OpenSS7 Signalling Gateway Platform High-Level Design

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Abstract:

This document provides a High-Level Design for the OpenSS7 Signalling Gateway Platform.

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Notice:

Short Contents

Table of Contents

Executive Overview

This document provides a High-Level Design for the OpenSS7 Signalling Gateway Platform. The initial and primary purpose of this equipment is to provide connectivity between a legacy SS7 network and a SIGTRAN network. Because the solution attempts to avoid excessive costs associated with long- and short-haul SS7 TDM circuits, the platform benefits from using low cost commodity hardware and open source software.

The OpenSS7 Project

The OpenSS7 Project is an open source software project that has developed many protocol components within the SS7, SIGTRAN, ISDN and VoIP protocol stacks. Intellectual property rights for the OpenSS7 Project are held by OpenSS7 Corporation. All OpenSS7 Project software is eventually licensed under the GNU Affero General Public License Version 3. OpenSS7 Corporation also provides commercial licensing of OpenSS7 Project software under terms less restrictive than the AGPL.

Signalling Gateway (SG) Platform

OpenSS7 can provide Signalling Gateway Platform capabilities in a high-performance, low-cost, small-footprint platform leveraging the GNU/Linux operating system distributions and tools, and utilizing low-cost commodity hardware.

For detail on platform applications, see Chapter 2 [Application Architecture], page 9, Chapter 3 [Network Architecture], page 11, Appendix A [Optional Application Support], page 37, and Appendix B [Optional Network Support], page 39.

Open Source Software

The OpenSS7 Project leverages the widespread use of GNU/Linux operation systems, distributions, and FSF tools such as '`autoconf`' and open source software such as *RPM*. For example, this document was formatted for PDF, HTML, info and plain text using the GNU *texinfo* system, '`autoconf`', and the TeX formatting system.

The open source model avoids proprietary lock-in and permits in-house or outsourced development. All source code is available for use and modification by the end customer. All build tools, documentation and associated resources are generally available. The availability of the source code and complete documentation eases problem resolution and can offer upgrades and fixes even in advance of client problem reports.

For details on software solutions, see Chapter 7 [Protocol Architecture], page 19, Chapter 8 [Software Architecture], page 27, Appendix E [Optional Protocol Support], page 45, and Appendix F [Optional Software Support], page 47.

Commodity Hardware

By best utilizing commodity PC or standardized CompactPCI and AdvancedTCA hardware, OpenSS7 makes available the highest performance platforms available on the market at back-to-school prices. When carrier-grade is not essential, 3GHz Pentium or Xeon class servers in hardened rack mount chassis can be used at a fraction of the cost, and yet outperform, other solutions. Where carrier-grade is necessary, embedded Linux on standardized CompactPCI and AdvanceTCA NEBS compliant chassis make for a higher cost, but more reliable alternative.

For details on hardware solutions, see Chapter 6 [Platform Architecture], page 17, Chapter 9 [Hardware Architecture], page 31, and Appendix G [Optional Hardware Support], page 49.

Integrated Management

Utilizing open source management tools, such as `net-snmp` and `OSIMIS`, OpenSS7 protocol stacks provide integrated management support for SNMPv2c, SNMPv3, or CMISE/CMIP. The entire platform, from alarms to provisioning, can be provided using integrated SNMP agents.

For details on management solutions, see Chapter 6 [Platform Architecture], page 17, Chapter 10 [Management Architecture], page 33, and Appendix H [Optional Management Support], page 51.

Rapid Development

The OpenSS7 Project has already developed protocol components completing the SS7 and SIGTRAN signalling stacks including MTP Level 2 and Level 3, ISUP, SCCP, TCAP; and SCTP, M2PA, M2UA, M3UA, SUA and TUA. Development of a Signalling Gateway Platform to meet small to large scale deployment requirement needs only customization of the platform for specific needs.

For details on scheduling, see Chapter 11 [Logistics], page 35.

An Evolving Solution

The OpenSS7 Project is evolving to support more protocol stacks including ISDN and VoIP. Support for an ever expanding capability is demonstrated by the additional options available as described in Appendix A [Optional Application Support], page 37, Appendix B [Optional Network Support], page 39, Appendix E [Optional Protocol Support], page 45, Appendix F [Optional Software Support], page 47, and Appendix G [Optional Hardware Support], page 49.

Conclusions

In summary, a Signalling Gateway Platform for small and large scale deployments is an excellent application of the OpenSS7 SS7 and SIGTRAN stacks and can be provided at an affordable price on short time-lines, while offering an evolution path for future deployment applications.

Brian Bidulock
The OpenSS7 Project

Preface

Document Information

Abstract

This document provides a High-Level Design for the OpenSS7 Signalling Gateway Platform.

Objective

The objective of this document is to provide a High-Level Design for the development of a low cost, high-performance, OpenSS7 Signalling Gateway Platform using OpenSS7 protocol components, software, and compatible systems and hardware.

Intent

The intent of this document is to act as a High-Level Design for a project for an High-Level Design. As a High-Level Design, this document discusses components and systems which are not necessarily complete. OpenSS7 Corporation is under no obligation to provide any software, system or feature listed herein.

Audience

This document is intended for a technical audience. The reader should be familiar with most ETSI, ITU-T and ANSI, Signalling System No. 7 recommendations, as well as IETF drafts and RFCs for SIGTRAN protocols. Because much of the focus of a Signalling Gateway Platform is on SS7 signalling, the reader should be familiar with ITU-T, ETSI and ANSI standards regarding Signalling System No. 7 as applied to Signalling Transfer Points.

Revisions

Take care that you are working with a current version of this document: you will not be notified of updates. To ensure that you are working with a current version, contact the Author, or check The OpenSS7 Project website for a current version.

Version Control

```
$Log: sg.texi,v $
Revision 1.1.2.4  2011-08-07 11:14:29  brian
- mostly mandriva and ubuntu build updates

Revision 1.1.2.3  2011-07-27 07:52:16  brian
- work to support Mageia/Mandriva compressed kernel modules and URPMI repo

Revision 1.1.2.2  2011-02-07 02:21:36  brian
- updated manuals

Revision 1.1.2.1  2009-06-21 10:48:29  brian
- added files to new distro
```

ISO 9000 Compliance

Only the TEX, texinfo, or roff source for this document is controlled. An opaque (printed or postscript) version of this document is an **UNCONTROLLED VERSION**.

Disclaimer

Document Organization

This document is organized as follows:

Appendix B [Optional Network Support], page 39
: Additional network interface support not directly contributing to the current objective.

Appendix E [Optional Protocol Support], page 45
: Additional protocol component support not directly contributing to the current objective.

Appendix F [Optional Software Support], page 47
: Additional software support not directly contributing to the current objective.

Appendix G [Optional Hardware Support], page 49
: Additional hardware support not directly contributing to the current objective.

Appendix H [Optional Management Support], page 51
: Additional managment component support not directly contributing to the current objective.

Appendix I [Programmatic Interfaces], page 53
: Programmatic interfaces to selected protocol components.

Appendix J [Platform Sizing], page 55
: Detailed platform sizing considerations.

[Index], page 75
: Index of concepts, manual pages, etc.

1 Introduction

This document provides a High-Level Design for a platform to provide the OpenSS7 Signalling Gateway Platform capabilities. The primary driver for the OpenSS7 Signalling Gateway Platform is to provide a system that avoids the use of expensive graded long haul SS7 facilities. The document provides a high-level design and proposal for a production system to provide this capability.

