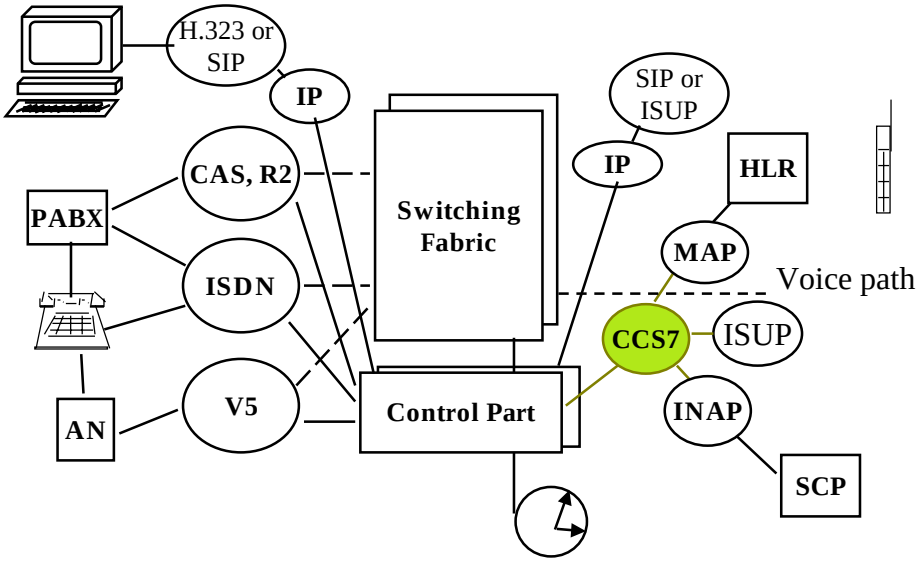
Common Channel Signaling Nr 7 (CCS7)

CCS7 is a *message based, multi-layer network to network* signaling system designed for fully digital exchanges.

- **Limitation of analogue signaling systems**
- **Basic definitions for CCS7**
- **CCS7 Requirements**
- **Functional Structure**
- **MTP and SCCP**
- **User Parts**
- **Strengths and weaknesses**

Course scope - lecture scope



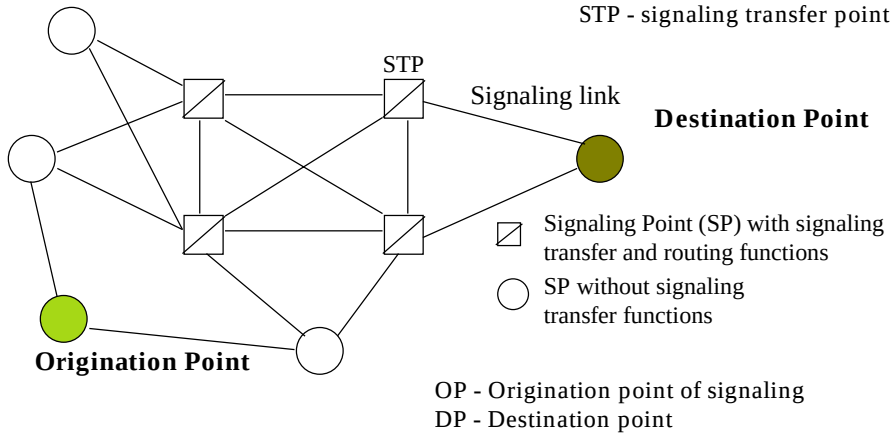
Limitations of Analogue signaling

- **Limited set of signals --> limited set of services**
- **Always bound to the voice path --> architectural limitation.**
- **Difficult to change anything in an established call because registers have been released and voice channel is reserved for voice.**
- **Slow --> uneconomical use of network resources.**
- **MF requires special equipment - Only recently general purpose DSPs have become powerful and cost efficient enough.**
- **HDLC on silicon --> processing hdlc frames and messages is simple and efficient on any computer.**

Does CCS7 remove all limitations?

