GSM and IN Architecture
a common component: TCAP

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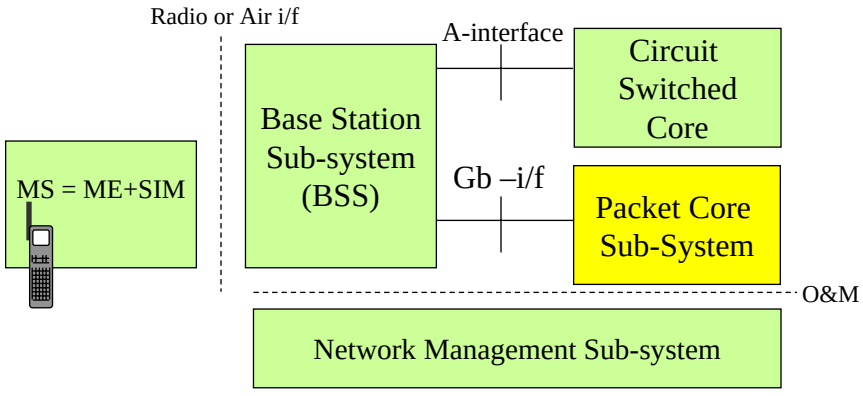
GSM system consists of sub-systems

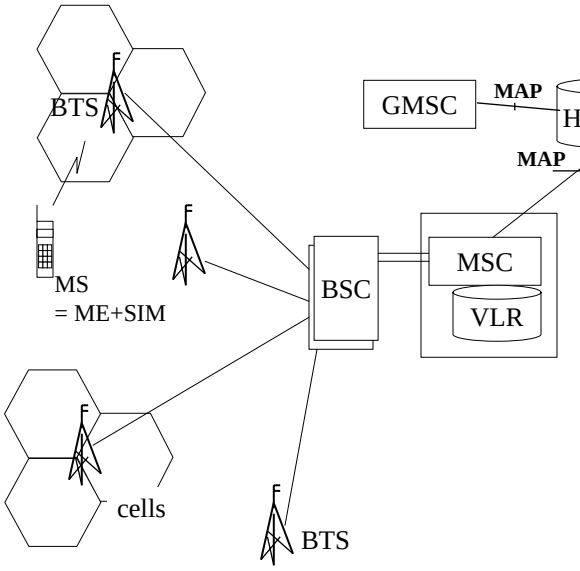


MS - Mobile Station
ME - Mobile Equipment
SIM - Subscriber Identity Module
BSS - Base Station Subsystem
HLR belongs to both CS and PS domains

Main differences cmp to wire-line networks
- air interface for the subscribers
- mobility and roaming of users

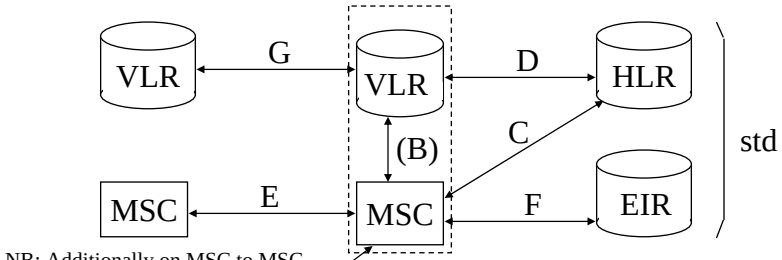
NB: the whole system is digital incl the ME.

The original GSM architecture



HLR - Home Location Register (kotirekisteri)
AC - Authentication Center (Varmennekeskus)
EIR - Equipment Identity Register (laiterekisteri)
MSC - Mobile Switching Center (matkapuhelinkeskus)
GMSC – Gateway MSC
VLR - Visitor location Register (vierailijarekisteri)
BSC - Base Station Controller (tukiasemaohjain)
BTS - Base Transceiver Station (tukiasema)

CS Core interfaces are



NB: Additionally on MSC to MSC interface ISUP is used.