The proposal utilizes, where possible, existing OpenSS7 SS7 and SIGTRAN stack components and provides a develoment plan for components that are specific to the OpenSS7 Signalling Gateway Platform requirements.

This document discusses the resulting software configuration that will be put in place on the production system, the platform configuration for the production system, and a network configuration for deployment. Also discussed is an overview of the project management logistics for successful completion over the course of this development project.

It is intended that this document be a "living" document, that is updated over the course of this development project.

1.1 The OpenSS7 Signalling Gateway

This project provides an OpenSS7 Signalling Gateway Platform that translates signalling traffic between the traditional SS7 signalling network and a SIGTRAN signalling network. The gateway also provides a basis for geographic and functional redundancy of systems within the SIGTRAN signalling network.

1.2 Project Drivers

The lead purpose of the OpenSS7 Signalling Gateway Platform is to provide a flexible and redundant Signalling Gateway front-end solution for the OpenSS7 VoIP Switch.

1.3 Scope

Because the focus on low cost, high performance, and production stability, the OpenSS7 Signalling Gateway Platform is constructed using commodity computing platforms and PCI based hardware cards, but using hardenned NEBS-3/ETSI compliant chasses in an active/standby failover configuration. This will result in a cost-effective carrier grade system for mid- to low deployment cost.

1.3.1 Phases

The longer term project is broken into the following phases:

Phase 1 The initial phase of the project is intended to provide the capabilities of the OpenSS7 Signalling Gateway Platform operation for the deployment platform.

Phase 2 The second phase of the project is intended on performing SS7 signalling interoperability testing for live deployment of the signalling gateway production platform.

Phase 3 The third phase of the project is to integrate the deployment platform with the OpenSS7 VoIP Switch using the Internet Protocol suite.

Phase 4 The fourth phase of the project is to perform interoperability testing and a field trial of the deployment platform.

Phase 5 The fifth phase of the project is to complete management system integration for remote monitoring and provisioning for production service.

1.3.2 Gates

Each phase of the project consists of seven gates. The seven gates are defined as follows:

Gate 0 — Concept
: *Gate 0* is passed when the initial concept has been elucidated and work is begun on a High-Level Design. This is an internal OpenSS7 gate.

Gate 1 — High Level Design
: *Gate 1* is passed when the high-level design has been reviewed to the satisfaction of the consumers of the project. This is an external review gate. OpenSS7 internally passes this gate once the High-Level Design has been published and work is begun on a detailed design.[1]

Gate 2 — Detailed Design
: *Gate 2* is passed when the detailed design has been reviewed to the satisfaction of the consumers of the project and the developers on the project. This is an external as well as an internal review gate. OpenSS7 passes this gate once the Detailed Design has been published and work has begun on development and implementation of the design.[2] Passing this gate moves from the design stage to the development stage of the project.

Gate 3 — Deployment and Implementation
: *Gate 3* is passed when the software and systems development and implementation to the detailed design is complete and testing has begun. This is an internal review gate. OpenSS7 internally passes this gate when software is code complete and hardware has been installed for testing.

Gate 4 — System Test
: *Gate 4* is passed once the product implementation meets all internal ad hoc and formal conformance test suites and internal testing is complete. This is an internal review gate. OpenSS7 passes this gate internally once conformance testing is complete. Passing this gate moves from the development stage to the support stage of the project.

Gate 5 — Acceptance Test
: *Gate 5* is passed once the product implementation has passed external Gamma client acceptance testing. This is an external review gate. OpenSS7 passes this gate internally once participation in external acceptance testing is complete.

Gate 6 — Project Complete
: *Gate 6* is passed once all support obligations for the product implementation have been discharged. This is an internal review gate. OpenSS7 passes this gate once support agreements have terminated.

For more details on Gate scheduling for Phase 1, 2 and 3 of the project, see Section 11.4 [Schedule], page 35.

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[1] This document is a High-Level Design document and it meets the internal requirements for passing Gate 1 of Phase 1 and Phase 2 of the project. An external review of this document by a Beta or Gamma client or sponsor is pending.

[2] OpenSS7 requires a contractual commitment for purchase from a Beta or Gamma client, or funding from a Sponsor of the OpenSS7 Project, before this gate can be passed and development started.

2 Application Architecture

The OpenSS7 Signalling Gateway Platform is intended to provide high performance, low cost Signalling Gateway services between traditional SS7 and SIGTRAN networks.

2.1 Application Background

2.2 Application Objectives

2.3 Application Requirements

Application requirements have been broken into 5 phases using the timeboxing approach.

2.3.1 Phase 1 Requirements

Phase 1 requirements provide an OpenSS7 Signalling Gateway Platform capability that will connect an existing SS7 network to application servers using M3UA.

2.3.2 Phase 2 Requirements

Phase 2 requirements provide

2.3.3 Phase 3 Requirements

Phase 3 requirements provide

2.3.4 Phase 4 Requirements

Phase 4 requirements provide

2.3.5 Phase 5 Requirements

Phase 5 requirements provide

2.4 Solution Architecture

Although the functions of *Media Gateway Controller*, *Media Gateway* and *Signalling Gateway* have been decomposed, and in the past these functional groups have been implemented on separate physical platforms, modern compute capacity and densities permit these functions to be integrated into a single physical platform without limitation. Open standard interfaces are utilized internal to the platform to permit a decomposed model to be split out and to permit ETSI Tiphon Version 4 compatibility as well as Multi-Services Forum Version 2 compatibility.

2.4.1 OpenSS7 Signalling Gateway Platform for Deployment

In light of the foregoing, the solution architecture takes the form of an integrated signalling gateway capable of providing a number of functional groups in the traditional models. The OpenSS7 Signalling Gateway Platform integrates the following functional groups while still permitting standard interfaces to be exposed for maximum deployment flexibility:

—

—

—

—

2.5 Message Flows

This section provides some illustrative application call flows:[1]

[1] This section is not intended as a *Detailed Design*, but provides illustration only for these *High-Level Design*.

3 Network Architecture

Figure 3.1 illustrates the network configuration of the OpenSS7 Signalling Gateway Platform in a typical deployment scenario. The SG platform is positioned and attached to switching equipment with A-Links, STPs with B/D-Links and Softswitches with M3UA.

