SS7 – Signaling System Number 7

GL Communications Inc.

818 West Diamond Avenue - Third Floor, Gaithersburg, MD 20878
Phone: (301) 670-4784   Fax: (301) 670-9187 Email: **info@gl.com**
Website: **https://www.gl.com**

1

SS7 – A Brief Overview

- Defined by ITU-T in its Q.700-series, ANSI, and ETSI

- Out-of-band signaling system

- Designed for call control, remote network management, and maintenance

- Combines circuit-switched and packet-switched networks

- Suitable for use on point-to-point terrestrial and satellite links

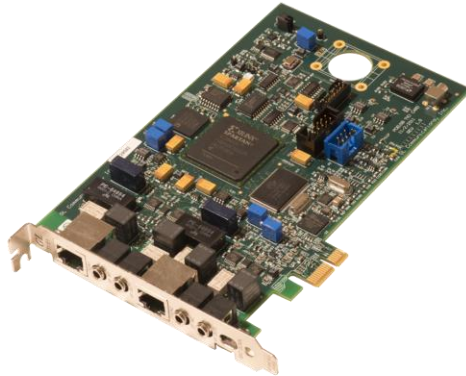- SS7 networks are flexible, reliable, with capacity up to 64 Kbps

T1 E1 Analyzer Hardware Platforms

Front Panel

Back Panel

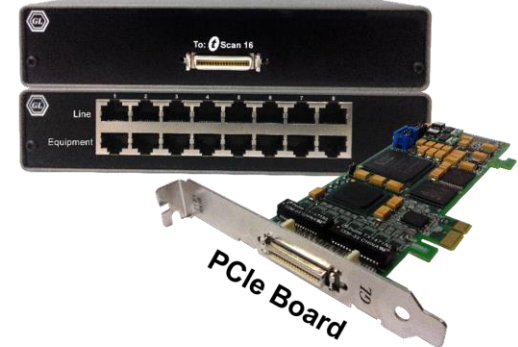**tProbe™ - Portable USB based T1 E1 VF FXO FXS and Serial Datacom Analyzer**

Quad / Octal T1 E1 PCIe Card

Dual T1 E1 Express (PCIe) Board

tScan16™ with 16-port T1 E1 Breakout Box

PCIe Board

GL Communications

3

TDM mTOP™ Solutions

mTOP™ tProbe™ FXO FXS Dual UTA

1U tProbe™ w/ FXO FXS

GL Communications

4

Applications

- Allows telecommunications networks to offer wide ranges of services such as telephony, fax transmission, data transfer

- Setting up and tearing down circuit-switched connections

- Support for Intelligent Network (IN) services such as toll-free (800) calling, SMS, EMS

- Mobility management in cellular networks

- Local Number Portability (LNP) to allow subscribers to change their service, service provider, and location without needing to change their telephone number

- Support for ISDN

GL
Communications

SS7 Network Architecture
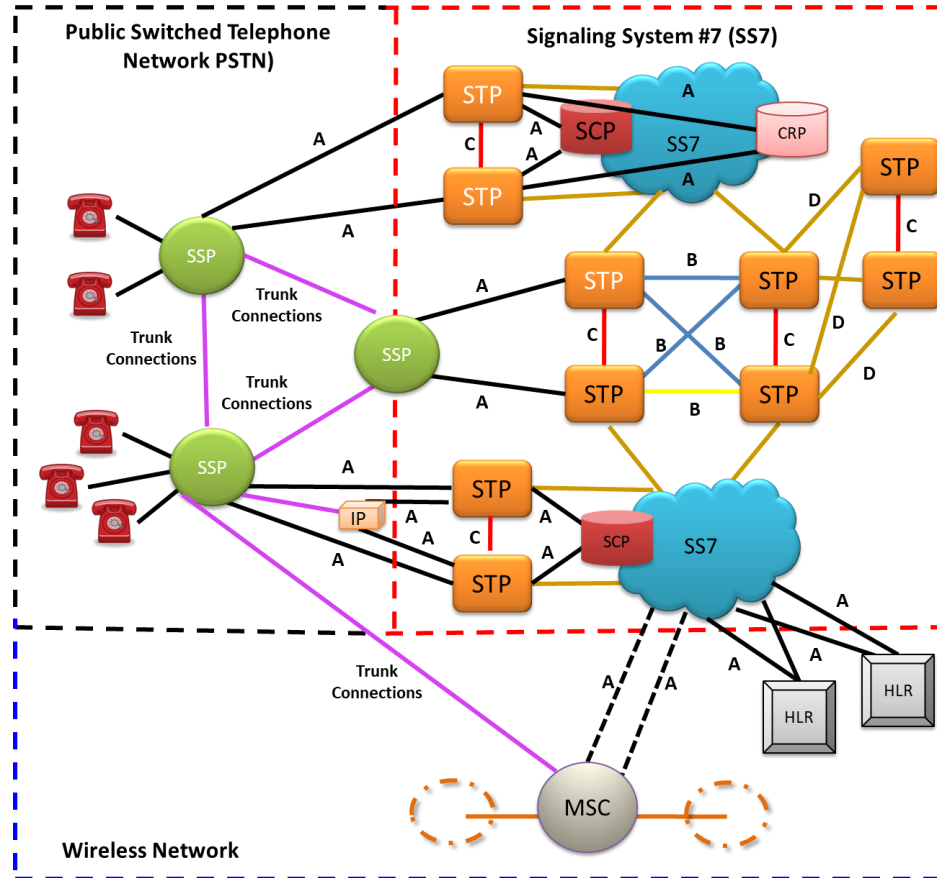
Signaling Points

- SS7 constitutes three different types of Signaling Points (SP):

  - Signaling Transfer Point

  - Service Switching Point

  - Service Control Point

Signaling Transfer Points	Service Switching Points	Service Control Points
Transfers SS7 messages between other SS7 nodes	Capable of controlling voice circuits via a voice switch	Acts as an interface between telecommunications databases and the SS7 network
Acts as a router for SS7 messages	Converts signaling from voice switch into SS7 format	Provide the core functionality of cellular networks
Does not originate SS7 messages	Can originate and terminate messages, but cannot transfer them	Provides access to database

Signaling Links
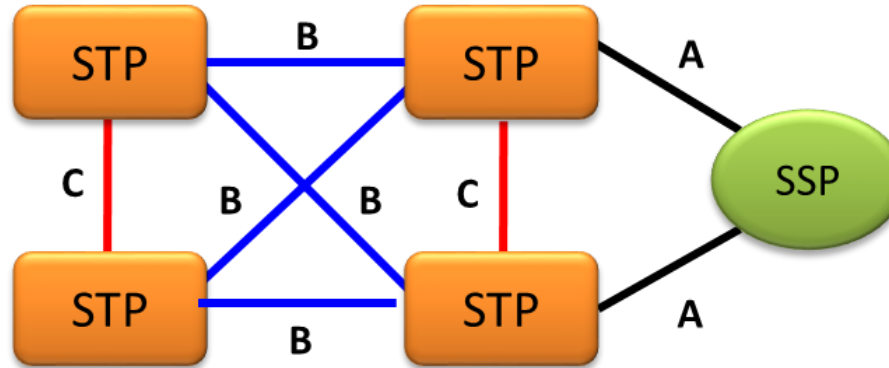
Bridge (B) Link

- **Access Links** connects SCP or SSP to an STP. Only messages originating from or destined to the signaling end point are transmitted on an "A" link

- **Bridge Links** connect mated pairs of STPs to each other at the same hierarchical level

Signaling Links (Contd.)
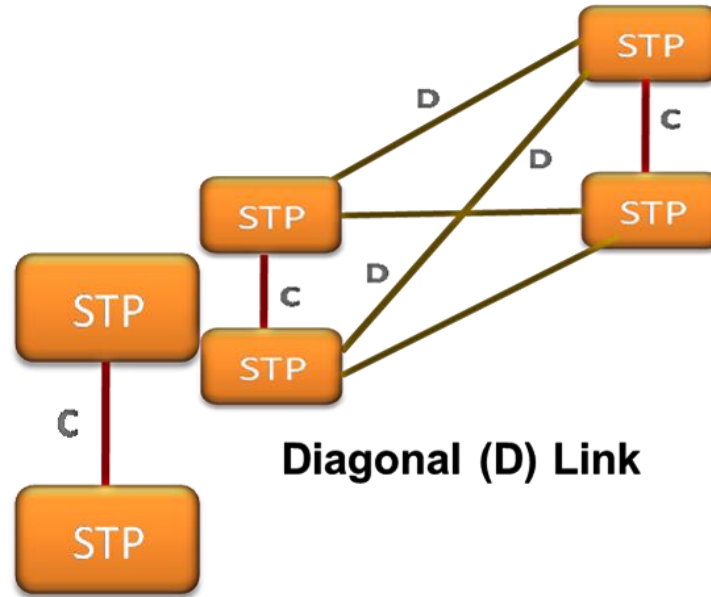
Diagonal (D) Link

- **Cross Links** connect STP to its mate STP. Not used for routing

- **Diagonal Links** connect mated STP pairs from one hierarchical level to another mated STP pair at a higher level

Signaling Links (Contd.)

