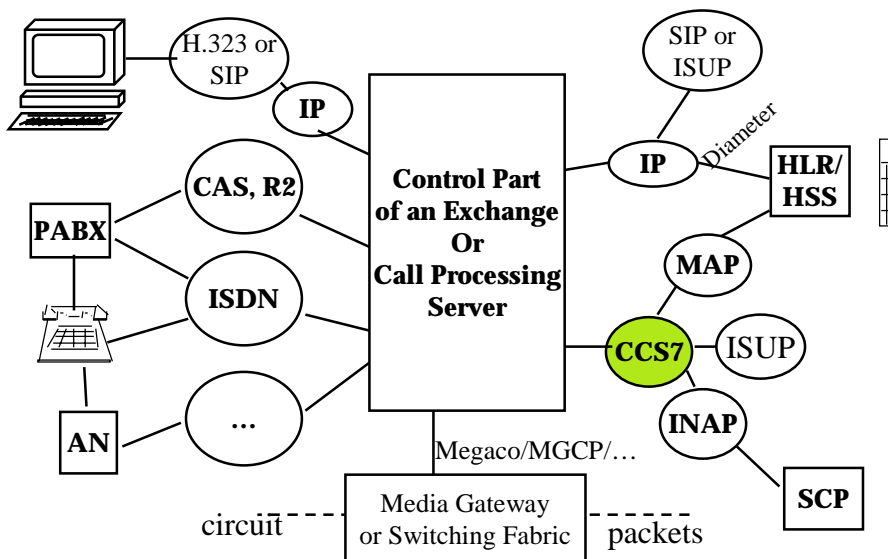


# Common Channel Signaling Nr 7 (CCS7)

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**

## Summary of course scope



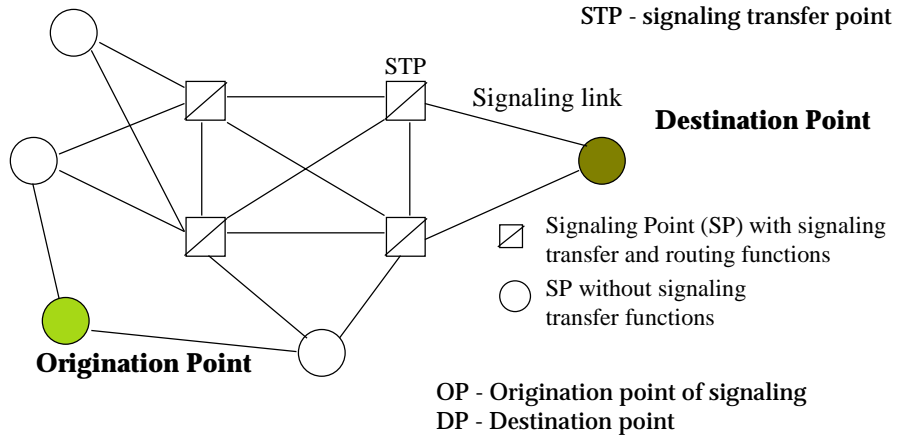
## *Limitations of Analogue signaling*

- › **Limited set of signals --> limited set of services**
- › **Always bound to a 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  $\approx 50$  ms. --> post dialling delay until ringing tone approaches zero.**
- ✓ **Makes use of HDLC -protocol framing and principles.**

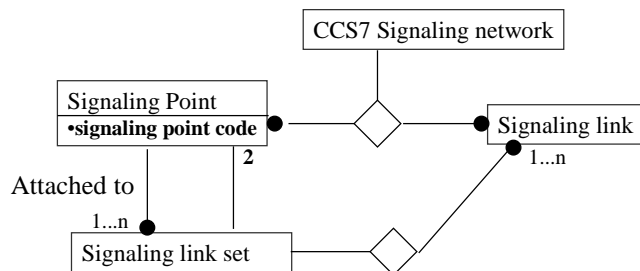
***Basis of CCS7 is the signaling network - a special kind of data network.***



