# SS7 – Signaling System Number 7

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 64Kbps

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.

SS7 Network Architecture
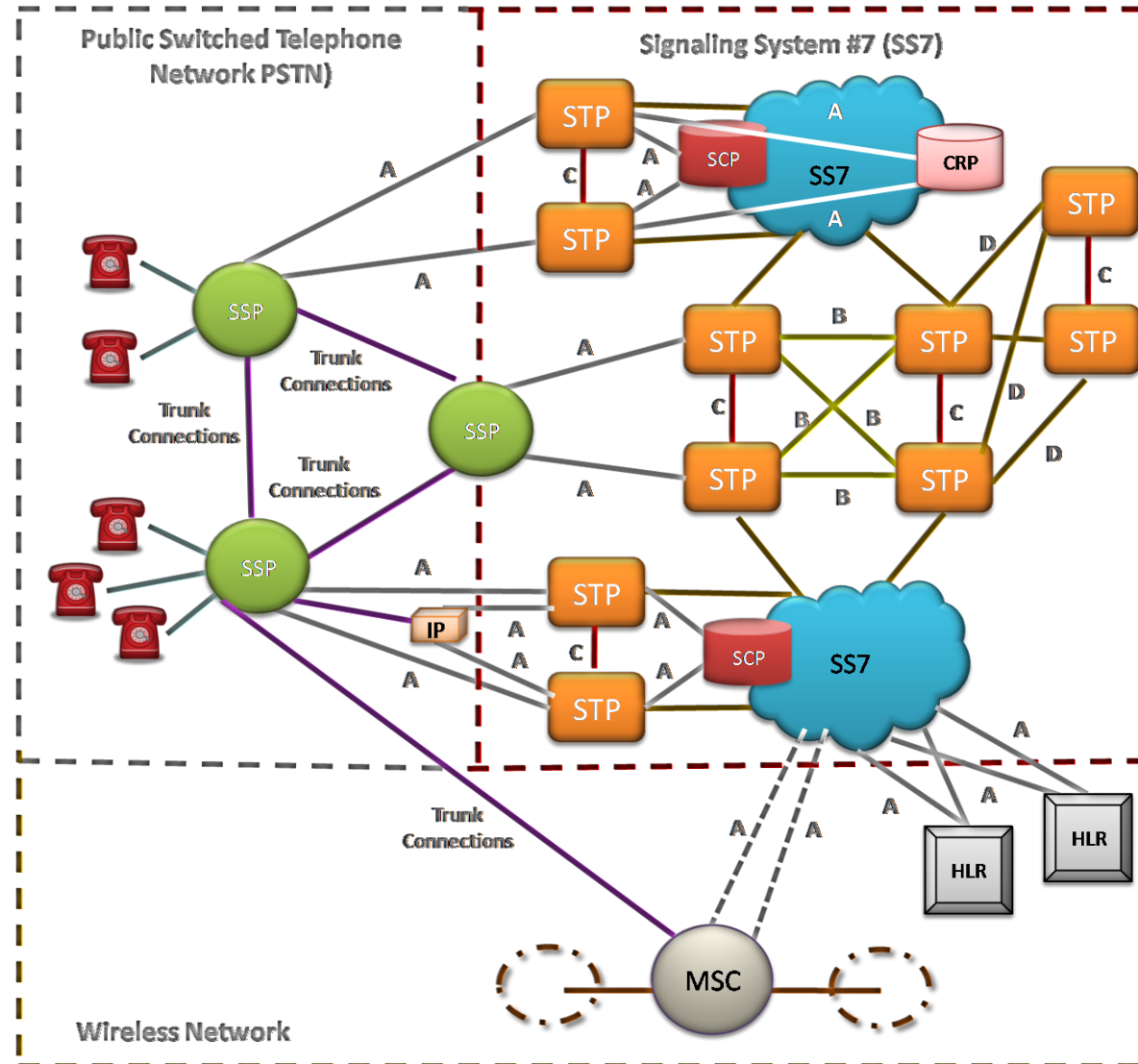
Signaling Points

SS7 Network Architecture

- 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

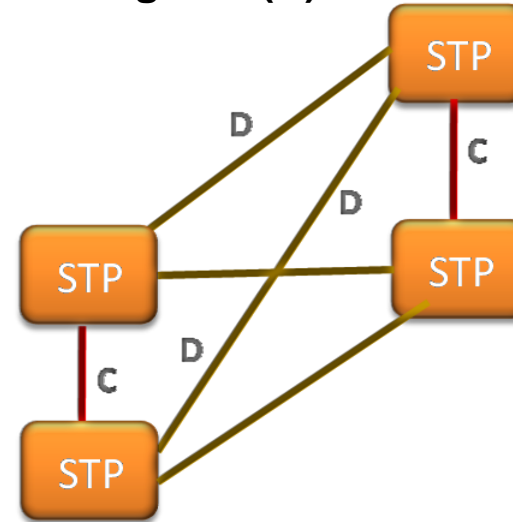**Access (A) Link**
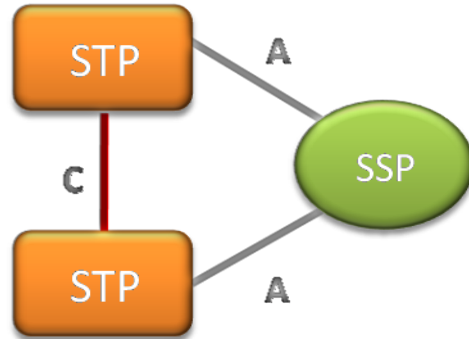
Bridge (B) Link
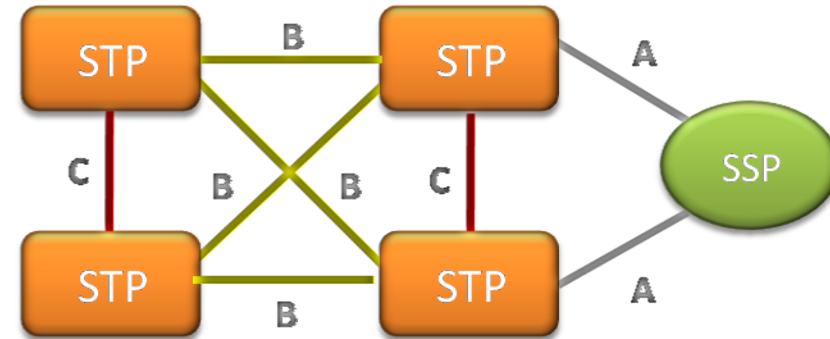
- **Access Links** connects SCP or SSP to an STP. Only messages originating

  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.

