internal routing within the EAGLE 5 ISS and are not known outside of the EAGLE 5 ISS. By making APCs private, it is possible to have a point code value indicated as private and still have the same point code value (as not private) available for network configuration.



5. Define bandwidth and use alarm (ent-ls).



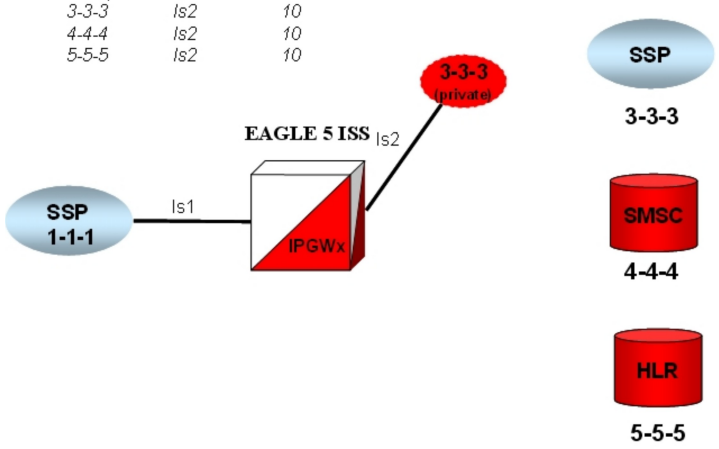
6. Tell the EAGLE 5 ISS that this is a SIGTRAN M3UA link (ent-slk).
7. Enter SEP point codes (ent-dstn).



8. Enter route (ent-rte).

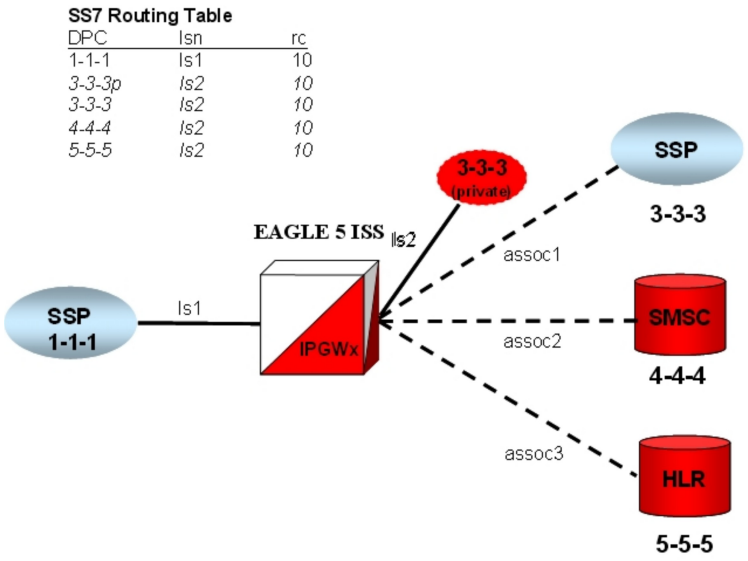
SS7 Routing Table

DPC	lsn	rc
1-1-1	ls1	10
3-3-3p	*ls2*	*10*
3-3-3	*ls2*	*10*
4-4-4	*ls2*	*10*
5-5-5	*ls2*	*10*



9. Define the IP settings for the Ethernet port (chg-ip-lnk).
10. Associate an IP address to a host name that will be used in configuring the association (entip-host).
11. Define the network devices that the DCM card will access (chg-ip-card).
12. Enter an Application Server Process and bind an SCTP association with it (ent-assoc).
13. Define the IP settings for the Ethernet port (chg-ip-lnk).

    Enter an Application Server Process and bind an SCTP association with it (ent-assoc).



Multihomed end points are SCTP associations configured with both the LHOST and ALHOST parameters specified. In this case, the LHOST represents an IP address corresponding to one of the network interfaces (A or B) of the IP application card, while the ALHOST represents an IP address corresponding to the other network interface of the same IP application card.

This command includes the rmin and rmax parameters.

14. Associate a routing key to an association name (ent-as).

    An Application Server is a logical entity serving a specific routing key or set of routing keys. The first ent-as command entered creates the Application Server, and subsequent ent-as commands add additional associations to the existing Application Server.

15. Set the network context for the message, either for the Signaling Gateway process (SGP) or application server process (ent-na)..
16. Allow card (alw-card).
17. Activate signaling link (act-slk).

Refine timers and parameters

Define RTIMES association retransmits

Set RTIMES such that an association will be marked unavailable after a reasonable amount of time based on RMODE, RMIN and RMAX.

For M2PA, this should be just after M2PA T7 expires (default 1.2 sec).

For example, consider a unihomed M2PA link with RMIN set to 100 msec and RMODE is LINEAR:

Time to mark as failed = `RMIN * RTIMES 1200 msec = 100 msec * 12`

As long as RTIMES = 12, the association will fail at about the same time MTP3 starts changeover procedures (12 is the maximum for RTIMES).

In this case, decrease M2PA T7 slightly using the chg-m2pa-tset command to guarantee that it will expire before the association is taken down.

For M3UA connections, make this a reasonable amount of time for the network, remembering that multihomed associations could be taken down after only RTIMES/2 retransmits.

Define RTO parameter

Use the ping-result average RTT measurement for calculation of RMIN

RMIN should be set to whichever is greater of 1.2 * (Avg. RTT) or (Avg. RTT) + 10 ms.

If errors are greater than 1 per 250,000, then investigate to determine if this can be improved in the network.

RMAX can be set to the worst recorded RTT and further tuned after the association has been established and `assocrtt` measured.

Measure jitter

Measure jitter by ping samples taken from the network; ideally, a relatively small subset of the samples deviate from the overall Average RTT for the network. The SCTP RMIN parameter value should be adjusted during deployment such that RMIN is approximately equal to 1.2 * Average RTT time in the network. RTT in the network should not exceed 70 ms for SSEDCMs and 120 ms for E5-ENETs.

Refine RTO parameter

After an association is established, the EAGLE 5 ISS pass command should be used to get the true RTT as experienced by the association.

