# BLG632 – Next Generation Wireless Networks

**Final Take Home Assignment**

**Weightage: 15% Course Grade**

**Submission:**

1. Presentation (10 minutes + 5 minutes question/answer): 70%

- 7 Slides maximum.

- Presentation on June 8th from 9:00 - 12:00 in classroom Z4.

- **Due date: June 8th, before the exam**.

2. Short report (5 pages max): 30%

- What is the main problem the paper is trying to solve?

- Explain the main concepts provided by the authors.

- Your review on the paper:

- readability of the paper

- significance of the results

- possible enhancement of the work.

- **Due date: June 9th, 17:00**

**Assignments (One for each student):**

Some of the papers are taken from the overview paper [1]"A roadmap for traffic engineering in SDN-OpenFlow networks", Ian F. Akyildiz, et. al, Computer Networks 71 (2014). Use this paper to find out references and papers needed for 1, 2, 5, 6 below.

1. Switch load-balancing/Dynamic flow management: Read up papers that describe Hedera and Mahout and explain how these schemes work. **Fareba**

2. Data-plane failure recovery mechanisms: Review one or two of the reference on these schemes [71-74] and provide an overview of one or two of these schemes. **Cağlar**

3. Provide an overview of: "CONGA: Distributed Congestion-Aware Load Balancing for Datacenters", Alizadeh, Sigcomm 2014 (best paper award). Provide main concepts from the paper. There is also a youtube video by Alizadeh explaining the scheme. https://www.youtube.com/watch?v=YcE2UrTShZQ **Kehlan**

4. Data-plane programmability: "Forwarding Metamorphosis: Fast Programmable Match-Action Processing in Hardware for SDN", Pat Bosshart, Sigcomm 2013. I have also placed some slides on google drive that cover this. https://drive.google.com/open?id=0B1-LbteB\_nm3YmtfZGFmSmFkeWc . **Volkan**

5. Header-space Analysis: read up reference [92,93] from Akyildis paper and provide an overview of header-space analysis. I have also included a slide-set for reference on google drive. There is also a video by Nick Feamster that provides an overview of header-space analysis. Try to do one or two examples of using header-space analysis to show your understanding of how header-space analysis may work. https://www.youtube.com/watch?v=xwhUh5PFGEs&list=PLpherdrLyny-4Y6jXKvi0Ia9jJAk3M\_Bs&index=18 **Tuğrul**

6. SDN Traffic Monitoring: " OpenSample: A Low-latency, Sampling-based Measurement Platform for Commodity SDN", Suh, 2014 IEEE 34th International Conference on Distributed Computing Systems. **Burak**

7. "VFP: A Virtual Switch Platform for Host SDN in the Public Cloud", Daniel Firestone, NSDI 17. https://www.usenix.org/conference/nsdi17/technical-sessions/presentation/firestone **Mehmet**

8. "SCL: Simplifying Distributed SDN Control Planes", A. Panda, et. al, NSDI 17. https://www.usenix.org/conference/nsdi17/technical-sessions/presentation/panda-aurojit-scl. Also, learn about the Paxos algorithm and explain how that works. **Elham**

9. "Let It Flow: Resilient Asymmetric Load Balancing with Flowlet Switching". NSDI 17, https://www.usenix.org/conference/nsdi17/technical-sessions/presentation/vanini **Benyamin**

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1. Answer the following questions: **TOTAL 10 POINTS**

a. Describe briefly what do Stage-1 specifications, Stage-2 specifications and Stage-3 specifications, cover? **3 POINTS**

b. What is the name of the temporary identity used by the eNB for a UE? What is the name of the temporary identity used by the MME for the UE? **2 POINTS**

c. What is the identity used by the MME to determine if the UE is roaming or not? **1 POINT**

d. RRC Messages are sent in PDCCH. TRUE or FALSE: **1 POINT**

e. OFDM is the multiplexing scheme used in both the uplink and downlink channels in LTE. TRUE or FALSE: **1 POINT**

f. Name the two main types of handovers in LTE? **2 POINTS**

2. Answer the following questions: **TOTAL 10 POINTS**

a. Can symmetric key cryptography provide non-repudiation? Explain why. **2 POINTS**

b. The user-plane traffic between the UE and the eNB is integrity protected. TRUE or FALSE? **1 POINT**

c. In LTE, describe the mechanism used to protect the user’s permanent identity (IMSI) from being compromised over the air or being hacked at eNB? **2 POINTS**

d. Is the following statement TRUE or FALSE: **1 POINT**

The UE NEVER sends it IMSI without encrypting it to the eNB.

f. Asymmetric key cryptography is used in LTE. TURE or FALSE. **1 POINTS**

g. Give an example of scheme which provides replay protection. Explain how the scheme provides replay protection. Is there is any limitation in using the scheme. **2 POINTS**

h. In asymmetric key cryptography one can provide data privacy by encrypting the data using the private key. TRUE or FALSE. **1 POINT**

