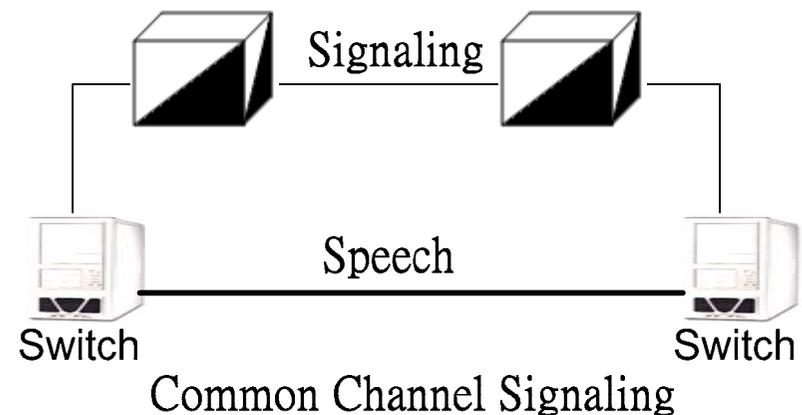
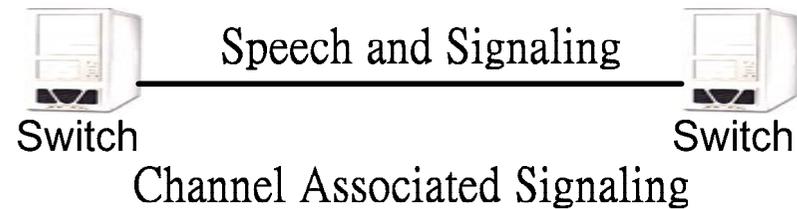


# VoIP and SS7

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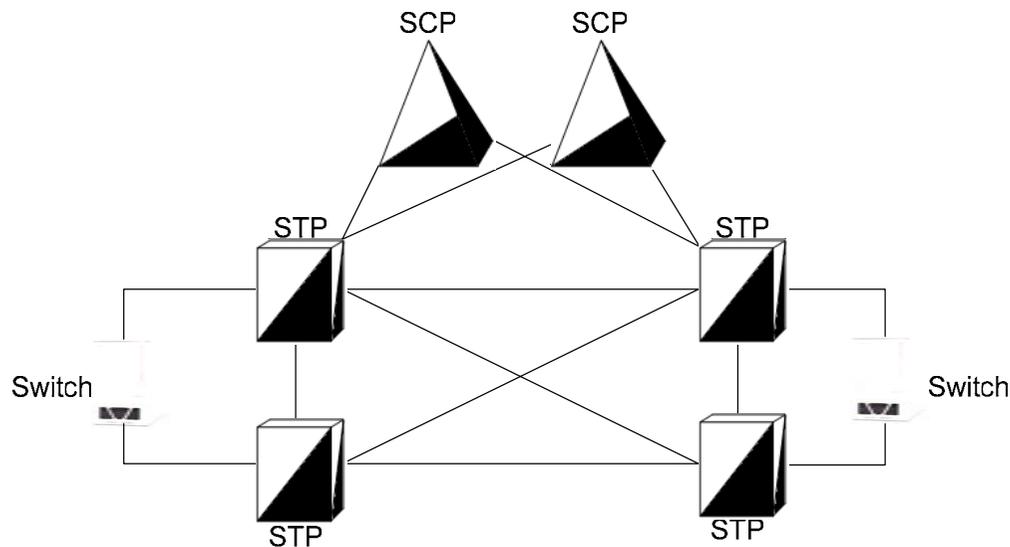
# Introduction

- Channel Associated Signaling (CAS)
  - Still widely deployed today
  - Considered as old technology
- Common Channel Signaling (CCS)
  - Separation of signaling and call paths
  - Signaling System 7 (SS7)
    - To enable a wide range of services to be provided to the end-user
    - Caller ID, toll-free calling, call screening, number portability, etc.
    - SS7 is the foundation for Intelligent Network (IN) services.