Base Station sub-system

MSC - Mobile Switching Center
HLR - Home Location Register
VLR - Visitor Location Register
EIR - Equipment Identity Register
NB: MSC+VLR always in the same node
+I - interface: MS - HLR (MS-MSC/VLR-HLR)

All CS Core interfaces: B-G conform to the MAP protocol

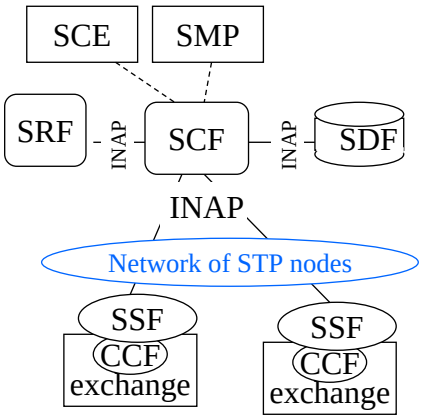
Business boundaries in GSM

- ✓ **Vendors and operators**
  - › **An operator can not just assume that all vendors conform to all interfaces that are found in GSM specs**
  - › **A-interface is firmly adhered to by all vendors: an operator can buy the cellular radio network from one vendor and the rest from another**
  - › **Also the Packet core is rather independent of the circuit network core – again two different vendors is a feasible alternative**
  - › **Advice: it is a good idea to buy HLR and MSC from the same vendor – if not two vendors may introduce features in a different order and the operator instead of getting the superset of features is getting the intersection of features.**
- ✓ **Mobile Virtual operators (MVO) of different types**
  - › **An MVO may but is not forced to have its own HLR**
  - › **The MVO HLR may need to work with MSC from a different vendor – not impossible**

CAMEL adapts the IN technology to GSM

- ✓**CAMEL - Customized Application for Mobile network Enhanced Logic**
- ✓**The goal is the capability of providing the home network services to visiting subscribers**
- ✓**CAP - CAMEL Application Part is a subset of ETSI CoreINAP**
  - › **phases (Capability Sets) 1…4 are ready**

IN is a way of implementing services in nodes separate from exchanges

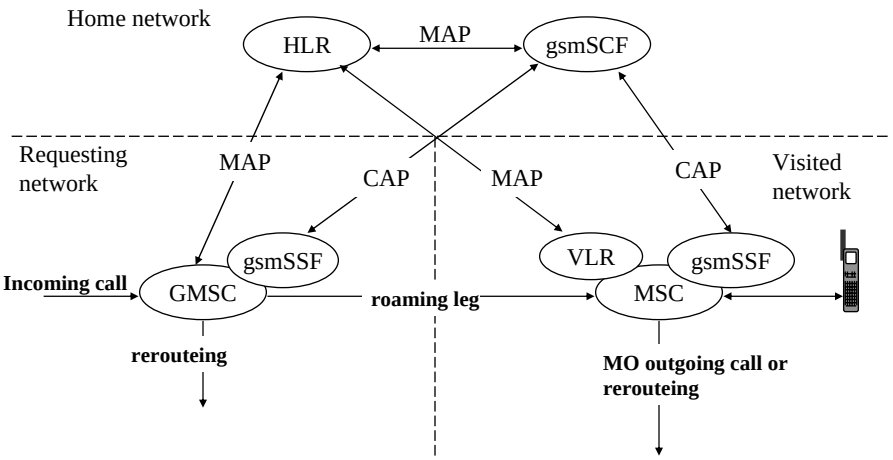


INAP = IN Application Part
= main protocol
CCF – Call Control Function
SSF - Service Switching Function
maintains call state with CCF
SCF - Service Control Function
implements service logic
SRF - Special Resource Function
processes in-band signals
SDF - Service Data Function
is a database
SCE - Service Creation Environment
for creating new service logic
SMP - Service Management Point
implements mgt functions

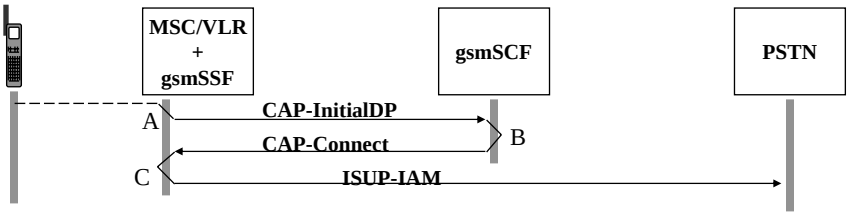
Features of the IN architecture ...

- ✓ **BCSM - Basic Call State Model is a standardized state machine in SSP - couples/ de-couples IN service logic from connection resources**
- ✓ **BCSM states (detection points) can be programmed to trigger queries on conditions to an SCF concerning a certain call**
- ✓ **BCSM architectural issue is that a call is also a service and therefore the architecture is service dependent**
- ✓ **INAP messages are independent of voice channel connections**

Phase 1 CAMEL architecture



MS originated CAMEL call



A - MSC gets the CAMEL service info from the VLR concerning the A subscriber, sees an active CAMEL service and hands the call to gsmSSF. gsmSSF queries gsmSCF:lle (service key, A-nr, B-nr, IMSI, location...