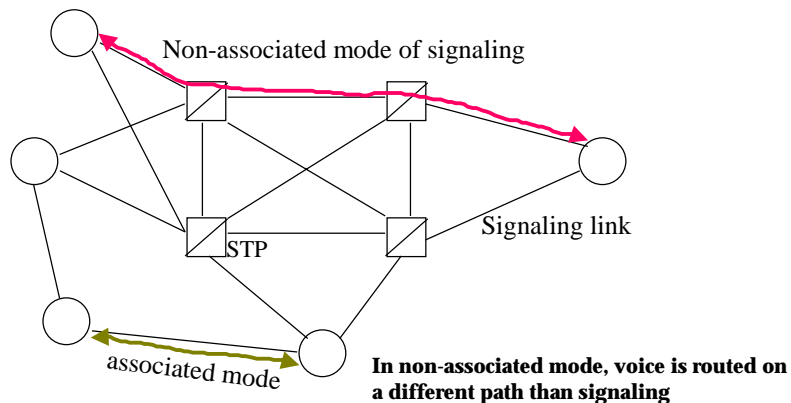
Example: In Finnish CCS7 no specialized STP -nodes were originally deployed. STP functions were integrated in exchanges. E.g in USA, specialized STP-nodes are commonplace.

## ***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*



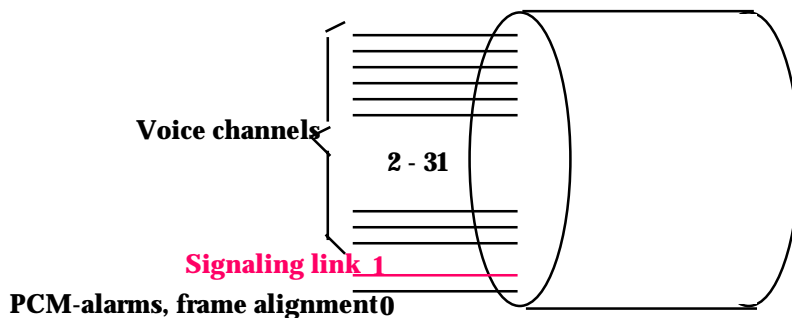
## *Signaling connection can be either direct or indirect (through STP nodes)*



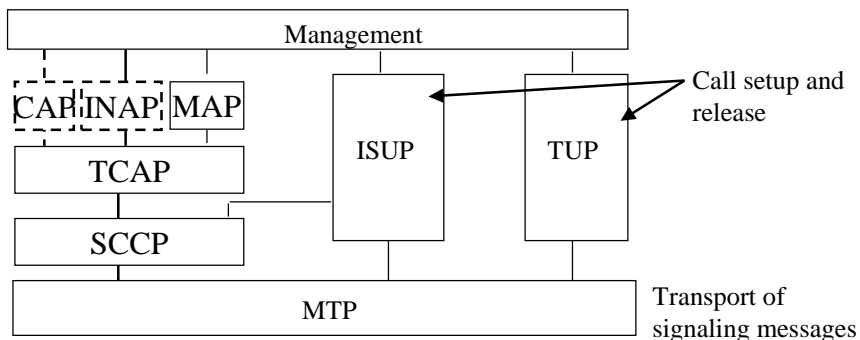
## *CCS7 reliability is built by software*

