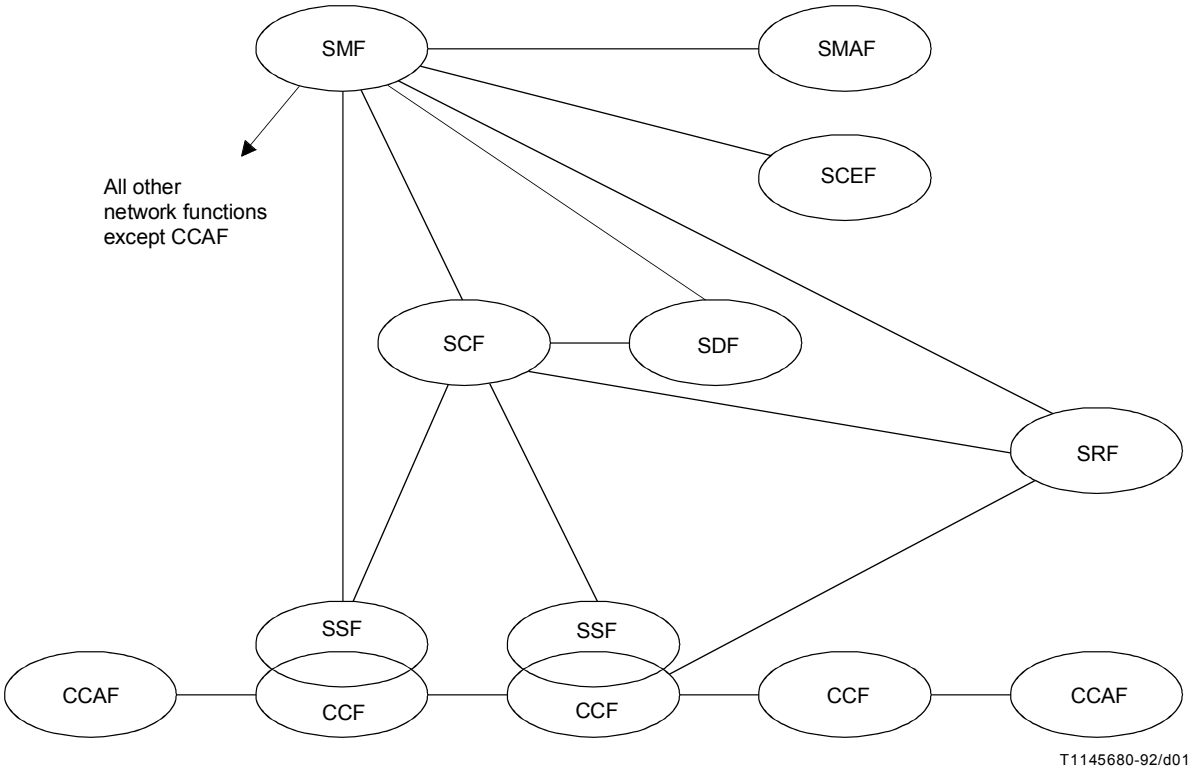
Network/Service Intelligence and Mobility Exam 2008:

Draft solution.

English

Problem 1 Intelligent Network Architecture (18%)

1.1 Make a drawing that illustrates the main functional blocks in an IN architecture and explain the functions.
Answer: Figure 6.2 in the lecture notes (a less detailed figure will also be honoured)



CCAF Call control agent function
CCF Call control function
SCEF Service creation environment function
SCF Service control function
SDF Service data function
SMAF Service management access function
SMF Service management function
SRF Specialised resource function
SSF Service switching function

NOTES
1 The two SSF/CCF have identical functionality and are only shown for some procedures like assist.
2 The definitions of CCAF and CCF are based on corresponding Q.71 ISDN definitions, but may be modified for use in IN.

FIGURE 2-1/Q.1204

IN distributed functional plane model

Note: a little less score if the student has not recognized the difference between a functional block/unit and a physical IN node (e.g. SRF is a function that may reside in an IP, and Adjunct an SSP etc.). Students that describe the

conceptual model instead are not given full credit, but are rewarded with about 50 % score.