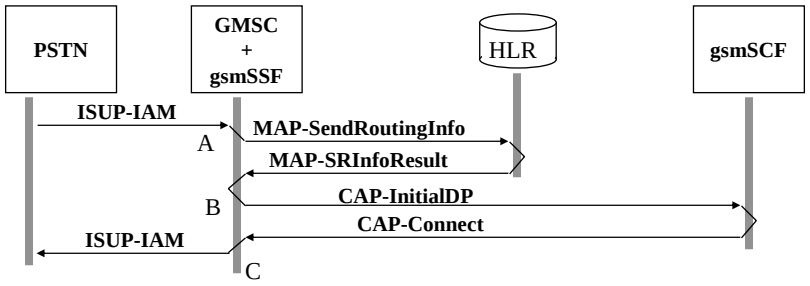
B - gsmSCF can for example do a number translation

C - MSC sets up a call using the received info

DP – detection point

NB: The the service for the visiting subscriber is executed cooperatively by the visited network (MSC/VLR) and the home network! → Home network is not autonomous in providing the service!

Mobile terminated CAMEL call

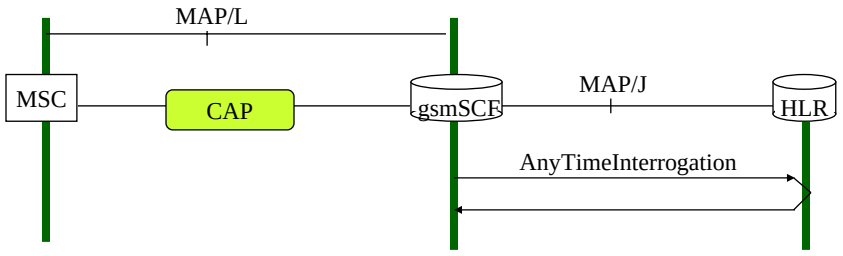


A - GMSC queries HLR of the location of the MS. HLR sends the terminating CAMEL service data of the subscriber.

B - GMSC hands the call to gsmSSF, which queries gsmSCF gsmSCF returns C-number that is used for routeing the call

C - GMSC sets up the call to C-number. If needed, GMSC can first do a new HLR query.

An SCF can interrogate HLR at any time



IN+GSM integration based on CAMEL is a step towards 3G

- ✓ **CAPv1 supports only 7 operations**
- ✓ **CAPv1 call model has only a few triggering points (TDP - trigger detection point)**
- ✓ **CAPv2 has 22 operations**
- ✓ **Still no triggering for Short Messages**
- ✓ **CAMEL compatible equipment is in use in many networks**
- ✓ **http://www.3gpp.org/TB/CN/CN2/camel-contents.htm contains an overview of CAMEL phases 1 to 4.**

Need to separate application logic states from communication states is common to IN and MAP

- ✓ **IN application is concerned with the end user service, its implementation may be broken into several modules each with its own communication needs between SCP and SSP.**
- ✓ **HLR and MSC may be discussing about a handover, VLR update etc in the same context – each part of MAP has its own communication needs.**
- ✓ **It makes sense to have a common component between the application and SCCP that will provide services friendly for applications and take care of communicating with the other part of the application in a remote node (HLR, VLR, MSC, SCP, SSP etc)**

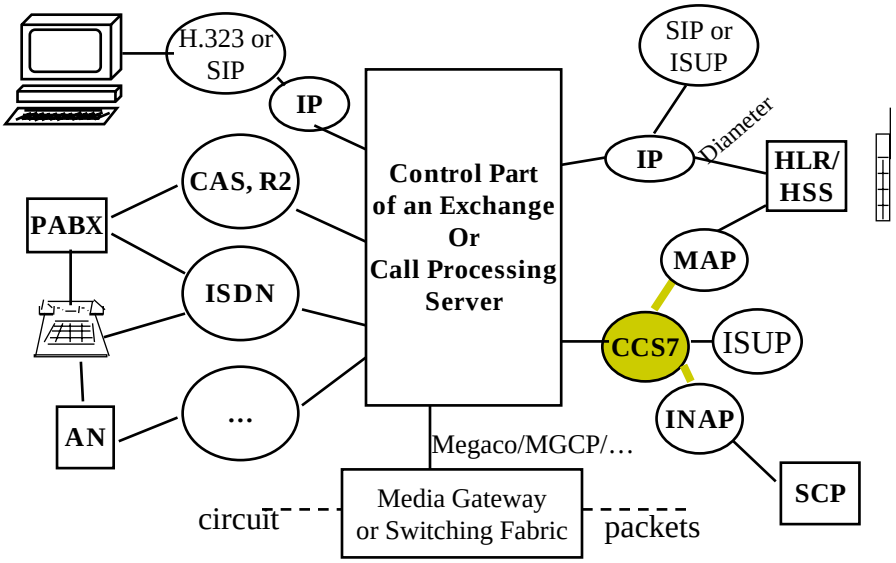
TCAP - Transaction Capabilities Application Part is used by