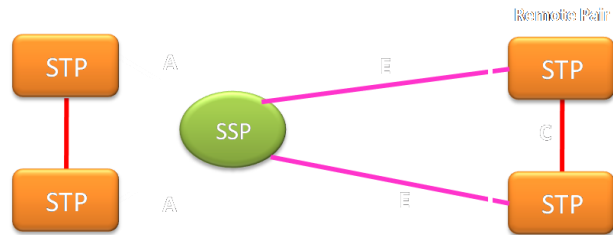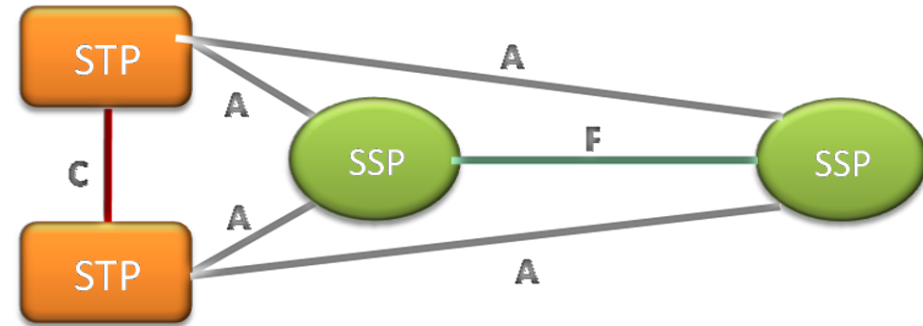# Signaling Links

Cross (C) Link
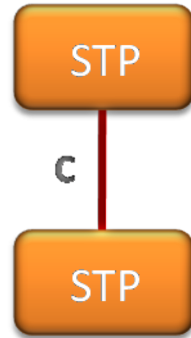
Diagonal (D) Link

- **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

Extended (E) Link
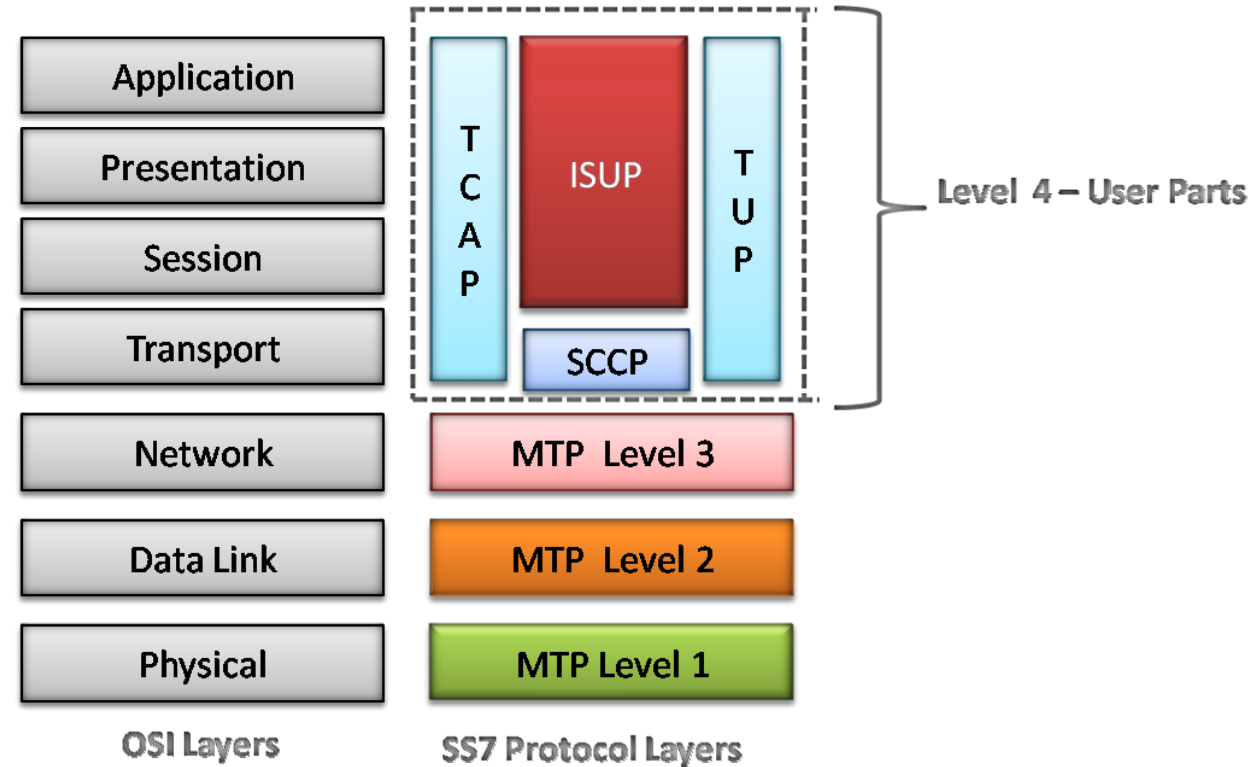
Fully Associated (F) Link

- **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

OSI Layers	SS7 Protocol Layers
Application	TCAP / ISUP / TUP — Level 4 – User Parts
Presentation	
Session	
Transport	SCCP
Network	MTP Level 3
Data Link	MTP Level 2
Physical	MTP Level 1

SS7 Layers

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

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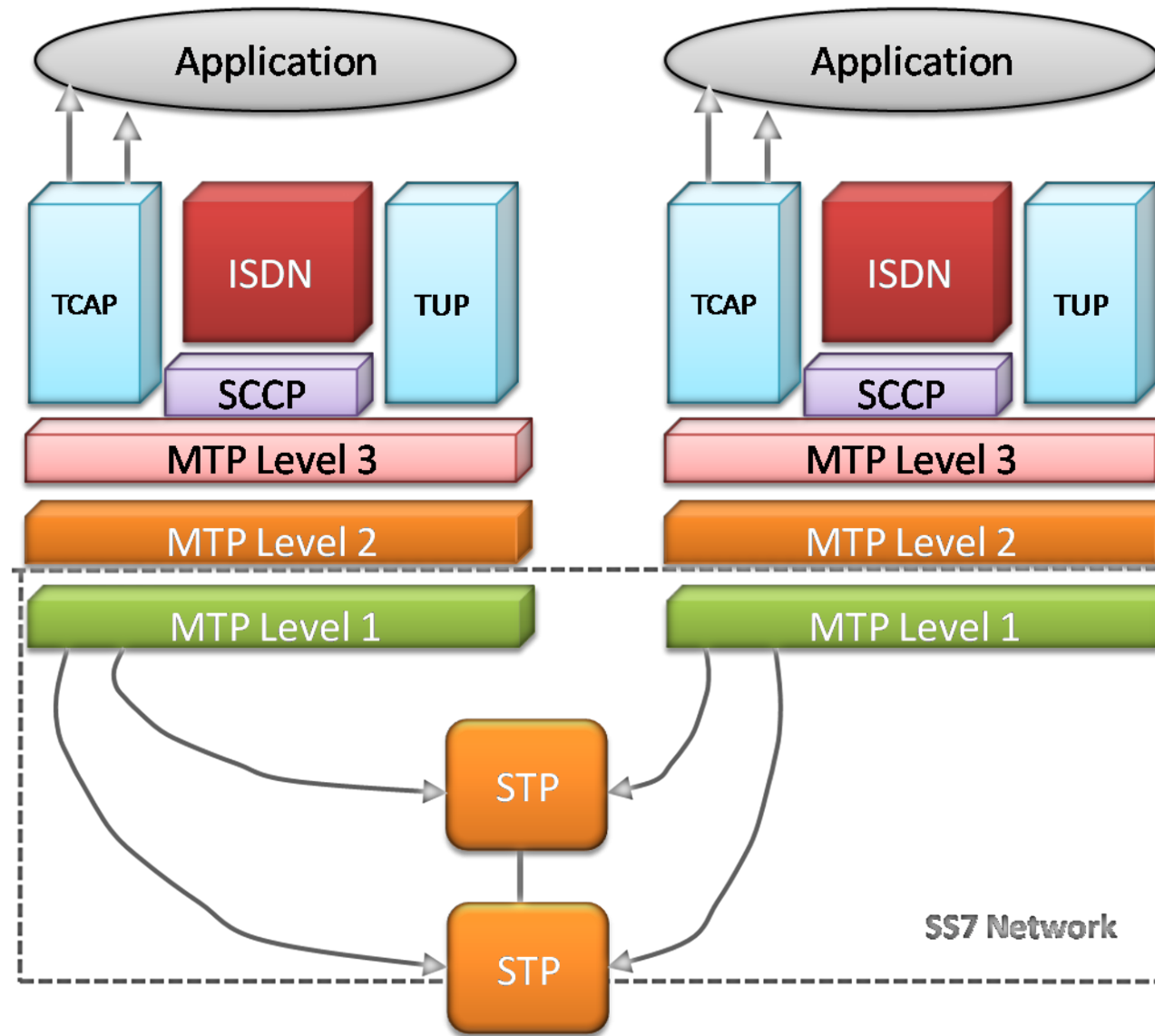
Signaling Link Level (MTP Level 2) & Signaling Units