- **Digital messages --> unlimited signal set: e.g. 2^{100} different signals can easily be devised.**
- **Common signaling channel for many voice channels (out-of-band) --> signaling is not, in principle, bound to calls nor voice/information channels. Signaling can continue during the call.**
- **Message round-trip delay on a 64kbit/s channel is ≈ 50 ms. --> post dialling delay until ringing tone approaches zero.**
- **Makes use of HDLC -protocol framing and principles.**

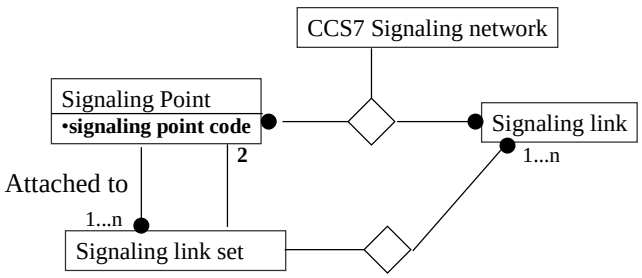
Basis of CCS7 is the signaling network - a special kind of data network.



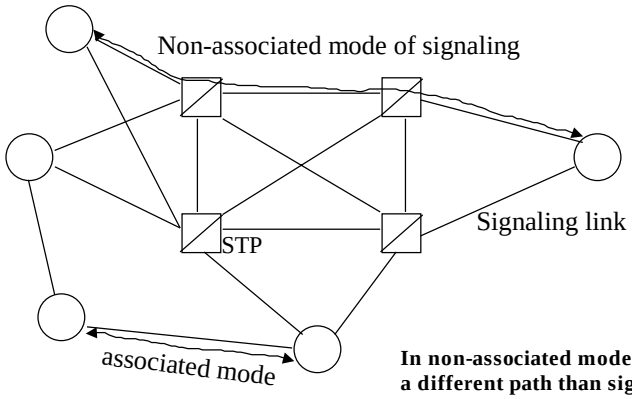
Examle: In Finnish CCS7 no specialized STP -nodes were originally deployed. STP functions were integrated in exchanges. In USA, China etc, specialized STP-nodes are commonplace.

Key definitions for CCS7

Signaling Point is a logical entity, e.g. in an exchange there can be one or more SPs. In one CCS7 signaling network an exchange will, however, have only one *Signaling Point Code*



Signaling connection can be either direct or indirect (through STP nodes)

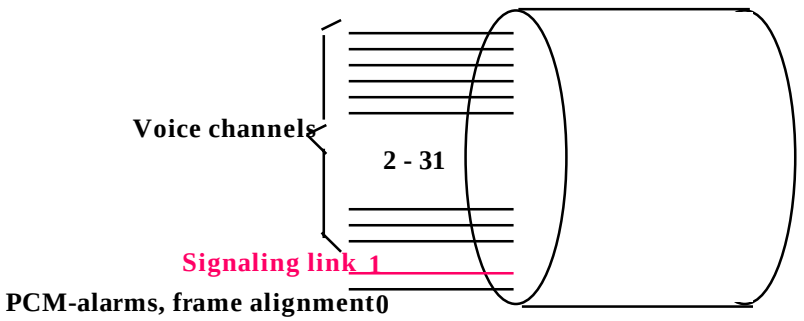


In non-associated mode, voice is routed on a different path than signaling

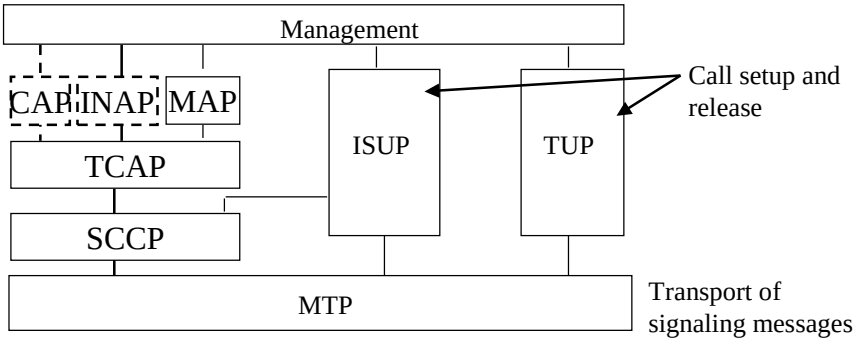
CCS7 reliability is built by software

- Speed: post dial delay (until ringing tone) ≤ 2.2s.
- MTP:
  - unavailability of signaling route set ≤ 10 min/annum
  - share of undetected faulty signaling messages: ≤ 10^{-10}
  - loss probability of signaling messages ≤ 10^{-7}
  - probability of reordering or replication of signaling messages ≤ 10^{-10}
- Expected quality of of the underlying transmission network:
  - Long term bit error rate ≤ 10^{-6}
  - Medium term bit error rate ≤ 10^{-4}
- Using software means reliability is increased by several 10-folds!!