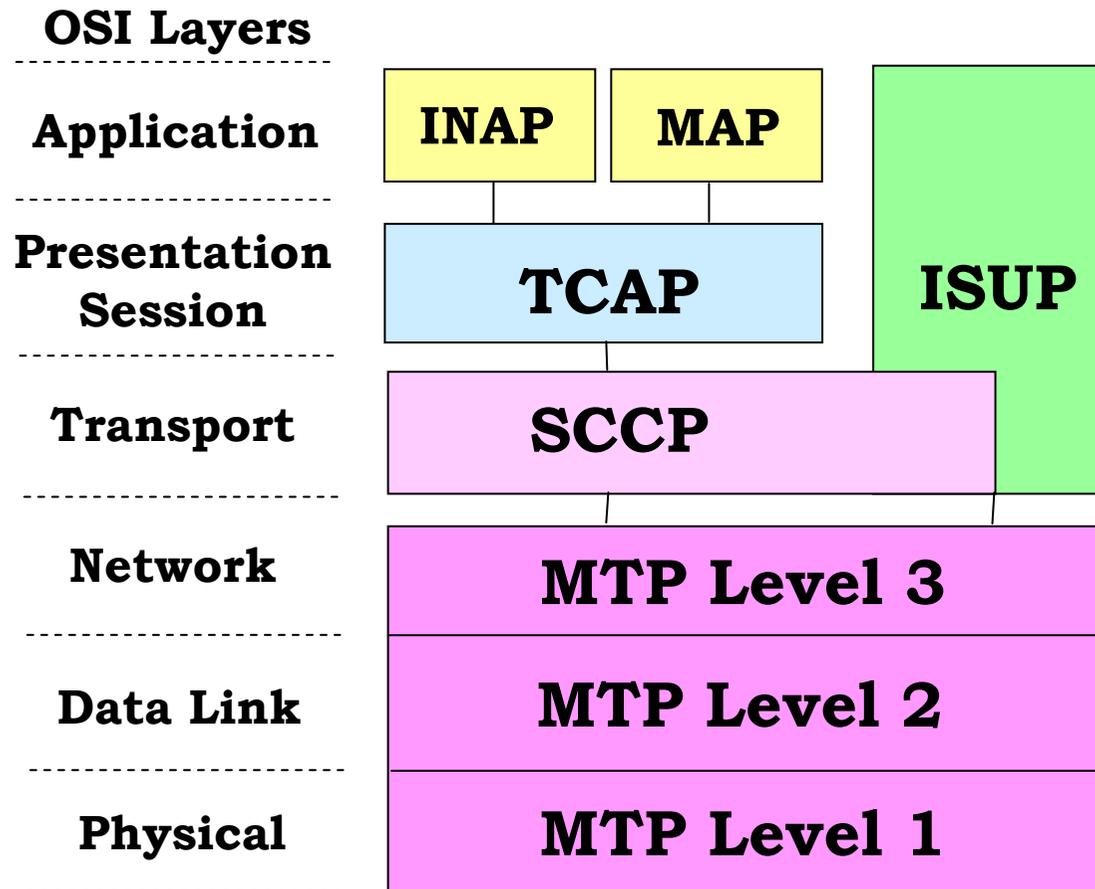


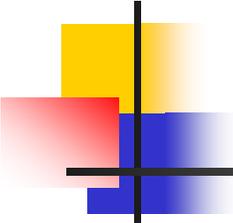
# SS7 Network Architecture

- A typical SS7 network arrangement
- This configuration serves several purposes.
  - A fully meshed signaling network is not required.
  - The quad arrangement ensures great robustness.



# SS7 Protocol Suite

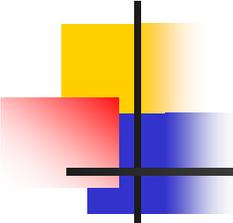




# MTP Levels 1 & 2

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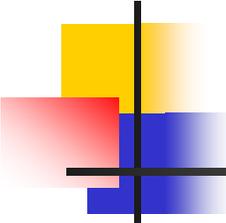
- Message Transfer Part
  - Responsible for getting a particular message from the source to the destination
- Level 1
  - Handling the issues related to the signals on the physical links between one signaling node and another
- Level 2
  - Dealing with the transfer of messages on a given link from one node to another
  - Providing error detection/correction and sequenced delivery of the SS7 messages



## MTP Level 3

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- Signaling message handling
  - Providing message routing between signaling points in the SS7 network
- Signaling network management
  - Rerouting traffic to other SS7 signaling links in the case of link failure, congestion or node failure
  - Load-sharing