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
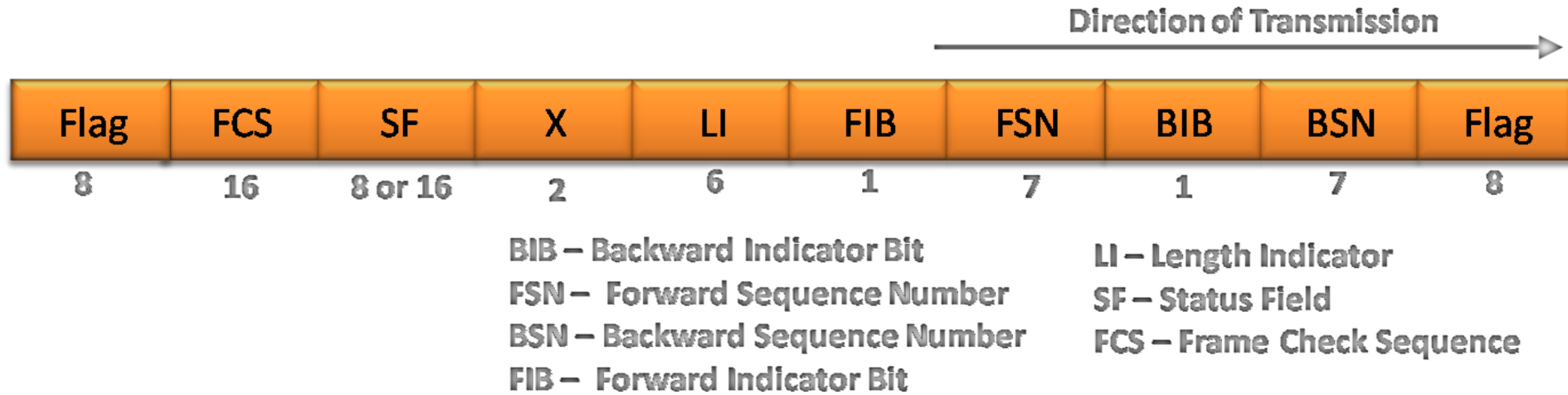BIB – Backward Indicator Bit
BSN – Backward Sequence Number

- 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, & message type)
- SS7 uses three types of signal units –
  - Message Signal Units (MSU) -
  - Link Status Signal Unit (LSSU)
  - Fill-In Signal Unit (FISU) –

Message Signaling Unit
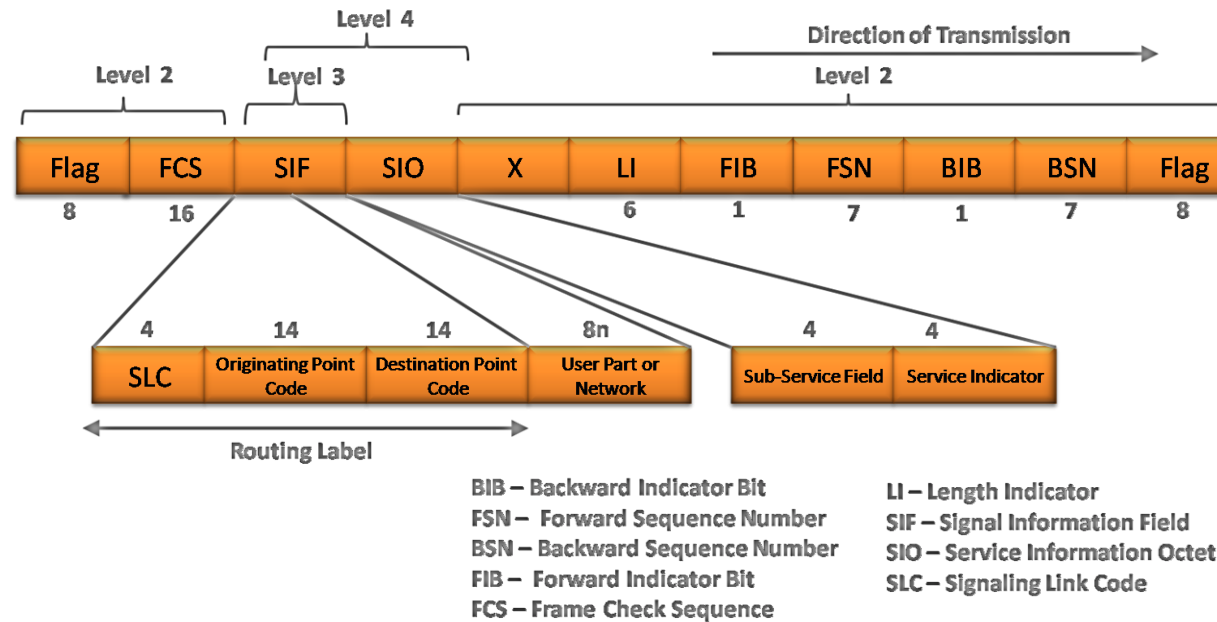
- **Carries SS7 information**

- **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
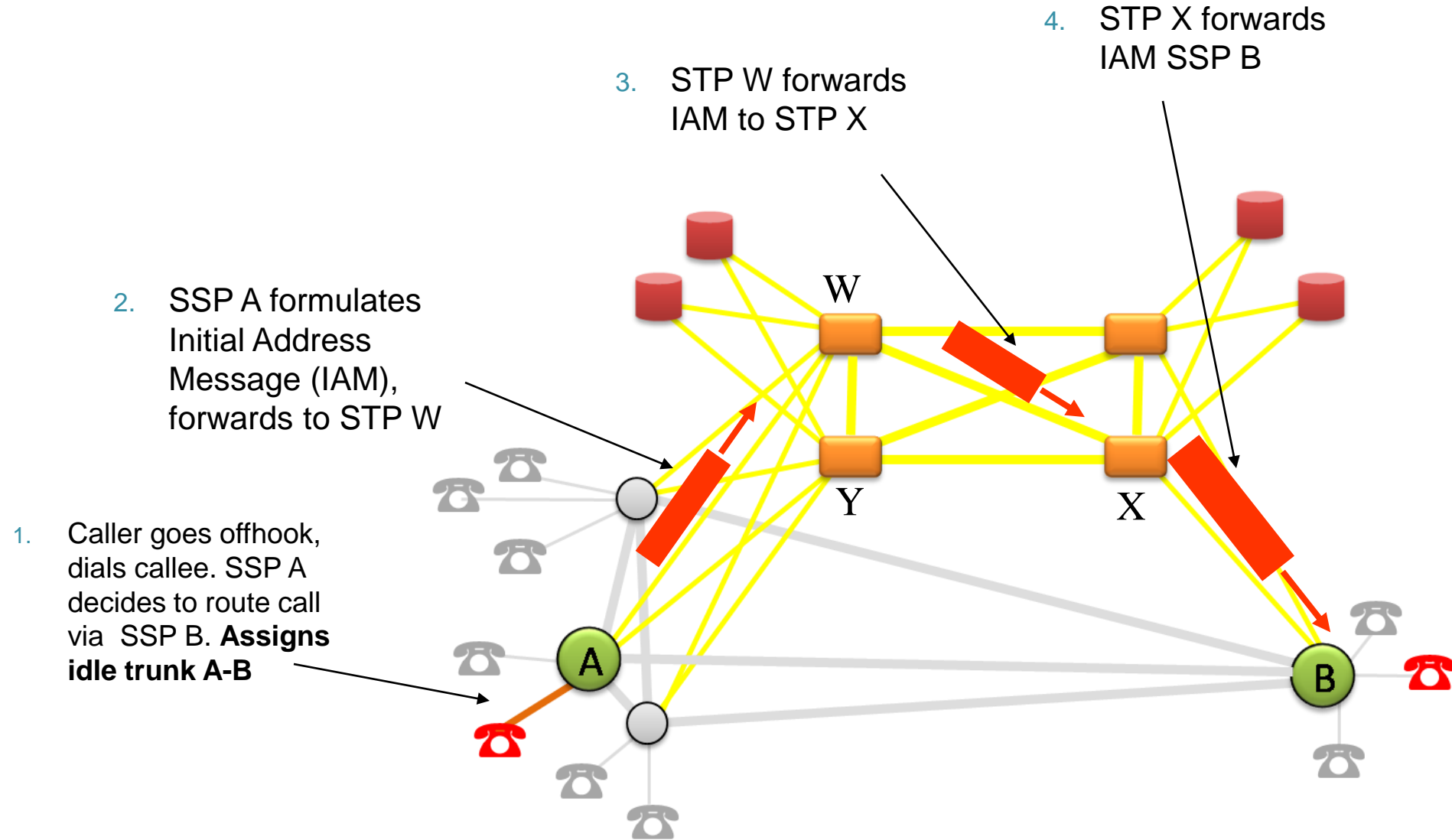
Link Status Signaling Unit