Use of PCM time slots in the Finnish CCS7 network



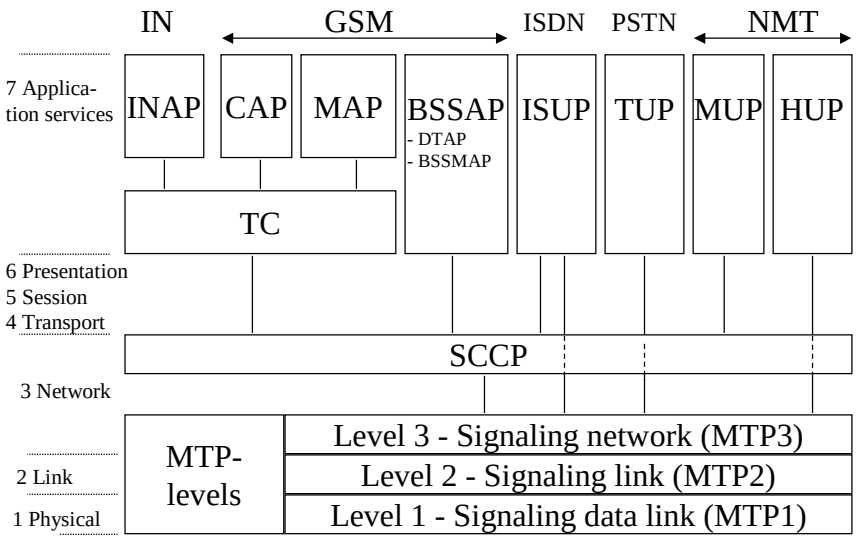
Principal components in CCS7



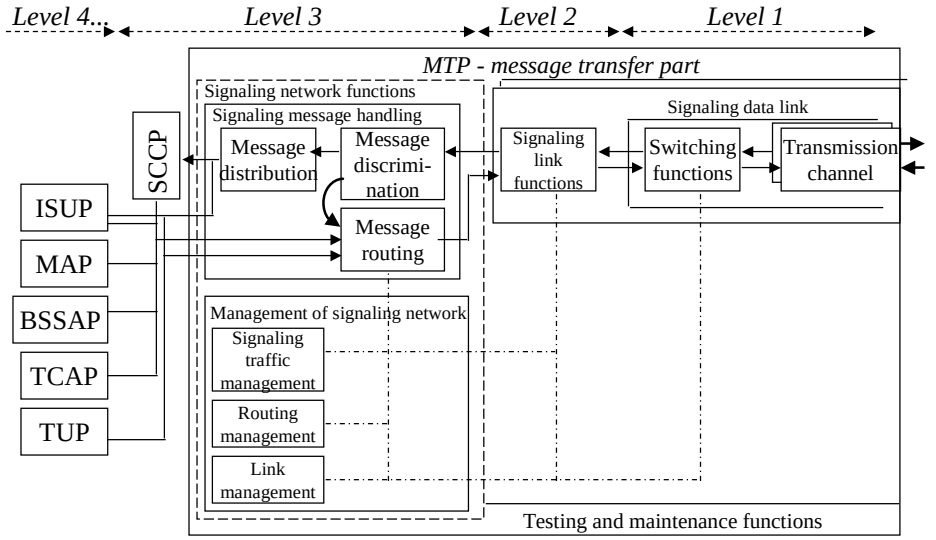
INAP - IN Application part
CAP - CAMEL Application part
CAMEL - Customized Applications for Mobile Enhanced Logic = "INAP" extension in GSM

TUP - Telephony User Part
ISUP - ISDN User Part
SCCP - Signaling Connection Control Part
TCAP - Transaction Capabilities Application Part
MAP - Mobile Application Part
MTP - Message Transfer Part