Fully Associated (F) Link
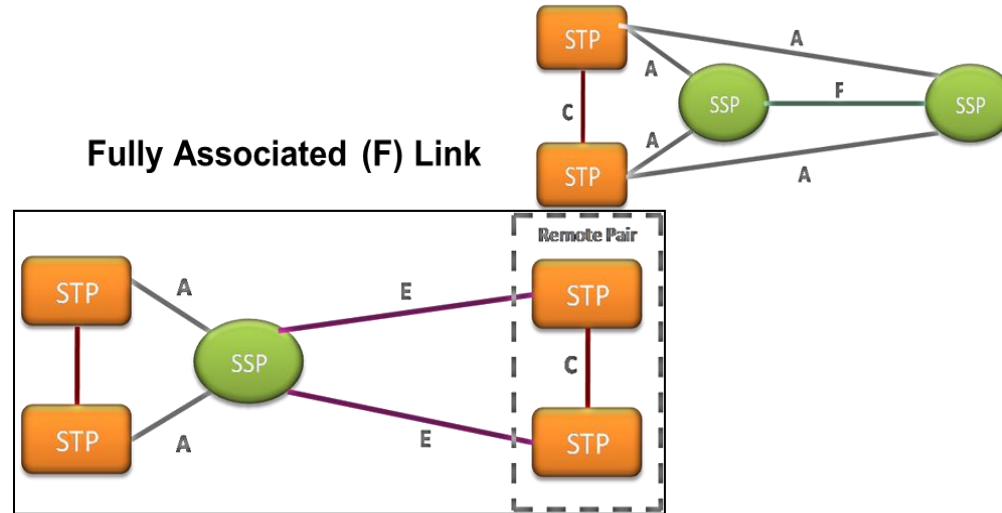
- **Extended Links** connect SSPs and SCPs to remote STP pairs

- **Fully Associated Links** route large amount of traffic between two SSPs. Connect network SSPs and/or SCPs directly to each other without using STPs

SS7 Protocol Stack

SS7 is developed in a layered architecture like OSI model.

OSI protocol stack implementation

- Physical Layer (Level 1)- MTP Level 1

- Data link Layer (Level 2)- MTP Level 2

- Network Layer (Level 3)- MTP Level 3 + SCCP

- User Part (Level 4) - INAP, MAP, IS-41, TCAP, CAP, ISUP, etc.
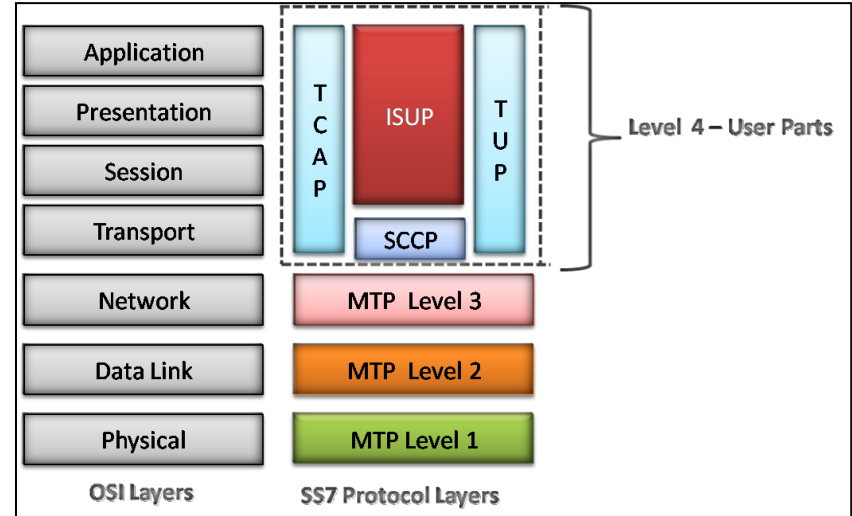
SS7 Layers (Contd.)

- Message Transfer Part (MTP) – divided into three levels

  - ➢ MTP Level 1 – defines the physical interfaces

  - ➢ MTP Level 2 – ensures reliable transfer of signaling messages

  - ➢ MTP Level 3 – provides message routing between signaling points in the SS7 network

- Signaling Connection Control Protocol (SCCP) –

  - ➢ Combination of MTP and SCCP forms the SS7 Network Services Part (NSP). Enhances the message carrying facilities of MTP

  - ➢ Provides some network layer protocol functions

- ISDN User Part (ISUP) and Telephone User Part (TUP) –

  - ➢ Defines the protocol used to set-up, manage, and release trunk circuits

- Transaction Capabilities Application Part (TCAP) –

  - ➢ Allow new applications to use SS7

GL
Communications

12

Application to Application Communication
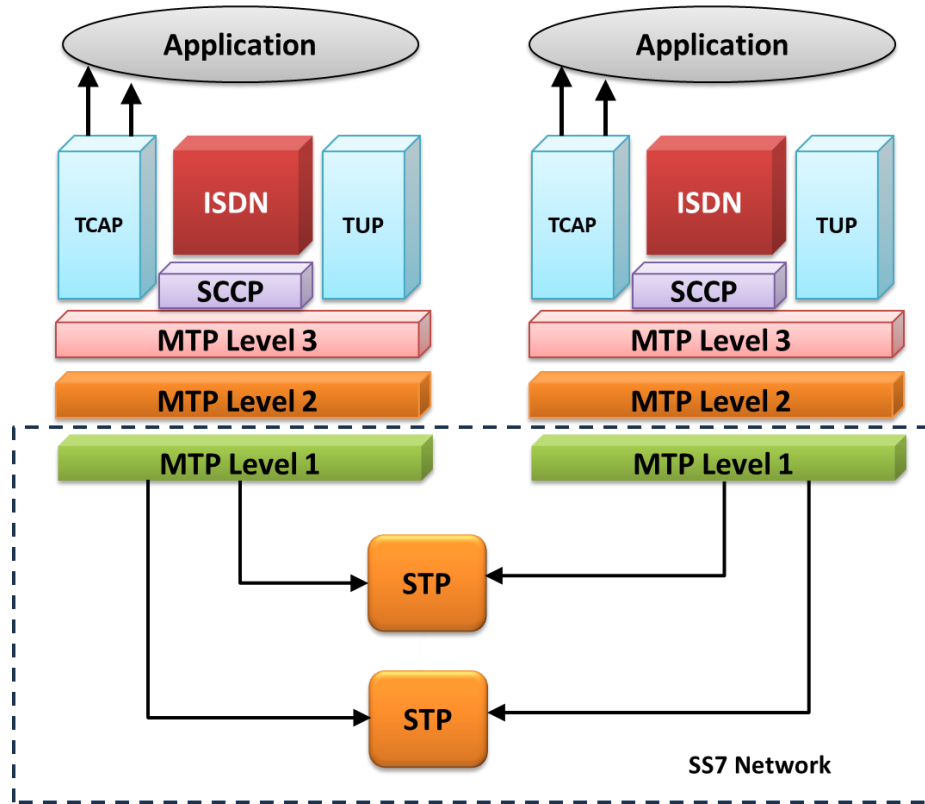
Signaling Link Level (MTP Level 2) and Signaling Units

Flag	FCS	Information	LI	FIB	FSN	BIB	BSN	Flag
8	16		6	1	7	1	7	8

Flag – 01111110
FCS - Frame Check Sequence
LI – Length Indicator

FIB – Forward Indicator Bit
FSN – Forward Sequence Number
BIB – Backward Indicator Bit
BSN – Backward Sequence Number

- Basic Frame Structure

- Frame with Error Correction (4 fields at the end and beginning of frame – BSN, BB, FSN, FB) and Length Indicator (contains info about bytes in information part, and message type)

- SS7 uses three types of signal units –

  ➢ Message Signal Units (MSU)

  ➢ Link Status Signal Unit (LSSU)

  ➢ Fill-In Signal Unit (FISU)

14

Message Signaling Unit
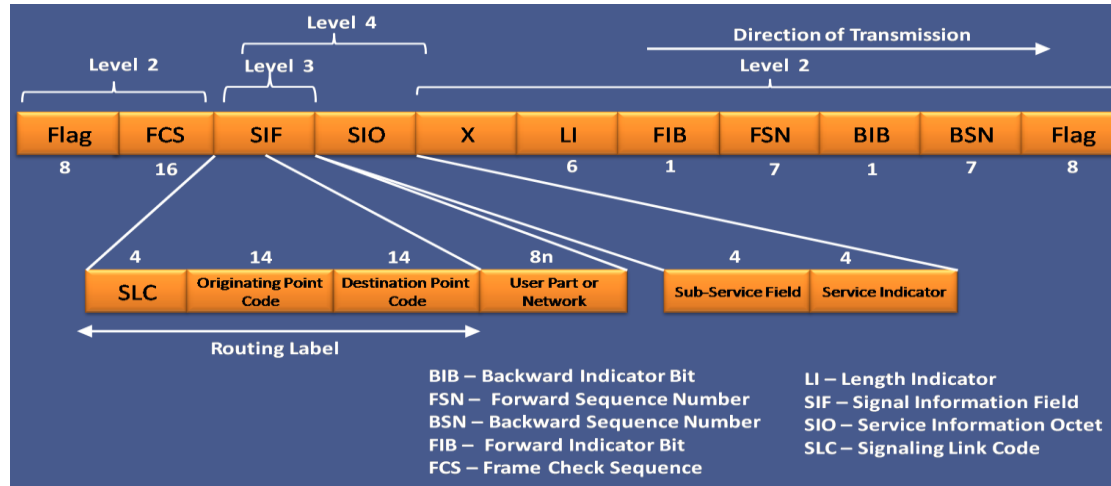
- Carries SS7 information
- Consists of MTP protocol fields and two additional fields
  - ➢ Service indicator octet (SIO) - indicates type of protocol at level 4, e.g., TUP, ISUP, and type of standard, e.g. national, international
  - ➢ Service information field (SIF) - used to carry control information as well as level 3 routing label. SIF can be up to 272 octets and is used by all level 4 protocols