1. Reset the counters: pass:loc=XXXX:cmd="assocrtt –r <assoc name>.
2. Wait a reasonable interval (preferably 24 hours) before collecting the measurements: pass:loc=XXXX:cmd="assocrtt <assoc name>.
3. Perform the sctp –g pegs or sctp –a assocname command to determine if any retransmissions have occurred.
4. Use the values reported to further tune RMIN and RMAX. Use the Weighted Average RTT in this case for defining RMIN.

```
pass:loc=1105:cmd="assocrtt c7000"

Command Accepted - Processing

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0
pass:loc=1105:cmd="assocrtt c7000"
Command entered at terminal #1

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0
PASS: Command sent to card

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0

ASSOCRTT: Association round trip time report (in milliseconds)

Retransmission Configuration
Retransmission Mode : LIN
Minimum RTO : 120
Maximum RTO : 800

Traffic Round-Trip Times

Minimum round-trip time : 5
```

```
Maximum round-trip time : 120
Weighted Average round-trip time : 10
Last recorded round-trip time : 10

Measured Congested Traffic Round-Trip Times

Minimum round-trip time : 0
Maximum round-trip time : 0
Weighted Average round-trip time : 0
Last recorded round-trip time : 0

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0
ASSOCRTT command complete
```

Define RTIMES association retransmits

Set RTIMES such that an association will be marked unavailable after a reasonable amount of time based on RMODE, RMIN and RMAX.

For M2PA, this should be just after M2PA T7 expires (default 1.2 sec).

For example, consider a unihomed M2PA link with RMIN set to 100 msec and RMODE is LINEAR:

Time to mark as failed = `RMIN * RTIMES 1200 msec = 100 msec * 12`

As long as RTIMES = 12, the association will fail at about the same time MTP3 starts changeover procedures (12 is the maximum for RTIMES).

In this case, decrease M2PA T7 slightly using the chg-m2pa-tset command to guarantee that it will expire before the association is taken down.

For M3UA connections, make this a reasonable amount of time for the network, remembering that multihomed associations could be taken down after only RTIMES/2 retransmits.

Define RTO parameter

Use the ping-result average RTT measurement for calculation of RMIN.

RMIN should be set to whichever is greater of 1.2 * (Avg. RTT) or (Avg. RTT) + 10 ms.

If errors are greater than 1 per 250,000, then investigate to determine if this can be improved in the network.

RMAX can be set to the worst recorded RTT and further tuned after the association has been established and `assocrtt` measured.

Measure jitter

Measure jitter by ping samples taken from the network; ideally, a relatively small subset of the samples deviate from the overall Average RTT for the network. The SCTP RMIN parameter value should be adjusted during deployment such that RMIN is approximately equal to 1.2 * Average RTT time in the network. RTT in the network should not exceed 70 ms for SSEDCMs and 120 ms for E5-ENETs.

Refine RTO parameter

After an association is established, the EAGLE 5 ISS pass command should be used to get the true RTT as experienced by the association.

1. Reset the counters: pass:loc=XXXX:cmd="assocrtt –r <assoc name>.
2. Wait a reasonable interval (preferably 24 hours) before collecting the measurements: pass:loc=XXXX:cmd="assocrtt <assoc name>.
3. Perform the sctp –g pegs or sctp –a assocname command to determine if any retransmissions have occurred.
4. Use the values reported to further tune RMIN and RMAX. Use the Weighted Average RTT in this case for defining RMIN.

```
;
pass:loc=1105:cmd="assocrtt c7000"

Command Accepted - Processing

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0
pass:loc=1105:cmd="assocrtt c7000"
Command entered at terminal #1

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0
PASS: Command sent to card

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0

ASSOCRTT: Association round trip time report (in milliseconds)

Retransmission Configuration
Retransmission Mode : LIN
Minimum RTO : 120
Maximum RTO : 800

Traffic Round-Trip Times

Minimum round-trip time : 5
Maximum round-trip time : 120
Weighted Average round-trip time : 10
Last recorded round-trip time : 10

Measured Congested Traffic Round-Trip Times

Minimum round-trip time : 0
Maximum round-trip time : 0
Weighted Average round-trip time : 0
Last recorded round-trip time : 0

rlghncxa03w 00-01-27 08:10:00 EST EAGLE5 31.6.0
ASSOCRTT command complete
```

System verification

Once you have finished configuring the EAGLE 5 ISS for SS7-over-IP, use the following steps to verify that it is correct. For details on the commands, see the EAGLE 5 ISS Command Manual.

Verify network connectivity

1. Is the IPLIM/IPGWx card IS-NR (In-service Normal)?

   ```
   rept-stat-card:mode=full:loc=<IP CARD location>
   ```

2. Is the Ethernet port up or down?

   ```
   rept-stat-card:mode=full:loc=<IP CARD location>
   ```

3. Are there errors on the Ethernet Interfaces? Are there collisions? CRC errors? Alignment errors? Retransmits?

   ```
   pass:loc=<IP card location>:cmd=netstat -d 0 <For Ethernet Interface A>
   ```

   ```
   pass:loc=<IP card location>:cmd=netstat -d 1 <For Ethernet Interface B>
   ```

4. Are there checksum errors?

   ```
   pass:loc=<IP card location>:cmd="netstat -p sctp
   ```

   Change the SCTP checksum if there are errors, rtrv-sg-opts will show you what checksum is set at; this must match on both ends.

5. Is the far end reachable? Does ping or traceroute work? Is the RTT acceptable? Is there Packet loss?

   ```
   pass:loc=<IP card location>:cmd=ping <far-end IP address>
   ```

   ```
   pass:loc=<IP card location>:cmd="traceroute <far-end IP Address>"
   ```

6. What is the delay or jitter of the network?

   ```
   pass:loc=<IP card location>:cmd="assocrtt <association>"
   ```

7. What is the far end advertising?

   ```
   pass:loc=<IP card location>:cmd="sctp -a association>"
   ```

Verify IPLIMx configuration

1. Is there an IPLIMx application in the system?

   ```
   rtrv-card
   ```

2. Is the IP-LNK table data filled properly? Duplex? 10 or 100 Mbps? Auto=no? IP address Correct? Subnet Mask Correct?
3. Is the IP-CARD table correct? Def router?
4. Is the IP-HOST table data filled? Local hosts specified? Remote hosts specified?
5. Are the Signaling Links built?