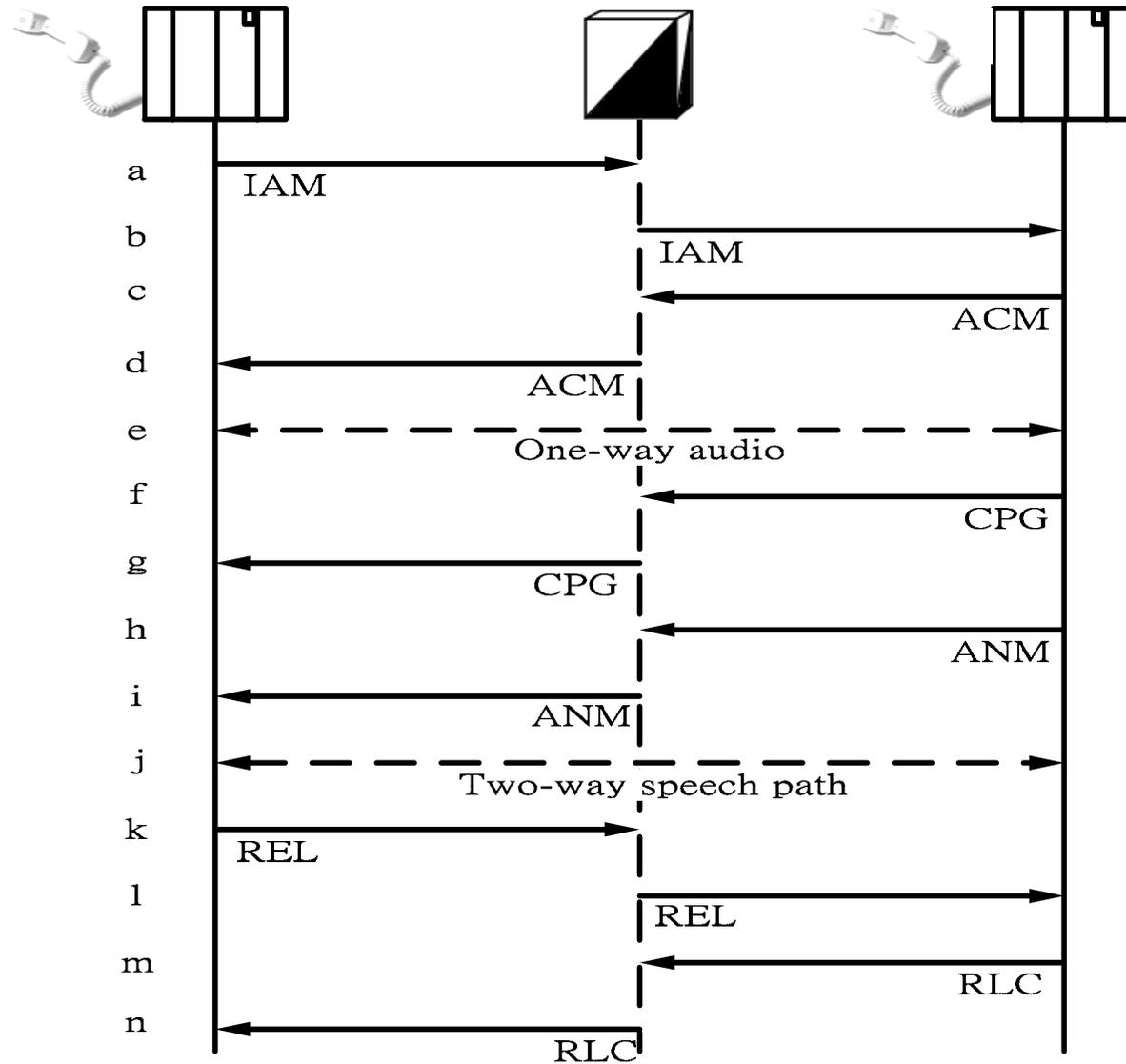


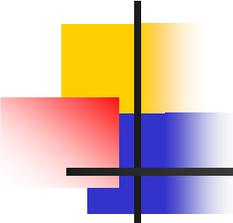
# ISDN User Part (ISUP)

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- Used as the protocol for setting up and tearing down phone calls between switches
- Initial Address Message (IAM)
  - To initiate a call between two switches
- Address Complete Message (ACM) - Optional
  - To cause a one-way audio path opened from the destination switch to the originating switch (the caller can hear a ring-back tone)
- Call Progress Message (CPG) – Optional
  - To provide additional information to the calling switch regarding the handling of the call
- Answer Message (ANM)
  - To indicate that a call has been accepted by the called party
- Release Message (REL)
  - To initiate call disconnection

# ISUP Call Establishment and Release

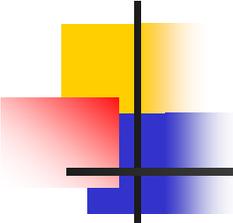




# SCCP

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- Signaling Connection Control Part
- Used as the transport layer for TCAP-based services
  - freephone (800/888), calling card, wireless roaming
- Both connection-oriented and connectionless
  - Mostly connectionless signaling
- Global title translation (GTT) capabilities
  - The destination signaling point and subsystem number is determined from the *global title*