- ✓ **Mobile services (roaming and mobility management)**
- ✓ **Intelligent Network services**
- ✓ **Services that are independent of voice circuits (look-ahead …)**
- ✓ **O&M applications**
- ✓ **etc**

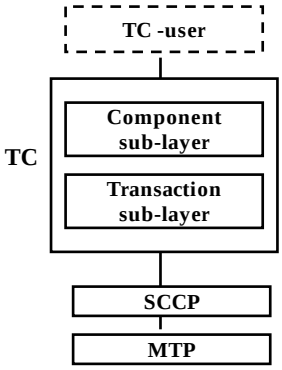
TCAP provides generic services supporting the execution of distributed transactions.
Parties in the transactions can be exchanges, service nodes, data bases etc.

TCAP offers a way to implement services that are independent of network resources.

Summary of course scope



TCAP has two sub-layers



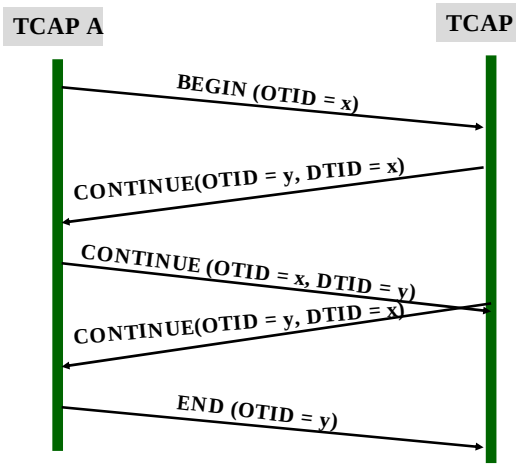
Component sub-layer: data units of the application protocol, requests and responses, dialogues: application context

Transaction sub-layer: message exchange between parties, optionally dialogues between parties.

TCAP has a lot of similarity with ROSE (Remote Operation Service Element) and ACSE (Association Control Service Element). ROSE ja ACSE are OSI layer 7 services.

Transactions are sequences of events that allow to read or write some data entry or entries in a remote network node.

A TCAP use case



Begin begins a dialogue

During the dialogue Continue - messages are sent in both directions.

End-message closes the dialogue.

OTID -identifies the dialogue/ for the sender of the transaction.

DTID -identifies dialogue/ for the object of the transaction.

TCAP supports four operation types

- ✓ **Class 1 - Both success and failure are reported**
- ✓ **Class 2 - Only failures are reported.**
- ✓ **Class 3 - Only success is reported.**
- ✓ **Class 4 - Nothing is reported**

An operation is identified by the Invoke-Id - identifier.

Indication (ind) is associated with the request (req) based on the Invoke-id.

A user may have many ongoing active operations simultaneously.

TCAP is a purely end-to-end function. There may be many intermediate nodes in the CCS7 network that do not touch TCAP.

Operations are identified and chained using the Invoke-Id

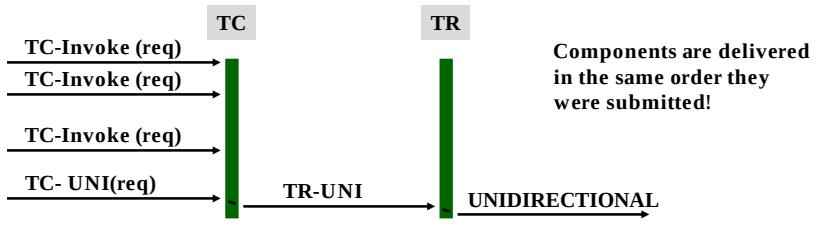
- ✓ **Operation is identified by the Invoke-Id.**
- ✓ **Indication (ind) is associated with the request (req) based on the Invoke-id.**
- ✓ **The Response can be a new operation request that is chained to the previous operation request using a link-identifier.**
- ✓ **A user may have many simultaneous operations.**