1.2 What kind of signalling system is used for communication in an IN network?

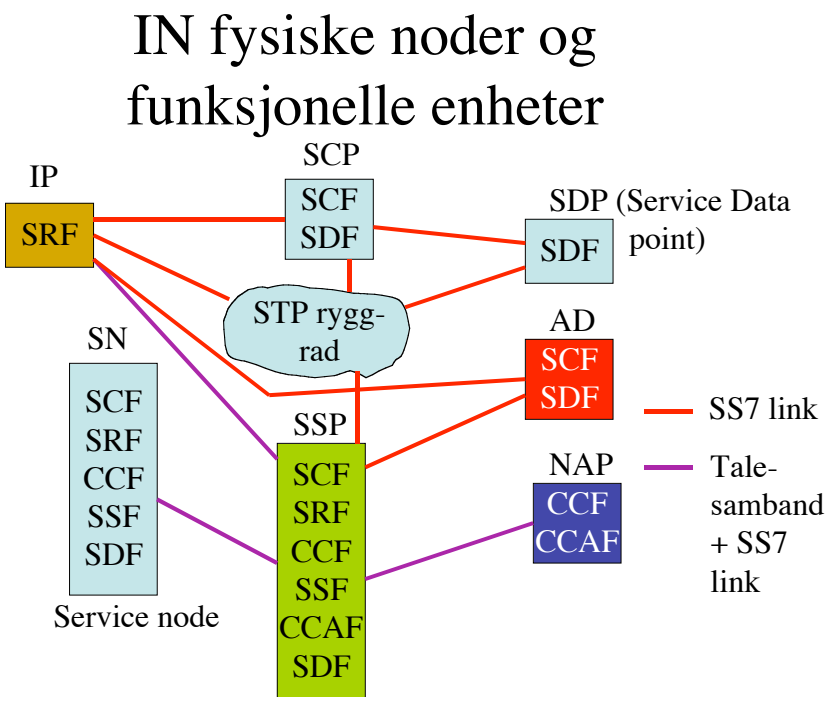
Answer: Signalling system No. 7.

1.3 What is (was) the main purpose of the IN system (contrasted with earlier systems)?

Answer: To create a standardised way of realising advanced services (other services than plain calls between two participants), and hence enable more competition among vendors and much shorter development time (shorter time to market) for new services.. This is accomplished by creating a new "control" plane separated from the "transport" plane. This new control plane has standardised functions and interfaces. Earlier solutions had all the "intelligence" embedded in the exchanges, and exchanges from different makers had proprietary interfaces. (This made it a slow, cumbersome and costly process to introduce new services.).

1.4 Give at least two samples of how functional blocks can be deployed (mapped) onto physical nodes and discuss/comment the options.

Answer: Functional blocks like SCF (Service Control Function) and SDF (Service Data Function) are usually deployed (realised) in various ways into physical network nodes according to practical considerations (e.g. minimising the load on the signalling links). A large exchange in a city may have nearly all the IN functions realised locally (in the SSP), whereas a small rural exchange may rely on neighbour exchanges when it comes to advanced IN functions (it is represented as a NAP (Network Access Point) in the IN family of physical nodes). Another example physical node is an Adjunct (AD) that in many cases is realised as a local add-on to an exchange which experience growing traffic demand, in order to relieve remote SCPs and the signalling system for the increased control traffic. Figure 6.11. Gives a number of examples. The SSP in the figure can be considers a "maximum" example from a big exchange. An SSP in a small exchange do not need to contain more then SSF (Signaling Switching Function) and CCF (Call Control Function))



Norw.: "ryggrad" Engl.: "backbone" , Norw. : "Talesamband" Engl: "Voice connection"

Problem 2 Number and Identities in the mobile network (20%)

2.1 Explain how the different number types and subscription identities (the IMSI) are utilized in the GSM network.

2.1a. What is TMSI (and what is its purpose)?

Answer: IMSI the International Mobile Subscription Identity is a "number" that is kept in SIM (Subscriber Identity Module) and also in the HLR (Home Location Register). The IMSI is divided into different fields yielding "country", "operator" (within a country) and "subscription number". The IMSI represents an ID used by the system "for internal purposes only", the IMSI value is normally not known by the subscriber herself.