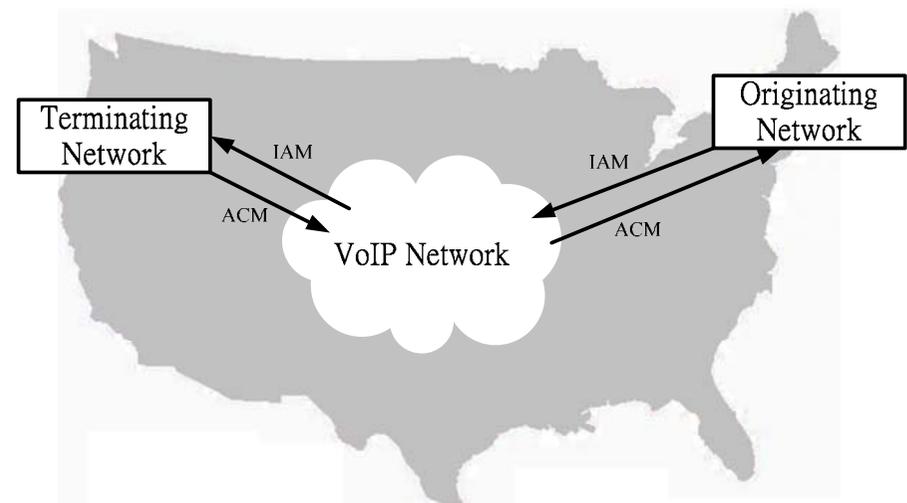
# TCAP, MAP and INAP

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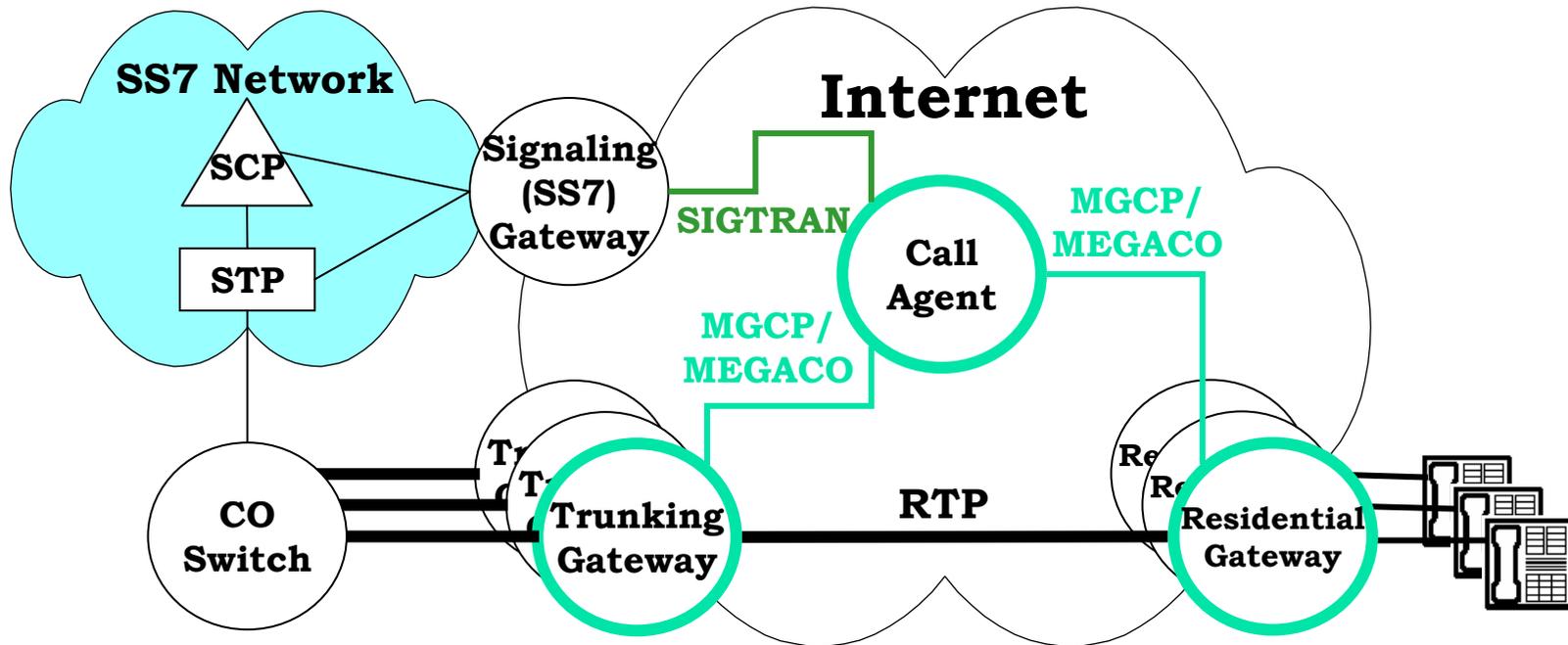
- TCAP (Transaction Capabilities Applications Part)
  - Supporting the exchange of non-circuit related information between signaling points
  - Queries and responses sent between SSPs and SCPs are carried in TCAP messages
- INAP (IN Application Part)
- MAP (Mobile Application Part)