   ```
   rtrv-card:loc=<IP Card location>
   ```

   ```
   rtrv-slk:loc=<ip card location>:port=<SS7 port>
   ```

6. Is the IPLIMx linkset built?

   ```
   pass:loc=<IP card location>:cmd="assocrtt <association>"
   ```

7. Is the adjacent point code built in the destination and route table?

   ```
   rtrv-dstn:dpc=<far end point code>
   ```

   ```
   rtrv-rte:dpc=<far end point code>
   ```

8. Are there associations using the IPLIMx application?
   `rtrv-assoc:display=all`
9. What is the status of the associations?
   `rept-stat-assoc`
10. What is the status of the linkset?
    `rept-stat-ls:lsn=<IPLIM linkset>`
11. What is the status of the SLKs?
    `rept-stat-slk:loc=<ip card location>:port=<SS7 port>`
12. What is the status of the adjacent point code?
    rept-stat-rte:mode=full:dpc=<adjacent point code

Verify IPGWx configuration

1. Is there an IPGWx application in the system?
   `rtrv-card`
2. Is the IP-LNK table data filled properly? Duplex? 10 or 100 Mbps? Auto=no? IP address Correct? Subnet Mask Correct?
3. Is the IP-CARD table correct? Def router?
4. Is the IP-HOST table data filled? Local hosts specified? Remote hosts specified?
5. Are the signaling links built?
   `rtrv-card:loc=<IP Card location>`
   `rtrv-slk:loc=<ip card location>:port=<SS7 port>`
6. Is the IPGWx linkset built? Does it have sufficient TPS?
   `pass:loc=<IP card location>:cmd="assocrtt <association>"`
7. Is the virtual adjacent point code built in the destination and route table?
   `rtrv-dstn:dpc=<virtual adjacent point code>`
   `rtrv-rte:dpc=<virtual adjacent point code>`
8. Are the far-end point codes built in the destination and route table?
   `rtrv-dstn:dpc=<far-end point code>`
   `rtrv-rte:dpc=<far-end point code>`
9. Are there associations using the IPGWx application?
   `rtrv-assoc:display=all`
10. Is an Application Server using the associations?
    `rtrv-as`
11. Is routing built in the APPL-RTKEY table for the far end nodes? SI of 0 is not necessary.
    `rtrv-appl-rtkey:display=all`

12. What is the status of the associations?

    `rept-stat-assoc`

13. What is the status of the Application Servers?

    `rept-stat-as`

    Note: Having associations from two different IPGWx linksets in the same Application Server is an unsupported configuration.

14. What is the status of the linkset?

    `rept-stat-ls:lsn=<IPLIM linkset>`

15. What is the status of the adjacent point code?

    rept-stat-rte:mode=full:dpc=<adjacent point code

16. What is the status of the far-end point code?

    rept-stat-rte:mode=full:dpc=<far-end point code>

Chapter 7

Troubleshooting

Topics:

This chapter offers troubleshooting procedures based on symptoms occurring in the network.

General troubleshooting

1. Work from the bottom of the protocol stack up: first, IP Network; then the SS7 link or connection; then traffic routing
2. Review provisioning and verify configuration in this order:

   - Card
   - Signaling (SS7) link
   - Linkset
   - IP link or IP network
   - Association or Application Server (IPGWx only)
   - Traffic routing or SS7 route and route key (IPGWx only

   General troubleshooting tools include the following:

   - `Ethereal` – PC-based network analyzer (sniffer) – www.ethereal.com/www.wireshark.com
   - `netstat/sctp` pass commands to display TCP/IP or SCTP/IP network statistics
   - `ualog/asplog/linkinfo` pass command to retrieve logs of events in stack and control messages transmitted or received
   - `msucount` pass command to display traffic counts of MSUs that have been transmitted, received, rerouted, or discarded, and the discard reason

Verify UIMs and UAMs

If there are any Unsolicited Information Messages (UIMs) or Unsolicited Alarm Messages (UAMs) occurring related to the SIGTRAN configuration, refer to the Corrective Maintenance section in the *EAGLE 5 ISS Maintenance Manual*.

Is the card configured correctly?

1. Card in system?

   ```
   rtrv-card
   ```

   ```
   rept-stat-card
   ```

   - IP link configured correctly? (rtrv-ip-lnk; preferred settings are 100/full duplex on card AND switch - no AUTO configure)
   - IP link configured correctly? (rtrv-ip-lnk; preferred settings are 100/full duplex on card AND switch - no AUTO configure)
   - IP host table configured? (rtrv-ip-host; check for local and remote addresses)
   - Signalling links (SLKs) and linksets configured correctly? (rept-stat-slk/rept-stat-ls)

2. IP link configured correctly?

```
rtrv-ip-lnk
```

Preferred settings are 100/full duplex on card AND switch - no AUTO configure

3. IP routing configured?

```
rtrv-ip-rte
rtrv-ip-card
```

4. IP host table configured?

```
rtrv-ip-host
```

Check for local and remote addresses.

5. Signalling links (SLKs) and linksets configured correctly?

```
rept-stat-slk
rept-stat-ls
```

Connection does not become established

1. Card up and stable?

```
rept-stat-card
```

2. Association status?

```
rept-stat-assoc
```

3. Network connectivity?

```
netstat -I
rept-stat-card:mode=full
```

4. Errors (collisions, etc.) on the network interface?

```
netstat -d 0/1t
```

5. Far end reachable?

```
ping
traceroute
```

6. Near end and far end use same SCTP CRC?

```
netstat –p
sctp/rtrv-sg-opts
```

Connection bounces and is unstable

1. Transport stable?

```
netstat –i
netstat –d
```

2. RMIN set too low?

```
ping
assocrtt
rtrv-assoc
```

Rule of thumb is above 1.2 * average RTT

AS/PC in route key does not become available or ACTIVE (IPGWx only)

1. Connection in correct AS?

```
rtrv-as
```

2. Routing key provisioned for AS?

```
rtrv-appl-rtkey
```

3. Network appearance/routing context required and matched?

```
rtrv-appl-rtkey
ualog
```

4. AS/ASP activated at far end?

```
aslog
ualog
```

5. SS7 APC/SAPC and associated route exists in the same network (and group code) as the PC?

```
rtrv-rte
rtrv-ls
```

IP destination is not informed of SS7 destination status changes; network management is not working correctly (IPGWx only)

1. Route key is not provisioned for IPGWx linkset virtual APC, but SS7 route is?

```
rtrv-rte
rtrv-appl-rtkey/display-=all
```

2. AS connections hosted by cards in different linksets/matesets; is the mateset equivalent to linkset?

```
rtrv-as
```

```
rtrv-assoc
rtrv-ls
```

Traffic not arriving at IP destination or traffic is lost

1. Route to destination's PC entered and available?

   ```
   rept-stat-dstn
   ```

2. Traffic being received/discarded on IP card? IPGWx application has numerous discard reasons!

   ```
   msucount -l
   ```

Are connection(s) congesting?

