BLG609E - Special Topics: 4G Wideband Wireless Network Architectures (Spring 2012)

Homework Assignment #1: Standards and Network Architecture

Due Date: Feb 20th (Monday), 2011 at start of lecture

TOTAL POINTS: 35 (Bonus Points)

1. From the documentation series of 3GPP (http://www.3gpp.org/Spcification-Numbering) or from your lecture notes answer the following questions: **(5 POINTS)**
   1. The Stage-2 specification of LTE radio network is provided by which 3GPP specifications?
   2. The Stage-2 (architecture) of Evolved Packet Core is specified by which specification?
   3. Which specification provides the non-access-stratum (NAS) Stage-3 of EPC?
   4. Which is the stage 3 specification of GTP-C used in EPC?

2. From TS 23.401, answer the following questions. **(5 POINTS)**
   1. What are the key functions of the MME?.
   2. UE's IP address allocation is performed by which node?
   3. If you are an operator and want to support VoIP when the user is roaming which of the architecture would you deploy: Figure 4.2.2-1 (roaming with home-routed traffic) or Figure 4.2.2-2 (roaming with local breakout)? Why.

3. Think about an fixed-line ADSL access system, example like the one you have in your house for internet traffic. Think about the various functions that you would want this system to provide. Enumerate these high level functions that you want this system to provide. Draw a block-level diagram for such a fixed line ADSL system. Provide names (create these) to the various network elements in your access system. Also provide names to the various interfaces in your system. Enumerate the key functions that are supported by the network elements. Also, state what occurs across the various interfaces in your system? **(10 POINTS)**

4. **IP Subnets. (10 points)**

   IP address consists of 32 bits = 8 bytes X 4

   IP address is typically represented in notation with 4 decimal numbers separated by dots, eg:

Decimal representation:	192 .	168 .	1 .	4
Bits representation:	1100 0000	1010 1000	0000 0001	0000 0100

   Subnetwork (subnet) is a logical subdivision of an IP network.

   A subnet consists of all IP nodes that are Ethernet (switch) connected to a Router's interface.