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

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

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

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

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

LI – Length Indicator
FIB – Forward Indicator Bit
FCS – Frame Check Sequence
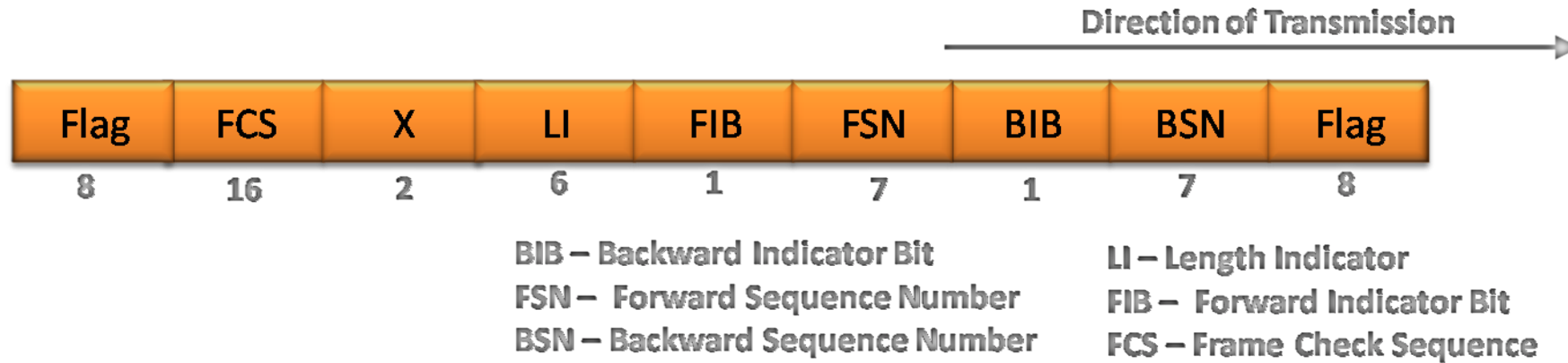
- Used when no information needs be sent and the network is idle

- 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

GL Communications

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Signaling in SS7 Network

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

Y

X

A

B

16

4. STP X forwards IAM SSP B

3. STP W forwards IAM to STP X

W

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

Y   X

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

A

B

GL
Communications

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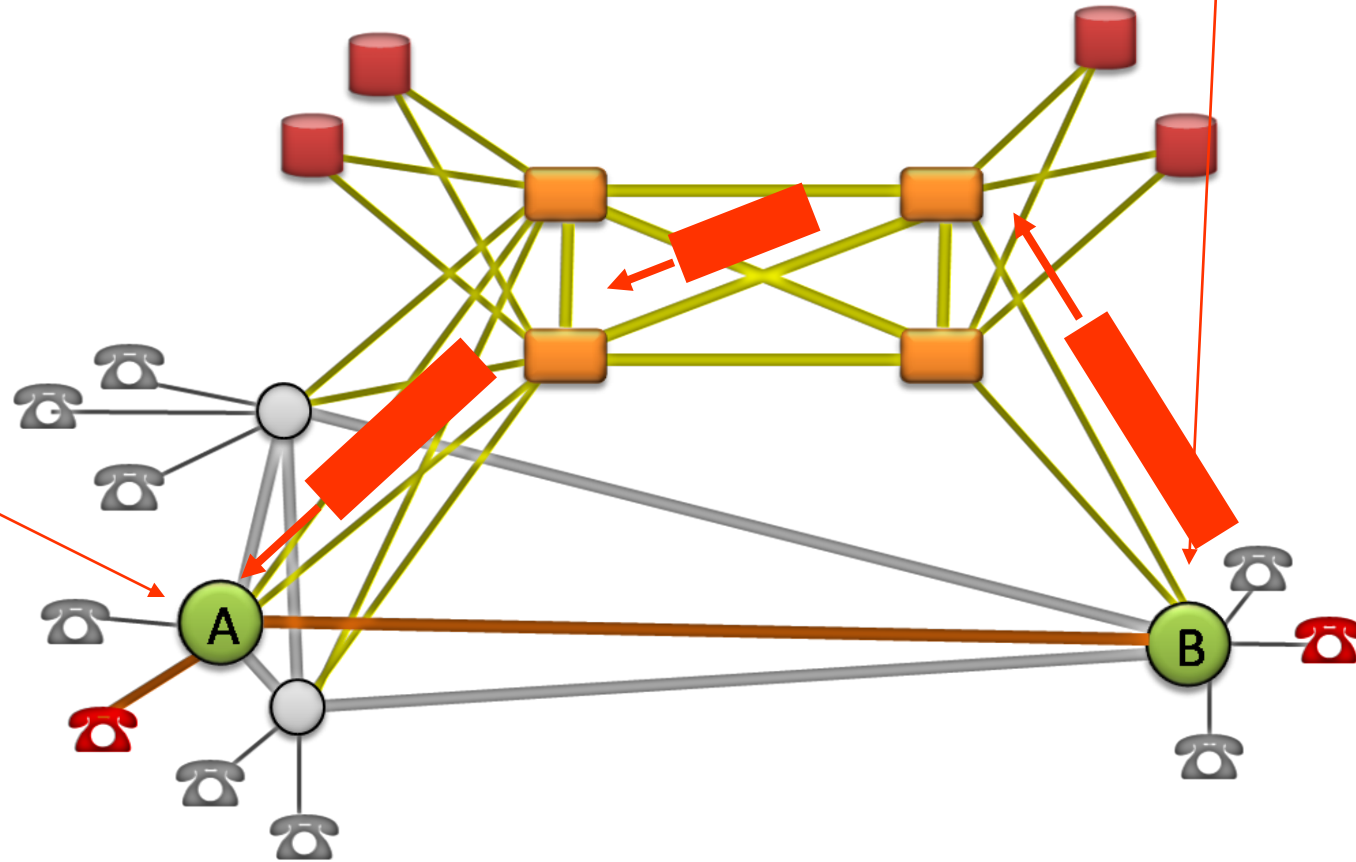
8. Callee goes off hook, SSP B sends answer message to A (ANM[A,B,trunk])