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

# Use of PCM time slots in the Finnish CCS7 network



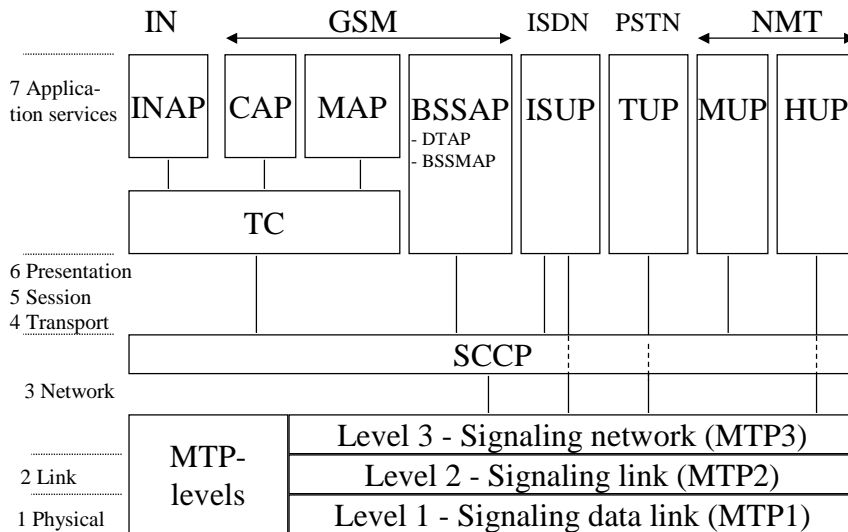
## Principal components in CCS7



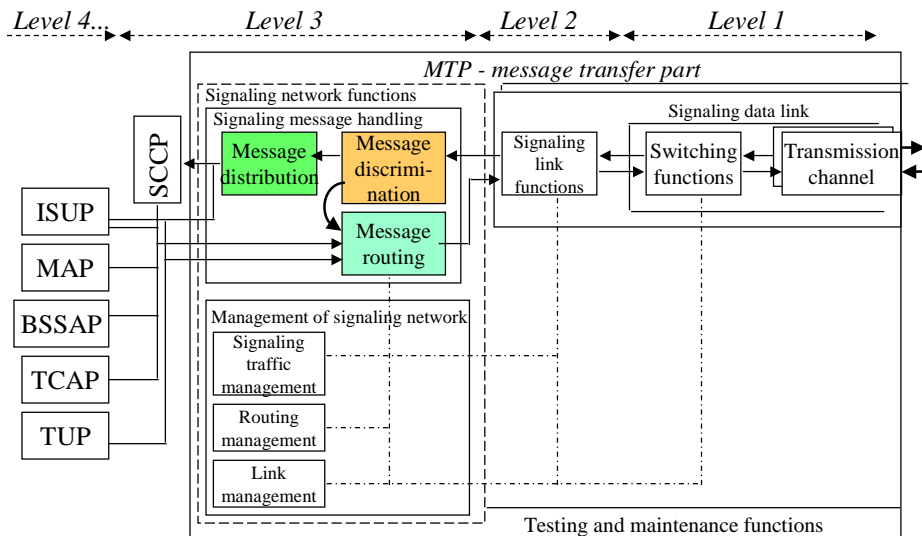
INAP - IN Application part  
 CAP - CAMEL Application part  
 CAMEL - Customized Applications  
 for Mobile Enhanced  
 Logic = "INAP"  
 extension in GSM