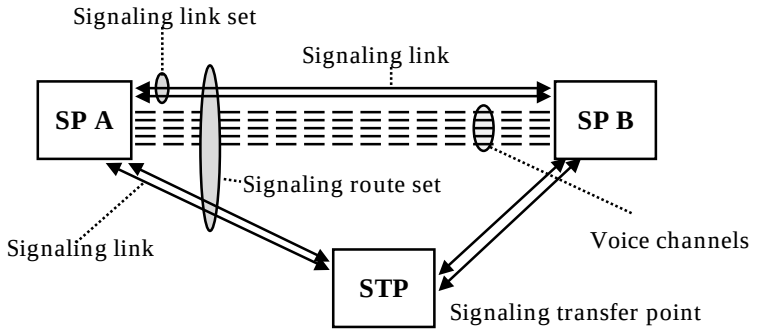
Structure of CCS7



Message transfer part, MTP, is the basis of CCS7

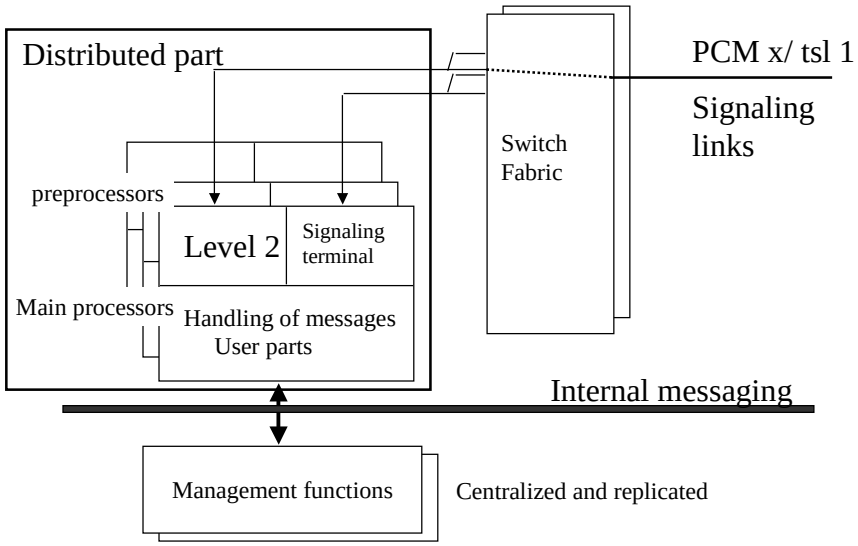


Key concepts in MTP are



- **Signalling link**
- **Signalling link set (SLS)**
- **Signalling Route**
- **Signalling Route set**

An example allocation of MTP -functions in a Switching system



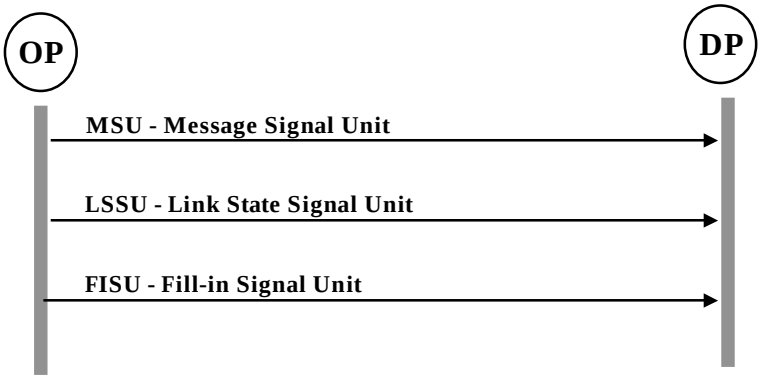
MTP - main functions are

- Switching functions: - reconfiguration of the signaling network
- LEVEL 2: Signaling channel functions: - LAPB / cmp. HDLC
  - frame alignment flags (delimiters) acc to HDLC principles
  - checksum, retransmission of message units, supervision of message ordering, acknowledgements, link fault detection and recovery

LEVEL 3:

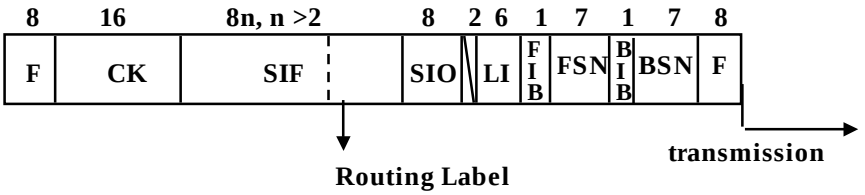
- *Load sharing among signaling links*
- *STP and distribution to User Parts*
- *Routing is based on 14-bit (ETSI) signaling point codes.*
  - Management of signaling traffic:
    - link switchover - messages are not lost!
    - (Original) link restoration
    - forced re-routing
    - controlled re-routing

MTP has three message types



MSU - carries all payload of upper layers
LSSU - MTP level messaging between neighboring SPs
FISU - when there is nothing else to send! Originally made implementation difficult - short FISUs -> when there is no useful information to send the signaling terminal had the peak load!