TMSI "Temporary Mobile Subscriber Identity" is an identity allocated to the subscriber by a visited network. The mapping between IMSI and TMSI is kept by the VLR. It is used as a security means to make it more difficult to track a certain user by someone trying to eavesdrop the traffic on the air.

MSISDN "Mobile Station International ISDN" number, this the directory number or the public address of the subscriber, it has a format that equals an ordinary telephone number in the fixed network (Country Code, National Destination Code (optional), and Subscriber number).

MSRN "Mobile Station Roaming Number", is a number in the same format as MSISDN (or a ISDN proper). It represents the current address of the subscriber, in the visited network.

IMSI is used by the mobile in order to identify itself in the visiting network, it is also used in the AAA process. During this process, the VLR and the subscribers HRL exchange information, and a MSRN and TMSI is allocated to the mobile.

When X is calling a mobile Y, the call process will use the MSISDN to identify and address the HLR. HLR shall have a pointer to the current address MSRN of the subscriber, so the call is redirected to this position. In the visiting domain, the MSC ("Mobile Switching Centre") normally will know the position of the terminal and air a call sett up (kind of a paging) request on a base station. The terminal then must be allocated signalling channels and at the end also ordinary traffic channels in order to complete the call. The TMSI if allocated, is used as an identifier in control messages in the visited network. The signalling (or control) message itself may be encrypted, but it has to carry an identity on "the outside of the envelope" in order to be picked up and processed by the right entities. There is also a terminal entity that identifies the terminal itself: the IMEI. This IMEI 15 digits long, will become replaced by IMEISV 16 digits long that will also contain a reference to software version.

The subscriber identities as described are valid for speech (circuit switched services). A given subscriber will have her own identity for packet switched services (a "TMSI" for packet switched services is often referred to as TLLI "temporary Logical Link Identity" or P-TMSI (P for packet).

2.2. In IMS explain the structure of a user identity.

Answer: In the IMS there is two types of user identities private and public:
The private is used by the network to identify the users subscription (it points to the subscription), it main use is for authentication, it can be used for accounting and administration purposes also. The format of an IMS private user Id. Shall be as specified for a NAI (Network Access Identifier) by the IETF e.g. jon.smith@example.com
The public user identities are used to request communication with other users (they represents the directory address). As IMS shall interwork with different brands of legacy networks there is optionally two forms specified for public user identities:

a. SIP uniform resource identities (e.g. sip: jo.doe@ims.example.com) or
b. Telephone uniform resource locator (e.g. tel: 47 73594324)

Note several public user identities may be allocated to the same private identity, they may be used to administrate different roles/profiles defined for the user.

2.2a. What is ISIM (IP multimedia Services Identity Module) and what is it used for? (From Wikipedia!)

Answer: An IP Multimedia Services Identity Module (ISIM) is an application running on a UICC smart card in a 3G mobile telephone in the IP Multimedia Subsystem (IMS). It contains parameters for identifying and authenticating the user to the IMS. The ISIM application can co-exist with SIM and USIM on the same UICC making it possible to use the same smartcard in both GSM networks and earlier releases of UMTS.

The ISIM contains a private user identity (a NAI address, username@operator.com), one or more public user identities (a SIP, sip:user@operator.com, or TEL, tel:+1-212-555-12345, address) and a long-term secret used to authenticate and calculate cipher keys.

2.2b. Explain the rationale behind private and public user identities and give an example of

- a SIP URI and
- a telephone ULR

Errata: "ULR" should have been "URL"
Answer: Se above.

Problem 3 Interworking between the Circuit Switched (CS) and Packet Switched (PS) domain (20%)

3.1. What issues must be solved in order to create interworking between the (old) ISDN/PSTN networks and the new IP based network (IMS)?

Answer: The ISDN network utilise TDM synchronised switching, PCM encoded voice format for media transfer and (mainly) the (Common Channel) Signalling System No. 7 (SS7) for control messages. Call routing is implemented by utilising the ISDN number system (E. 164 "the international public telecommunication numbering plan"). IP based network use packet switched voice (, video , etc) with a number of optional codecs. Control messages (signalling) is realised (in the IMS case) by a SIP based signalling system (SIP: Session Initiation Protocol, defined by IETF). In order to realise interworking the following issues have to be resolved:

A: Media Gateway Functions: Transcoding between codec formats used in the IP area and ISDN (PCM encoding). Also two-way format adaption between packet switching/circuit switching.