1. Is SCTP buffering set correctly for network RTT?

   ```
   rtrv-assoc
   assocrtt,
   sctp
   ```

2. Is IPTPS set correctly for IPGWx?

   ```
   rept-stat-iptps
   rtrv-ls
   ```

3. Is an interface set to half-duplex somewhere in the path to the far end, causing excessive retransmissions?

   rtrv-ip-lnk

   ```
   sctp
   ```

Traffic not load-balanced properly

1. Source traffic has uneven SLS distribution?
2. All cards in linkset or mateset do not host a connection to the IP Application Server(IPGWx only)?

   ```
   rtrv-assoc
   rtrv-as
   ```

3. IPGWx cards in mateset with no established connections have signaling link deactivated to minimize 'double-hopping ' (IPGWx only)?

rept-stat-card

```
msucount -l
```

Link level events

1. IPLIM pass command

   linkinfo -l

2. IPLIMx linkinfo has other interesting options?

   ```
   -c
   ```

   ```
   -m
   ```

3. IPGWx pass command

   ualog

   ```
   aslog
   ```

4. Both commands have event filtering (link events vs. traffic), so look at options

Association

IPLIM/ pass command

```
sctp -a
```

Appendix A

Additional Deployment Scenarios

Topics:

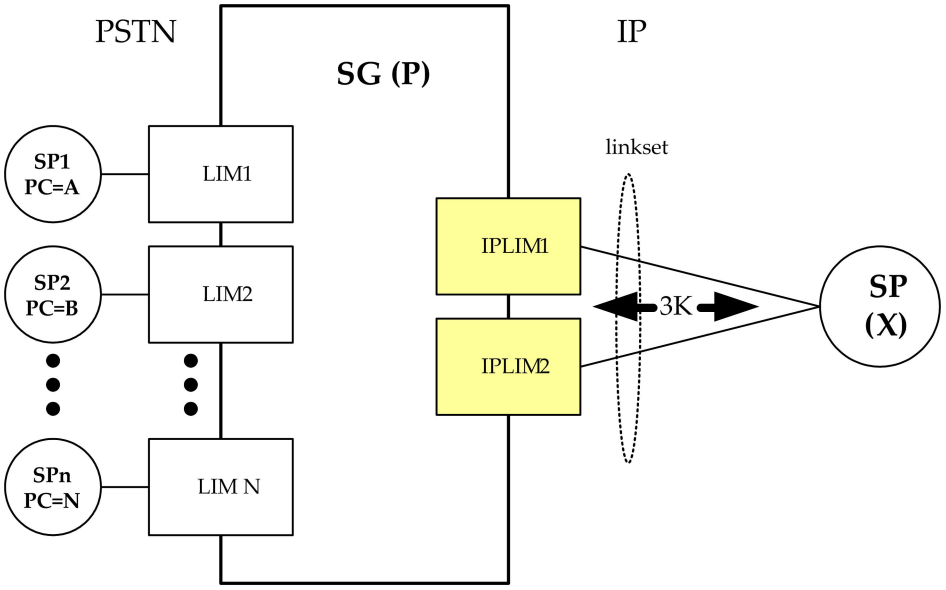
This chapter provides various additional scenarios for deployment of SS7-over-IP using SIGTRAN.

IPLIM/M2PA deployment scenarios

Simple M2PA A-link configuration (3,000 TPS)

The following figure shows a Signaling Gateway (SG) connected to an IP-based Signaling End Point (SEP) via two M2PA links, one per IPLIMx card. Each M2PA link involves an SCTP association that is multihomed across two Ethernet interfaces. This configuration provides for 2,000 TPS with a single failure.

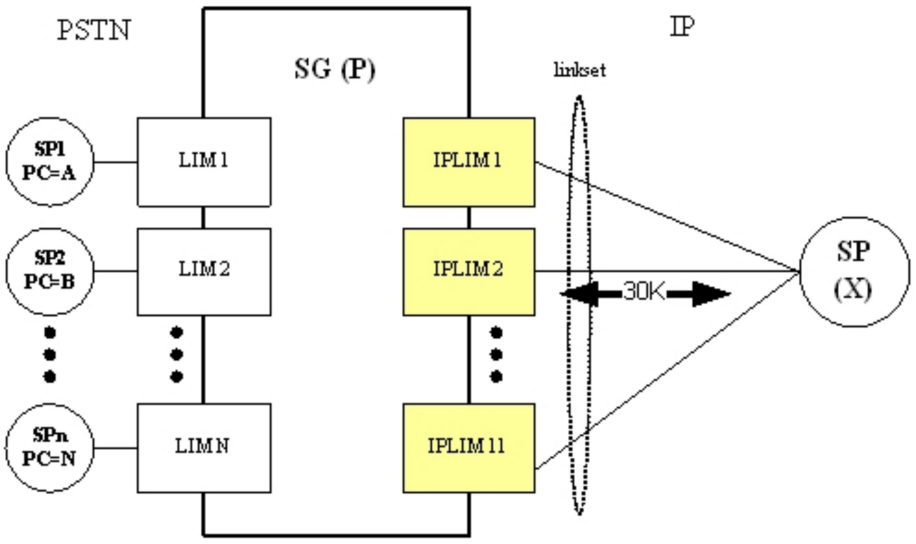
Figure 17: SG connected to IP SEP via two M2PA links



High-throughput M2PA A-link configuration (30,000 TPS)

The following figure shows a Signaling Gateway (SG) connected to an IP-based SEP via eleven M2PA links, one per IPLIMx card. Each M2PA link involves an SCTP association that is multihomed across two Ethernet interfaces. This configuration provides for 2,000 TPS with a single failure (N+1 redundancy). Up to 16 M2PA links can reside in a linkset, but the 30K TPS constraint still applies, even if 16 SSEDCMs are used.

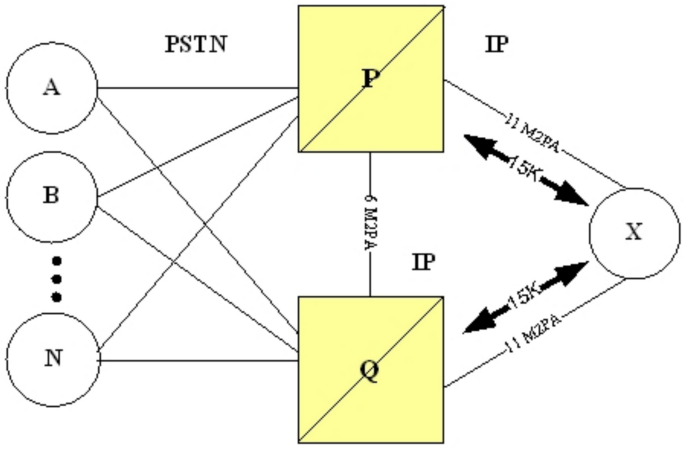
Figure 18: SG connected to IP SEP via eleven M2PA links



High-throughput M2PA C-link configuration (30,000 TPS)

The following figure shows two mated Signaling Gateways connected to an IP-based SEP. The C-links between the Signaling Gateways and the A-links to the IP signaling end point of the M2PA type. Enough C-links are provisioned to handle the case where one Signaling Gateways loses all connectivity to X. In this situation, 15K TPS unidirectional occurs for a short period of time across the C-links.