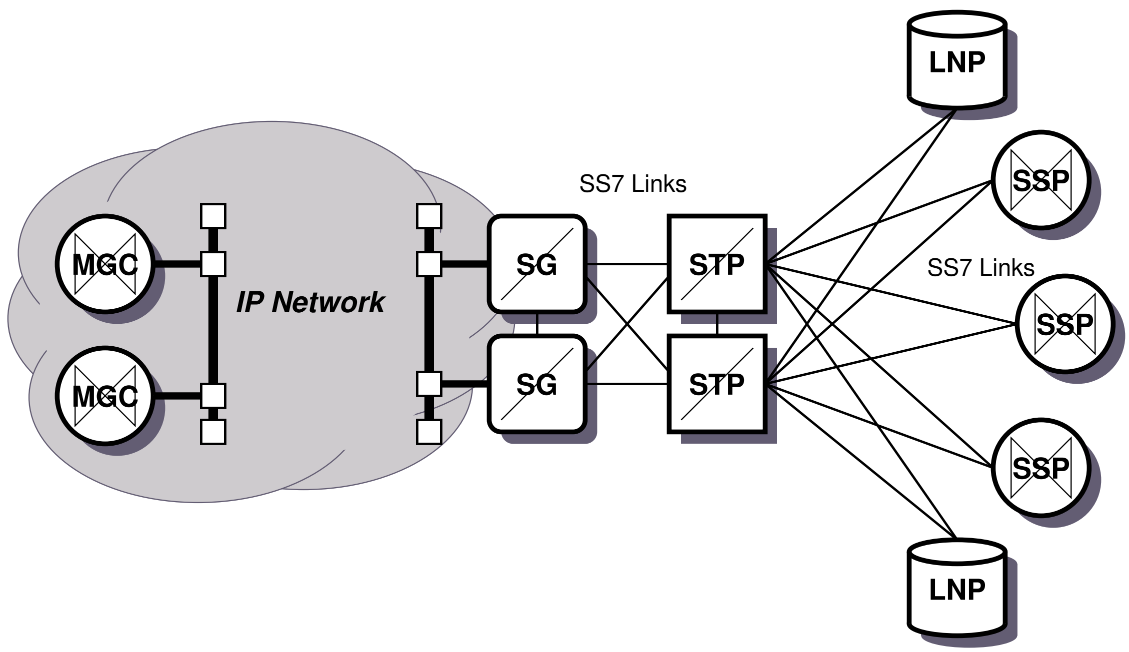

Figure 3.1: *Network Architecture*

The device is attached to STPs (Signalling Transfer Points) in the SS7 network via V401P-SS7 or other OpenSS7 SS7 link cards[1] terminating SS7 B/D-Links, either 24 channels per span (T1), 56kbps or 64kbps ANSI T1.111.3 links, or 31 channels per span (E1), 64kbps Q.703 links, or full span ANSI T1.111.3 Annex B 1.544Mbps or Q.703 Annex B 2.048Mbps high-speed links, or via a signalling gateway device terminating SS7 level 2, 3 or 4 and transporting M3UA back-haul signalling to the load device over SCTP (Stream Control Transmission Protocol).

On the IP network side of the device, the platform is connected on an internal LAN with multiple Ethernet segments and IP subnetworks. ISUP signalling originating at a Service Switching Point (SSP) within the SS7 network are accepted and responded to by MGC within the IP network. Signalling lis converted from traditional TDM SS7 to SIGTRAN over the IP network via the Signalling Gateway.

From the viewpoint of the SS7 or SIGTRAN network, the platform acts as a Signalling Gateway for the purposes of passing ISUP and LNP messages between the MGC and the remotely attached SSPs and SCPs.

[1] For other hardware alternatives, see Chapter 9 [Hardware Architecture], page 31

From the SS7 network, the SG platforms appear to be STPs and are connected with B/D-Links to an adjacent STP pair.[2]

From the IP network, the SG platforms appear in the SG as STP configuration for SIGTRAN. Although MGC's are shown within the IP network as being provided SS7 connectivity by the SG platforms, any SIGTRAN equipped SS7 user application may also be supported by this configuration.

[2] The SG platforms also support full STP operation and can locally attach SSP and SCP nodes with A-, E-, or F-links.

4 Reference Architecture

5 System Architecture

This section details the solution system architecture. The solution system architecture consists of the computing platform and it placement within the locale installation environment.

The solution system has the following requirements:

— 19" rack.

— -48 VDC electrical power.

— CO cooling.

— Bantam to RJ-48c patch pannel.

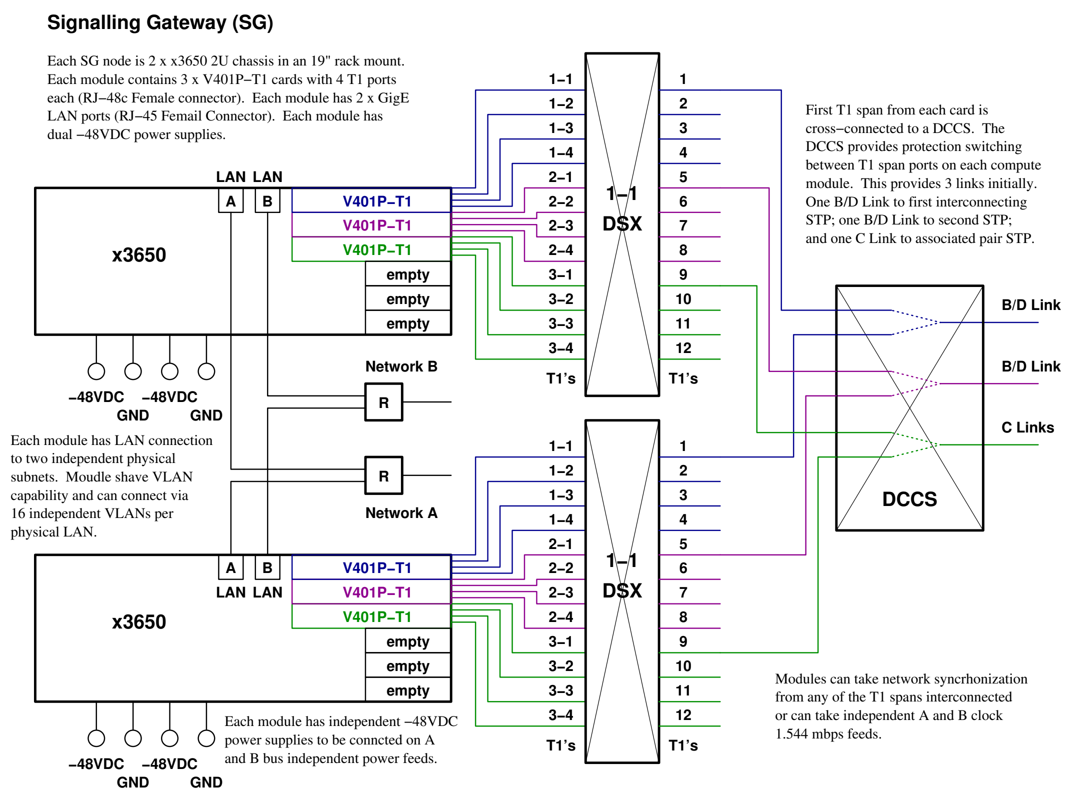

Figure 5.1: *System Architecture*

6 Platform Architecture

This section details the platform architecture. The solution platform architecture consists of the computing platform and associated hardware, interfaces and peripherals.
Figure 6.1 illustrates the solution platform rack configuration.

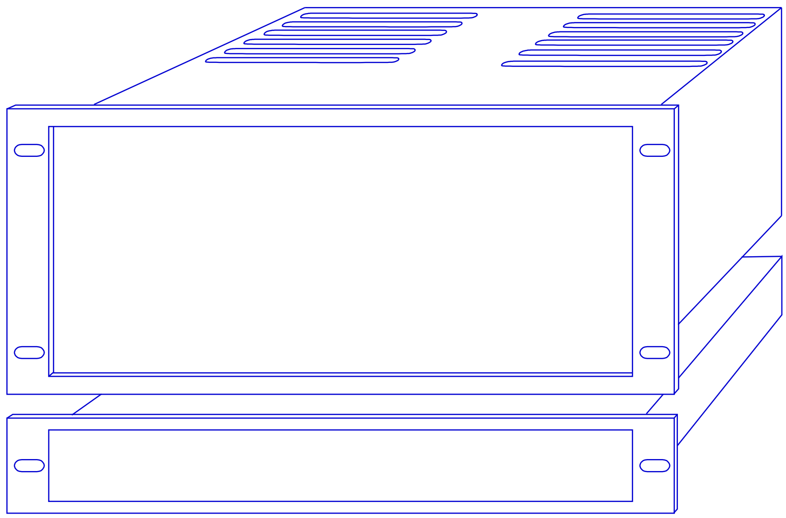

Figure 6.1: *Rack Mount Components*

The solution platform consists of the following:
— Two hardened PC (2U) chassis per system.
— Two GigE (1000baseT) RJ-48c Layer 2 Ethernet Switches.
— Two 1-1 DSX 14 T1 patch pannels.