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

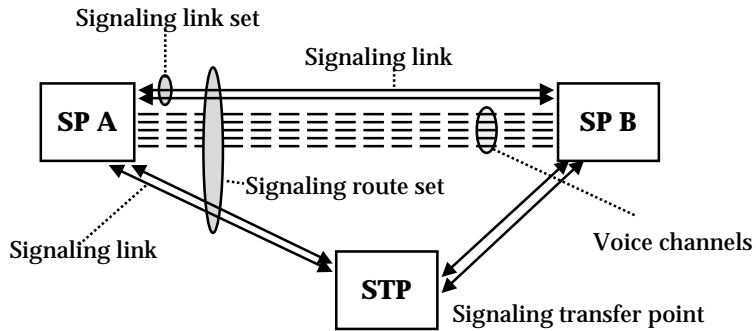
# Structure of CCS7



# Message transfer part, MTP, is the basis of CCS7

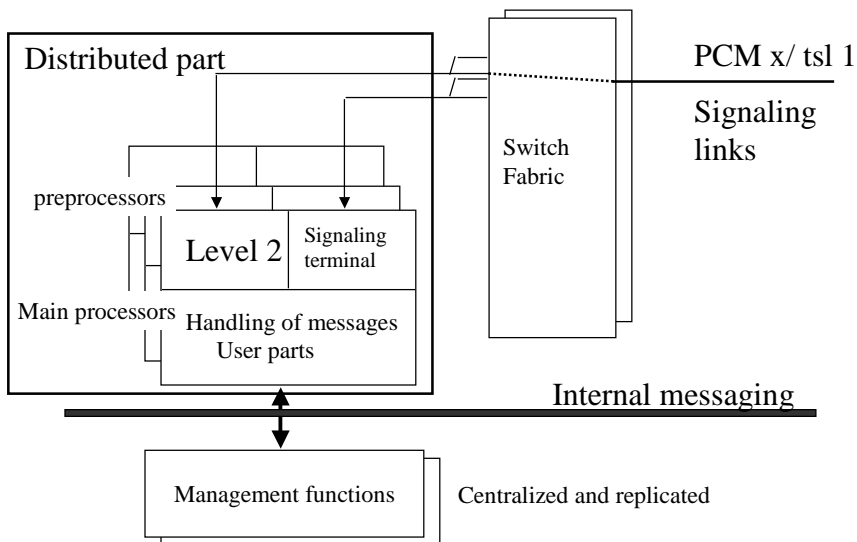


## Key concepts in MTP are



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

## An example allocation of MTP -functions in a Switching system (DX 200)



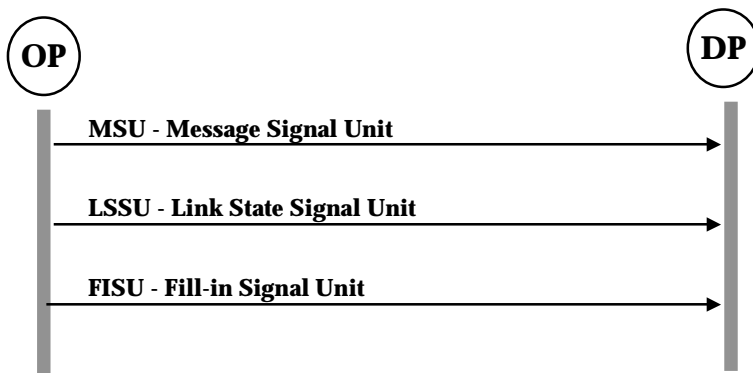
## ***MTP - main functions are***

- 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***



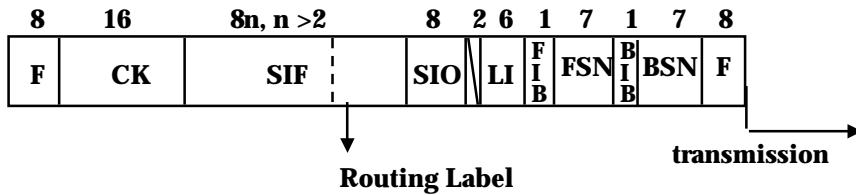
MSU - carries all payload of upper layers

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 -01111110)**

**BSN - Backward sequence number**

**BIB - Backward indicator bit**

**FSN - Forward sequence number**

**FIB - Forward indicator bit**

**LI - Length indicator**

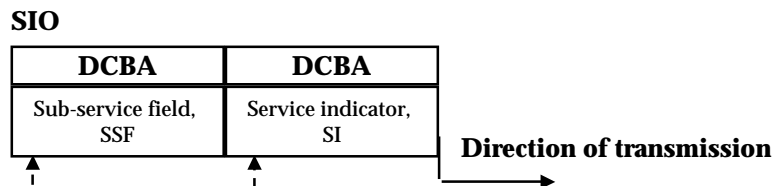
**SIO - Service information octet**

**SIF - Service Information field**

= payload

**CK - Check bits**

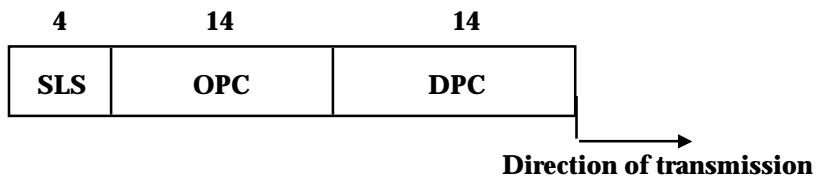
## Service Information Octet (SIO) defines the target application



Addressing to an MTP function or  
 a User Part or  
 an Application Part

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

## *MTP Route Label has three fields*



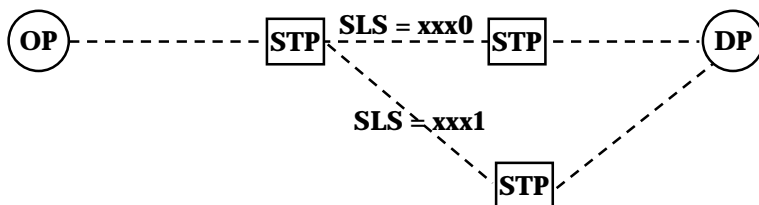
**SLS - Signalling link selection (for link load sharing)**

**DPC - destination point code**

**OPC - originating point code**

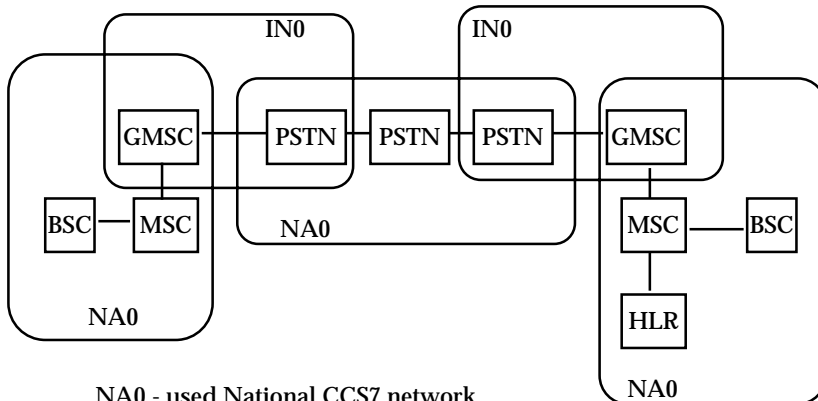
*The shown lengths are acc to International (and Finnish) specification, in ANSI specs OPC/DPC lengths are 24 bits!*