   For example, the following figure includes 4 subnets

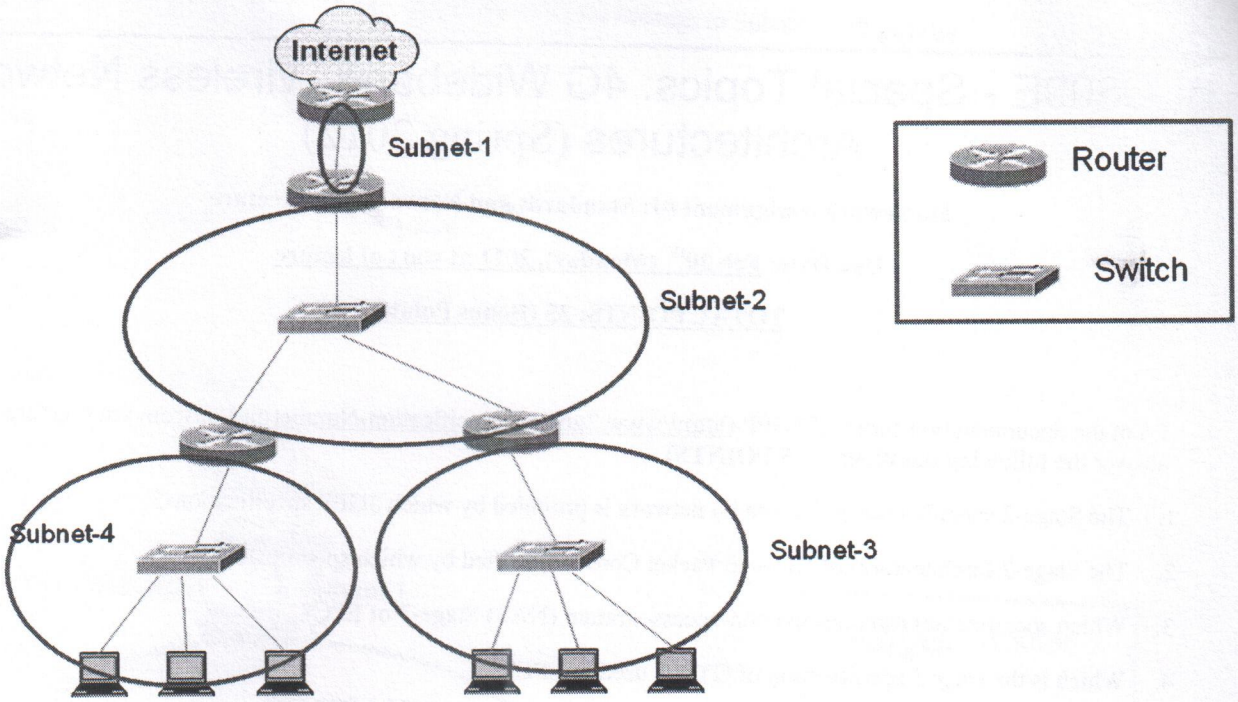


Figure-1

A Subnet is represented by the following notation : 192.168.1.0 /24 (Prefix/length)

192.168.1.0 is called the prefix of the subnet. It is also the first IP address in the subnet.

24 is length of the prefix in bits. It is also number of bits set to 1 in a mask used by the router to determine if an IP address belongs to a subnet. This is also called the subnet mask

So the subnet mask in this case is (24 "1" bits):

Bits representation:	1111 1111		1111 1111		1111 1111		0000 0000
Decimal representation:	255	.	255	.	255	.	0

If an IP address, say IP-1 belongs to a subnet, then

IP-1 AND Subnet Mask = Subnet Prefix

(AND is bit wise AND operation)

Otherwise, the IP address does not belong to the subnet.

32 minus Prefix_length is equal to the number of bits available for IP-addresses in the network. Hence, in our example 8 bits (= 32 -24) are available for IP-addresses in the subnet 192.168.1.0. The first address in the subnet is 192.168.1.0 and the last address in the subnet is 192.168.1.255. Typically, the first and last address in a subnet are not assigned to hosts. Hence, the number of hosts possible in our case is 2^8 – 2 = 254.

Graphically, IP subnetworks with IP addresses assigned are shown as in the figure below.