6.1 Platform Capacity

The PC chasses is equipped with the following:[1]

- 2 x 3.2GHz Xeon class E7520 based Motherboard.
- 2 x 100MHz PCI-X 2.1 bus.
- 4G DDR memory.
- 2 x Ultra320 SCSI hard drives.
- 2 X GigE Ethernet NICs.
- 3 x V401PT Quad T1 interface cards.

[1] For detailing sizing considrations, see Appendix J [Platform Sizing], page 55.

7 Protocol Architecture

Figure 7.1 illustrates the protocol configuration of the OpenSS7 Signalling Gateway Platform system. The protocol stack uses the following OpenSS7 stack components:

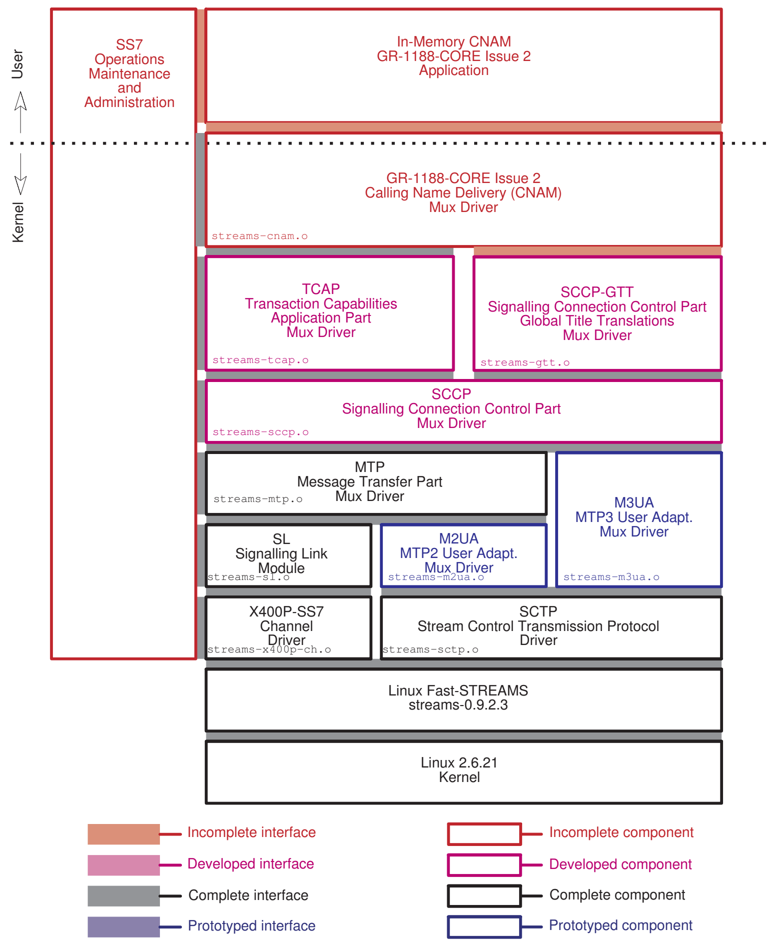

Figure 7.1: *Protocol Architecture*

7.1 Protocol Components

The following Protocol Components are provided as part of the OpenSS7 SS7 and SIGTRAN stacks:

7.1.1 SS7/SIGTRAN Stack Manager

7.1.2 SCCP User Adaptation Layer (SUA) Driver

The SUA driver provides the SG with the ability to act as an SUA SG (Signalling Gateway) in conjunction with an SUA AS (Application Server). In this project, the SG function is performed by the OpenSS7 Signalling Gateway Platform. The SUA driver accepts the trasnport of SCCP to SCCP-User interface form the SG to the AS. The SUA driver links SCTP driver streams underneath it to provide the transport services for exporting the MTP-User interface. The SUA driver provides the same interface to its users as the OpenSS7 SCCP.

The SUA driver is a STREAMS driver that runs int he Linux kernel for maximum performance.

This is an existing OpenSS7 SIGTRAN stack component: for documentation, see: `sua(4)`. *Phase 1* activities for SUA include integration testing with the SG components.

7.1.3 Signalling Connection Control Part (SCCP) Driver

The Signalling Connection Control Part driver performs the essential transport functions of the SS7 signalling stack. Message Transfer Part or MTP3 User Adaptation Layer streams are linked under the driver and the driver provides the functions of a SCCP endpoint or relay with full global title translations. Signalling Connection Control Part streams bound to TCAP SCCP-SAPs are linked under the TCAP driver to form a complete SS7 stack in support of call transactions.

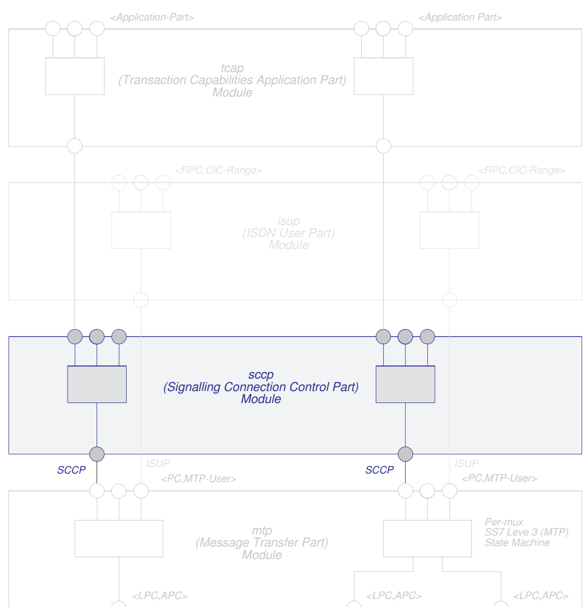

Figure 7.2: *Signalling Connection Control Part (SCCP) Module*

The SCCP driver supports all CCITT/ITU-T versions (Blue Book forward), ETSI and ANSI versions (1992 forward), including both connectionless and connection-oriented protocol classes 0 through 3. The SCCP driver provides an extended NPI Revision 2.0 interface to its users and accepts an NPI Version 2.0 (Connectionless) MTP interface from beneath or a specialized OpenSS7 MTPI interface. In addition, a TPI Revision 2.0 user interface supporting an X/Open XNS 5.2 XTI library interface is provided.

The SCCP driver also provide GTT streams for servicing Global Title Translations requests. These streams can be used by a user-space program for servicing GTT requests from a local or remote database, or can have specialized STREAMS modules pushed to perform rule-based GTT in the operating system kernel.

The SCCP driver is a STREAMS driver that runs in the Linux kernel for maximum performance.

The Signalling Connection Control Part (SCCP) STREAMS module is responsible for providing SCCP services on top of a Message Transfer Part (MTP) Level 3 (MTP3) or MTP3-User Adaptation Layer (M3UA) stream. In addition, it is possible to use an ISO/OSI connectionless Network Service Provider to provide the network services to SCCP.

The OpenSS7 SCCP component has message encoding and decoding for ITU-T/ETSI and ANSI SCCP. Interfaces provided to SCCP users include an XTI/OSI capable TPI Revision 2.0 interface, an NPI Revision 2.0 interface, and an SCCP-specific interface.

The OpenSS7 SCCP module supports all Protocol Classes.

This is an existing OpenSS7 SS7 stack component; for documentation, see: sccp(4). *Phase 1* activities for SCCP include integration testing with the SG components.