Figure 19: SG connected to IP SEP via eleven M2PA links



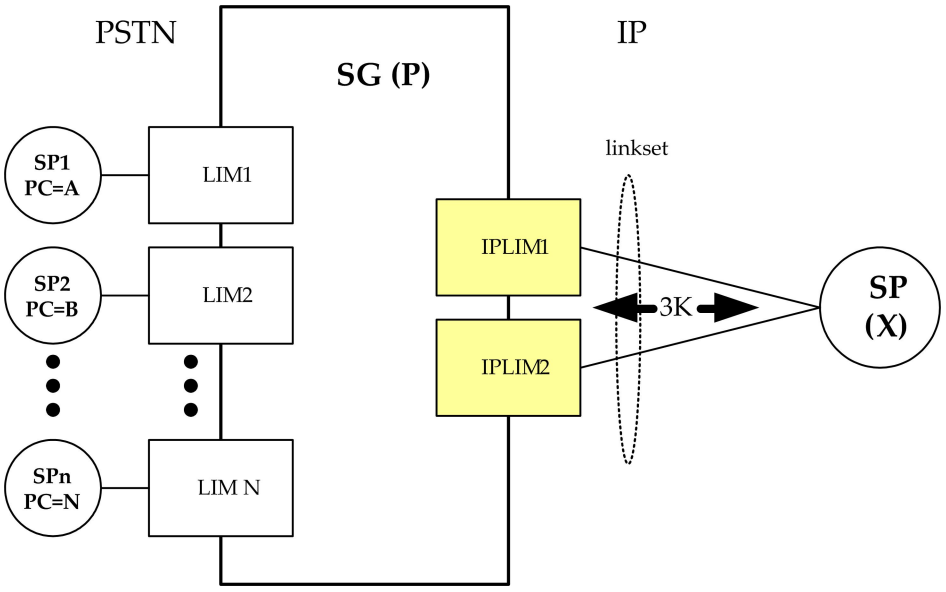
IPLIM/M2PA deployment scenarios

Simple M2PA A-link configuration (3,000 TPS)

The following figure shows a Signaling Gateway (SG) connected to an IP-based Signaling End Point (SEP) via two M2PA links, one per IPLIMx card. Each M2PA link involves an SCTP

association that is multihomed across two Ethernet interfaces. This configuration provides for 2,000 TPS with a single failure.

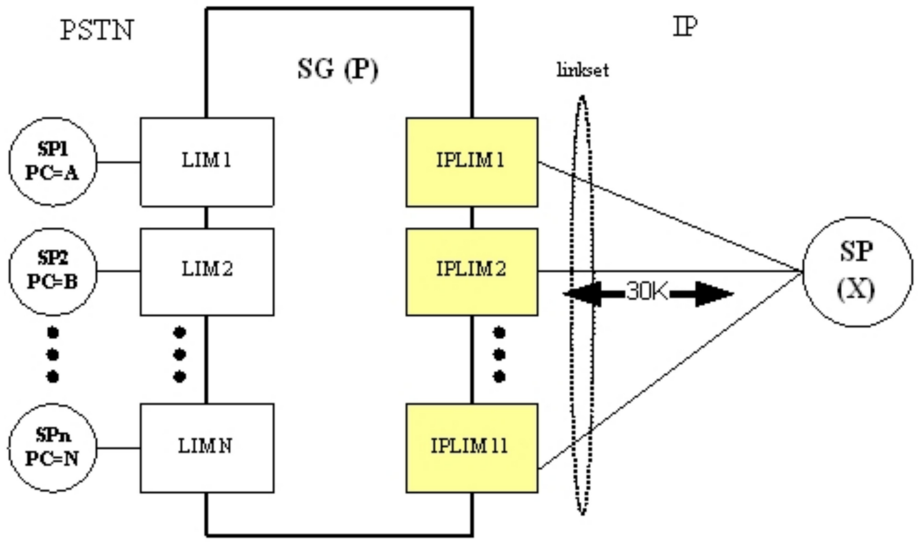
Figure 20: SG connected to IP SEP via two M2PA links



High-throughput M2PA A-link configuration (30,000 TPS)

The following figure shows a Signaling Gateway (SG) connected to an IP-based SEP via eleven M2PA links, one per IPLIMx card. Each M2PA link involves an SCTP association that is multihomed across two Ethernet interfaces. This configuration provides for 2,000 TPS with a single failure (N+1 redundancy). Up to 16 M2PA links can reside in a linkset, but the 30K TPS constraint still applies, even if 16 SSEDCMs are used.

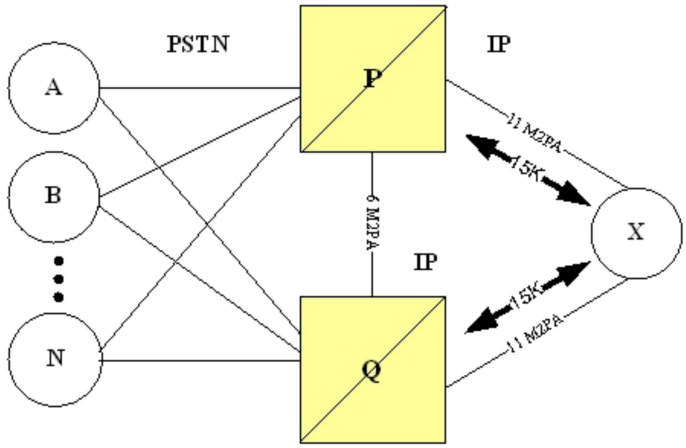
Figure 21: SG connected to IP SEP via eleven M2PA links



High-throughput M2PA C-link configuration (30,000 TPS)

The following figure shows two mated Signaling Gateways connected to an IP-based SEP. The C-links between the Signaling Gateways and the A-links to the IP signaling end point of the M2PA type. Enough C-links are provisioned to handle the case where one Signaling Gateways loses all connectivity to X. In this situation, 15K TPS unidirectional occurs for a short period of time across the C-links.