9. ANM routed to A

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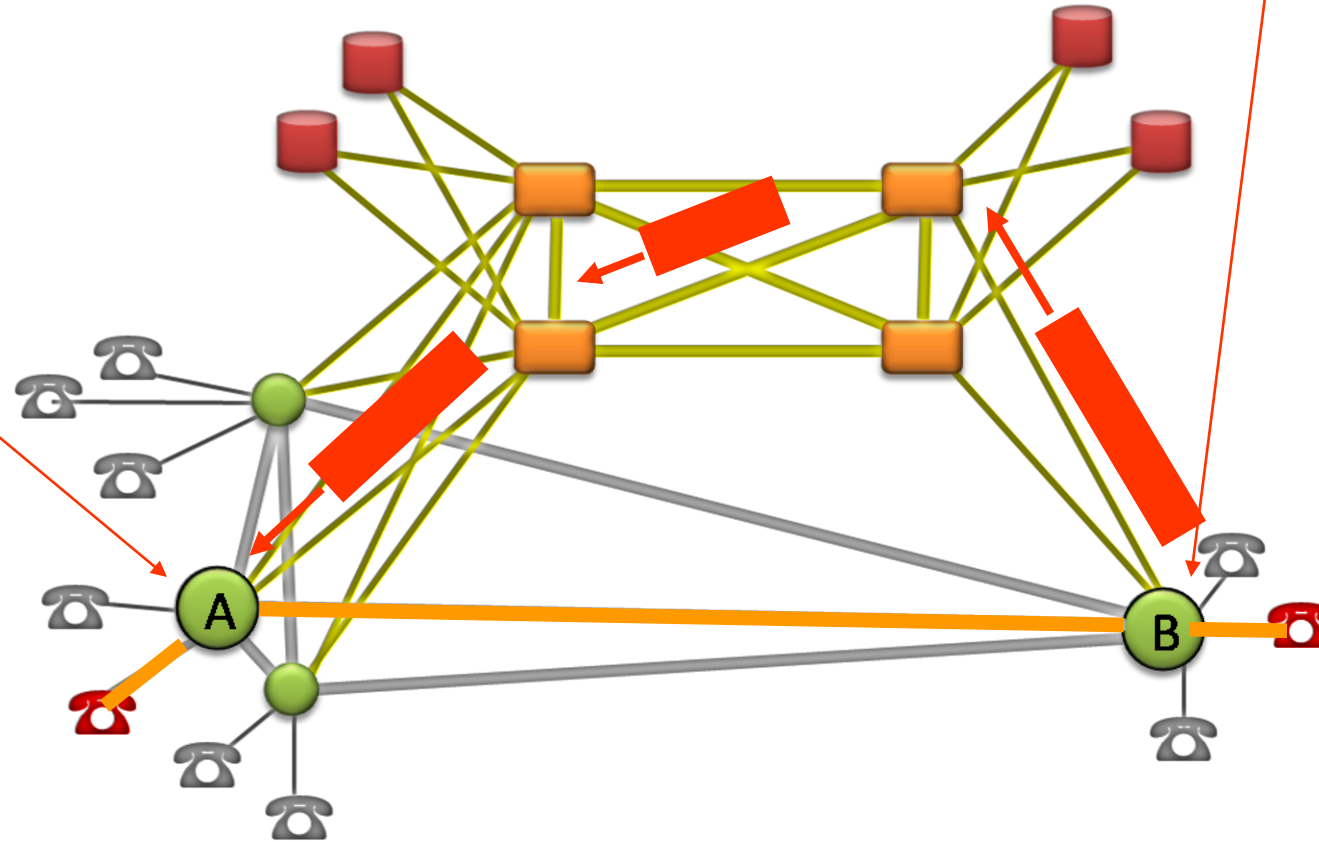
800 number: logical phone number

- Translation to physical phone number needed, e.g., 1-800-CALL_ATT translates to 162-962-1943