7.1.3.1 Global Title Translations (GTT)

The Signalling Connection Control Part (SCCP) Global Title Translations (GTT) module is responsible for responding to SCCP-GTT translations originating from the SCCP module beneath and is responsible for generating outgoing SCCP-GTT translations to the SCCP module beneath. To perform its function, the SCCP-GTT indexes all information based on the SCCP Address, including dynamic (state) and provisioned (result) information. For performance in both a testing and production environment, the module provides three levels of database partitioning and caching:

Rules
: Rules can be provided that are used to determine provisioned information based on components of the index (GT). These rules can be used to generate a rather large simulated database without maintaining or accessing large database record areas. The rule base provides a simulated partitioned database. Each rule refers to a template or partial template of provisioned data.

Templates
: Templates can be provided that specify a profile of provisioned information for a class of indexes (GT). Templates provide a compact local in-kernel cache of templates. Indexes reference templates rather than complete records.

Records
: Records can be provided that specify the provisioned information for the specific index (GT). Records provide a local in-kernel cache of specified records. Records are unique for each index.

Translations
: The application can be queried by indicating the index (GT) and the module awaits a response containing the provisioned information. Translations provide access to an external database or algorithm.

: For the High Performance GSM/UMTS GPRS HLR application, messages can be routed on Translation Type or on the basis of the Subsystem Number alone, resulting in a simple rule provided to the SCCP-GTT. If the High Performance GSM/UMTS GPRS HLR application is not expected to perform in any other role, the High Performance GSM/UMTS GPRS HLR application can bind as the "Default Destination" for all SCCP Unitdata messages, obviating the need for GTT.

This is an existing OpenSS7 SS7 stack component; for documentation, see: sccp(4). *Phase 1* activities for SCCP include integration testing with the SG components.

7.1.4 MTP Level 3 User Adaptation Layer (M3UA) Driver

The M3UA driver provides the SG with the ability to act as an M3UA SG (Signalling Gateway) in conjunction with an M3UA AS (Application Server). In this project, the SG function is performed by the OpenSS7 Signalling Gateway Platform. The M3UA driver accepts the transport of the MTP to MTP-User interface from the SG to the AS. The M3UA driver links SCTP driver streams underneath it to provide the transport services for exporting the MTP-User interface. The M3UA driver provides the same interface to its users as the OpenSS7 MTP.

The M3UA driver is a STREAMS driver that runs in the Linux kernel for maximum performance.

This is an existing OpenSS7 SIGTRAN stack component; for documentation, see: `m3ua(4)`. *Phase 1* activities for M3UA include integration testing with the SG components.

7.1.5 Message Transfer Part (MTP) Driver

The message transfer part driver performs the essential network functions of the SS7 signalling stack. M2UA streams (see below) may be linked under the driver and the driver provides the functions of a Signalling End Point (SEP) or Signalling Transfer Point (STP).[1]

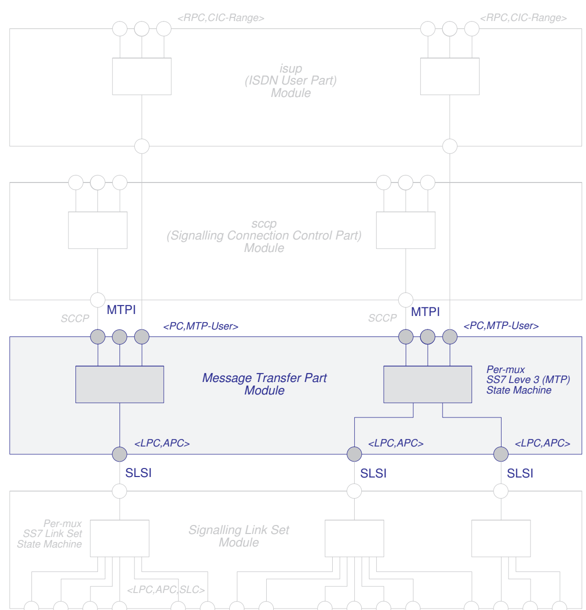

Figure 7.3: *Message Transfer Part (MTP) Level 3 (MTP3) Module*

The MTP driver supports all CCITT/ITU-T versions (Blue Book forward), ETSI and ANSI versions (1992 forward), including full transfer function. The MTP driver provides a specialized MTP interface to its users, in addition to an NPI Revision 2.0 connectionless interface. A TPI Revision 2.0 (connectionless) user interface support X/Open XNS 5.2 XTI library functions is also provided.

The MTP driver is a STREAMS driver that runs in the Linux kernel for maximum performance.

The Message Transfer Part (MTP) Level 3 (MTP3) module is responsible for providing MTP services to its users.

[1] Message Transfer Part streams bound to ISUP MTP-SAPs are linked under the ISUP driver above to form a complete SS7 stack in support of call switching. Message Transfer Part streams bound to SCCP MTP-SAPs are linked under the SCCP driver above to form a complete SS7 stack in support of transaction services.

The Message Transfer Part (MTP) Level 2 (MTP2) module is responsible for providing MTP services to its users.

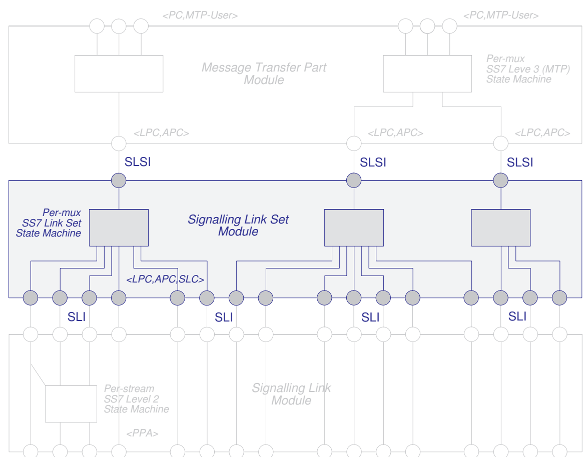

Figure 7.4: *Message Transfer Part (MTP) Level 2 (MTP2) Module*

These are an existing OpenSS7 SS7 stack components; for documentation, see: `mtp(4)`. *Phase 1* activities for MTP3 and MTP2 include integration testing with the SG components.

7.1.6 MTP Level 2 User Adaptation Layer (M2UA) Driver

The M2UA driver provides the SG with the ability to act as both an M2UA SG (Signalling Gateway) and an M2UA AS (Application Server). In this project, the both the SG and AS functions are performed by the OpenSS7 Signalling Gateway Platform. M2UA is used primarily for redundancy between internal nodes of the SG. The M2UA driver accepts the transport of SL to SL-User interface from the SG to the AS.[2] The M2UA driver links SCTP driver streams underneath it to provide the transport services for exporting the SL-User interface. The M2UA driver provides the same interface to its users as the OpenSS7 SL.

The M2UA driver is a STREAMS driver that runs in the Linux kernel for maximum performance.

This is an existing OpenSS7 SIGTRAN stack component: for documentation, see `m2ua(4)`. *Phase 1* activities for M2UA include integration testing with the SG components.

7.1.7 Signalling Link Multiplexing (SL-MUX) Driver

The SL-MUX is a Signalling Link Multiplexing (SL-MUX) driver for the OpenSS7 stack. It provides a convenient mechanism for the management of signalling links of a wide variety of types. The SL-MUX driver links signalling links conforming to the SL to SL-User interface and provides a global naming and Physical Point of Attachment scheme for all signalling links. V401P-SS7 signalling links, channel driver signalling links, M2PA signalling links and M2UA accessible signalling links can all be linked beneath the SL-MUX driver.