3. Answer the following questions **TOTAL 5 POINTS**

a. In the Static Location Area Scheme (location areas or tracking areas are pre-defined and consist of fixed number of cells), what is the effect of minimizing the number of cells per Location Area on both location update cost and paging cost? **2 POINTS**

c. (TRUE or FALSE) In LTE, during idle-mode, the process of cell-selection by the UE is controlled by the eNB. **1 POINT**

c. Fill in the blank. In LTE, during idle-mode, the location of the UE is known in the network at the granularity (level) of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ **1 POINT**

d. What is the process of active-mode mobility in LTE called? Which node controls active mode mobility and how? **(1 POINTS)**

4. Summarize the following IP addresses (show your working). The Summarized address should include all the addresses that are being summarized, eg. the summarization of 10.100.0.0/31 and 10.100.0.2/31 is 10.100.0.0/30: **5 POINTS**

i. 10.100.12.0/25 and 10.100.12.128/25: **2 POINTS**

ii. 192.168.32.0/24 through 192.168.63.0/24: **3 POINTS**

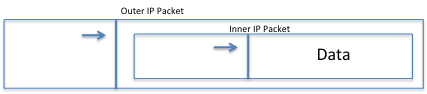
5. Consider the following variation of Mobile IPv6 called Hierarchical Mobile IPv6 (HMIPv6), shown in the figure below. The main objective of HMIPv6 is to reduce the long transit time of binding updates between the Mobile node (Bob) in the visited network and its home-agent in the home network. A new entity, call the mobility anchor point (MAP) is introduced in the visited network. While in the visited network, Bob’s mobility is anchored in the MAP; hence binding updates occur only in the visited network between Bob and the MAP. The MAP provides a Regional Care-of-address (RCoA@) to BoB while Bob is in the visited network. This RCoA@ is registered at the home-agent as Bob’s CoA while in the visited network. Bob is also provided a care-of-address (CoA@) which belongs to the subnetwork in which Bob is currently present. So when Bob is in subnetwork-1, he has care-of-address CoA@-1. When Bob moves to subnetwork-2, Bob has address CoA@-2. The Home-agent tunnels a packet from Correspondent Node (Alice) to the MAP by using the RCoA@ in Tunnel-1 as shown in the figure. The MAP further tunnels the packet to the CoA@-2 of Bob. Bob’s address is denoted by “home@” and Home Agents address is denoted by “HA@” (**5 POINTS**)



Figure: Hierarchical Mobile IPv6 (HMIPv6)

a. What is the source and destination address in the outer and inner IP packet on **Tunnel-1**, shown in the figure above? (**2.5 POINTS**)

b. What is the source and destination address in the outer and inner IP packet on **Tunnel-2**, shown in the figure above? (**2.5 POINTS**) 



6. Using the figure below, explain how the tracking area list concept of LTE (i.e. the mobile may be admitted to multiple tracking area identities) can be used to implement “distance based location management”, i.e creating location areas that are centered at the UE’s location (TAI) from where it last performed a location area update? The goal is to create a dynamic location area for the UE such that when the UE moves in idle mode to any of the adjacent TAI from the one where it last performed TAU, it does not need to perform TAU. Only when it moves to tracking area two removed from the TAI where it last performed TAU, it shall perform a TAU and then will be provided a new tracking area list. Each circle in the figure below represents a tracking area whose tracking area identity is indicated by TA*n*. Assume that when the UE attaches to the network it is located in a cell which is in TA1. Assume that the UE can be provided 7 TAIs in a Tracking area list. Explain which TAIs will be provided to the UE at network attach, in which TAI# will the UE do the next tracking area update and what would be the new set of TAIs provided to the UE. Draw out the sequence of tracking areas allocated to the UE in the figure below. **TOTAL 10 POINTS**

TA1

TA2

TA3

TA4

TA5

TA6

TA7

TA8

TA9

TA10

TA11

TA12

TA13

TA15

TA16

TA17

TA18

TA19

TA20

TA21



TA22

TA23

TA24

TA25

TA26

TA27

TA28

TA29

TA30

TA31

TA32

TA33

TA34

TA35

TA36

TA37

TA38

TA39

TA40

TA41

TA42

TA43

7. The 5G Architecture Diagram as being created by 3GPP is shown below. You will notice a lot of similarity with the 4G Network Architecture that you have studied in class. The AMF function handles mobility management, i.e. registration state of the UE, idle and connected state of the UE and handovers. The SMF function handles the session management, i.e. creating, modifying and deleting bearers, providing the right quality of service for the bearers, etc. **TOTAL 5 POINTS**

You will also notice that there is a much cleaner user-plane and control-plane separation in the core-network.

**5G Architecture Diagram**



Answer the following questions:

a. Which two entities combined are equivalent to the MME? **1 POINT**

b. What are the 4G equivalent interface names to the following 5G interfaces: **3 POINTS**

N2 =

N3 =

N4 =

N9 =

Xn =

c. 5G Architecture explicitly shows the NAS interface of the UE. (The NAS interface was not explicitly shown in the 4G architecture and did not have an interface name). What is the name of this interface? **1 POINT**