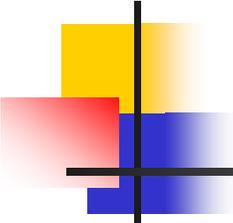
# Performance Requirements for SS7

- VoIP networks should support the performance requirements specified for SS7.
- A given route set should not be out of service for more than 10 minutes per year.
- No more than  $1 \times 10^{-7}$  messages should be lost.
- No more than  $1 \times 10^{-10}$  messages should be delivered out of sequence.
- In ISUP, numerous timing requirements must be met.
- How to make sure that VoIP networks can emulate the signaling performance of SS7.
  - SIGTRAN (Signaling Transport) group of IETF



# Softswitch Architecture

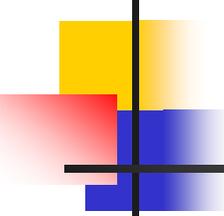




# Signaling Transport (SIGTRAN)

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- Addressing the issues regarding the transport of signaling within IP networks
  - The issues related to signaling performance within IP networks and the interworking with PSTN
- SIP/MGCP(MEGACO)/ISUP Interworking
  - Translating the MTP-based SS7 message (e.g., IAM) to IP-based message (e.g., IP IAM)
  - Just a simple translation from point code to IP address ???



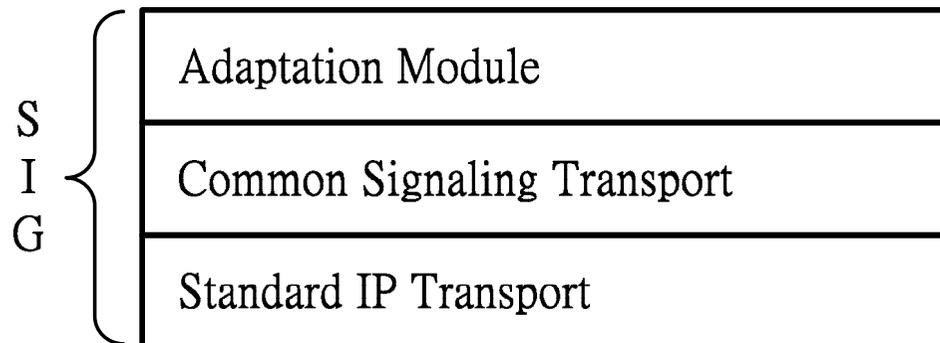
# SIGTRAN

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- Issues discussed in SIGTRAN
  - Address translation
  - How can we deploy an SS7 application (e.g., ISUP) that expects certain services from lower layers such as MTP when lower layers do not exist in the IP network?
  - For transport layer, the ISUP message must be carried in the IP network with the same speed and reliability as in the SS7.
    - UDP x
    - TCP x
- RFC 2719, “Framework Architecture for Signaling Transport”
  - To describe an overall approach and methodology for signaling transport within IP networks