The SL-MUX driver is a STREAMS multiplexing driver that runs in the kernel for maximum performance.

[2] Or, in this case, between SG's.

This is an existing OpenSS7 SS7 stack component: for documentation, see sl-mux(4). *Phase 1* activities for the SL-MUX include integration testing with the SG components.

7.1.8 MTP Level 2 Peer-to-Peer User Adaptation Layer (M2PA) Module

The M2PA module provides the SG with the ability to utilize SCTP-based high-speed signalling links. In this project, M2PA signalling links are used primiarily for backup C-Links between SG nodes acting as Signalling Transfer Points (STPs). The M2PA module pushes over an SCTP driver transport Stream to form a complete Signalling Link (SL). The M2PA module provides the same interface to its users as the OpenSS7 Signalling Link (SL).

The M2PA module is a STREAMS module that runs in the Linux kernel for maximum performance.

This is an existing OpenSS7 SIGTRAN stack component: for documentation, see m2pa(4). *Phase 1* activities for M2PA include integration testing with the SG components.

7.1.9 Signalling Link (SL) Module

The signalling link module performs HDLC and SS7 Message Transfer Part Level 2 (Link) functions on a raw communications channel, such as that provided by the X400P-SS7 driver and the V401P-SS7 card. This module converts between the channel media stream (raw octet stream) and an SS7 signalling link signalling Stream. These Streams comprise SS7 signalling links and are linked under the SL-MUX or MTP driver.

The SL module supports CCITT/ITU-T versions (Blue Book forward), ETSI and ANSI versions (1992 forward), including Q.703 and Q.703 Annex B (HSL) operation. TTC JQ.703 (1994) is also supported. The SL module provides a specialized SL interface to its users, in addition to an NCR Comten CDI Revision 2.0 Style 2 connectionless interface.

The SL module is a STREAMS module that runs in the Linux kernel for maximum performance.

The Signalling Link (SL) module is responsible for providing SL services to its users.

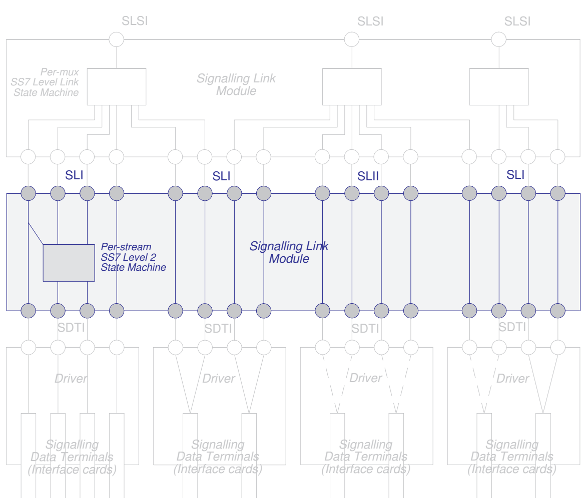

Figure 7.5: *Signalling Link (SL) Module*

This is an existing OpenSS7 SS7 stack component; for documentation, see: sl(4). *Phase 1* activities for MTP2 include integration testing with the SG components.

7.1.10 Signalling Data Terminal (SDT) Module

The signalling data terminal module performs HDLC and lower level SS7 Message Transfer Part Level 2 (Link) functions including DAEDR, DAEDT, AERM, SUERM or EIM and SU Compression/Repetition on a raw communications channel or span, such as that provided by OpenSS7 Channel Drivers. This module converts between the raw channel media stream (raw octet stream) and an SS7 signalling data terminal Stream. These Streams comprise SS7 signalling data terminals and are pushed beneath the SL module.

The SDT module supports CCITT/ITU-T version (Blue Book forward), ETSI and ANSI versions (1992 forward), including Q.703 and Q.703 Annex B (HSL) operation. TTC JQ.703 (1994) is also supported. The SDT module provides a specialized SDT interface to it users, in addition to an NCR Comtem CDI Revision 2.0 Style 2 connectionless interface.

The Signalling Data Terminal (SDT) module is responsible for providing SDT services to its users.

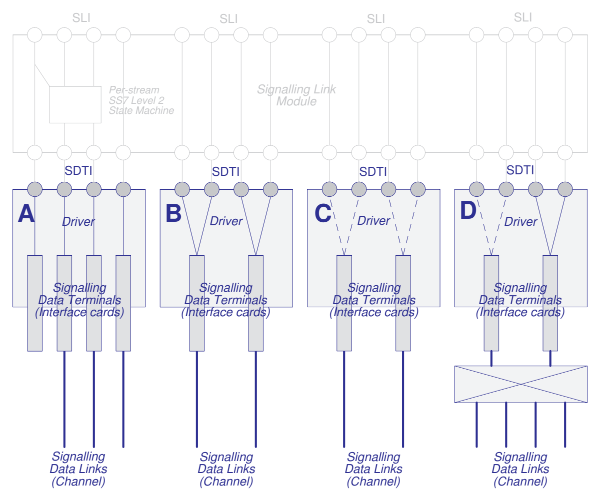

Figure 7.6: *Signalling Data Terminal (SDT) Module*

This is an existing OpenSS7 SS7 stack component; for documentation see: `sdt(4)`. *Phase 1* activities for SDT include integration testing with the SG components.

7.1.11 Signalling Data Link (SDL) Module

The signalling data link module performs conversion between OpenSS7 channel drivers and the Signalling Data Link interface used by other SS7 modules and drivers. This module converts between the Channel primitives and the Signalling Data Link primitives. Streams with this module pushed comprise SS7 signalling data links and are pushed beneath the SDT module.

The SDL module supports CCITT/ITU-T version (Blue Book forward), ETSI and ASNI version (1992 forward), including Q.703 and Q.703 Annex B (HSL) operation. TTC JQ.703 (1994) is also supported. The SDL module provides a specialized SDL interface to its users, in addition to an NCR Comten CDI Revision 2.0 Style 2 connectionless interface.

The Signalling Data Link (SDL) module is responsible for providing SDL services to its users.

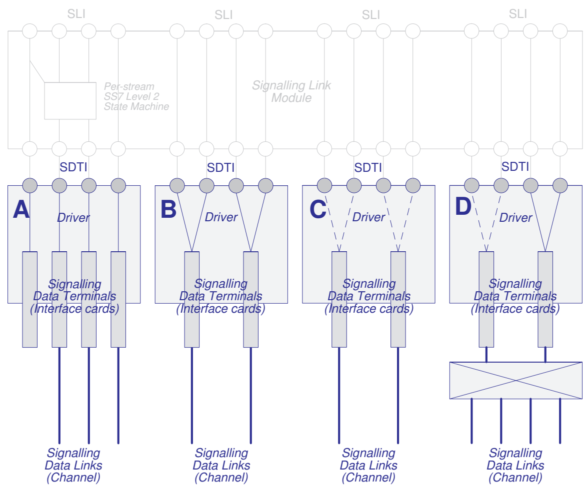

Figure 7.7: *Signalling Data Link (SDL) Module*

This is an existing OpenSS7 SS7 stack component; for documentation see: `sdl(4)`. *Phase 1* activities for SDL include integration testing with the SG components.