Link Status Signaling Unit

Direction of Transmission →

Flag	FCS	SF	X	LI	FIB	FSN	BIB	BSN	Flag
8	16	8 or 16	2	6	1	7	1	7	8

LI – Length Indicator
SF – Status Field
FCS – Frame Check Sequence
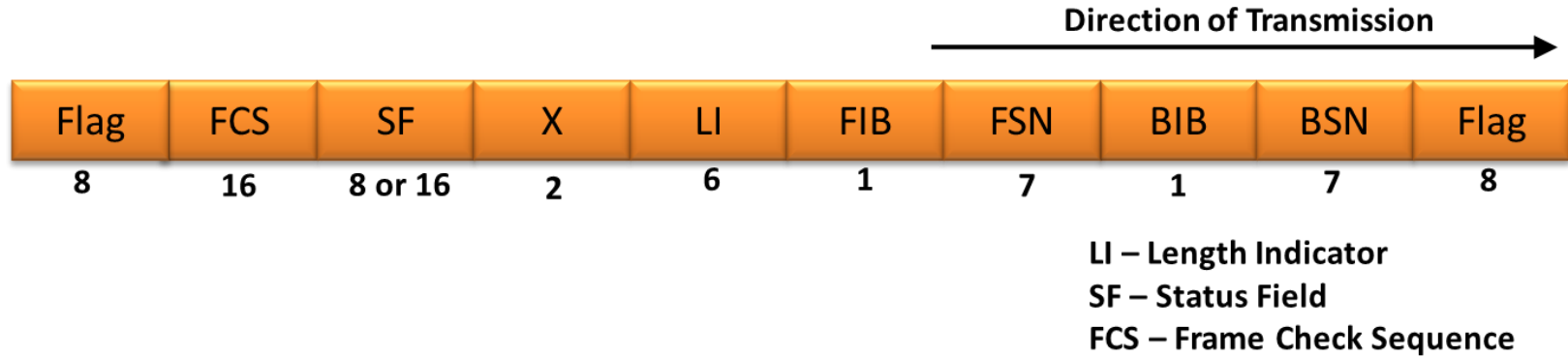
- Carries link status information
- Used by level 3 at one node to transmit link status information to its adjacent node
- Used only on single point-to-point links, and never through the network
- Carries no information traffic on a link when LSSU are sent

GL Communications

16

Fill-In Signaling Unit

Direction of Transmission →

Flag	FCS	X	LI	FIB	FSN	BIB	BSN	Flag
8	16	2	6	1	7	1	7	8
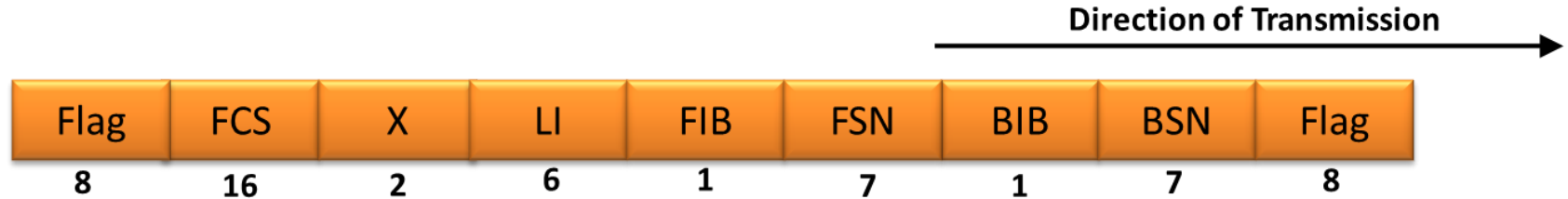
- Used when no information needs be sent, and the network is idle
- Used to monitor error rates on links. This allows SS7 to be highly reliable as it can detect link quality even when idle
- Constantly monitors the link status

Signaling in SS7 Network

Signaling transfer point (STP):

➢ Send/receive/route signaling messages

➢ Packet switches of SS7 network

Signaling control point (SCP):

➢ "services" go here

➢ E.g., database functions

Signaling switching point (SSP):

➢ attach directly to end user

➢ endpoints of SS7 network

Signaling in SS7 Network (Contd.)

4. STP X forwards IAM SSP B

3. STP W forwards IAM to STP X

2. SSP A formulates Initial Address Message (IAM), forwards to STP W

1. Caller goes offhook, dials callee. SSP A decides to route call via SSP B. Assigns idle trunk A-B

W

Z

Y

X

A

B

GL
Communications
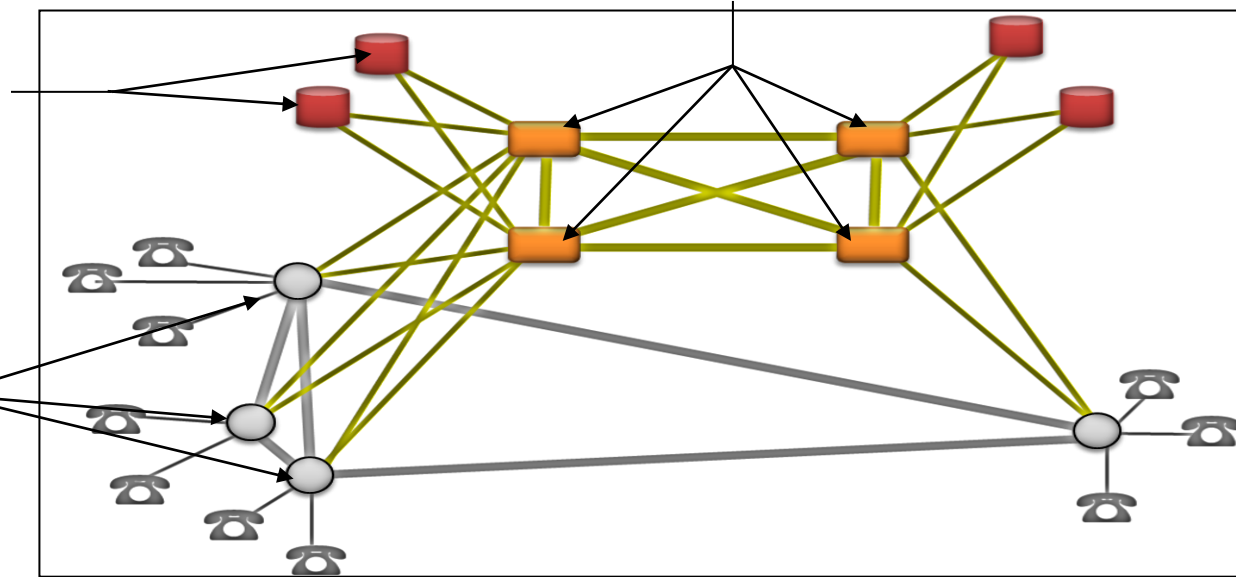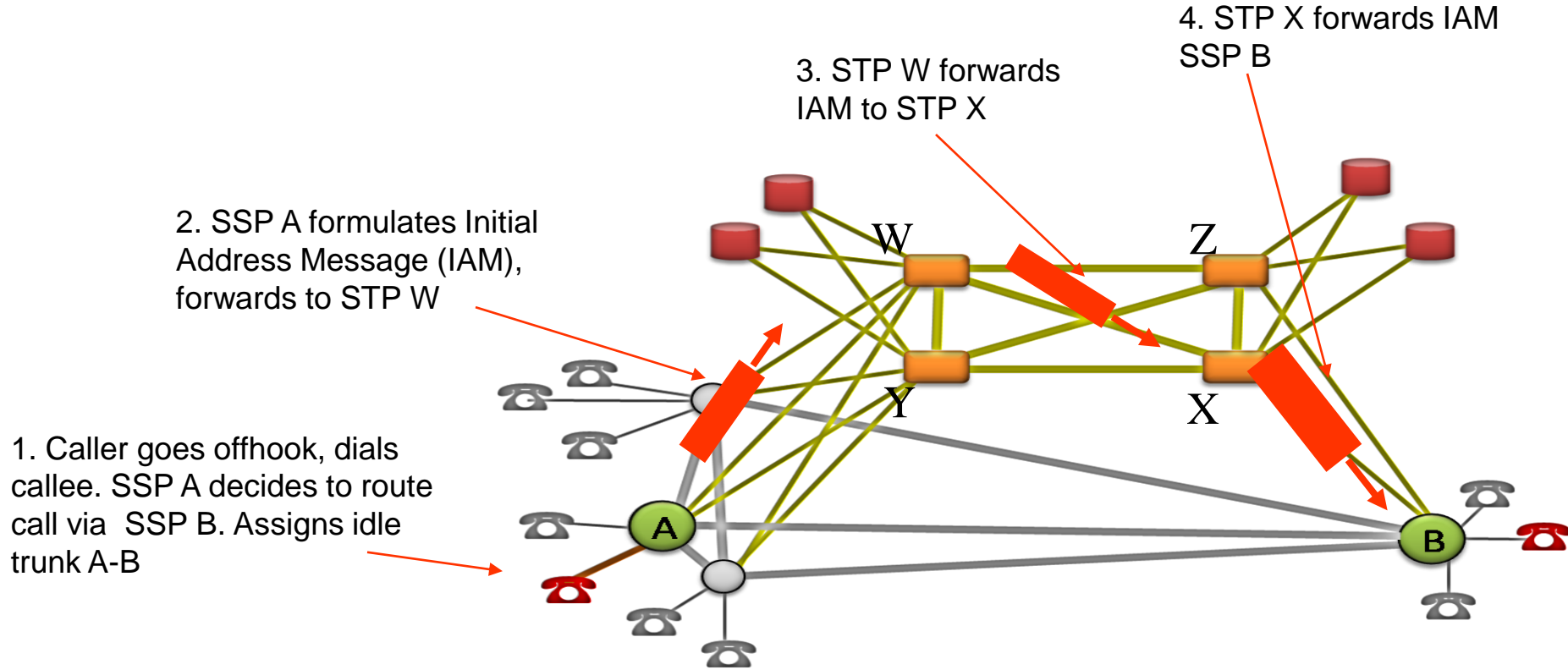
Signaling in SS7 Network (Contd.)