B: Signalling Gateway Functions: Translation between essentially SIP based signalling schemes (in the PS area) and SS7 in the CS area.

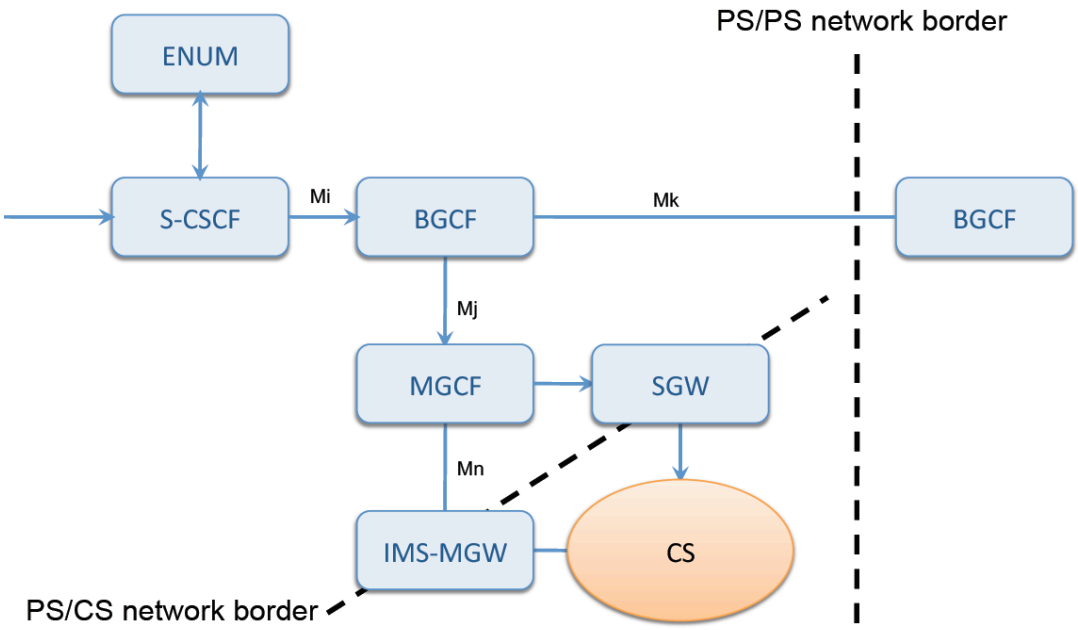
C: Media Gateway Control Functions: Control (e.g. switching on an off the right transcoding schemes) of the Media Gateway.

D: Breakout points: When going from one system (PS) to the other (CS) both globally present, a suitable point must be decided for the interworking functions (should it be a close to the destination as possible, or?). One has to establish strategies that details the choice of breakout points according to availability, price and service quality.

3.2. Sketch a call set-up (include the functional blocks in the sketch) from a
a. telephone in the PS domain to a telephone in the CS domain
b. telephone in the CS domain to a telephone in the PS domain
and describe the call process in both cases.