7.1.12 Multiplex/Channel (MX/CH) Driver

The Multiplex/Channel (MX/CH) Driver performs soft-switching of multiplex Streams as well as channel access to channels within multiplex Streams. This driver links multiplex interfaces beneath it and presents both multiplex and channel interfaces to its users. For this project, the MX/CH driver is used to link V401P-MX Streams beneath the driver and provide channel access to DS0 or full DS1 channels within the multiplex for use by SS7 signalling links. Multiplex streams present an MX interface to its users. Channel streams present a CH interface to its users. The CH interfaces are converted to SDL Streams using the SDL module and then have SDT and SL modules pushed to form a complete Signalling Link stream.

The MX/CH drivers supports T1, E1 and J1 operation, as well as T3 and E2 operation. The driver provides a specialized MX and CH interface to its users.

This is an existing OpenSS7 channel stack component; for documentation see `mx(4)` and `ch(4)`.

The Multiplex/Channel (MX/CH) driver is responsible for providing CH services to its users.

7.1.13 V401P-MX (X400-MX) Driver

7.1.14 Stream Control Transmission Protocol (SCTP) Driver

OpenSS7 has two implementations (STREAMS and Linux Sockets) that provide support for this new transport protocol and that provide transport for SIGTRAN and other protocols. The STREAMS SCTP implementation provides an NPI Revision 2.0 and TPI Revision 2.0 interface to its users. Alos supported is an X/Open XNS 5.2 XTI Library and ITOS (ISO over SCTP). The Linux Native SCTP implementation provides a Sockets interface.

This is an existing OpenSS7 SIGTRAN stack component; for documentation, see: `sctp(4)`. *Phase 1* activities for SCTP include integration testing with the SG components.

8 Software Architecture

This chapter details the software configuration of the OpenSS7 solutions. OpenSS7 stack software is based on the STREAMS facility running on the Linux Operating System. This provides for use of the Linux Operating System while maintaining portability and consistency with major UNIX operating systems that provide an *SVR 4.2 ES/MP STREAMS* facility.

8.1 Linux Operating System

The OpenSS7 STREAMS releases and stacks currently support the 2.4, 2.6 and 3.x Linux Kernel. A Linux kernel version greater than or equal to 2.4.18 is recommended for 2.4 kernels. The Linux 2.5 series kernels are not supported. A Linux kernel version greater than or equal to 2.6.9 is recommended for 2.6 kernels. Any kernel beginning with 3.0 in the 3.x kernel series is acceptable. Linux 2.4, 2.6 and 3.x kernels released by popular distributions are supported. These include kernel.org releases, RedHat (7.2, 9, EL3, AS/EL4, EL5, EL6), WhiteBox (EL3, EL4), Fedora Core (FC1-FC15), Debian (Woody-Wheezy), Ubuntu (6.10-11.04), SuSE (8.2-12.4 OSS, 9.0-12.1 SLES), CentOS(4, 5 and 6), Lineox (4 and 5), Scientific (5 and 6), PUIAS (5 and 6), Oracle (5 and 6). Currently our preferred distribution is CentOS 5 with all updates applied.

Although OpenSS7 STREAMS SS7 and SIGTRAN stacks are tested primarily on ix86 hardware, the stacks compile and install on PPC (MPC 8260, Freescale 440), HPPA, and other processor architectures supported by the Linux 2.4, 2.6 and 3.x kernels.

For the current project, RedHat AS/EL5 or CentOS 5 is recommended.

8.2 STREAMS Facility

OpenSS7 STREAMS SS7 and SIGTRAN stacks utilize a *SVR 4.2 ES/MP STREAMS* facility.

8.3 OpenSS7 SS7 and SIGTRAN Stacks

The OpenSS7 SS7 and SIGTRAN stacks are implemented using the STREAMS facility. Protocol moduels within the stack are implemented as STREAMS modules, device drivers, multiplexing drivers and pseudo-device drivers. The STREAMS facility has the ability to stack modules and multiplexing drivers above read or pseudo-device drivers using the STREAMS `I_PUSH(7)` an `I_LINK(7)` facilities. Since STREAMS modules and drivers run within the context of the Operating System Kernel using message-based scheduling, greatly increased performance is experienced over equivalent user-space applications. STREAMS modules and drivers communicate by passing priority. In addition, STREAMS provides memory management, timer, locking, syncrhonization, flow control and other facilities commonly used by protocol modules.

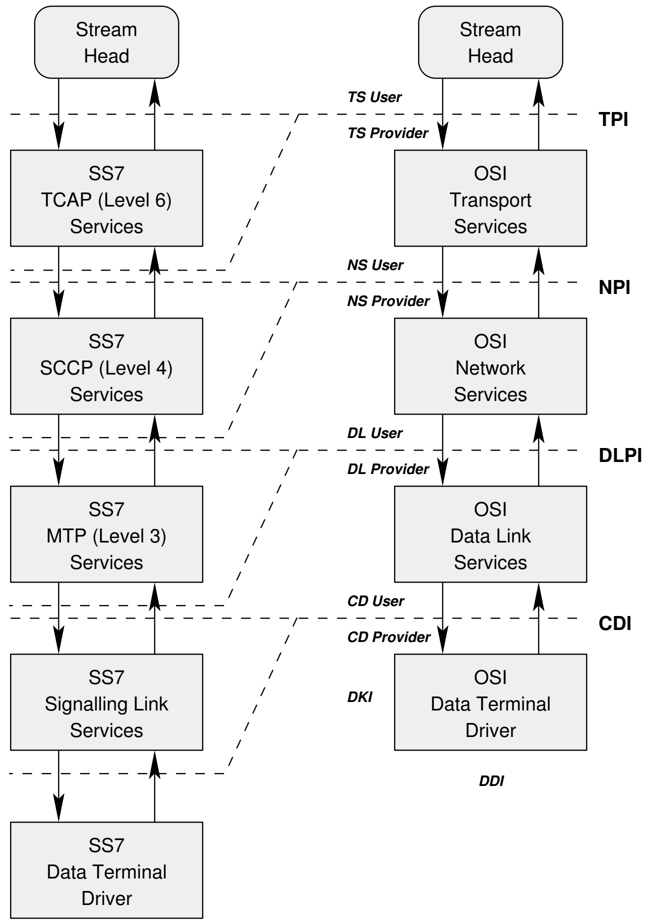

Figure 8.1: *SS7 to ISO/OSI Mapping*

Each OpenSS7 protocol module provides standardized X/Open ISO/OSI interfaces as well as more SS7 specialized interfaces. Many of the OpenSS7 protocol modules provide TPI Revision 2.0 interfaces with support fot he OpenSS7 XTI/TLI Library.