5. SSP B determines it serves callee, creates address completion message (ACM[A, B, trunk]), rings callee phone, sends ringing sound on trunk to A

6. ACM routed to Z to Y to A

7. SSP A receives ACM, connects subscriber line to allocated A-B trunk (caller hears ringing)

20

Signaling in SS7 Network (Contd.)

8. Callee goes off hook, SSF
B sends answer message to
A (ANM[A,B,trunk]

9. ANM routed to A

10. SSP A receives ANM,
checks caller is connected in
both directions to trunk. *Call
is Connected!*

W

Z

Y

X

A

B
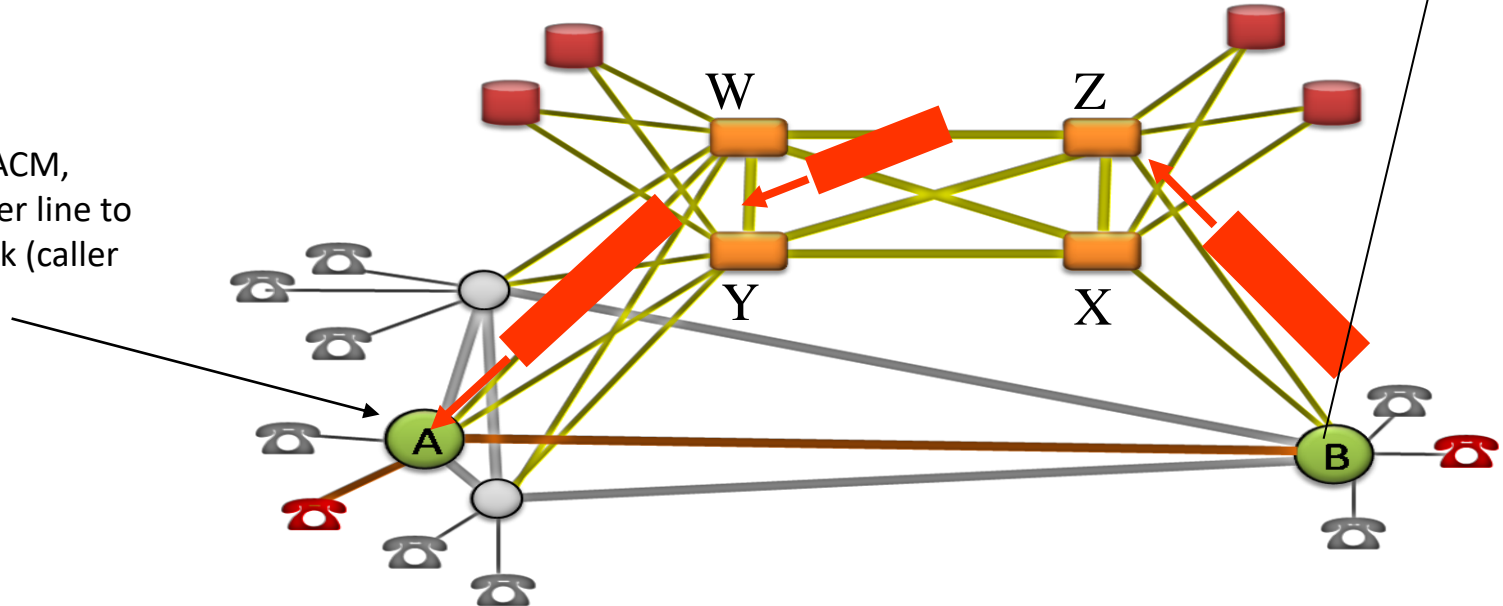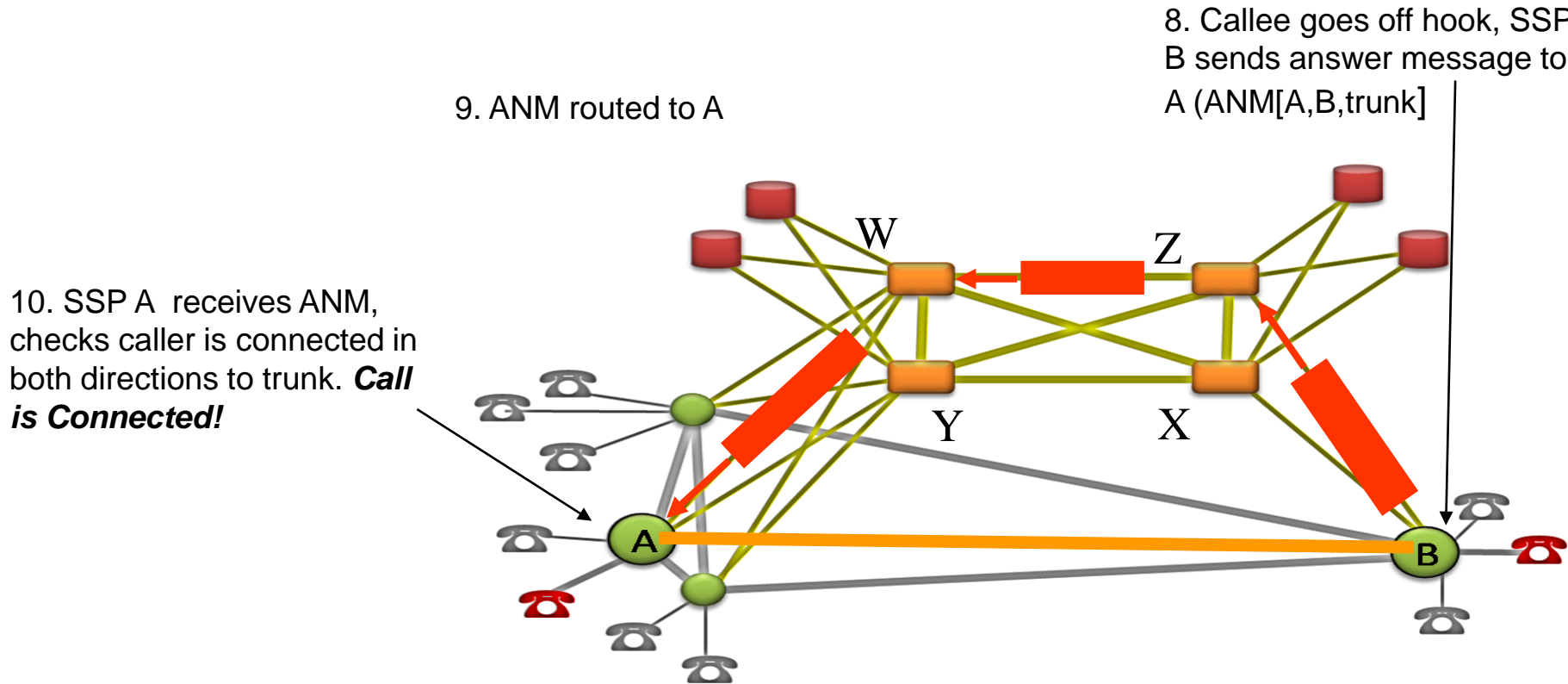
Advanced Intelligent Network (AIN)

- It is a telephone network architecture which separates the service logic from switching equipment and allows new services to be added without redesigning switches to support added services

- Provides advanced services using distributed databases which provides additional information to call processing and routing requests

- AIN is a combination of the SS7 network, interactive database nodes, and development tools which allow the processing of signaling messages

- The supported services are CNAM (Calling Name Delivery), LNP (Local Number Portability), and Toll-free 800 Number over TCAP layer as per ANSI

Example of AIN Toll-Free 800 Service

SCP

DATABASE

3 : Returns Routing Number

2 : Query

4 : Response

1 : Dial 800-*****

(Free Call)

Originating Switch

5 : Translates Routing Number

(Service Provider Charged)