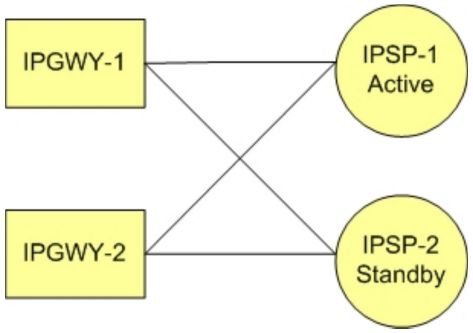
Figure 22: SG connected to IP SEP via eleven M2PA links



IPGW/M3UA deployment scenarios

Active/standby configurations

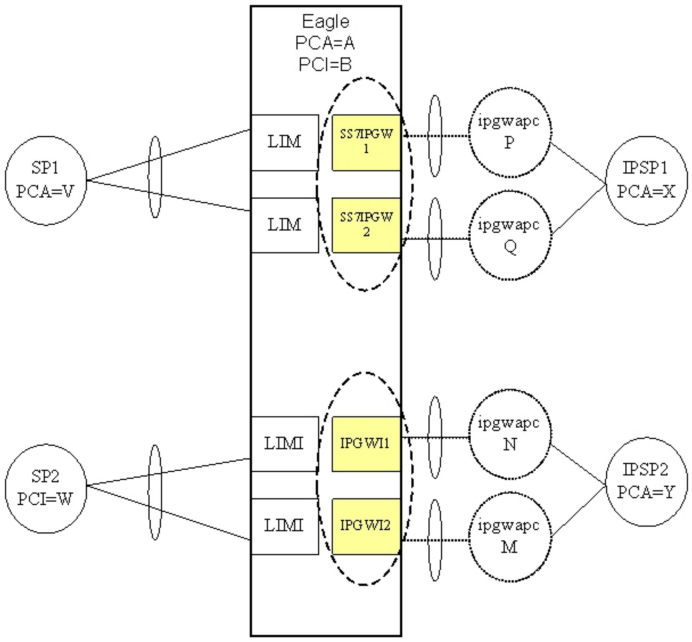
Figure 23: IPGWx active/standby configuration



- Active/standby configurations should be implemented at the IP Signaling Points (IPSPs) rather than at the EAGLE 5 ISS.
- All DCMs assigned to an IPGWx mateset should host connections to nodes comprising an Application Server and should loadshare traffic in the absence of failures. Deployments of active/standby DCMs result in excessive IMT utilization in the absence of failures due to double-hopped outbound traffic.

Two-pair IPGWx

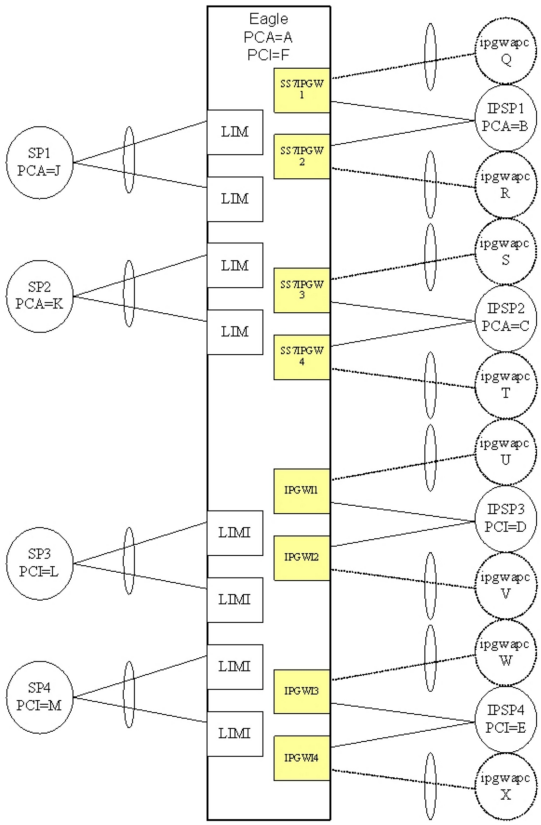
Figure 24: Two-Pair IPGWx for Maximum TPS



- Two IPGWx cards are deployed as a mateset. No more than two cards for each application are allowed.
- Each card has one signaling link, represented by a hatched line. Each IPGWx signaling link is alone in a linkset, represented by an ellipse.
- Each card has a fake adjacent signaling point represented by a hatched circle and having an IPGWx Adjacent Point Code. Each of the IPGWx linksets has an IPGWAPC.
- Two equal cost routes are provisioned for X, thereby combining the two SS7IPGW linksets. Two equal cost routes are provisioned for Y, thereby combining the two IPGWI linksets.
- Each card has one or more IP connections to the IPSP, represented by a solid line. Each IP connection has only an indirect relationship to a signaling link.
- If each card is rated at 2,000 TPS, then the maximum transaction rate to/from a point code is 2,000 TPS (1+1 redundancy), and the total system-wide TPS supported is 4,000 TPS.
- This feature will continue to allow the preceding deployment (two pairs, combined linksets) to be used, and will expand the number of deployment variations supported. It will do this by modifying the definition of a SS7IPGW or IPGWI mateset.

Four IPGWx pairs

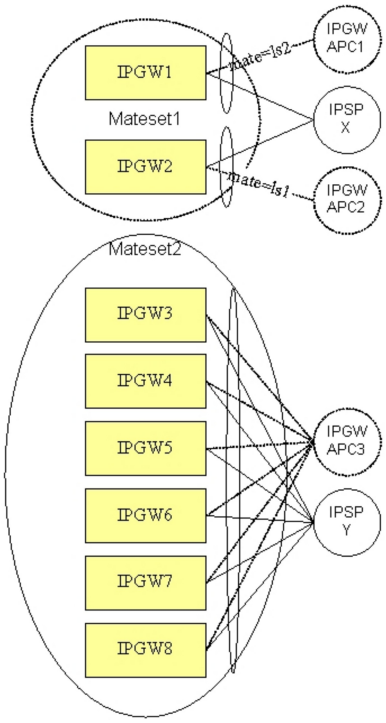
Figure 25: Four IPGWx pairs (two SS7IPW pairs and two IPGWI pairs)



- There are four IPGWx matesets, each comprised of two linksets (a combined linkset).
- Each IPSP is only connected to cards within an IPGWx mateset. No IPSP (or Application Server) crosses IPGWx mateset boundaries.
- This deployment is 1+1 redundancy.
- Another supported variation of this deployment would involve different numbers pairs or linksets, and possibly one linkset per pair.