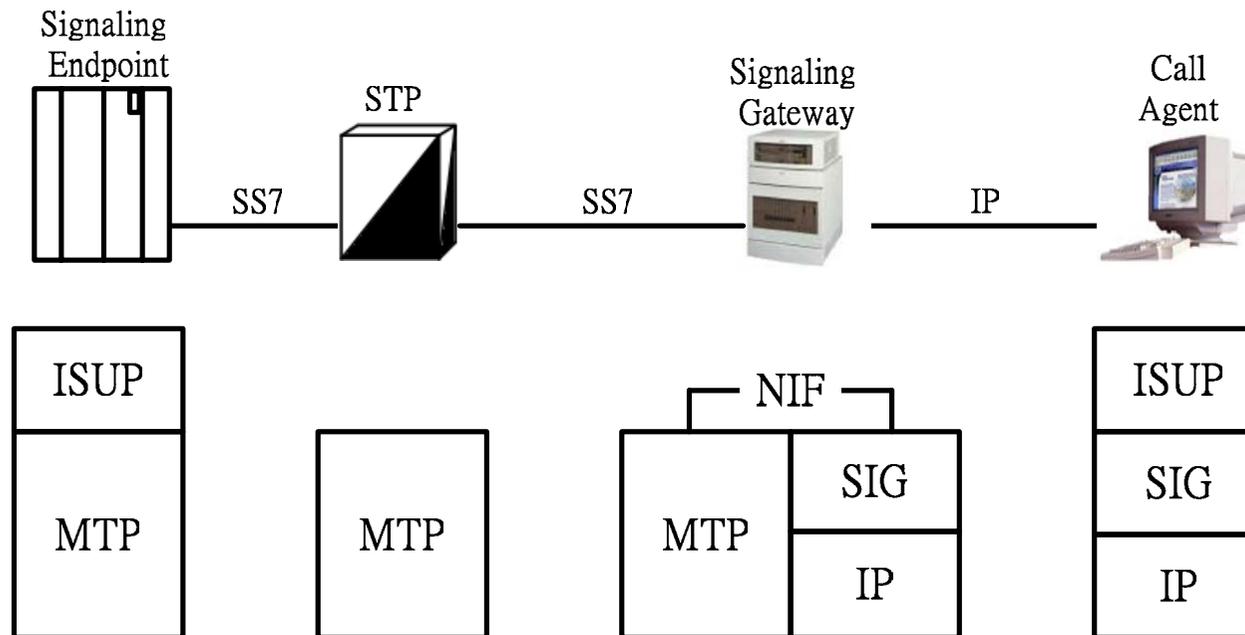
# SIGTRAN Architecture

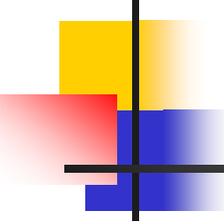
- Signaling over standard IP uses a common transport protocol that ensures reliable signaling delivery.
  - Error-free and in-sequence
  - Stream Control Transmission Protocol (SCTP)
- An adaptation layer is used to support specific primitives as required by a particular signaling application.
  - The standard SS7 applications (e.g., ISUP) do not realize that the underlying transport is IP.



# ISUP Transport to MGC

- NIF (Nodal Interworking Function) is responsible for interworking between the SS7 and IP networks

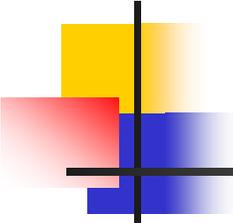




# SCTP

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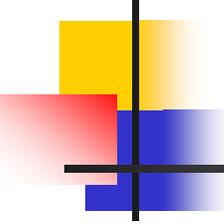
- To offer the fast transmission and reliability required for signaling carrying.
- SCTP provides a number of functions that are critical for telephony signaling transport.
  - It can potentially benefit other applications needing transport with additional performance and reliability.
- SCTP must meet the Functional Requirements of SIGTRAN.



# Why not use TCP?

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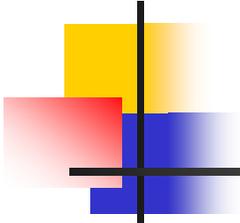
- TCP provides both reliable data transfer and strict order-of-transmission, but SS7 may not need ordering.
  - TCP will cause delay for supporting order-of-transmission.
    - Head-of-line Blocking
- The limited scope of TCP sockets complicates the task of data transmission using multi-homed hosts.
- TCP is relatively vulnerable to DoS attack, such as SYN attacks.



## What Supported By Using SCTP?

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- To ensure reliable, error-free, in-sequence delivery of user messages (optional).
- To support fast delivery of messages and avoid head-of-line blocking.
- To support network-level fault tolerance that is critical for carrier-grade network performance by using multi-home hosts.
- To provide protection against DoS attack by using 4-way handshake and cookies.