Terminating Switch

Caller
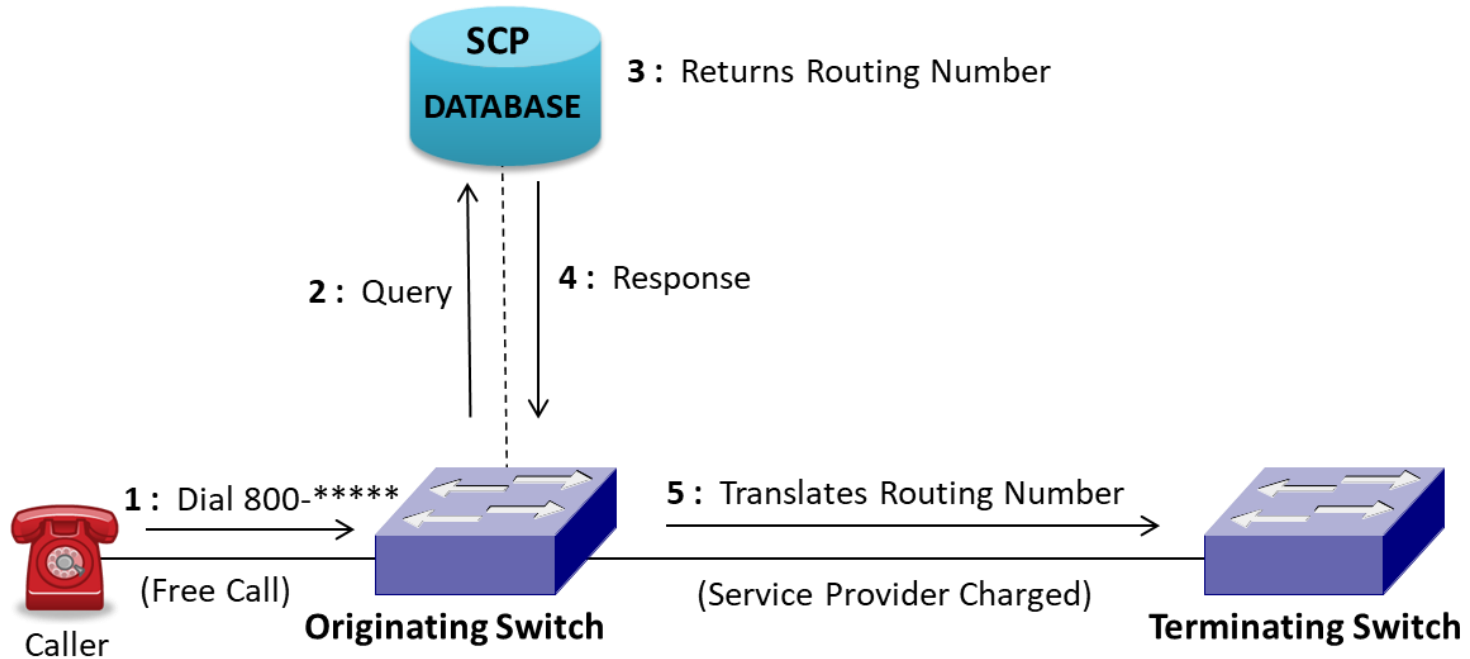
Calling Name Delivery Service (CNAM)

SCP

DATABASE

3 : Response (Name, Status)

2 : Query (Name Request)

Originating Switch

Terminating Switch

1 : IAM (Calling Number)

4 : "Name"

Calling

Called
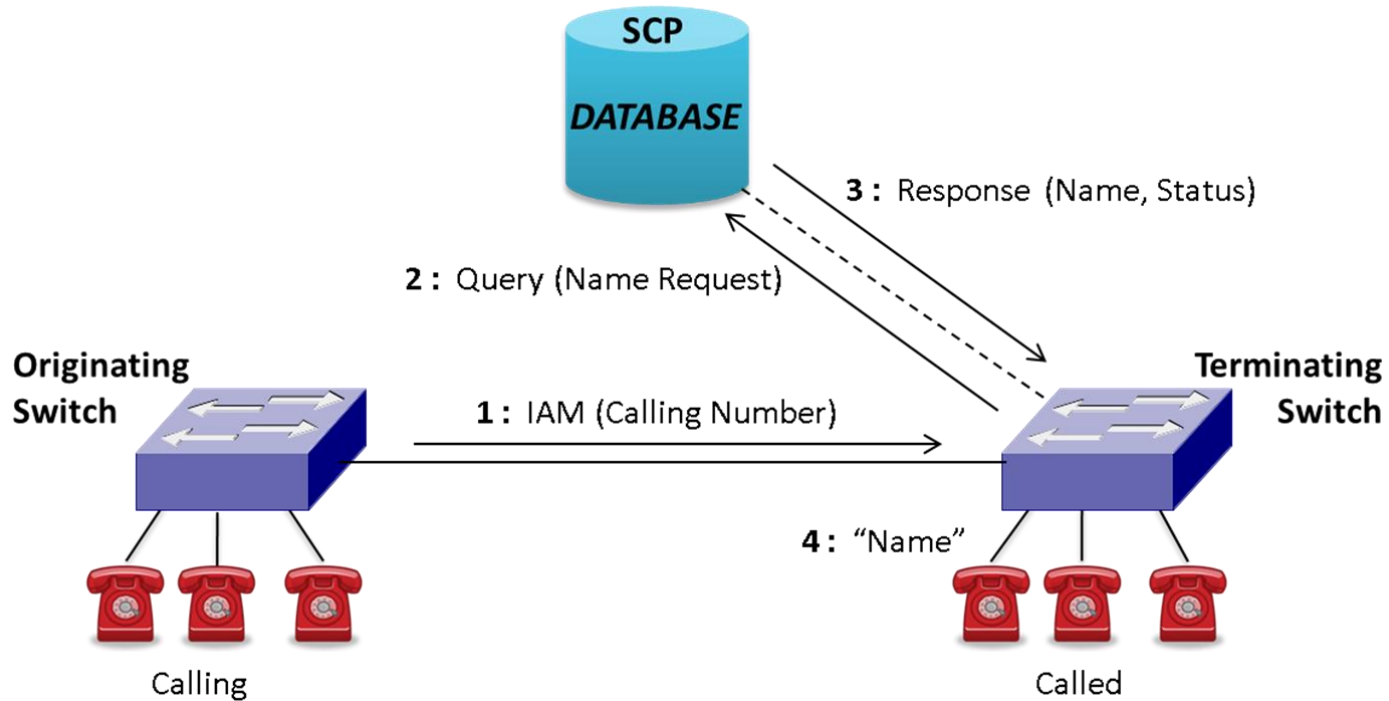
LNP (Local Number Portability) Service
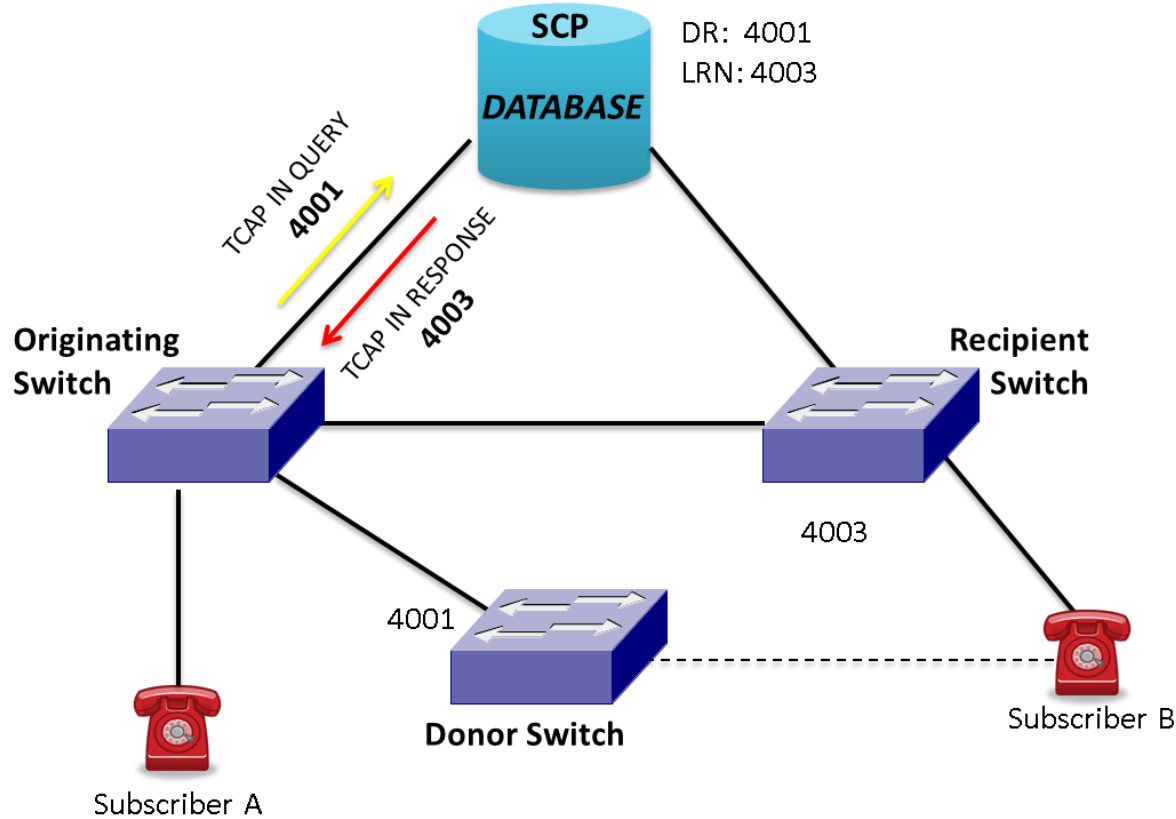
User Parts Functionality in SS7 Network

- The User parts in SS7 protocol stack offers its services to user designed applications

- The Transaction Capabilities Application Parts (TCAPs) are employed when the application deals with Database query and response

  - ➢ Exchange of non-circuit related data

  - ➢ Queries and responses sent between SSPs and SCPs

  - ➢ Sends and receives database information

- The Integrated Services Digital Network User Parts (ISUPs) are meant for handling of telephone call related messaging which is sent from switch to switch

  - ➢ Sends and receives database information

  - ➢ Messages are sent from a switch, to the switch where the next circuit connection is required

  - ➢ Call circuits are identified using circuit identification code (CIC)

ISUP Messages

- Initial address message (IAM): Contains all necessary information for a switch to establish a connection

- Address complete message (ACM): Acknowledge to IAM and reserve the required circuit

- Answer message (ANM): Occurs when the called party picks up the phone and actual connection is established

- Release (REL): Sent by the switch to clear the call

- Release complete (RLC): Acknowledges to the receipt of REL by each exchange that receives REL