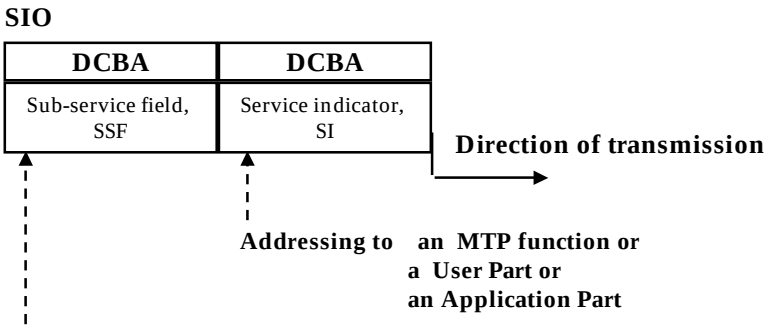
Message Signaling Unit structure is



F - Flag (delimiter)
BSN - Backward sequence number
BIB - Backward indicator bit
FSN - Forward sequence number
FIB - Forward indicator bit

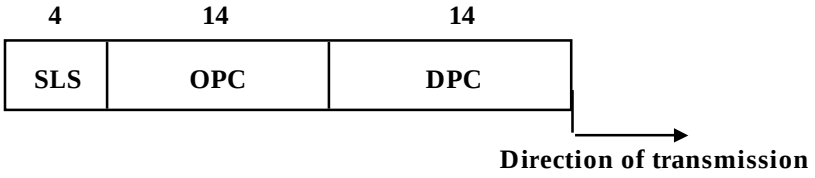
LI - Length indicator
SIO - Service information octet
SIF - Service Information field = payload
CK - Check bits

Service Information Octet (SIO) defines the target application



Network indicator: National NA0, 1 or International IN0, 1 -network.

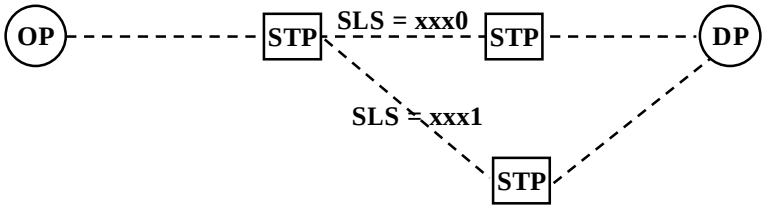
MTP Route Label has three fields



SLS - Signalling link selection (for link load sharing)
DPC - destination point code
OPC - originating point code

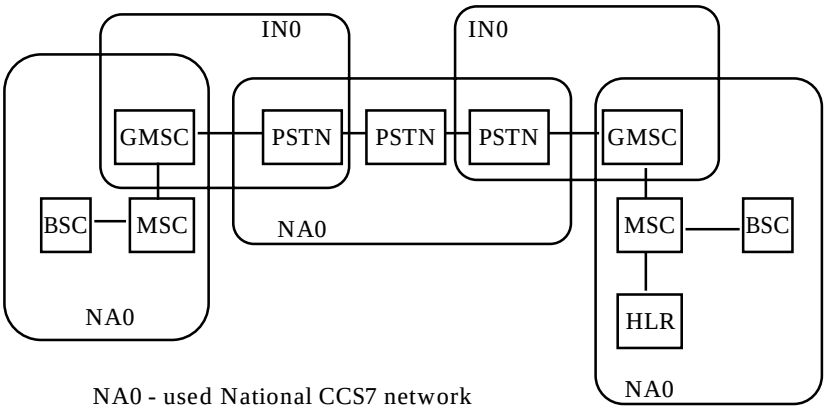
The shown lengths are acc to International(and Finnish) specification, in ANSI specs OPC/DPC lengths are 24 bits!

Load sharing has an impact on signal routing



To preserve the order of signals, higher levels set the SLS value so that the route remains the same e.g. for all signal messages of a single call.