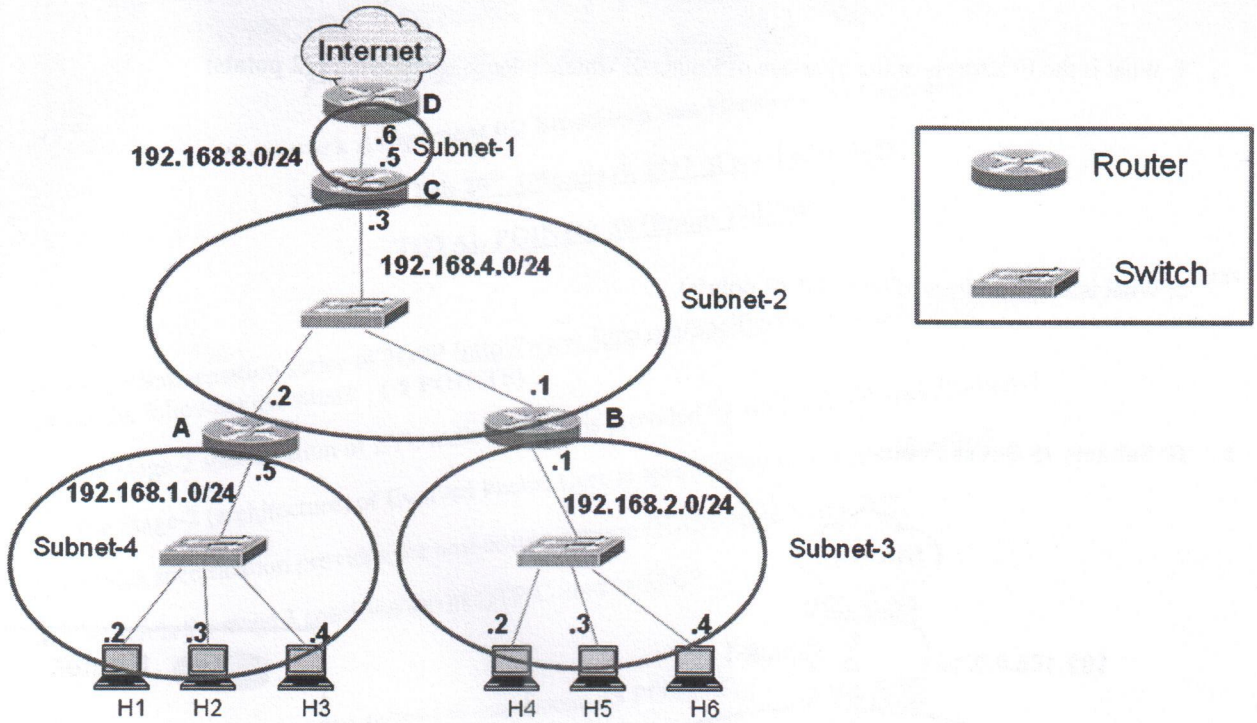


Figure-2

In addition to the subnet prefix/length, the IP addresses of all interfaces of routers and hosts are shown as above. Hence, the interface of Router-B which belongs to subnet-3 has the following address: 192.168.2.**1** and host H2 has the following address: 192.168.1.**3**.

All questions below refer to figure-2

1. For Subnet-2 in the figure above, please provide the subnet mask both in the bit representation and decimal representation: **(2 points)**

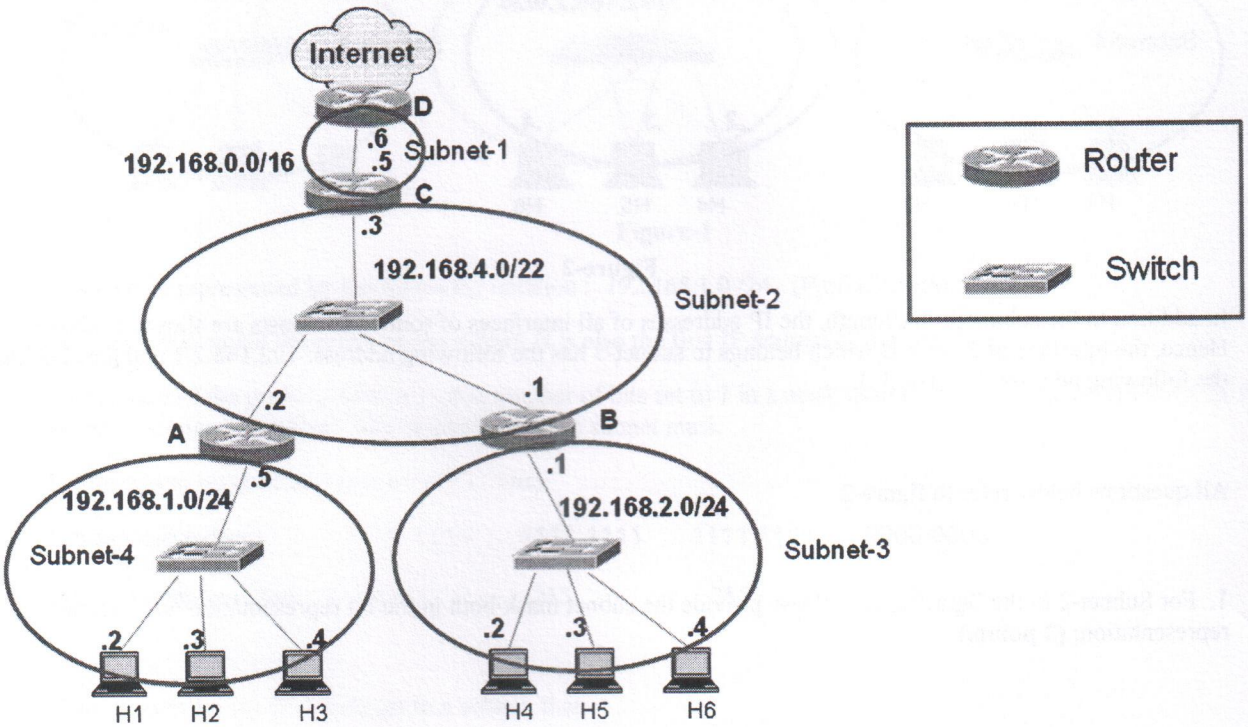
2. Does IP address 192.168.3.0 belong to Subnet-2? Why (show your working below)? **(2 points)**

3. How many IP-addresses can belong to Subnet-2? What is the first IP address and the last IP address that can belong to Subnet-2? **(2 points)**

4. What is the IP address of the interface of Router-B which belongs to Subnet-2? **(2 points)**

5. What is the IP address of host H5? **(2 points)**

5. **IP Subnets. (5 Bonus Points)**



What is wrong with the above Subnet example? Explain. *Hint: Look at Subnet-2 and Subnet-1.*