3. SCP M performs lookup, sends reply to A

2. STP W forwards request to SCP M

1. Caller dials 800 number, SSP A recognizes 800 number, formulates translation query, send to STP W
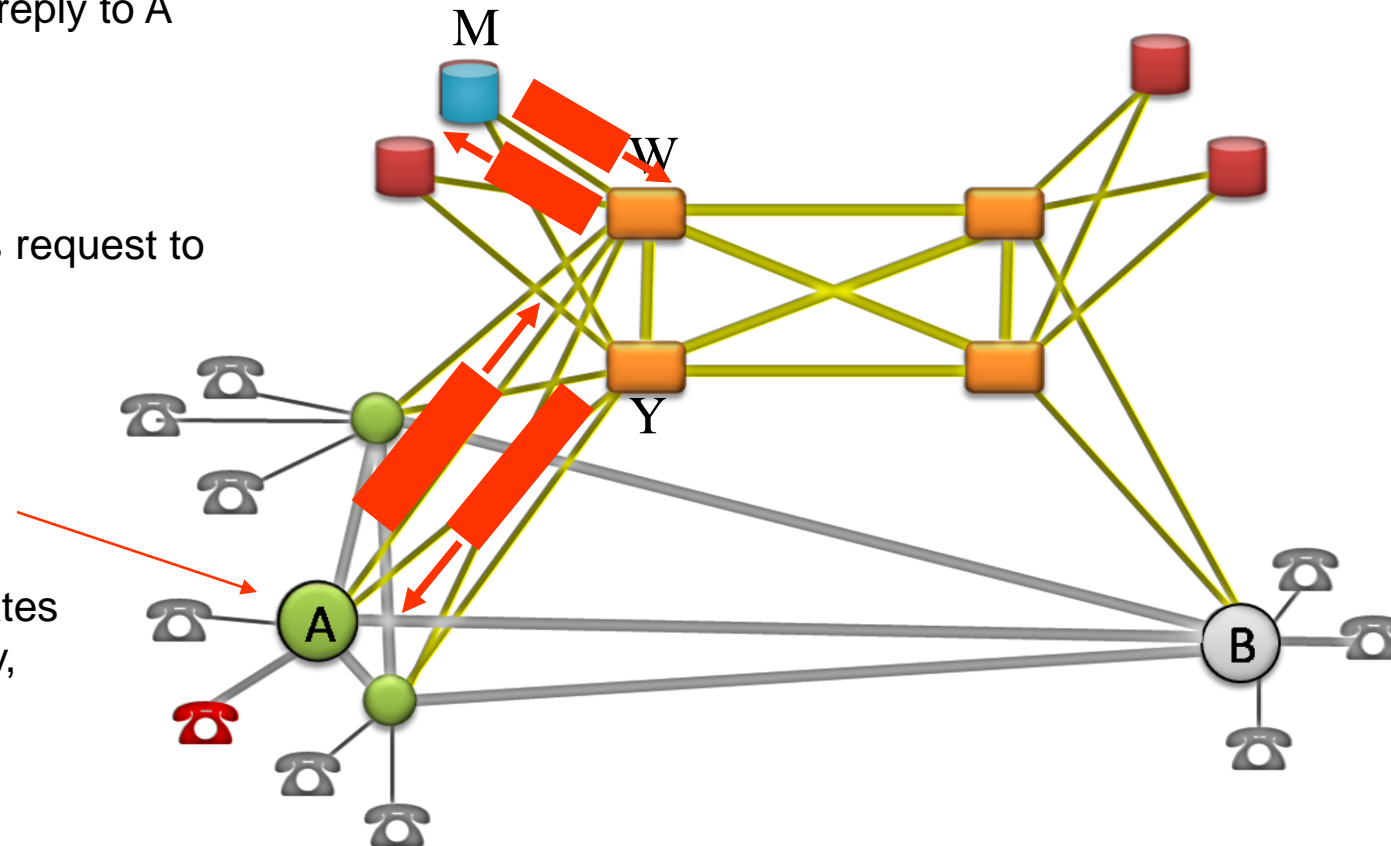
- SSP A begins signaling to set up call to number associated with 800 number
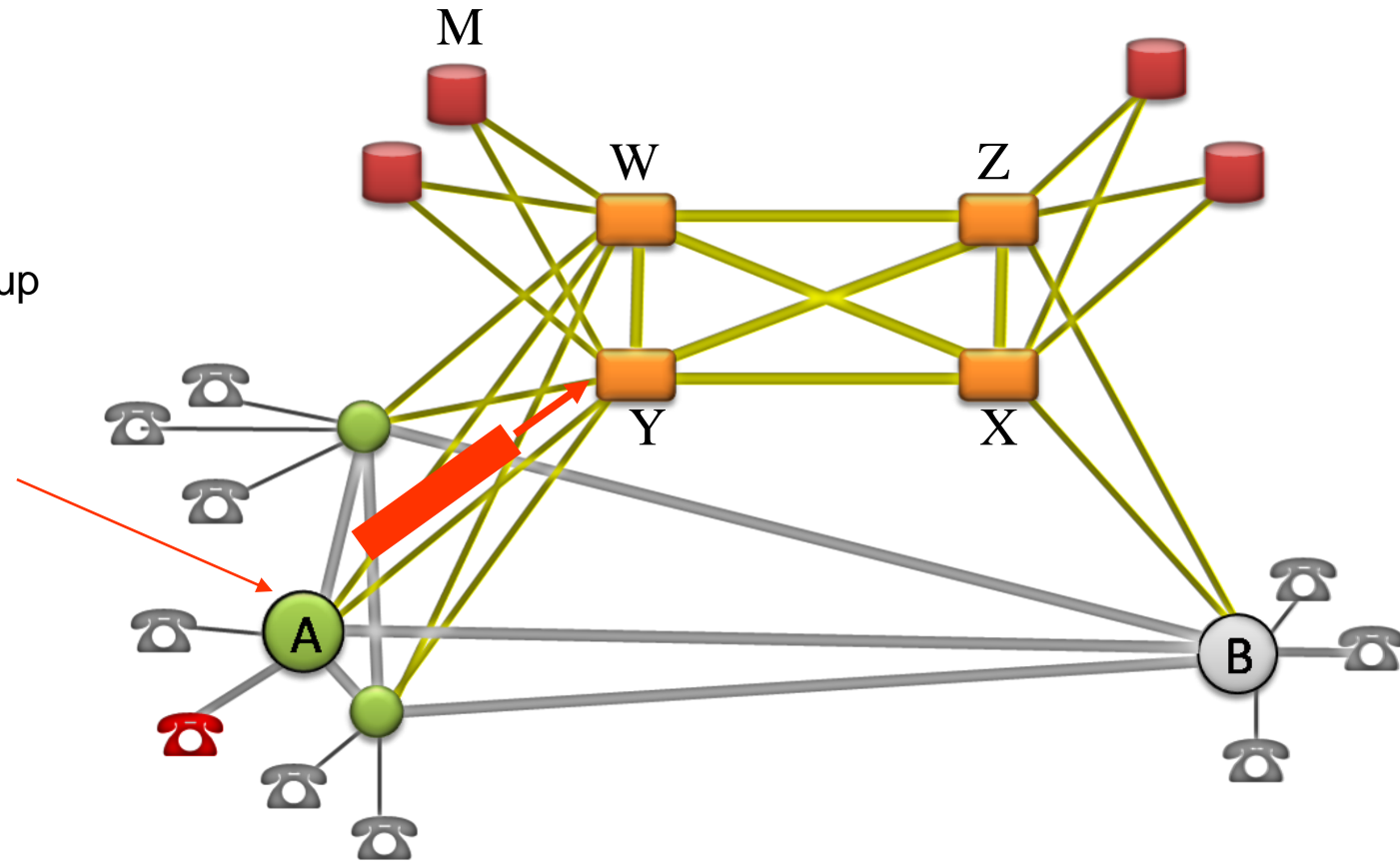
User Parts Functionality in SS7 Network

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

ISUP Normal Call Flow Scenario

User Parts Functionality in SS7 Network
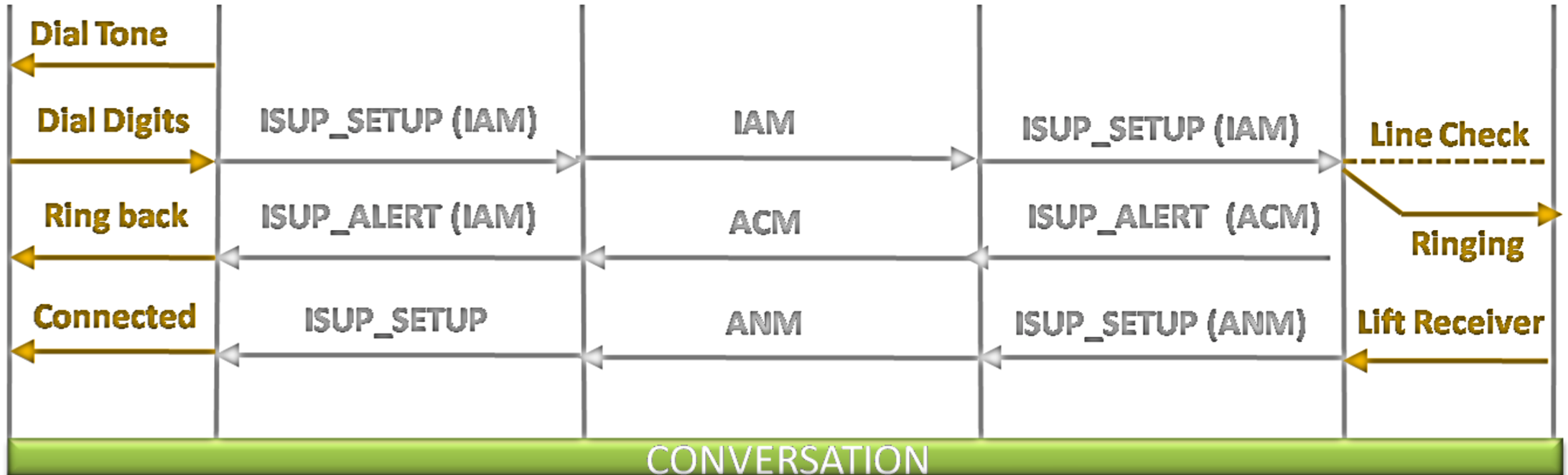
GL's SS7 Analyzer