Flow of signaling messages in case of International GSM location update



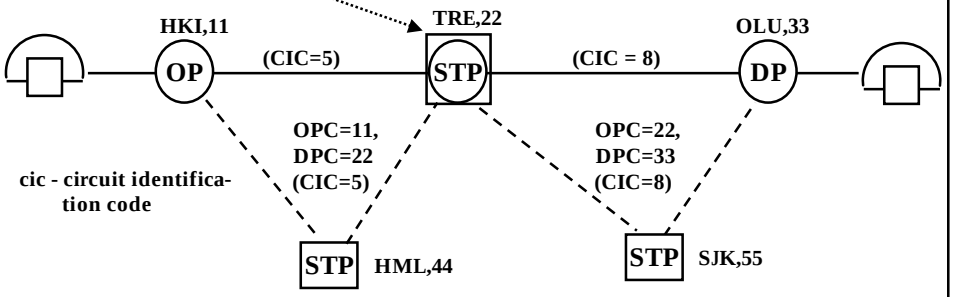
NA0 - used National CCS7 network
IN0 - used International CCS7 network

Signaling Point Codes are unique only in one signaling network !!

SCCP - Signalling Connection Control Part expands MTP networking services

- **MTP uses 14-bit signaling point codes as addresses - this is not enough in the global network.**
- **No relationship to voice channels: can be used to signal events that are unrelated to calls.**
- **SCCP brings Global Title - an extension to the addressing mechanisms provided by the MTP.**

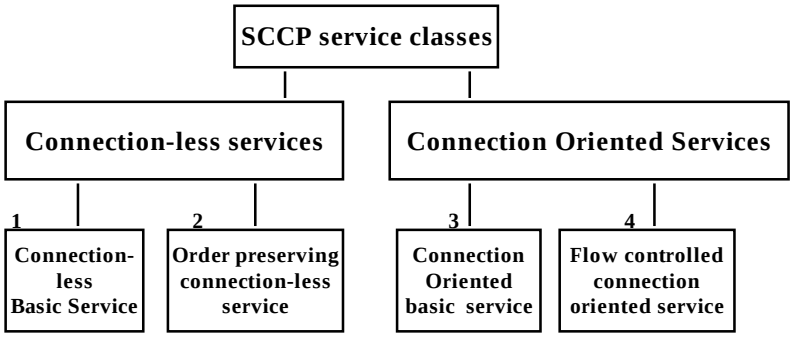
Forth level is needed, when MTP-signal message routing is not enough



- **Messages/calls through an international signaling point**
- **Calls across an operator boundary**
- **Intelligent Network calls**
- **In general, when the OP does not know the location of the called party**

4th level = SCCP or a User Part.

SCCP provides four service classes



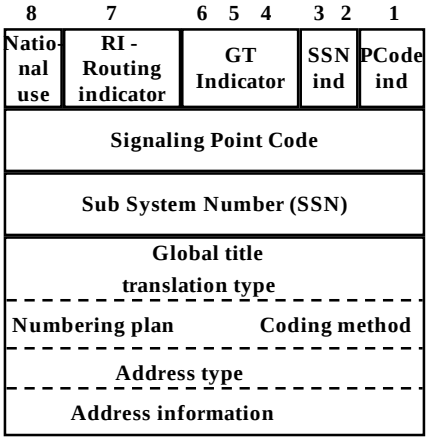
vrt. IP

Only classes 1 …3 are in use.

- **Connection Oriented message transfer**
  - **› on demand connections as a service to UPs**
  - **› permanent connections with management commands**

Global Title in SCCP supports global messaging over the CCS7 network

Calling and called party in SCCP



SSN (cmp. Port Numbers in TCP/IP)