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Feburary 20, 2012

BLG609E - Special Topics: 4G Wideband Wireless Network Architectures
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Homework-1: Standards and Network Architecture

1. From the documentation series of 3GPP (http://www.3gpp.org/Spcification-Numbering) or from your lecture notes answer the following questions: (5 POINTS)

   1. The Stage-2 specification of LTE radio network is provided by which 3GPP specifications?

      TS 23.401 GRPS Enhancements for E-UTRAN Access (Describes the overall LTE system architecture)

      TS 36.300 E-UTRA & E-UTRAN Overall Description (Describes the Radio Access Network part of LTE) [1]

   2. The Stage-2 (architecture) of Evolved Packet Core is specified by which specification?

      Evolved Packet Core Stage 2 is specified by specification number: 23.401 [1]

   3. Which specification provides the non-access-stratum (NAS) Stage-3 of EPC?

      3GPP specification with number: 24.301 provide NAS Stage-3 of EPC. [2]

      Note: specification numbers in 24 series are for signalling protocols ("stage 3") - user equipment to network. [3]

   4. Which is the stage 3 specification of GTP-C used in EPC?

      3GPP specification with number: 29.060 provides GTP-C (GPRS tunnelling protocol) used in EPC. [4]

      Note: specifications in 29 series are for signalling protocols ("stage 3") - intra-fixed-network. [3]

2. From TS 23.401, answer the following questions. **(5 POINTS)**

   1. What are the key functions of the MME?

      Key functions of MME: NAS Security, Idle state mobility handling and EPS Barrier control. [1]

      MME functions defined in [5]: NAS signalling, NAS signalling security, Inter CN node signalling for mobility between 3GPP access networks (terminating S3), UE Reachability in ECM-IDLE state (including control and execution of paging retransmission), Tracking Area list management, Mapping from UE location (e.g. TAI) to time zone, and signalling a UE time zone change associated with mobility, PDN GW and Serving GW selection, MME selection for handovers with MME change, SGSN selection for handovers to 2G or 3G 3GPP access networks, Roaming (S6a towards home HSS), Authentication, Authorization, Bearer management functions including dedicated bearer establishment, Lawful Interception of signalling traffic, Warning message transfer function (including selection of appropriate eNodeB), UE Reachability procedures, Support Relaying function (RN Attach/Detach). [5]

   2. UE's IP address allocation is performed by which node?

      UE's IP address allocation is performed by P-GW network element. [1]

   3. If you are an operator and want to support VoIP when the user is roaming which of the architecture would you deploy: Figure 4.2.2-1 (roaming with home-routed traffic) or Figure 4.2.2-2 (roaming with local breakout)? Why.

      If I am an operator and want to support VoIP when the user is roaming, the architecture I would you deploy would be the one visualized in: Figure 4.2.2-2 (roaming with local breakout). Reason is, briefly: In the chosen architecture, most of the signalling work is performed in the Visited PLMN (Including

Serving GW - PDN Gateway signalling), therefore the expected delay on these operations is less than in the architecture visualized in Figure 4.2.2-1 in which these operations are performed by Home PLMN (Serving GW in VPLMN has to connect to HPLMN PDN GW). Especially for VoIP traffic, the delay (actually jitter) is one of the main performance concerns.

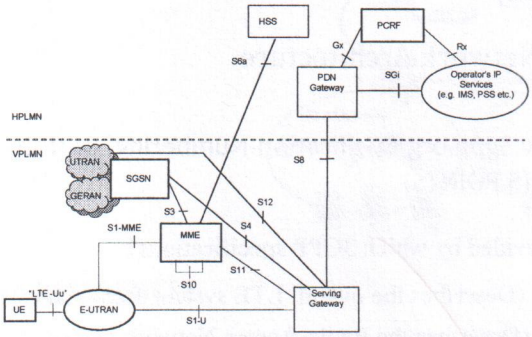


Figure 4.2.2-1: Roaming architecture for 3GPP accesses. Home routed traffic [5]