GL's SS7 Analyzer

Summary View

Detail View

Hex dump View

Protocols Standards
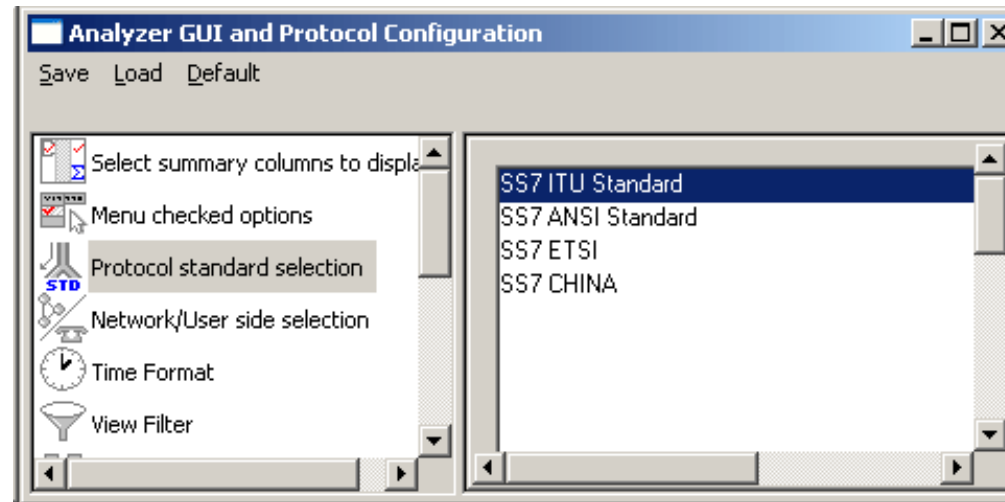
- MTP2
- MTP3
- SCCP, MAP, CAMEL, ISUP, TUP, TCAP
- MAP: 3GPP TS 09.02 V7.14.0 (2003-09)
- INAP CS1 (Capability Set 1)
- INAP CS2 (Capability Set 2) - INAP CS2 ITU & INAP CS2 ETSI
- Test & Network Management Messages
- TCAP (IS 41): Q.773, CCITT (ITU-T) Blue Book / ANSI T1.114 –1996/ TIA/EIA/IS-41.5-C

Filter Frames (Real-time)
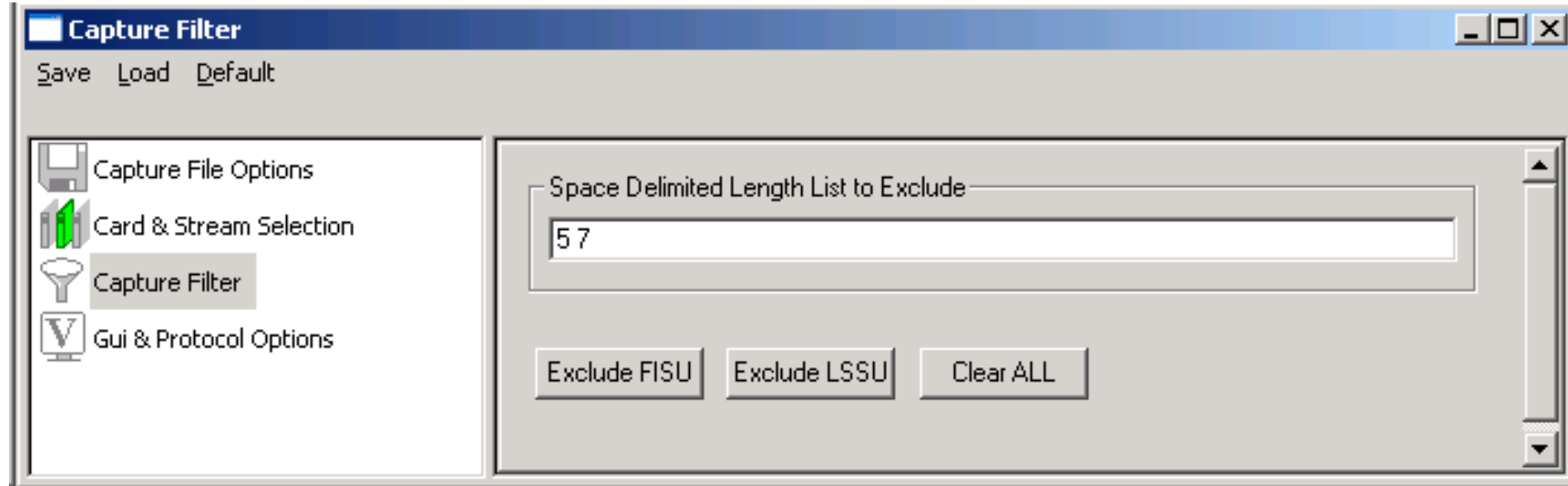
- Isolate certain specific frames from all frames in real-time as well as offline

- Real-time Filter applies to the frames being captured and is based on the frame length

Filter Frames (Offline)
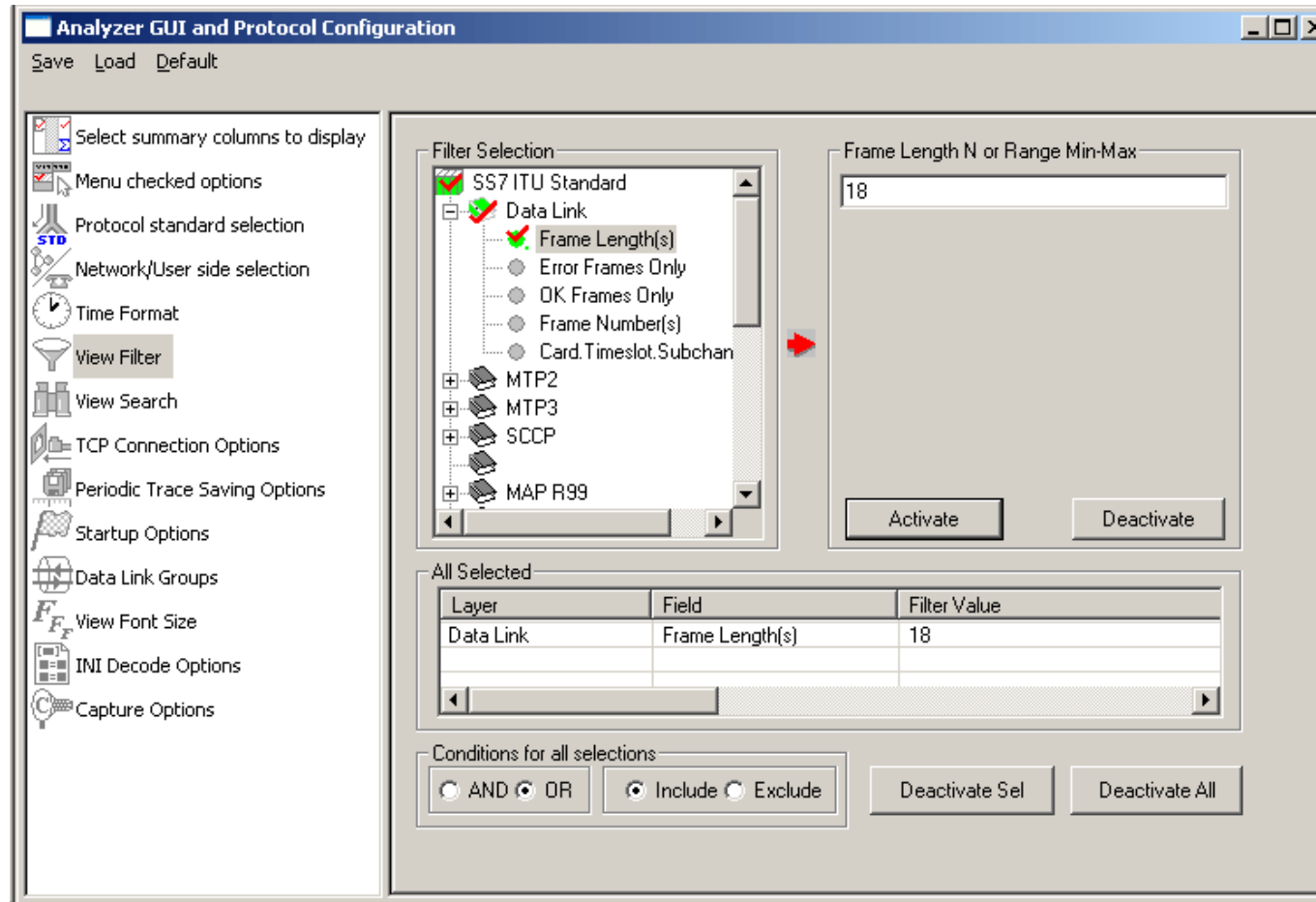
- The frames can be filtered after completion of capture based on BSN, BIB, FSN, FIB, Status Field, OPC, DPC, SSN, CIC, Called and Calling party number and types of different SS7 message.