The result of an operation sent to a remote system can be

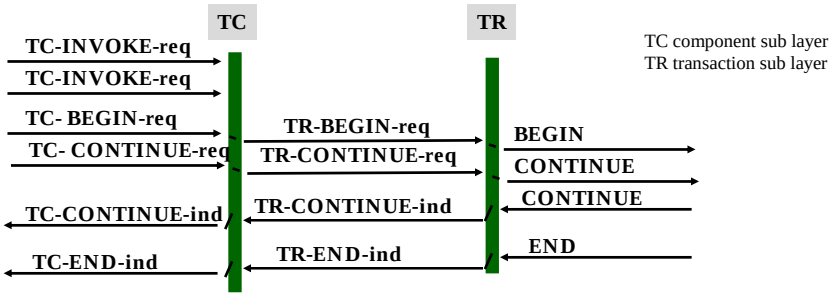
- ✓ **Result: Operation succeeded.**
  - › **The result can also be segmented (chained)**
- ✓ **Error: Operation failed.**
- ✓ **Reject: Execution of the operation is not possible.**
- ✓ **Before sending the result, the remote system can send an arbitrary number of linked operations.**

Non-structured dialogue transfers one or more components

- ✓ **TC-user can send many components in Class 4 operations by a UNIDIRECTIONAL message.**
- ✓ **Components with the same dialogue -id can be sent in one message.**
- ✓ **Control over sequencing of operations is left to the application.**

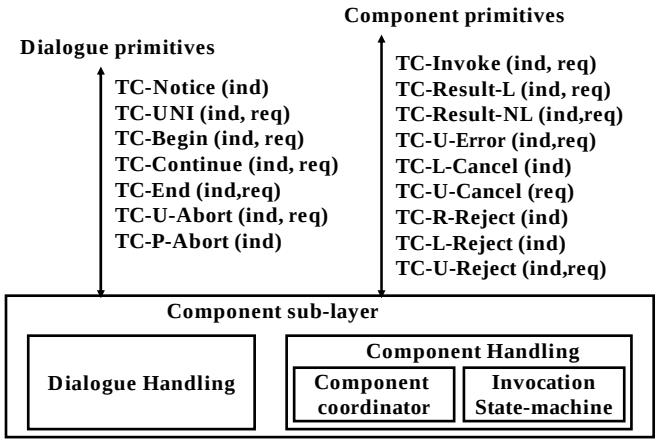


A Structured dialogue has a beginning, information transfer, ending or abort



- **Begin causes a *transaction identifier* to be reserved.**
- **The remote system can either continue the transaction or close it.**
- **Continue - messages are exchanged in a full-duplex mode.**
- **Closing options:**
  - **based on pre-arrangement independently**
  - **normally by the End-message or "abnormally" by an Abort message**

The Component sub-layer is split into dialogue handling and component handling



Component handling primitives are

TC_INVOKE - Invocation of an operation which may be linked to another operation

TC_RESULT_L - Only result or last part of segmented result of a successful operation

TC_RESULT_NL - non-last part of segmented result

TC_U_ERROR - reply to a previously invoked op that failed

TC_L_CANCEL - informs user of local timeout

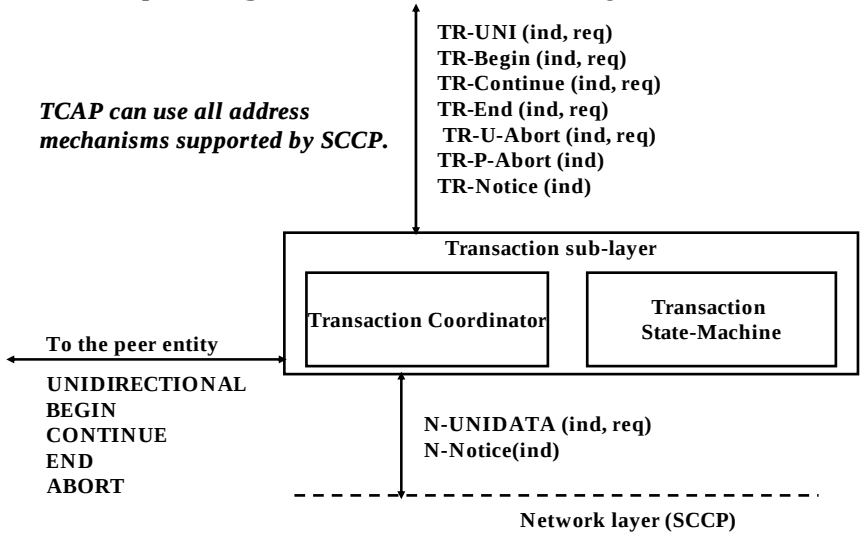
TC_U_CANCEL - Causes local termination of op on TC_user request