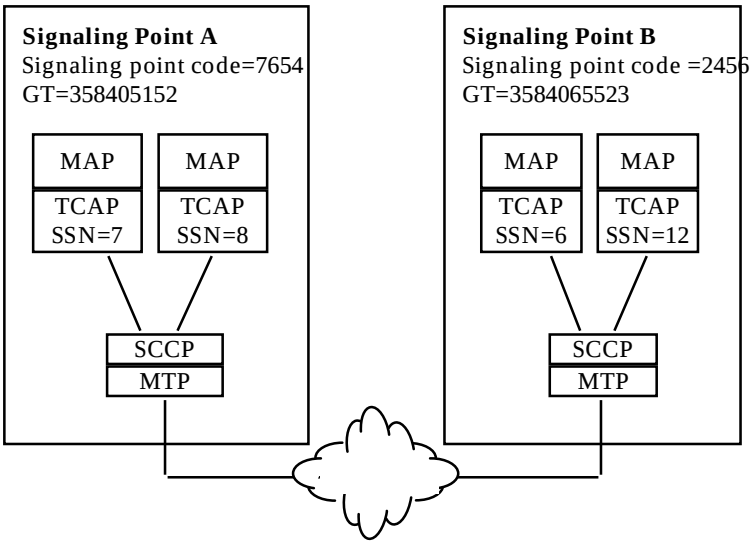
1 - SCCP management
2 - TUP
3 - ISUP
4 - OMAP - Operation and Maintenance AP
5 - MAP - Mobile AP
6 - MAP/HLR
7 - MAP/VLR
8 - MAP/MSC
9 - MAP/EIR - Equipment Id reg
10 - MAP/AuC
11 - ISUP/SS ISUP supplementary services
12…247 , 249…252 reserved
248 - MUP (NMT Mobile UP
253 - OMC - Operation and Maintenance Center
254 - BSSAP - BSS Applic. part

Address Information in GT of SCCP can be a telephone number or a subscriber identity

E.212: IMSI:	MCC	MNC	MSIN	E.g. 244 05 87654321
E.164: MISDN:	CC	NDC	SN	E.g. 358 40 540 3127
E.214: Hybrid:	CC	NDC	MSIN	E.g. 358 40 87654321

IMSI - International Mobile Subscriber Identity
MCC - Mobile Country Code
MNC - Mobile Network Code
MSIN - Mobile Subscriber Identity Number
CC - Country Code
NDC - National Destination Code
SN - Subscriber Number

A use case of addressing



User Parts (Ups)

For call setup, release and supplementary services!

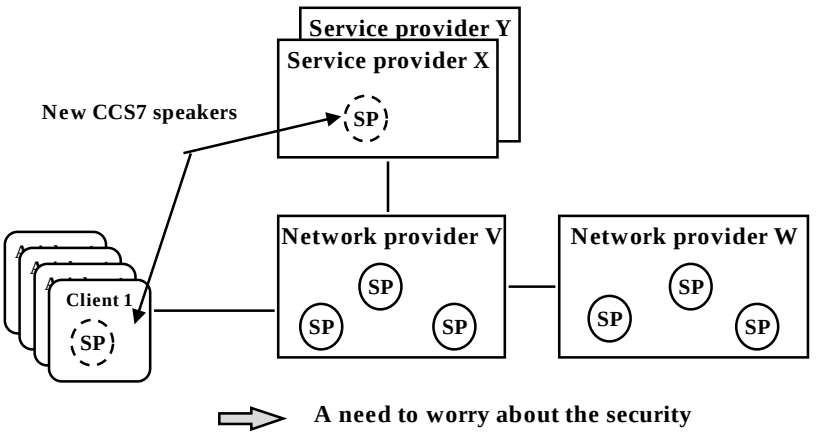
- **TUP - Telephony User Part - oldest and simples**
  - **National variants!**
  - **Messages bound to voice channels with Circuit Identification Code (CIC) in every message**
- **ISUP - ISDN User Part**
  - **supports wire-line ISDN calls**
    - speech, 64kbit/s, multi-channel: 128, 384, 1536, 1920 kbit/s services
- **MAP - Mobile Application part -**
  - **used in GSM e.g. for HLR - MSC communication**
  - **provides mobility management**

CCS7 Strengths and weaknesses

- **Large nrof of signals**
- **message based -> native for digital exchanges and computers**
- **out-of-band --> signaling can continue for the duration of the call and even independent of any calls**
- **Reliable**
- **MAP - provides mobility management**
- **Complicated to implement**
- **Heritage of a closed market**
- **Service dependent - new services require new fields into signaling messages and thus software upgrades in exchanges**
- **Requires new features to be secure in a competitive multi-operator environment**

* **At its best overlying a rather unreliable base network, reliability has been enhanced by software functions.**

The emerging CCS7 environment may have potentially hostile third parties



A need to worry about the security