GL
Communications

ISUP Normal Call Flow Scenario

SS7 SIGTRAN

PSTN

Signaling Gateway

SCP

T1 E1

SIGTRAN

Soft Switch

SIGTRAN

Signaling Gateway

PSTN

SCP

T1 E1

CO

SIP

SIP

RTP

RTP

CO

CO

Media Gateway

SIP

IP

Media Gateway

IP Phone

SIGTRAN (SS7 over IP)
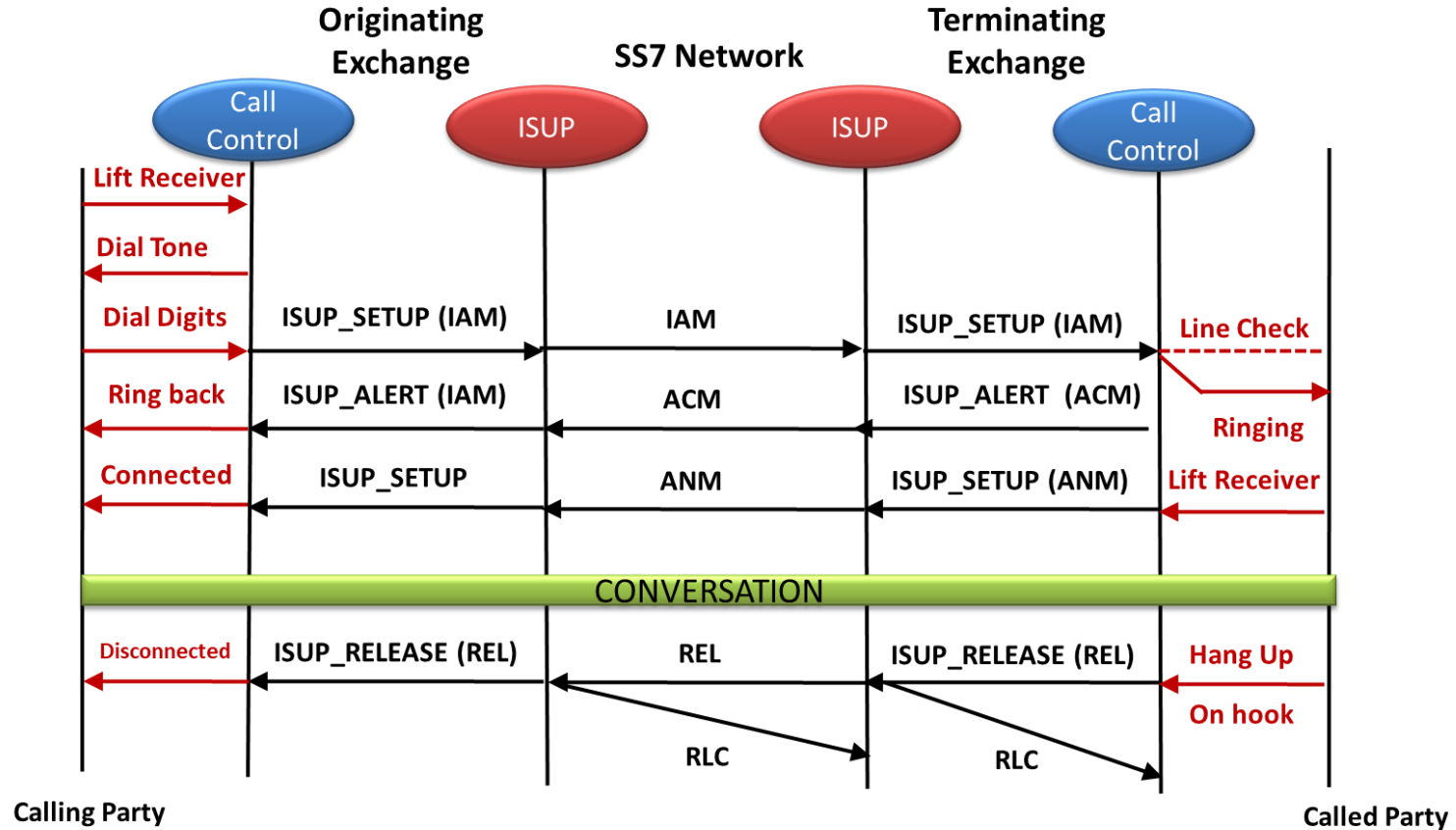
Message Automation & Protocol Simulation (MAPS) SIGTRAN
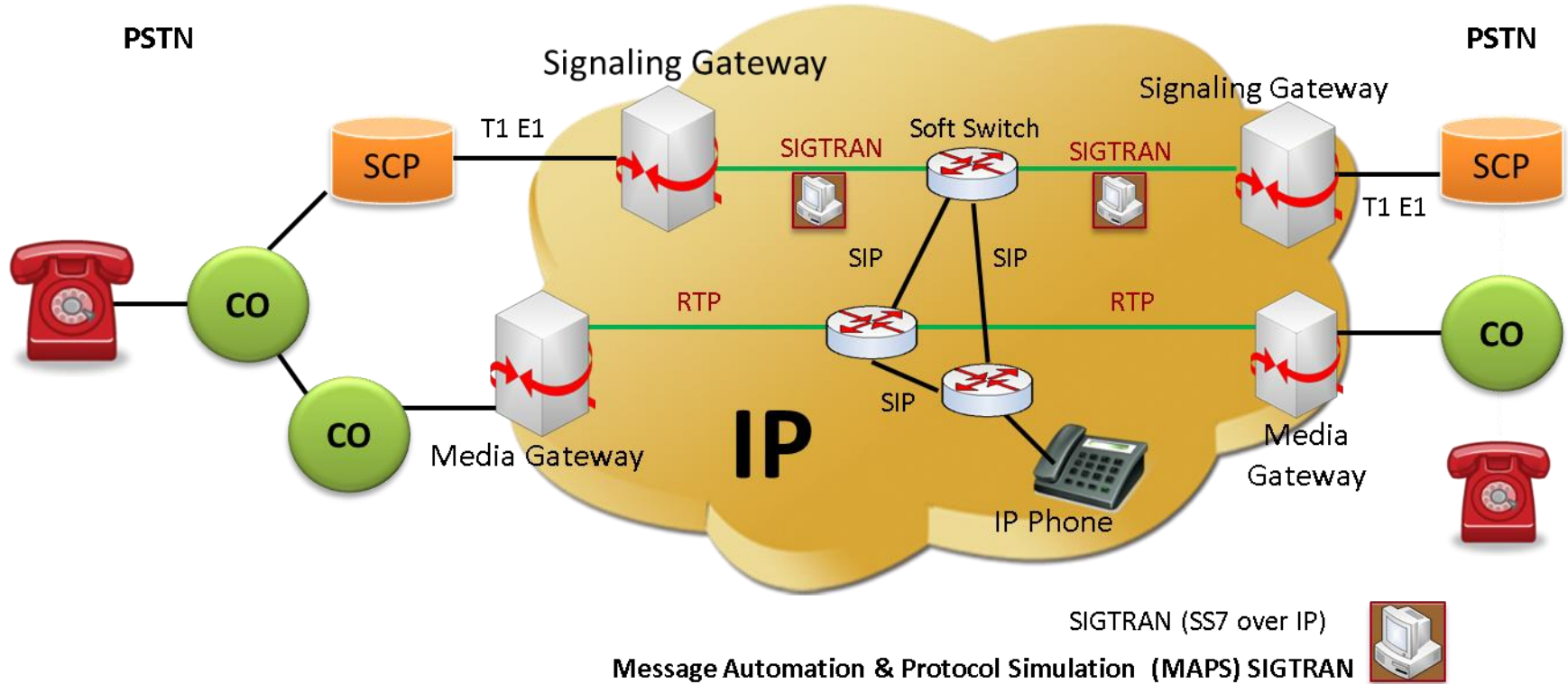
SIGTRAN Call Flow Scenario

SS7 Analyzer

GL's SS7, Protocol Analysis

31

SS7 Analyzer View

Summary View

Detail View

Hex Dump View

Statistics View

CDR View

Key Features

- Perform real-time / offline / remote analysis

- Consolidated GUI – Summary of all decodes, detail and hex-dump views of each frame, statistics view, and call detail record views

- Supports various protocol standards for proper decode

- Capture options - Channel selection, CRC, bit reversion, bit inversion, scrambler and more

- Any protocol field can be added to the summary view, filtering, and search features providing users more flexibility to monitor required protocol fields

- Call Detail Recording feature includes data link groups that help in defining the direction of the calls in a given network and form logical groups comprised of unidirectional (either 'Forward' or 'Backward') data links

- Option to create multiple aggregate column groups and prioritize the groups as per the requirement to display the summary results efficiently

- Allows the user to create search/filter criteria automatically from the current screen selection

Key Features (Contd.)