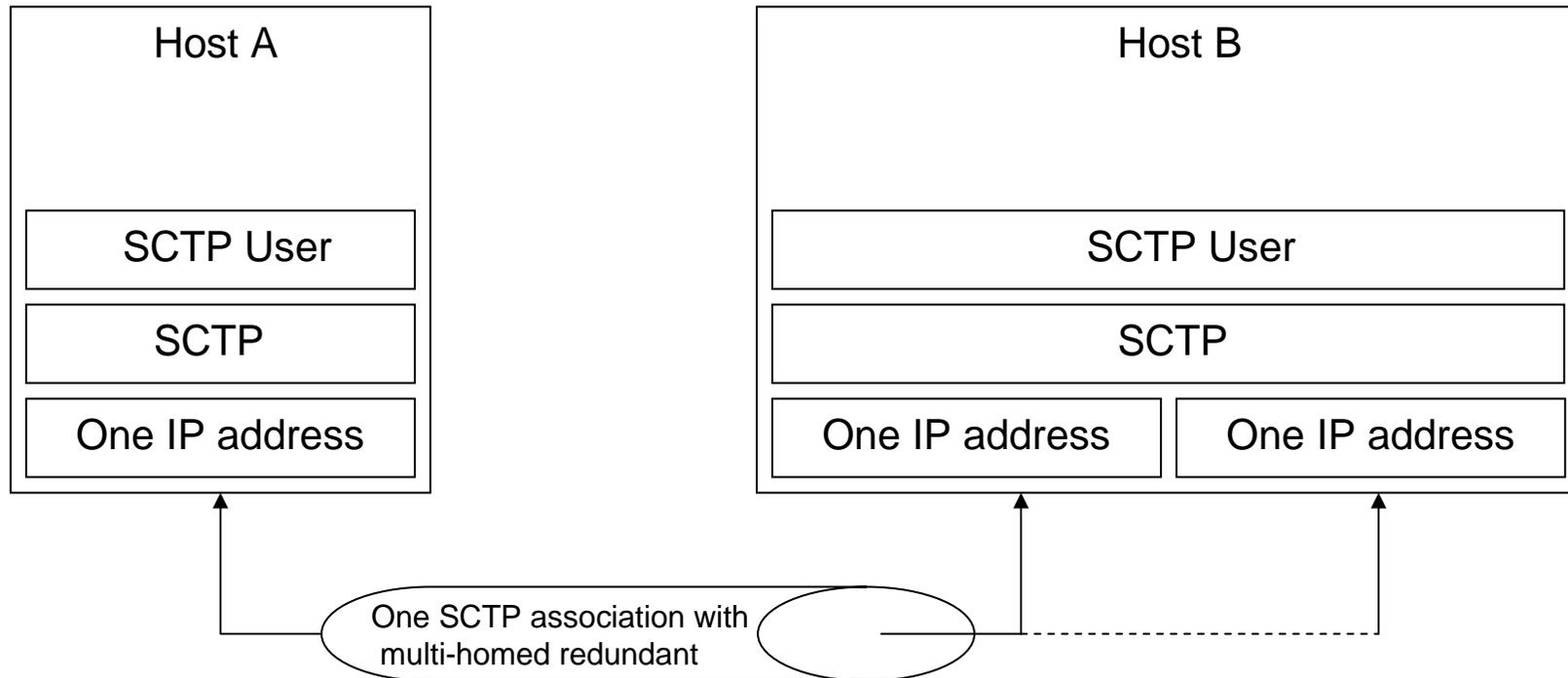


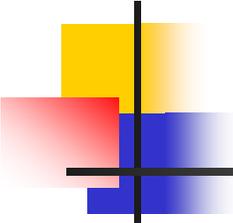
# SCTP Endpoint & Association

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- Endpoint
  - The logical sender/receiver of SCTP packets.
  - Transport address = IP address + SCTP port number
  - An endpoint may have multiple transport addresses (for multi-homed host).
- Association
  - A protocol relationship between SCTP endpoints.
    - Before applications at two endpoints can communicate, an association must be established.
  - Two SCTP endpoints **MUST NOT** have more than one SCTP association.
  - The task of instigating an SCTP association falls to the applicable adaptation layer.

# Multi-Homed Host

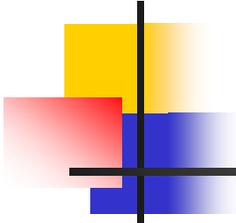




# SCTP Streams

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- A stream is a one-way logical channel between SCTP endpoints.
  - The number of streams supported in an association is specified during the establishment of the association.
- To avoid head-of-line blocking and to ensure in-sequence delivery
  - In-sequence delivery is ensured within a single stream.