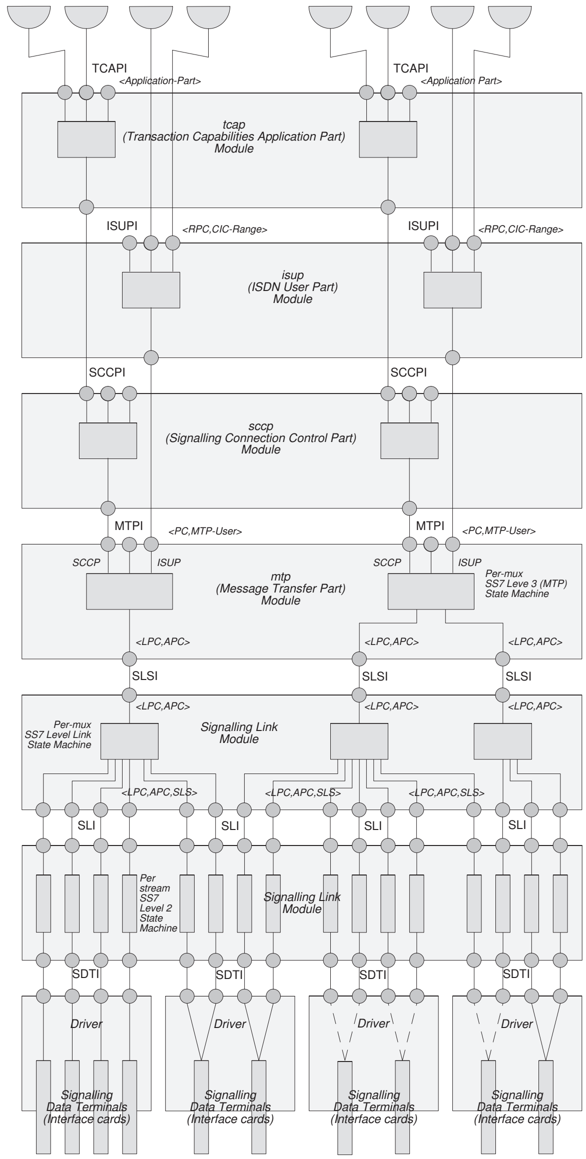

Figure 8.2: *STREAMS SS7/SIGTRAN Stack Architecture*

Figure 8.2 illustrates the organization of STREAMS modules, multiplexing drivers, pseudo-device drivers and real device drivers in the OpenSS7 SS7 stack. At each interface, the equivalent SIGTRAN User Adaptation Layer (UA) can be used. So, for example, between MTP Level 3 and its Users, the M3UA protocol can be employed. Each UA provides the same lower layer interface and upper layer interface. So, M3UA provides an MTP/MTP-User interface at its lower layer interface as well as at it supper layer interface.

9 Hardware Architecture

Figure 9.1 illustrates the hardware configuration for the OpenSS7 Signalling Gateway Platform.

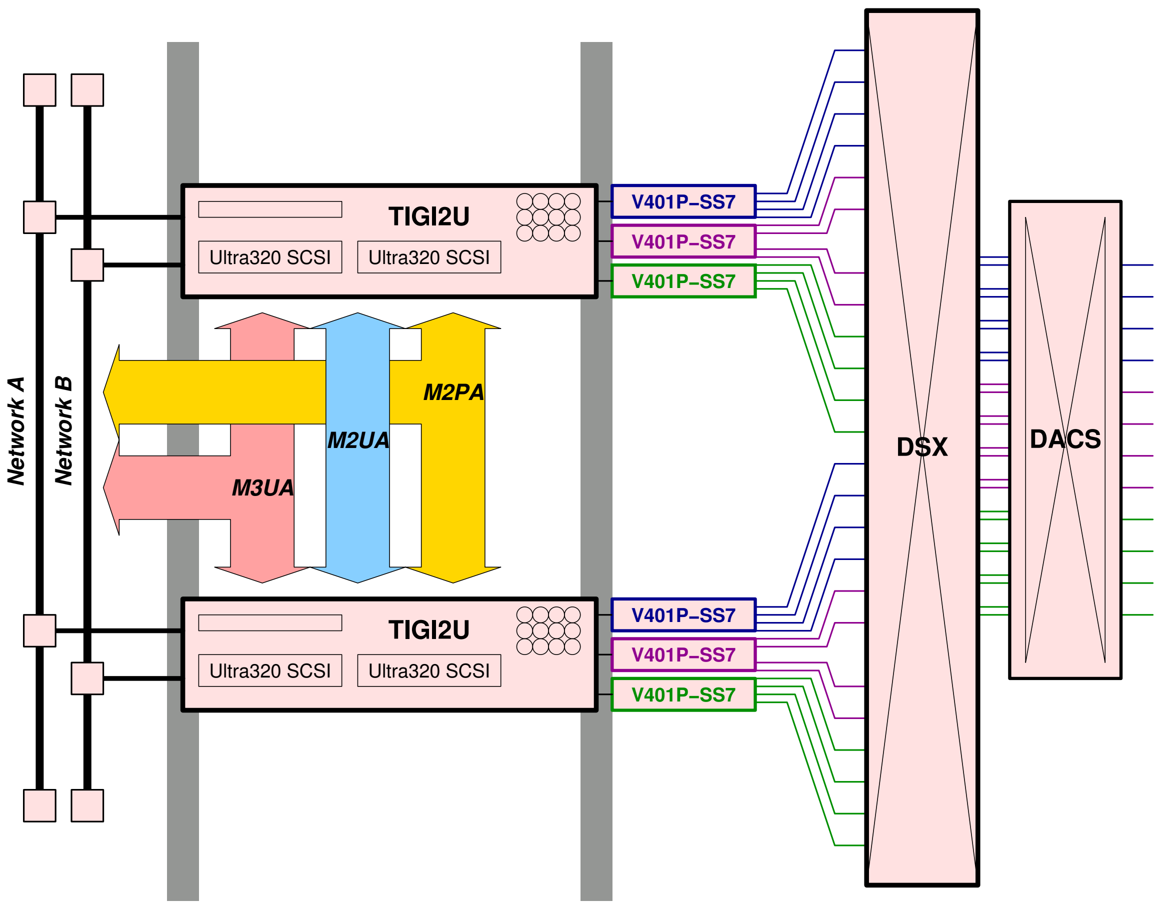

Figure 9.1: *Platform Architecture*

The configuration show in Figure 9.1 shows:

- Two compute nodes attached in a fully redundant configuration.
- Each compute node has 3 x V401P-SS7 cards proding quad DSX-1 connectivity per card, for a total of 12 DSX-1's per compute node.
- Each compute node is attached via cross-connect over 12 DSX-1's (each) to a DACS which has drop-down capability on each pair of DSX-1's consisting of one DSX-1 from each compute node.
- On the IP network side, each compute node supports 2 GigE NIC ports.
- Each NIC port on each compute node is attached to a GigE rail or swtich which subsequently attacheds to two Routers, one for Network A and one for Network B.

- The configuration shown supports up to 288 low-speed (56 or 64 kbps) signalling links or up to 12 high-speed (1.544 Mpbs) signalling links.
- Compute nodes communicate with each other over the IP network, either via local switch or remote router, using M2UA. This SIGTRAN protocol permits the compute node to logically share their V401P-SS7 hardware interfaces.
- Compute nodes communicate with the associated STP pair via TDM links as well as using the M2PA protocol. The M2PA SIGTRAN protocol provides an IP-based high-speed SS7 link and is used to augment TDM links to implement C-Links on the platform.
- Compont nodes act as SGP within the SG and provide MTP Level 3 and above connectivity to remote application servers using the M3UA SIGTRAN protocol. The M3UA SIGTRAN protocol exports the MTP to MTP-User interface and effectivley transports the interface to the application server from the signalling gateway.

10 Management Architecture

11 Logistics

11.1 Hardware

11.1.1 Sizing Considerations

11.2 Software

11.3 Consulting

11.4 Schedule

11.4.1 Gate 0 — Concept

11.4.2 Gate 1 — High-Level Design

11.4.3 Gate 2 — Detailed Design

11.4.4 Gate 3 — Development and Implementation

11.4.5 Gate 4 — System Test

11.4.6 Gate 5 — Acceptance Testing

11.4.7 Gate 6 — Support Complete

11.5 Cost

Appendix A Optional Application Support

Appendix B Optional Network Support

Appendix C Optional System Support

Appendix D Optional Platform Support

Appendix E Optional Protocol Support

Appendix F Optional Software Support

Appendix G Optional Hardware Support

Appendix H Optional Management Support

Appendix I Programmatic Interfaces

Appendix J Platform Sizing

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Index

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