CARLETON UNIVERSITY

Department of Systems and Computer Engineering
SYSC4700 Telecommunications Engineering 2010

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TERM PROJECT

Beyond-4G Cellular Technologies and Applications circa 2025

SUBMIT TWO HARD COPIES OF THE REPORT IN THE ASSIGNMENT BOX BY 4:00 PM, WEDNESDAY, APRIL 7.

1. Context

Commercial cellular wireless communications have a history of about 25 years. Not too long ago the use of bulky yet expensive phones was a privilege affordable to only a small percentage of the population; in wireless terminology, these early networks are referred to as the first generation (1G) networks and the corresponding phones as the 1G phones. Over time wireless technologies evolved and became more affordable with the advent of compact 2G phones which are mainly used for voice communications and for sending short text messages. In the recent years 3G services have become available worldwide. Although internet connectivity has been available in 2G networks, the data rates have been too slow for comfortable web browsing. 3G networks enable wireless internet usage at reasonable speeds; however, cost still remains a deterring factor.

With advent of 4G networks, wireless internet connectivity will be faster and more affordable which will result in substantial increase in wireless internet usage. Currently there are two competing 4G technologies waiting for ITU approval. The development of the 3GPP Long-Term Evolution (release 8) and WiMAX 2.0 (IEEE 802.16m) standards have recently been finalized. The first large-scale LTE commercial service may start in as early as December 2010 in USA (by Verizon). The LTE-Advanced (3GPP release 10) standardization is expected to be complete around 2012. The LTE-Advanced services may start in the subsequent years.

Since the 4G concepts have already moved to the standardization phase, we must start articulating on the following generation (beyond-4G or 5G) wireless networks. These networks will facilitate the provision of ubiquitous and affordable broadband (very high speed) wireless connectivity. The beyond-4G networks will not be limited to supporting only cellular mobile phones; rather, such advanced networks will support a plethora of

devices with different capabilities in a truly pervasive wireless environment facilitating human-to-human, human-to-machine, and machine-to-machine communications. This connectivity will enable various services such as e-health, e-government, e-learning, and e-business, which are expected to result in an improved quality of life and a better functioning society. As such, broadband wireless connectivity will become an inseparable part of our lives, and in a not too distant future, ubiquitous and affordable wireless broadband connectivity will be one of the most important measures in determining the extent of development in societies.

2. Description

This project is on

- cellular technologies,
- the enabling standards, and
- the available services

around year 2025.

In order to articulate on beyond-4G cellular networks, you must first understand 4G well. There is a lot of material in the internet on 4G. The keywords you may use to search the internet may include (but are not limited to)

- cellular, 4G
- LTE, LTE-Advanced
- WiMAX, 802.16m

Here are some website that you may find useful (among very many):

- WiMAX Forum (http://www.wimaxforum.org)
- IEEE 802.16 Working Group (http://www.ieee802.org/16)
- 3GPP (http://www.3gpp.org)
- 4G (http://www.4g.co.uk)
- Wireless Week (http://www.wirelessweek.com)

You may also find the below visionary article useful:

Halim Yanikomeroglu and Jietao Zhang, “Beyond-4G cellular networks: advanced radio access network (RAN) architectures, advanced radio resource management (RRM) techniques, and other enabling technologies”, in *Proc. World Wireless Research Forum Meeting #21*, 13–15 October 2008, Stockholm, Sweden.
http://www.sce.carleton.ca/faculty/yanikomeroglu/Pub/wwrf21-WG4-15-yz.pdf

Note that the project is not on 4G, but it is on beyond-4G scenarios circa 2025.

3. Requirements

The report will address the followings, in separate sections, in addition to addressing other issues at your discretion:

- Describe the evolution of cellular from 1G to 2G to 3G to 4G. For each generation, highlight

    - transmission rates and other important technical parameters,
    - distinguishing features which were not available previously,
    - the enabling technologies.

- In the light of the previous section, describe the articulated beyond-4G scenarios highlighting

    - transmission rates and other important technical parameters,
    - distinguishing features which were not available previously,
    - the enabling technologies.

Carefully substantiate the highlighted points. Note that this is not a science-fiction project; rather you are trying to make projections for the beyond-4G networks in the light of the specifications and the capabilities of the upcoming 4G technologies.

- Describe two novel services and applications which become available around 2025.

- Give an overview of the anticipated wireless technologies and services around 2050 (this corresponds to, more or less, your retirement time). A brief qualitative discussion will be sufficient.

4. Report

A group is normally formed by three or four students. Two-members groups are not allowed.

There are two deadlines ahead of you:

- Deadline 1: midnight, Tuesday, March 9. E-mail your group information to the course TA Akram Bin Sediq at akram@sce.carleton.ca. The only information required is the names of the students in your group. **This e-mail must be copied to all group members.**

- Deadline 2: 4:00 pm, Wednesday, April 7. Two copies of the final report due in the course assignment box.

Missing the first deadline may result in some penalty in your overall mark for this project.

Each group will write one report, and will submit it in two hard copies. All group members will get the same mark. It is up to your group to organize the work and allocate tasks to group members. Your group output will be a report which addresses the above issues. Include references (papers, books, internet, etc.), with enough information that they can be verified by readers.

Do not copy from other sources (especially from internet) or use others' ideas, unless they are acknowledged and properly referenced. Violating this rule amounts to plagiarism, which is a serious instructional offence (see "instructional offences" in the undergraduate calendar, and www.plagiarism.org for definitions and examples of plagiarism.). Reference to "other sources" also includes any overlap of your own work in other courses, such as fourth year projects, for example.

The report itself (without figures) should be no more than 10-15 pages of double-spaced text; you may put as many figures as you deem appropriate. Your marks will be based on the correct knowledge and persuasiveness revealed in your report, its organization, coherence and clarity, and use of references.