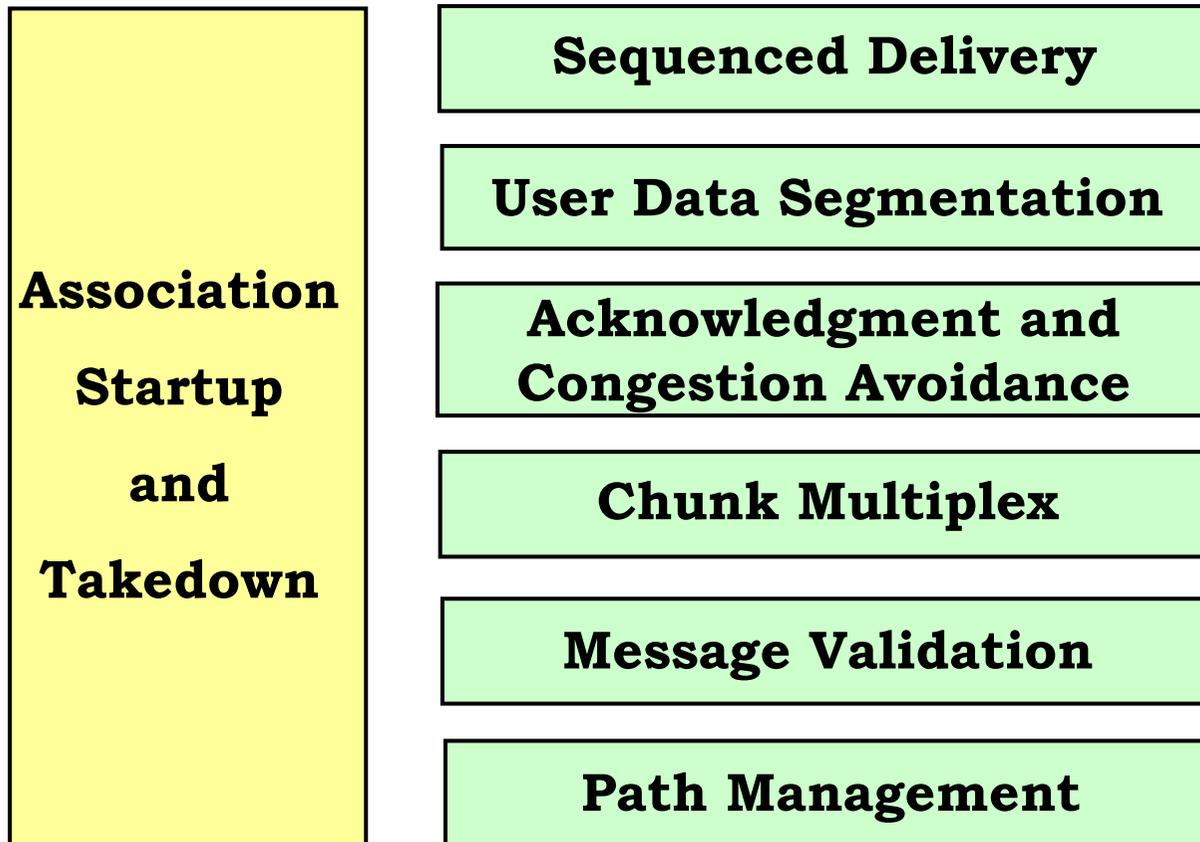


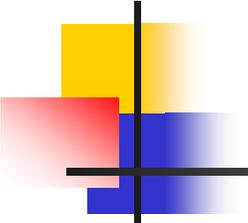
# SCTP Functional View [1/5]

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## **SCTP User Application**

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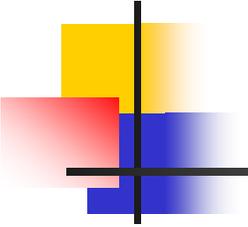




## Functional View [2/5]

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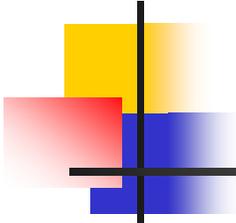
- Association Startup and Teardown
  - An association is initiated by a request from the SCTP user.
  - SCTP provides for graceful close of an active association.
    - On request from the SCTP user
  - SCTP allows ungraceful close.
    - On request from the user (ABORT primitive) or as a result of an error condition detected within the SCTP layer



## Functional View [3/5]

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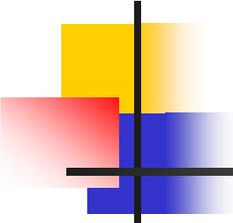
- Sequenced Delivery within Streams
  - Stream is used to refer to a sequence of user messages that are to be delivered to the ULP.
  - SCTP ensures that messages are delivered to the SCTP user in sequence within a given stream.
  - SCTP provides a mechanism for bypassing the sequenced delivery service.



## Functional View [4/5]

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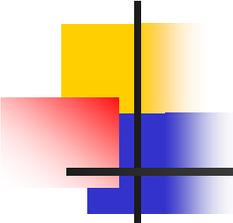
- User Data Fragmentation
  - Fragmenting user messages to conform the lower layer MTU
- Acknowledgement and Congestion Avoidance
  - Responsible for packet retransmission when timely acknowledgement has not been received
- Packet Validation
  - Verification Tag
  - Checksum



## Functional View [5/5]

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- **Chunk Bundling**
  - The SCTP user has the option to request bundling of more than one user message into a single SCTP packet.
- **Path Management**
  - To monitor reachability of the far-end endpoint through heartbeats



# SCTP Robustness

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- Robustness is a key characteristic of any carrier-grade network.
  - To handle a certain amount of failure in the network without a significant reduction in quality
  - The network should provide a graceful rather than a drastic degradation in the event of failures or overload.
- Congestion and Flow Control
- Multi-home hosts
- SCTP ensures that endpoint is aware of the reachability of another endpoint through the following mechanisms.
  - SACK if DATA chunk have been sent
  - HEARTBEAT chunks if an association is idle