- Call trace defining important call specific parameters such as call ID, status (active or completed), duration, calling number, called number, and more are displayed

- Fine tune results with filtering and search capability based on OPC, DPC, ISUP message types, SCCP message types, CIC, and more

- Extensive statistics measurement ability

- Exports Summary View information to a comma delimited file for subsequent import into a database or spreadsheet

- Capability to export detail decodes information to an ASCII file

- Trace File Saving Options

- Remote-access capability

Protocol Standards

Filter and Search

Statistics View

Call Detail Records View

- Call trace defining important call specific parameters such as call ID, status (active or completed), duration, calling number, called number, release complete cause etc are displayed

Applications

- Can be used as independent standalone units as "probes" integrated in a network surveillance systems

- Triggering, collecting, and filtering for unique subscriber information and relaying such information to a back end processor

- Collecting Call Detail Records (CDR) information for billing

Filtering Criteria From Screen Selection

• Allows the user to create filter criteria automatically from the current screen selection

Search Criteria From Screen Selection

• Allows the user to create search criteria automatically from the current screen selection

Define Summary Columns

- Required protocol fields can be added through Define summary column option

- User can remove the protocol field which is not required

Aggregate Group Column

- The user can create multiple aggregate column groups and prioritize the groups as per the requirement to display the summary results efficiently

SS7 Packet Data Analysis (PDA)

Packet Data Analyzer over TDM
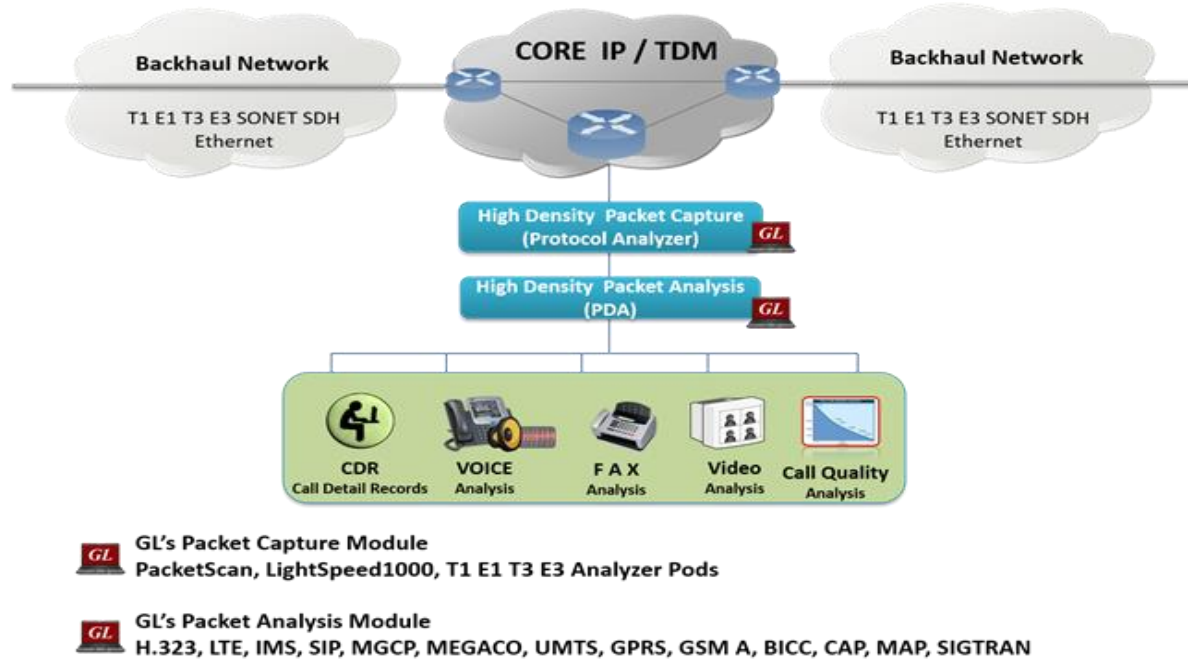
- Monitors live TDM networks including capture, analysis, and reporting of every call-in detail. Supported protocols include CAS, ISDN, ISUP, CAMEL, MAP, INAP, and GSM

Main Features

CDR, Call Flow, Statistics, and Report Generation	• Isolates call specific information for each individual call from the captured data and displays the information in an organized fashion • A host of call and message counters gives the user an instantaneous snapshot of the traffic on the network • Pictorial representation of the statistics including ladder diagrams for the calls of various protocols • Ability to export and analyze call detail records of completed calls in CSV file format • These reports can be further fed to DB and accessed using GL's NetSurveyorWeb™ Lite for analysis. • Isolates calls, a graphical call flow diagram can be created from a call trace • Filters on CDR information feature is used to search required calls by using "key" as CDR parameters • Event counters on CDR information provides over all count of completed events such as total calls, active calls, completed calls, purged calls, failed calls, calls per second, remaining calls and more • Flexible options are provided to interchange/hide the columns as required
Traffic Recording	• Supports capturing of voice, digits, tones and FAX etc to *.PCM file format
Triggers and Actions	• Filter captures based on protocol parameters such as OPC, DPC or CIC in case of ISUP followed by a set of actions such as save call, send mail, trigger alarm notification etc for the completed calls
Exporting Calls	• Supports saving the selected calls from traffic analyzer into *.HDL, *.PCAP, or *.PCAPNG formats

GL Communications

Traffic Recording Configurations

SS7 Call Summary

Active Call Graph

Summary View

Supported Protocols

Triggers and Action Settings

Alert Summary

- With this option, the user can set the alarm type and alarm message for the selected triggering type

Alert Summary (Contd.)

Call#	Protocol	Message	Type	Threshold	Value	Caller	Callee	CallId
26	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	4713318	26
56	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	3524936	56
86	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	6613093	86
116	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	7630644	116
146	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	9949501	146
176	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	8216780	176
206	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	5242990	206
236	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	4315996	236
266	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	9284515	266
297	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	1089521	297
322	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	4011142	322
373	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	1176208	373
403	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	2285801	403
433	ISDN	Triggers at the specified value.	Warning	5552525	5552525	5552525	5723954	433

Load or Save Configurations
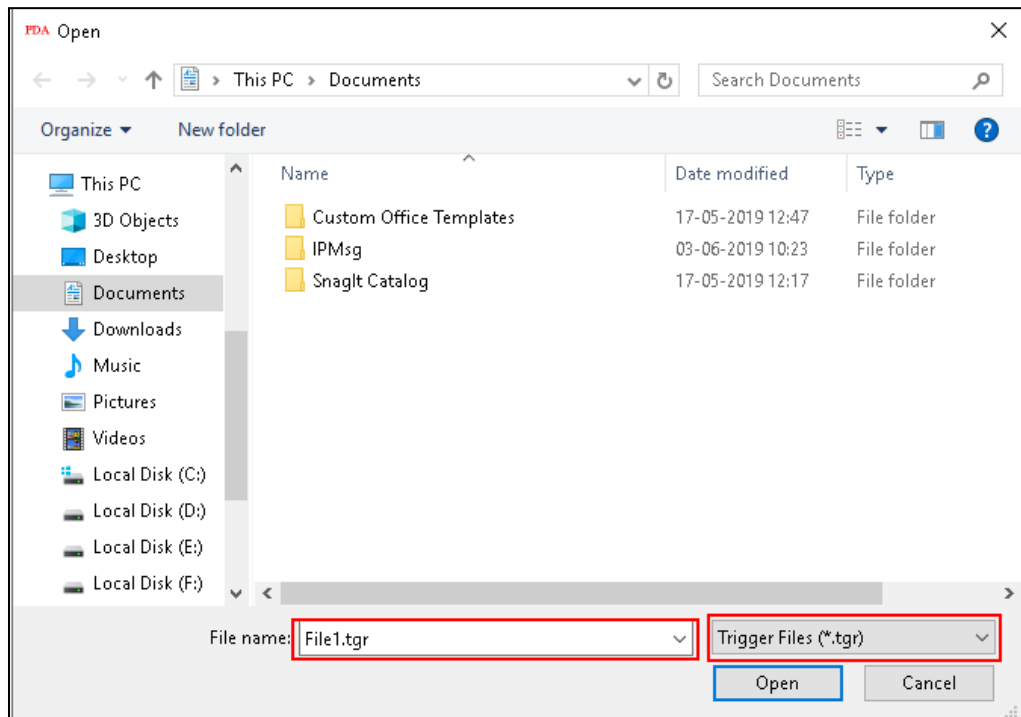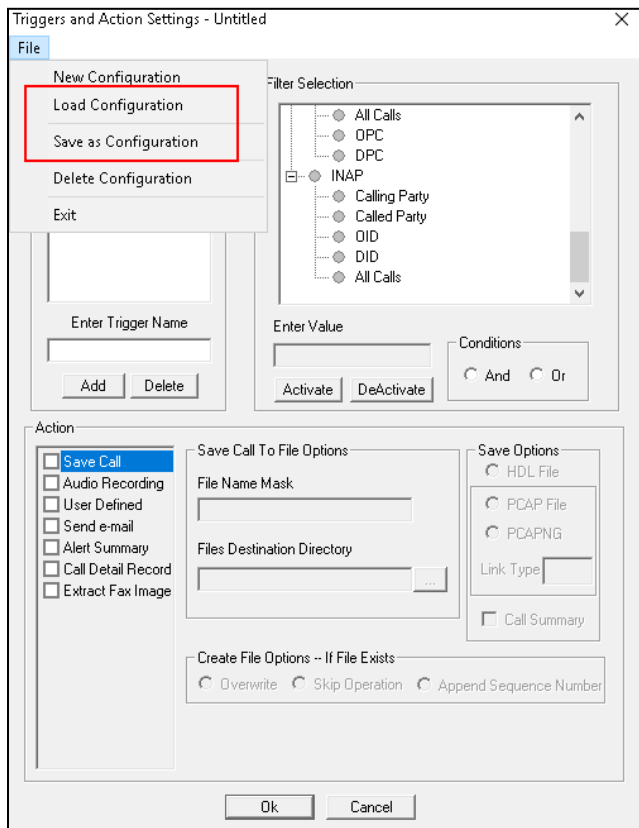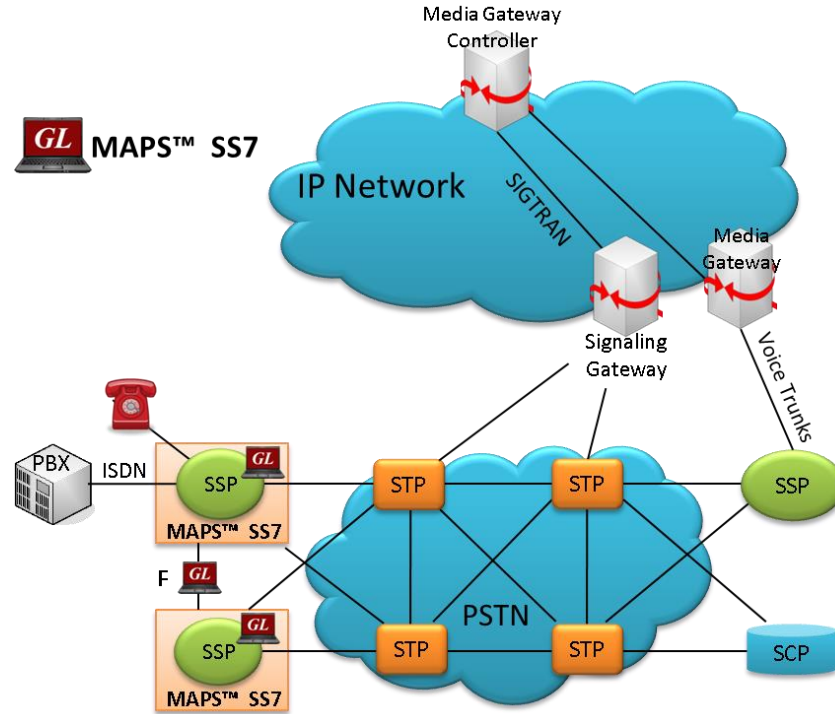
PDA Startup Options
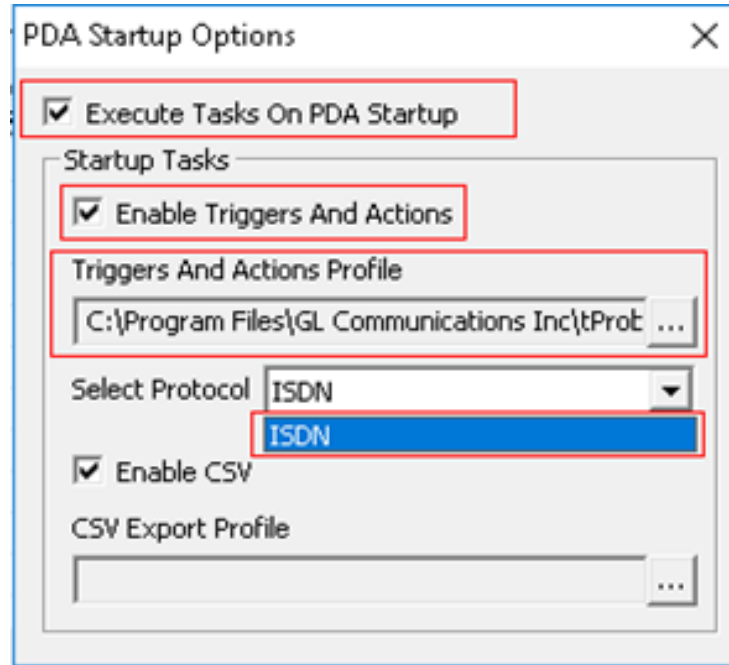
- Allows user to configure start-up tasks which will be started automatically whenever PDA is launched