Eight IPGWx cards

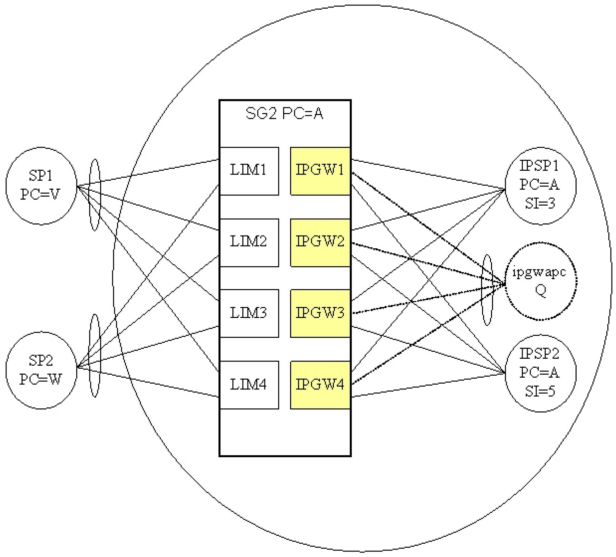
Figure 26: Eight IPGWx cards, two mates, three linksets



- Eight IPGWx cards are present, each having a single signaling link. IPGW1 and IPGW2 have their links assigned to distinct linksets. The remaining IPGWx cards have their links assigned to a common linkset.
- The route-set to PC X involves a combined linkset, i.e. two equal-cost routes
- Connectivity to the IPSPs does not cross IPGWx mateset boundaries.
- More than two IPSPs can be supported in either IPGWx mateset. The actual limit is based on IP connections and routing keys.
- Other supported variations of this deployment involve different numbers of cards in the Mateset2 or different numbers of IPSPs.

Four IPGWx cards

Figure 27: Four IPGWx cards, one linkset for end office

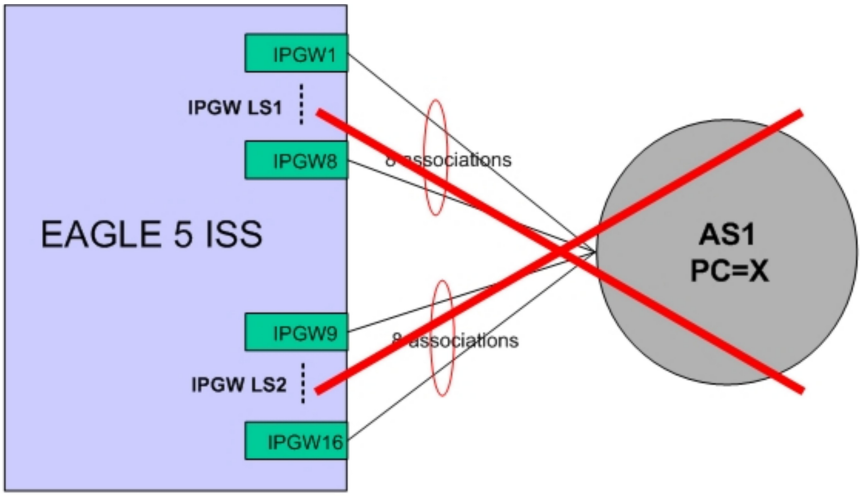


- Four IPGWx cards are present, each having a single signaling link. All of the IPGWx signaling links are assigned to a linkset having an IPGWAPC (virtual point code) of Q.
- Two IP-based signaling points or Application Servers are each connected to the full set of IPGWx cards and are distinguished by user part (SI).
- Because the IPGWx signaling links are part of a single linkset, each card cannot use TFP/TFA to divert traffic to other IPGWx cards.
- The EAGLE 5 ISS is operating in End Office Mode. This means that the IPSPs are IP-attached remote user-parts that share the true and secondary point codes of EAGLE 5 ISS (PC=A). In order to route from the inbound LIMs to the outbound IPGWx cards, an internal point code (IPC) is used.
- Because only one IPC is currently supported, only one IPGWx mateset is supported for End Office mode traffic. There can be other IPGWx matesets, but only one can serve End Office remote applications.
- Other supported variations of this deployment involve different numbers of cards in the mateset or different numbers of IPSPs.

Unsupported Scenarios

The following figure shows that the route to IPGWx linksets 1 and 2 are combined. Combined linksets are not supported.

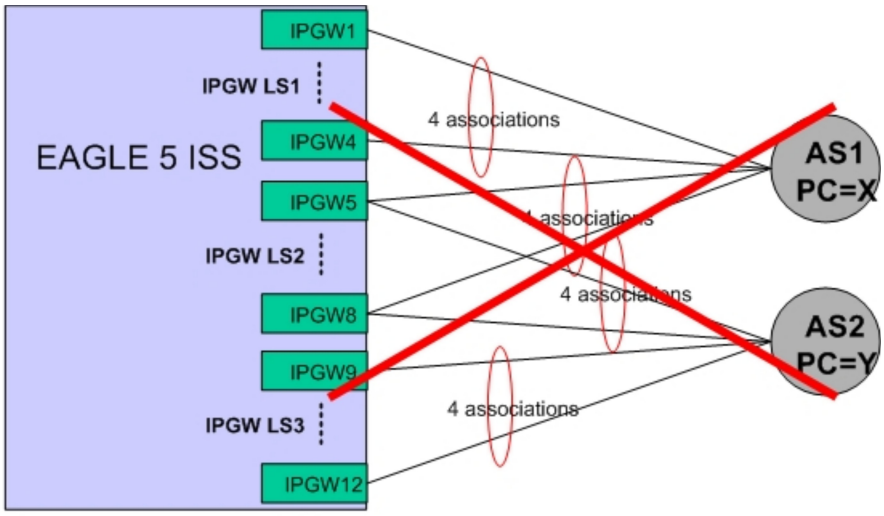
Figure 28: Unsupported deployment scenario: Combined linksets (1)



- EAGLE 5 ISS route to PC=X is a combined linkset for IPGW LS1 and IPGW LS2
- SLS determines which card in either IPGWLS1 or IPGWLS2 is chosen to send traffic to AS1
- Each card in each IPGWLS has 1 association to AS1

The following figure shows that the route to IPGWx linksets 1 and 2 are combined for AS1; and linksets 2 and 3 are combined for AS2. Combined linksets are not supported.