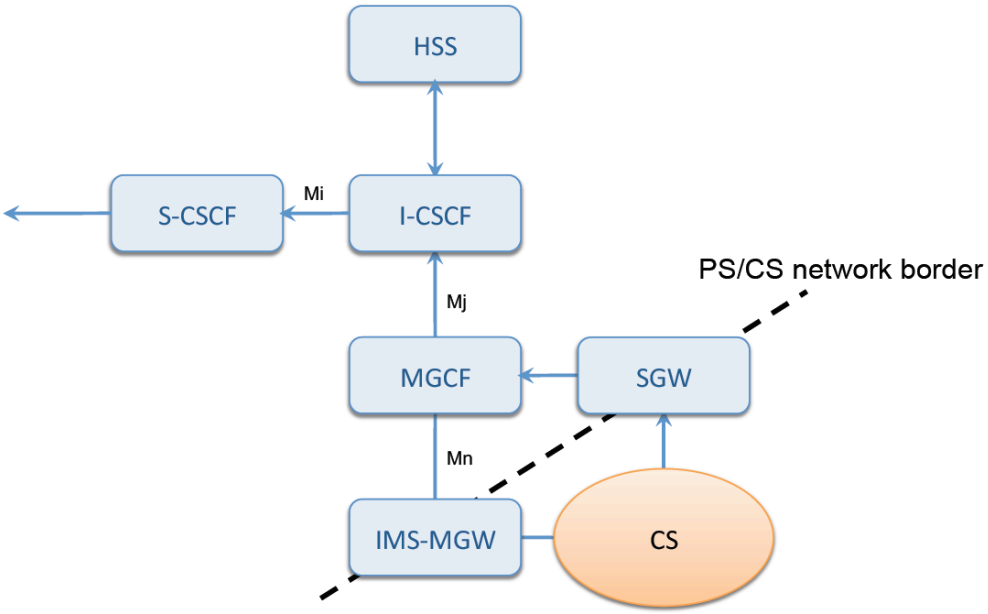
Answer:

IMS-CS interworking configuration when an IMS user calls a CS user



a. A description of a call setup with reference e.g. to the given functional blocks (you may number the steps). ENUM is a address translation service.
b. A description of a call setup with reference to functional blocks as given below (Simpler schemes are also honoured!):

IMS-CS interworking configuration when a CS user calls an IMS user



Problem 4 Mobility (22%)

4.1 Explain the difference between terminal mobility and user/personal mobility.

Answer: Terminal mobility reflects the capability of a system to let a terminal roam or move between different network attachment points (between different locations). User or personal mobility characterise a capability of a system that gives the user access to her services on any location (covered) irrespective of the terminal used. E.g. : You could theoretically implement a user mobility system in an old time fixed telephone system , if you allowed the users to register themselves at a local telephone after each movement.

4.2 **Try to characterize a basic implementation of the following types of mobility as terminal or user mobility.**

- **Mobile IP**
- **GSM**
- **SIP**
- **3GPP/IMS**

Please also comment the different cases.

Answer: Mobile IP is terminal mobility as the a fixed IP address is allocated to the device (IP interface), and it is this address (id) that is tracked.
GSM represents by and large terminal mobility (if we consider the SIM card to belong to a terminal). If however a user choose to retrieve the SIM card and use it in a new terminal in another location – this would correspond to user mobility.

(This is not very practical to realise to day.) The GSM type of mobility has be nicknamed “plastic card mobility” or “SIM card mobility”
SIP realise user mobility, see also point 4.3 (4.4) below
The 3GPP/IMS system tries to realize a wide and flexible range of mobility functions.
Still referring to a SIM residing on a plastic card, it could be referred to the same way as for GSM. However, a single subscription in the IMS may be represented in more than one device simultaneously, and the use of different public and private identities makes other types of mobility possible (e.g. role mobility), so it its difficult to characterise it in a simple way.

4.2 (should be 4.3) Session Mobility

- **What is meant by session mobility?**
- **Does session mobility have to be continuous?**
- **Define “handover” and state whether it can be characterized as session mobility or not.**

Answer: Session mobility is the capability to maintain a session while moving to a new network attachment point. This type of mobility need not necessarily be continuous: It could e.g. be OK to pause a TCP file transfer while moving, and the resume it at the new location.
Handover is defined as a capability of a system to “handover” a connection while maintaining the service. (The Wikipedia states that: The British English term for transferring a cellular call is handover, which is the terminology standardised by 3GPP within such European originated technologies as GSM and UMTS i US English they use “handoff”.) When looking on the details there can be handover of many types soft handovers (typically “make before break” and hard handover (“break before make”). Generally if a system is capable of doing handovers it also supports session mobility.
Comment: It seems that the prevailing interpretation of session mobility is transferring a session from one terminal to the other – i.e. among different terminals **(Contrary to the teacher’s assumptions!)** In this case handover cannot be said to represent session mobility. Answers according to this view, will be honoured.

4.3 (should be 4.4) SIP mobility

It is said that SIP support the concept of user mobility. Could you please elaborate on this, and tell how (max ½ page)?