Search Frames
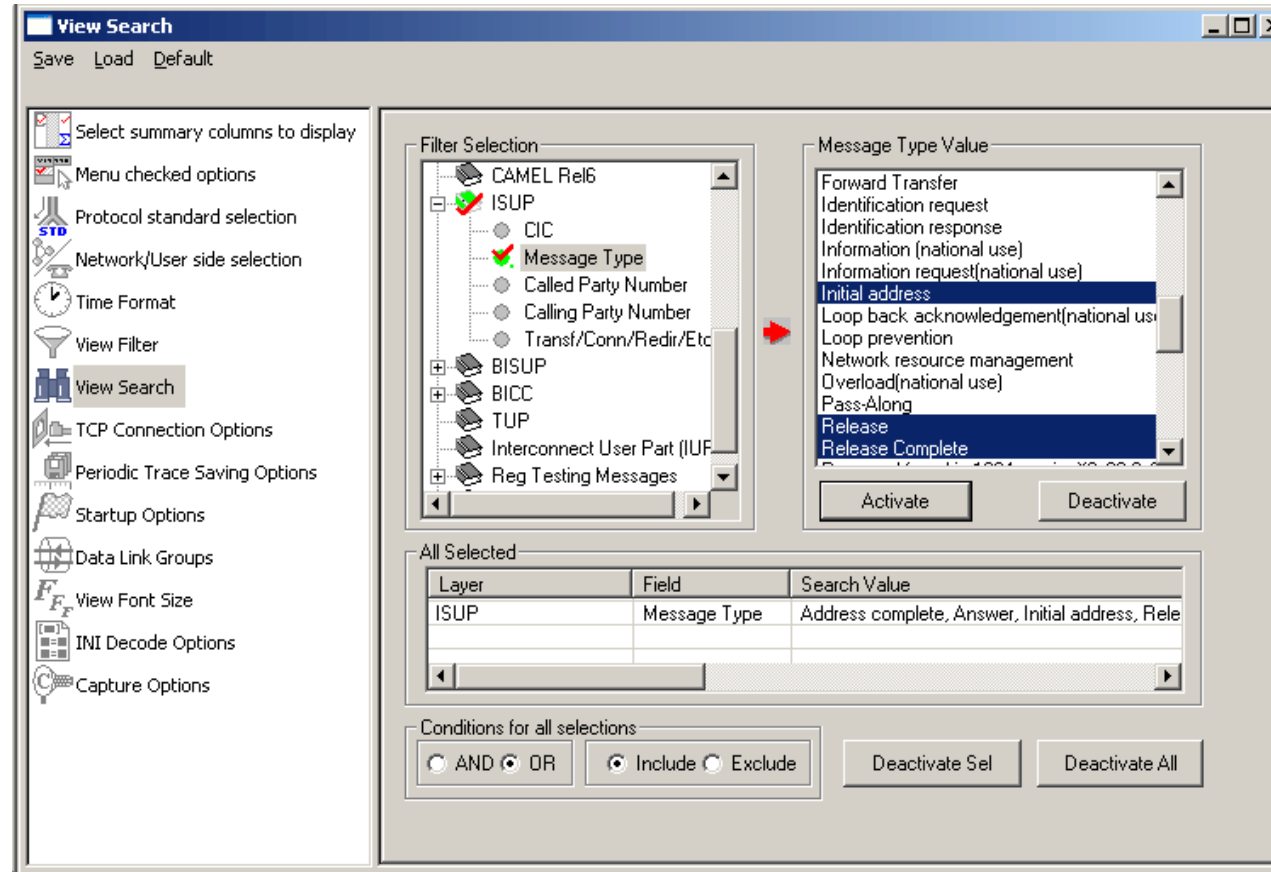
- Search features helps users to search for a particular frame based on specific search criteria

Statistics
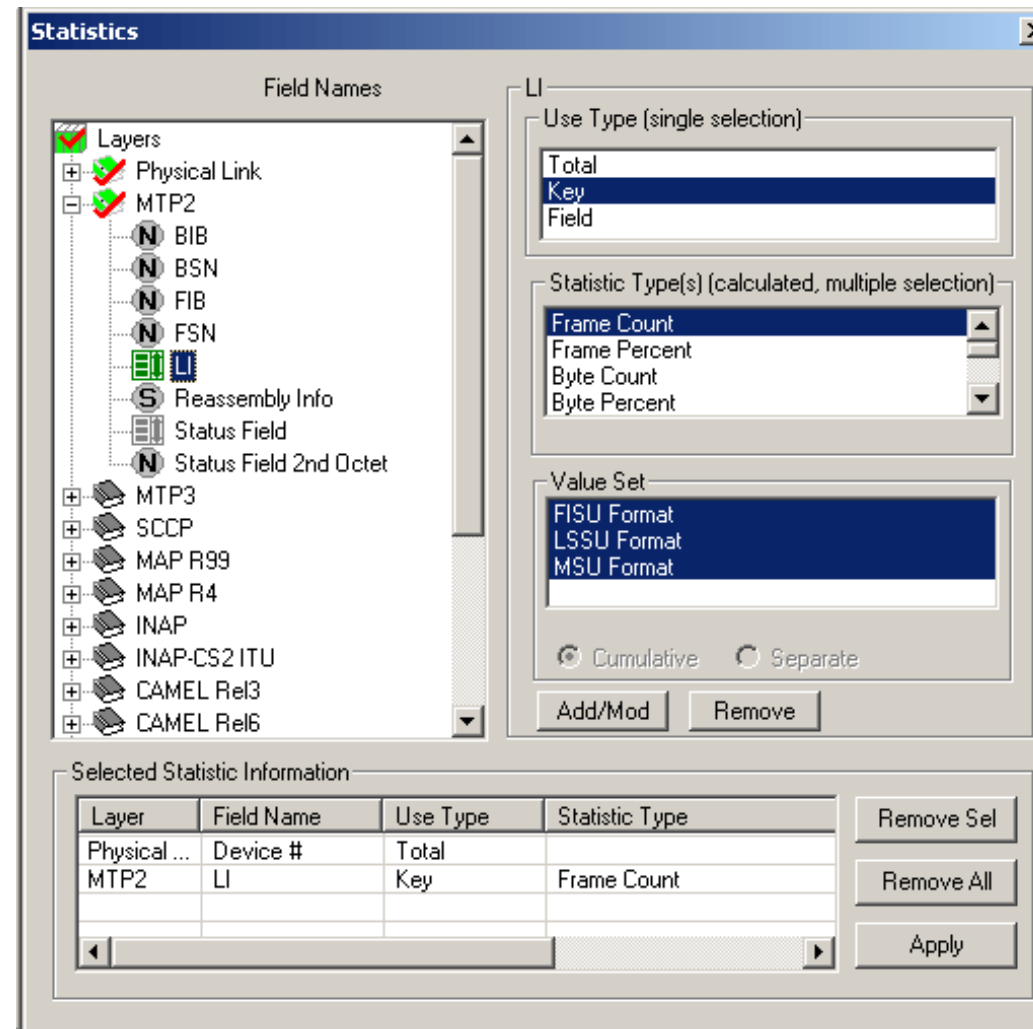
- Numerous statistics can be obtained to study the performance and trend in the network

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

THANK YOU