## *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*



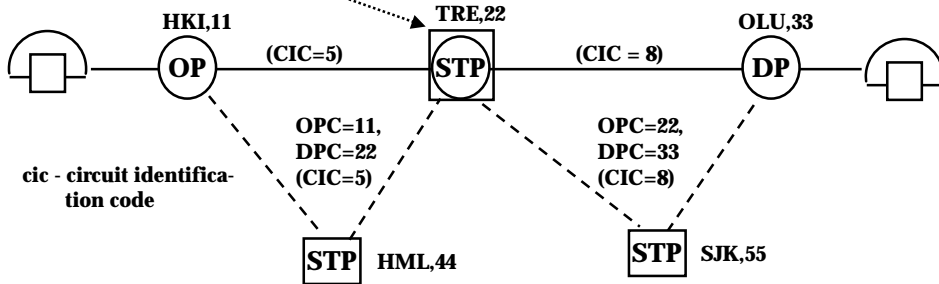
NA0 - used National CCS7 network  
IN0 - used International CCS7 network

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 (such as location updates in mobile networks).**
- ✓ **SCCP brings Global Title - an extension to the addressing mechanisms provided by the MTP.**

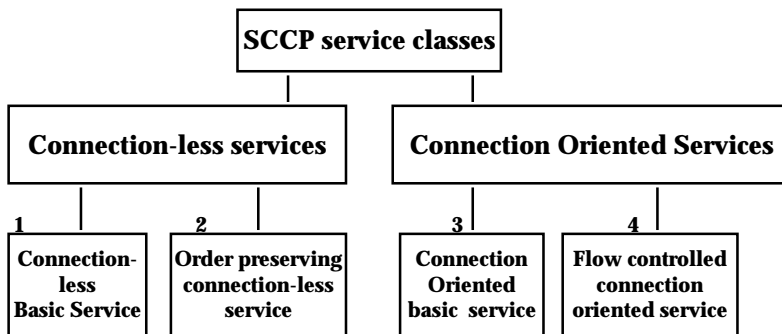
## *Forth level is needed, when MTP-signal message routing is not enough*



- 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*



virt. IP

### ✓ Connection Oriented message transfer

Only classes 1 ...3 are in use.

- > 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

8	7	6 5 4	3 2	1
National use	RI - Routing indicator	GT Indicator	SSN ind	PCode ind
Signaling Point Code				
Sub System Number (SSN)				
Global title translation type				
-----		-----		
Numbering plan		Coding method		
-----				
Address type				
-----				
Address information				

### 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:                E.g. 244 05 87654321

E.164: MISDN:                E.g. 358 40 540 3127

E.214: Hybrid:                E.g. 358 40 87654321

IMSI - International Mobile Subscriber Identity

MCC - Mobile Country Code

MNC - Mobile Network Code

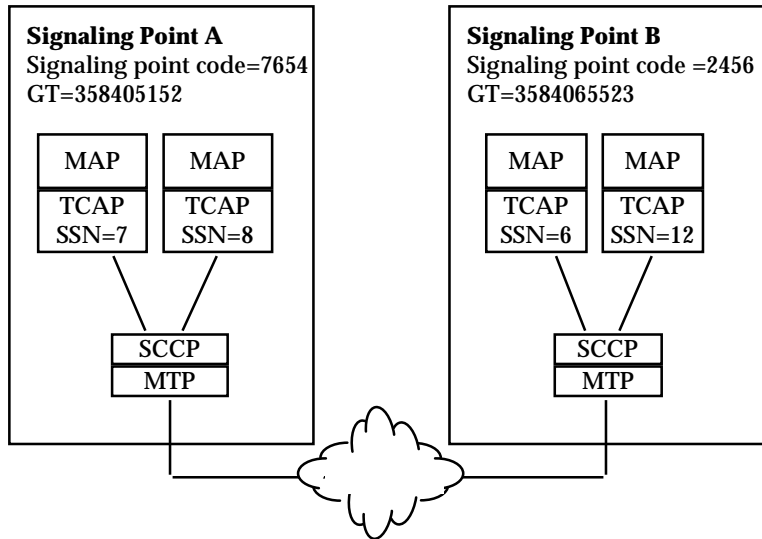
MSIN - Mobile Subscriber Identity Number

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 simple**
  - › 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

# *Strengths and weaknesses*

## *CCS7*

- ✓ Large number 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*