Answer: In SIP the user by logging in on a computer or a device normally triggers the SIP UA. This UA then register itself at its home Location Server, with its current status and IP address (location) given. When the user logs off, shuts down the terminal, the Location Server will either have an explicit deregistration or the entry will experience a time out. The entry (entries) belonging to a single subscriber thus mirrors this subscriber’s location. – In fact some systems allow the same subscriber to be logged in at different terminals in parallel.
By and large it is the position of the subscriber that is tracked, irrespective of the terminal used. Hence the system support user mobility

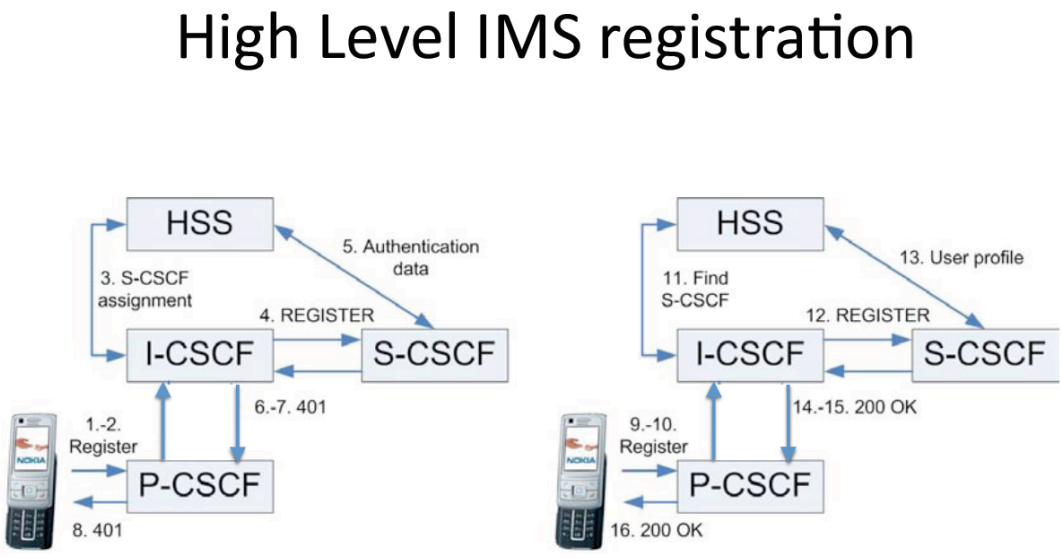
Problem 5 Call processing and registration in the IMS (20%)

5.1 The call process (signalling process) of a normal call set-up in IMS may utilize 3 different "Call Session Control Functions". What are they? - Please explain their characteristics, and how they are deployed.

Answer: P-CSCF Proxy Call Session Control Function, I-CSCF Interrogation Call Session Control Function and S-CSCF Service Call Session Control Function. P-CSCF is the first entity handling a call request, it resides in the visited network (the network of the subscribers current location), I-CSCF represents the entry point to the home network of the subscriber. S-CSCF controls resides in the home network and controls the service execution and accounting of the subscriber. About deployment: Note the entities described are functions. A given network node may realised more than one such function. (For further explanation you may see page 83 -85 in the lecture notes or Chapter 2.2.1 pages 20 to 23 in the IMS book, note Figure 2.7 in the IMS book is not very good as it does not show the HSS of the A subscriber. The HSS shown is probably the one belonging to B.)

5.2 Prior to a call attempt the terminal has to "attach to the network", this process is called registration. Describe (illustrate with a sketch) normal steps when a terminal registers itself in a GPRS based access network (GPRS: General Packet Radio Service). – In this context, please explain also the role of the two network nodes: GGSN and SGSN.

Answer: See Chapter 3.2 in the IMS book. The corresponding figure is rendered here (leftmost part: The system challenges the UE, rightmost part the UE challenges the system and completes the registration). –Further details are given in the book, it's a mutual authentication scheme.



Before starting on the process shown, the UE must invoke an GPRS attachment procedure and establish a PDP context between itself through SGSN to GGSN (The PDP context act as kind of an IP tunnel, through the GPRS "territory" (This question was a little difficult to answer).