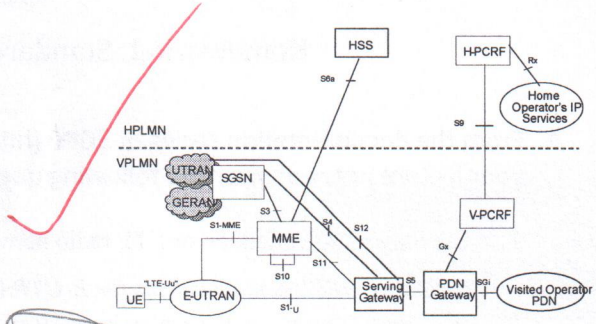
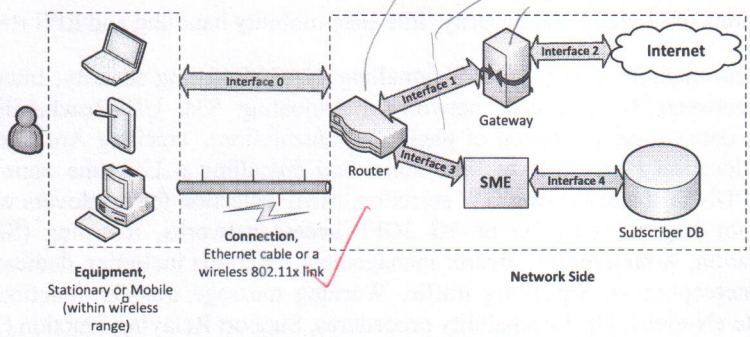


Figure 4.2.2-2. Roaming Architecture for Local Breakout, with home operator's Application Functions only [5]

3. Think about an fixed-line ADSL access system, example like the one you have in your house for internet traffic. Think about the various functions that you would want this system to provide. Enumerate these high level functions that you want this system to provide. Draw a block-level diagram for such a fixed line ADSL system. Provide names (create these) to the various network elements in your access system. Also provide names to the various interfaces in your system. Enumerate the key functions that are supported by the network elements. Also, state what occurs across the various interfaces in your system? (10 POINTS)

- High level functions:
  - internet connectivity
  - High DL data rate
  - Security
  - Reasonable cost
  - Network stability

- Block level diagram for such a fixed line ADSL system:



- Names of network elements (with key functions) and interfaces (with descriptions):
  - Router : Responsible for scheduling connected devices' IP connectivity
  - Gateway : Responsible for retrieving IP address
  - SME : *Security Management Entity* responsible for security issues including operator side issues like my internet connection aggrement's properties (e.g. download limit of TTnet)
  - Subscriber DB : Kepps users' aggrement conditions and security parameters
  - Interface 0 : is between router and user equipment: user connects to the router representing its request for internet connection
  - Interface 1 : is between router and GW, router requests an IP connection from GW

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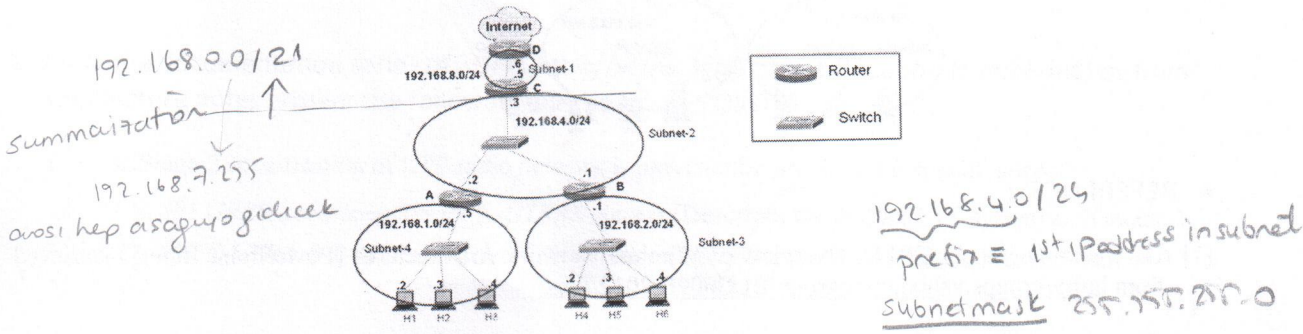
- Interface 2 : is between GW and Internet: GW searches for an available IP address (with the help of a DHCP server) and retrieves one for the router's request
- Interface 3 : is between router and SME: signallings on security issues
- Interface 4 : is between SME and SDB: signalling with SDB inorder to retrieve a specific user's conditions on security and/or license/aggrement on internet usage.