Figure 29: Unsupported deployment scenario: Combined linksets (2)



- EAGLE 5 ISS route to AS1 PC=X is combined linkset for IPGW LS1 and IPGW LS2
- EAGLE 5 ISS route to AS2 PC=Y is combined linkset for IPGW LS2 and IPGW LS3

Appendix B

References

Topics:

This appendix lists Tekelec-internal and external references used in this manual. Customers requiring access to Tekelec-internal references should contact their Sales Representative to obtain equivalent information. This section also provides the location of customer documentation on the Tekelec Customer Support site.

Tekelec internal references

1. Sigtran Implementation, David Prince, April 2007,
2. Tekelec Engineering Rules for Determining IP7 Application Throughput, Tekelec, TR005007
3. Engineering Rules for IP Networks for IP7 Application Deployment, Tekelec, TR002826
4. TK149 V4.1 Student Guide.ppt
5. SCTP RFC 2950 Compliance Matrix, Tekelec, CM005012
6. M2PA RFC 4165 Compliance Matrix, Tekelec, CM005086
7. M3UA RFC 4666 Compliance Matrix, Tekelec, CM005022
8. SUA RFC 3868 Compliance Matrix, Tekelec, CM005002
9. Increase System-Wide IPGWx TPS, FD005446
10. Site Survey: Message Feeder on T1000 Platform
11. SigTran_Training_24 October 06 for Customers.ppt, Tekelec
12. TK149-SIGTRAN IPLIM and IPGW Provisioning Student Guide, Rev. 4.1, Tekelec, 2007

External References

1. *Database Administration - IP7 Secure Gateway Manual* of your current EAGLE 5 ISS documentation set. Log in here to locate the manual for your specific release: *https://support.tekelec.com/*
2. *IETF RFCs* *http://tools.ietf.org/wg/sigtran/*
3. *Site Security Handbook, RFC 2196* *http://tools.ietf.org/html/rfc2196#section-1.5*
4. *BITS GUIDE TO BUSINESS-CRITICAL TELECOMMUNICATIONS SERVICES* *http://www.bitsinfo.org/downloads/Publications%20Page/bitstelecomguide.pdf*
5. *Quality of Service Technical White Paper* *http://www.microsoft.com/technet/prodtechnol/windows2000serv/plan/qosover2.mspx*
6. *Linux Bandwidth* *http://www.skywayradio.com/tech/linux/bandwidth.html*
7. *SS7 over IP Signaling Transport & SCTP* *http://www.iec.org/online/tutorials/ss7_over/index.html*

Glossary

A

AS	Application Server A logical entity serving a specific Routing Key. An example of an Application Server is a virtual switch element handling all call processing for a unique range of PSTN trunks, identified by an SS7 DPC/OPC/CIC_range. Another example is a virtual database element, handling all HLR transactions for a particular SS7 DPC/OPC/SCCP_SSN combination. The AS contains a set of one or more unique Application Server Processes, of which one or more normally is actively processing traffic.
ASP	Application Server Process A process instance of an Application Server. An Application Server Process serves as an active or standby process of an Application Server (e.g., part of a distributed virtual switch or database). Examples of ASPs are processes (or process instances of) MGCs, IP SCPs or IP HLRs. An ASP contains an SCTP end-point, and may be configured to process signaling traffic within more than one Application Server.
Association	An association refers to an SCTP association. The association provides the transport for protocol data units and adaptation layer peer messages.

B

B

bandwidth	The data rate supported by a network connection or interface; most commonly expressed in terms of bytes per second (bps).

H

hop	An intermediate connection in a string of connections linking two network devices. On the Internet, for example, most data packets need to go through several routers before they reach their final destination. Each time the packet is forwarded to the next router, a hop occurs. The more hops, the longer it takes for data to go from source to destination. You can see how many hops it takes to get to another Internet host by using the PING or traceroute utilities.

I

IMF	Integrated Message Feeder The IMF sits on the EAGLE and replicates the signaling data that is processed through the EAGLE to send to an off-board processor (the IXP in the case of IAS). Because it replicates the data (and doesn't introduce a new element in the path) it does not introduce any delay to the signaling and it does not create a separate footprint for a "probe" system.
IP	Internet Protocol IP specifies the format of packets, also called datagrams, and the addressing scheme. The network layer for the TCP/IP protocol suite widely used on Ethernet networks, defined in STD 5, RFC 791. IP is a connectionless, best-effort packet switching protocol. It provides

I

	packet routing, fragmentation and re-assembly through the data link layer.
IPGWx	Point-to-multipoint MTP-User signaling (e.g. ISUP, TCAP) over IP capability. Typicallyused for A link connectivity which require routing keys. Far End not required to support MTP3. The IPGWx GPL (IPGWI, SS7IPGW) run on the SSEDCM/E5-ENET hardware.
IPLIMx	Point-to-point MTP3 and MTP3-User signaling over IP capability. Typically used for B-C-D links but can be used for A links but does not have routing key functionality. Far End required to support MTP3. The IPLIMx GPL (IPLIMI, IPLIM) run on the SSEDCM/E5-ENET hardware.

M

M3UA	SS7 MTP3-User Adaptation Layer
Message Signaling Unit (MSU)	See MSU.
Message Transfer Part (MTP)	See MTP.

S

SCTP endpoint	The logical sender/receiver of SCTP packets. On a multihomed host, an SCTP endpoint is represented to its peers as a combination of a set of eligible destination transport addresses to which SCTP packets can be sent, and a set of eligible source transport addresses from which SCTP packets can be received. All transport addresses used by an

S

	SCTP endpoint must use the same port number, but can use multiple IP addresses. A transport address used by an SCTP endpoint must not be used by another SCTP endpoint. In other words, a transport address is unique to an SCTP endpoint.
SIGTRAN	The name given to an IETF working group that produced specifications for a family of protocols that provide reliable datagram service and user layer adaptations for SS7 and ISDN communications protocols. The most significant protocol defined by the SIGTRAN group was the Stream Control Transmission Protocol (SCTP), which is used to carry PSTN signalling over IP. The SIGTRAN group was significantly influenced by telecommunications engineers intent on using the new protocols for adapting VoIP networks to the PSTN with special regard to signaling applications. Recently, SCTP is finding applications beyond its original purpose wherever reliable datagram service is desired.
SS7	Signaling System #7
SUA	SCCP User Adaptation Layer A protocol for the transport of any SCCP-User signaling over IP using the SCTP. The protocol is designed to be modular and symmetric, to allow it to work in diverse architectures.

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