TC_L_REJECT - local reject by Component sub-layer to TC_user

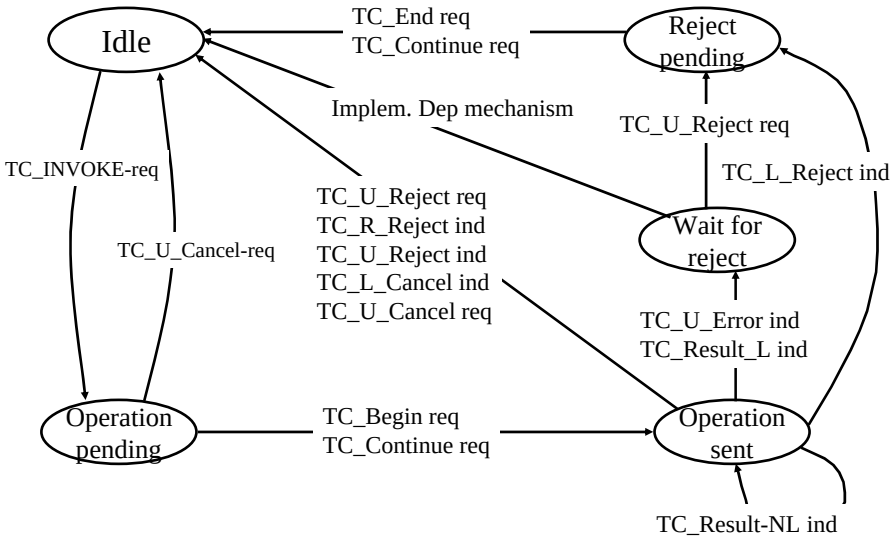
TC_R_REJECT - remote reject by remote component sub-layer

TC_U_REJECT - Rejection by TC_user indicating malformation

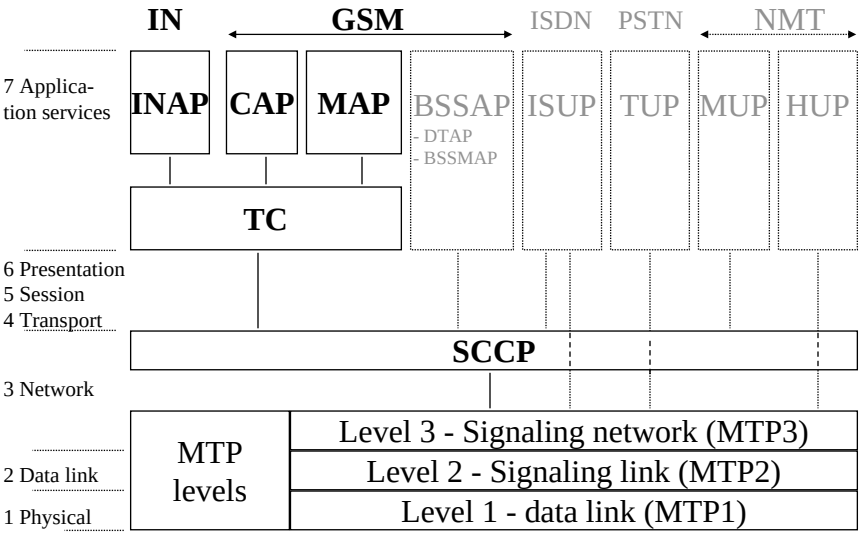
Transaction sub-layer handles the interfacing to the network layer



State transition Diagram for Class 1 Operations



Most important users of TCAP are..



Summary: TCAP added value is

- ✓ **Decoupling the actions and states of an application from communication states for managing the flow of information with the remote end**
- ✓ **Takes care of managing the communication with the peer – lets the application concentrate on essential matters**
  - › **four classes of service**
  - › **report on success tells the application that the remote end has done its job for sure**
  - › **report on failures speeds up recovery (but an application can not really rely on getting the report on every failure!)**
  - › **or alternatively can let the application take care of all acknowledgements**