4. IP Subnets. (10 points)



1. For Subnet-2 in the figure above, please provide the subnet mask both in the bit representation and decimal representation: (2 points)

   the subnet mask is (24 "1" bits):

Bits representation	:	1111 1111	1111 1111	1111 1111	0000 0000
Decimal representation	:	255 .	255 .	255 .	0

   IP & SubnetMASK ebakarız ? = subnet prefix

2. Does IP address 192.168.3.0 belong to Subnet-2? Why (show your working below)? (2 points)

   192.168.3.0 && 255.255.255.0 = 192.168. 3. 0 ≠ 192.168.4.0 (subnet prefix)

   => does NOT belong to subnet-2.

   10

3. How many IP-addresses can belong to Subnet-2? What is the first IP address and the last IP address that can belong to Subnet-2? (2 points)

   2^8 = 256 IP addresses can belong to Subnet-2.

   1st IP address: 192.168.4.0, last IP address: 192.168.4.255

   .0 .255 typically but reserved.

4. What is the IP address of the interface of Router-B which belongs to Subnet-2? (2 points)

   Router-B's interface to Subnet-2 is the 1st host in subnet-2, therefore its IP address is: 192.168.4.1

5. What is the IP address of host H5? (2 points)

   H5 is the 3rd host in Subnet-3 whose prefix is 192.168.2.0. Therefore, its IP address is: 192.168.2.3

5. IP Subnets. (5 Bonus Points)

- What is wrong with the given Subnet example? Explain. *Hint: Look at Subnet-2 and Subnet-1.*

  Subnet 1 IP address space: 192.168.0.0 – 192.168.255. 255 ($2^{32-16=16}$ = 65536 = 0.1.0.0)

  Subnet 2 IP address space: 192.168.4.0 – 192.168.7. 255 ($2^{32-22=10}$ = 1024 = 0.0.4.0)

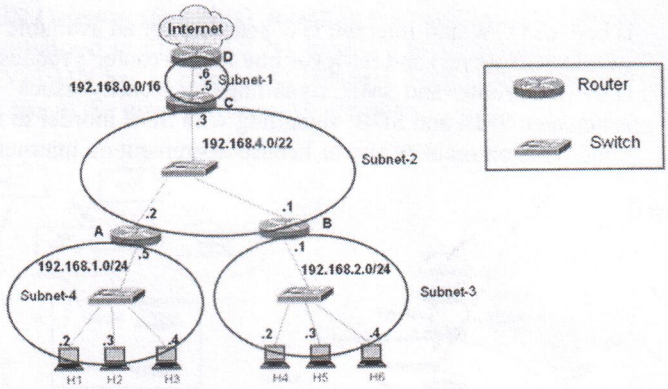
  5

  These IP ranges intersect at range 192.168.4.0 – 192.168.7. 255 ! More precisely, Subnet 1 space INCLUDES Subnet 2 address space. Router C cannot determine which port to forward for a retrieved packet matching with this range (Subnet 1 or 2). An IP address within this range say 192.168.5.65

  192.168.5.65 && mask1: 255.255.0.0 = 192.168.0.0 = prefix 1 !

  192.168.5.65 && mask2: 255.255.252.0 = 192.168.4.0 = prefix 2 !

  } Subnet 1 or 2?



- REFERENCES:

[1] Ali, I. and Yegin, A. (2011). Overview of Wireless Network Architectures [PowerPoint slides]. Retrieved from http://groups.yahoo.com/group/BLG609E-2012/files/

[2] 3rd Generation Partnership Project . (2012, February) 3GPP Specification detail, 3GPP TS 24.301. [Online]. Available: http:/www.3gpp.org/ftp/Specs/html-info/24301.htm

[3] 3rd Generation Partnership Project . (2012, February) Specification Numbering. [Online]. Available: http://www.3gpp.org/specification-numbering

[4] 3rd Generation Partnership Project . (2012, February) 3GPP Specification detail, 3GPP TS 29.060. [Online]. Available: http://www.3gpp.org/ftp/Specs/html-info/29060.htm

[5] ETSI. (2011, June) ETSI TS 1 23.401 V10.4.0 (2011-06) (3GPP TS 23.401 version 10.4.0 Release 10)Technical Specification [Online]. Available: http://www.etsi.org/deliver/etsi_ts/123400_123499/123401/10.04.00_60/ts_123401v100400p.pdf