- Loads the selected Triggers and Actions profile while invoking PDA

MAPS™ ISUP

Scripted ISUP Simulation - MAPS™ SS7 (XX649)

MAPS SS7 Simulation

Key Features

- ISUP (SSP) simulation over TDM (T1 E1)

- Supports transmission and detection of TDM traffic - digits, voice file, single /dual tones

- User-friendly GUI for configuring the SS7 MTP Layers

- User Configurable Signaling Links

- User-configured Circuit Mapping, i.e., defines Circuit Identification Codes (CIC) and map these CICs to Timeslots/Trunks in order to enable Voice / Data traffic

- Supports MTP2 and MTP3 protocol machine

- Multiple MTP links

- Access to all ISUP Message Parameters CIC, calling number, called number, and more

- User controlled access to optional ISUP parameters such as timers

- Subsequent Address Message (SAM) configurations available

- Fully Supported Continuity Testing (COT) that includes COT messages

Call Generation and Reception

MAPS™ - SIGTRAN (SS7 over IP)

PSTN

PSTN

STP

STP

T1 E1

T1 E1

SGW

SGW

SIGTRAN

SIGTRAN

SIGTRAN

SIGTRAN

Local
Switch

Local
Switch

Voice

Voice

SIGTRAN

SIGTRAN

MGC

TGW

IP Phone

MAPS™ SIGTRAN
Simulate Elements in SS7 Network over IP

- - - - - - - ▶   TRAFFIC

- - - - - - - ▶   SIGNALING

61

Key Features

- SS7 simulation over IP

- User-friendly GUI for configuring the SS7 M3UA Layers

- User Configurable Signaling Links

- Supports M3UA and SCTP protocol machine

- Multiple M3UA links

- Access to all ISUP Message Parameters Initial Address, Subsequent Address, Release messages, and more

- User controlled access to optional ISUP parameters such as timers

- Subsequent Address Message (SAM) configurations available

- Fully Supported Continuity Testing (COT) that includes both COT messages

- Logging of all SS7 Messages in real-time. Each SS7 message displays CIC values defined within the message

Call Generation and Reception

Scripted MAP Simulation -MAPS™ MAP
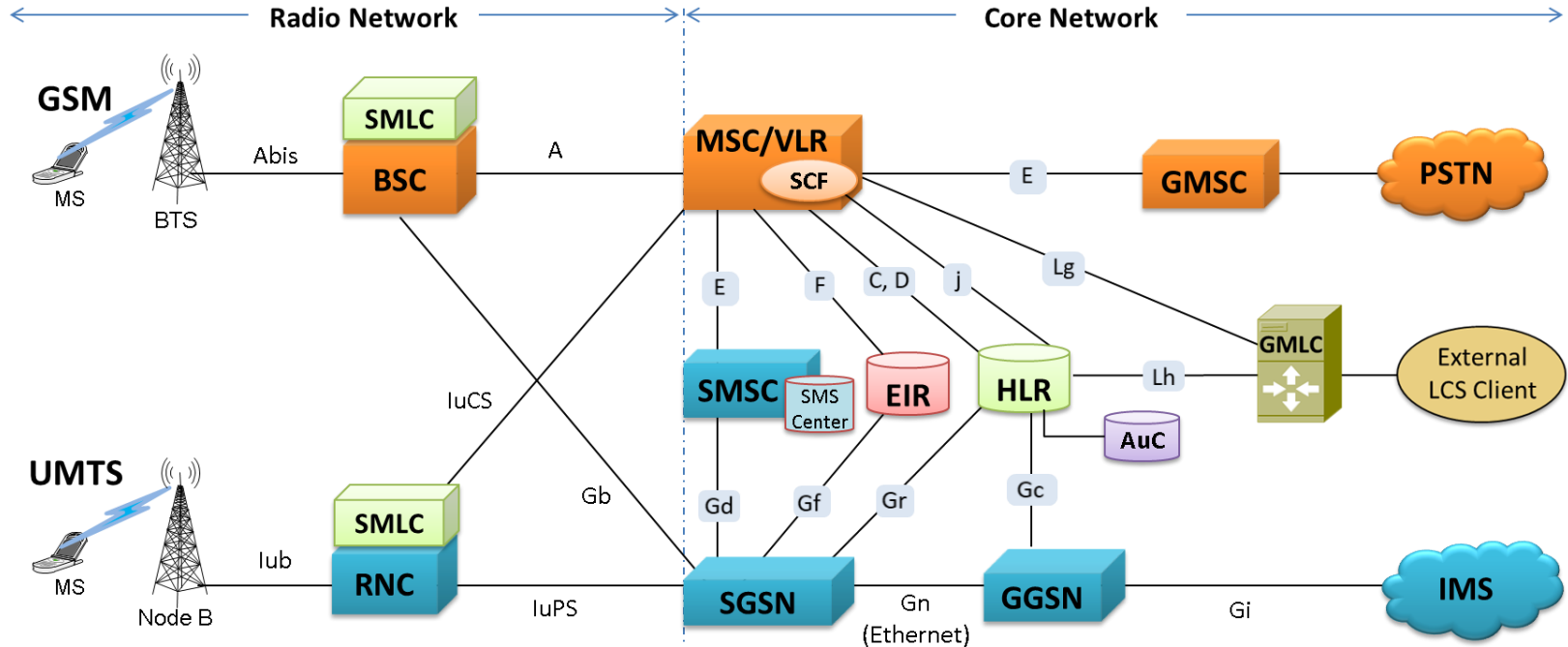
MAPS™ MAP over IP & TDM Emulator
MAP (Mobile Application Part)

C, D, E, F, J
Gc, Gd, Gf, Gr
Lg, Lh

Features

- MAP protocol simulation over TDM (T1 E1)

- Emulator can be configured as MSC (VLR), HLR, GMSC, EIR, AuC, SMSC, SGSN and GGSN entities and emulate the respective interfaces

- User-friendly GUI for configuring the MAP signaling links

- Access to all MTP3, SCCP, and MAP R4 protocol fields such as TMSI, IMSI, MCC, MNC, MSIN, CCBS and more

- Ready scripts for monitoring other end, set reporting state for the requested service, report an event or call outcome, report remote subscriber status procedures

GL Communications

Call Generation and Reception

Thank you