PRINCE OF SONGKLA UNIVERSITY
FACULTY OF ENGINEERING

Final Examination: Semester 2 **Academic Year**: 2009

Date: 25 February 2010 **Time**: 09.00-11.00 (2 hours)

Subject Number: 241-500 **Room**: Robot Head

Subject Title: Research and Development Methodologies

Exam Duration: 2 hours

This paper has 2 parts and 10 pages.

It aims to collect 30 marks (30%).

Authorised Materials:

- Writing instruments (e.g. pens, pencils).
- Textbooks, a notebook, handouts, and dictionaries are permitted.

Instructions to Students:

- Scan all the questions before answering so that you can manage your time better.
- Write your answers in **Thai**.
- Write your name and ID on every page.
- Any unreadable parts will be considered wrong.

When drawing diagrams or coding, use good layout, and short comments; marks will not be deducted for minor syntax errors.

Cheating in this examination

Lowest punishment: Failed in this subject and courses dropped for next semester.

Highest punishment: Expelled.

Name____________________________________ID____________________

Section 1

Lecturer: Asst. Prof. Dr. Pichaya Tandayya

Time to be taken: about 1 hour

This part has 6 pages, 4 questions 20 marks (20%).

NO	Time (Min)	Marks	Collected	Total	Collected
1	10	4		20	
2	10	3			
3	10	4			
4	20	9			

Name____ ID________________________

Question 1 **(4 Marks)**

a) Give the cause that two calculators give different results when repeating the calculation process. (1 mark)

____

____

____

____

b) Give reason why it is not possible to forecast the weather in a long run. (1 mark)

____

____

____

____

c) Why could a small change at the input lead to an unexpectedly great effect? (1 mark)

____

____

____

____

d) Give reasons why some statistic results are not reliable. (1 mark)

____

____

____

____

Question 2 **(3 marks)**

a) Why is the reliability of a parallel system better than the reliability of a series system? (1 marks)

____

____

____

____

b) How can *System Hardware* be made reliable? (1 mark)

____

____

____

c) How can *Software* be made reliable? (1 mark)

Question 3 **(4 Marks)**

a) Explain the meaning of the degree of freedom and also how to calculate the degree of freedom. (1 mark)

b) Give a clear example why sometimes the significant level of 99% is still not good enough. (1 mark)

c) Explain why a calculated T-test value for proving a hypothesis using one-tailed test and two-tailed test could give different results, say deny H_0 at one test and accept H_0 at another. Use graphs to help with the explanation.

(2 marks)

Question 4 **(9 Marks)**

a) Give reasons for statistic study. (1 mark)

b) Compare *Probability* and *Non-Probability Sampling* and give sampling examples. (2 marks)

c) What is *Time Series* for and explain its factors? (2 marks)

d) Compare *Descriptive* and *Inferential Statistics* and give method examples. (2 marks)

Name________________________________ID____________________

e) Compare *Pearson Product Moment Correlation (R_{xy})* and Regression Analysis (2 mark)

____

____

____

____

____

____

____

____

Written by Pichaya Tandayya

Name____ID________________________

Section 2

Lecturer: Assoc. Prof. Dr. Sinchai Kamolphiwong

Time to be taken: about 1 hour

This part has 6 pages, 2 questions 14 marks (14%).

NO	Time (Min)	Marks	Collected	Total	Collected
1	20			14	
2	40				

Name____ID______________________

1. If you are writing your thesis report, please make the out-line in the order by putting a sequence number on the topics given below:

    ___ Copyright and Declaration
    ___ Abstract
    ___ Conclusions
    ___ Table of contents
    ___ Title page
    ___ Acknowledgments
    ___ List of Figures
    ___ Introduction
    ___ Literature review
    ___ Appendices
    ___ Materials and Methods
    ___ Architecture Design and Development
    ___ References
    ___ List of Tables
    ___ Results and discussion

2. Read all the given technical paper below. Then try to put appropriate topics from [A] to [P]

Name____ID______________________

[A]

[B]

[C]

Medium access control (MAC) protocol defines rules for orderly access to the shared medium and plays a crucial role in the efficient and fair sharing of scarce wireless bandwidth. The nature of the Radio Access Network channel brings new issues like location-dependent carrier sensing, time varying channel burst errors low power requirements add to the challenge. The MAC protocols for 3rd generation mobile phone systems have been heavily investigated. This paper presents a design framework of MAC protocol for third generation mobile phone systems. In this framework, MAC architecture and mode of operations and well as MAC entities are investigated. A design protocol state transition is described to allow us to develop protocol software in the future.

[D]: Medium Access Control Protocol, MAC, Wireless Protocol, 3G, Mobile phone systems

[E]

Technology advantage of the new mobile telecommunication systems is being developed. The third generation (3G) of mobile phone systems referred to in this project as Universal Mobile Telecommunication System (UMTS). Wideband Code Division Multiple Access (WCDMA) is the main of third generation air interface in the world and will be deployed in Europe and Asia, including Japan and Korea, in the same frequency band, around 2 GHz [1].

Third generation systems are designed for multimedia communications; with them person-to-person communication can be enhanced with high quality images and video, and access to information and services on public and private networks will be enhanced by the higher data rates and new flexible communication capabilities of the generation systems. This, together with the continuing evolution of the second generation systems, will create new business opportunities not only for manufacturers and operators, but also for the providers of contents and applications using this network [2].

[F]

The UMTS system consists of a number of logical network elements that each has a defined functionality. The networks elements are grouped into the Radio Access Network (RAN, UMTS Terrestrial RAN = UTRAN) that handles all radio-related functionalities, and the Core Network, which is responsible for switching and routing calls and data connections to external networks [4]. To complete the system, the User Equipment (UE) that interfaces with the user and the radio interface is defined. The high-level system architecture is shown in Figure 1 [5].

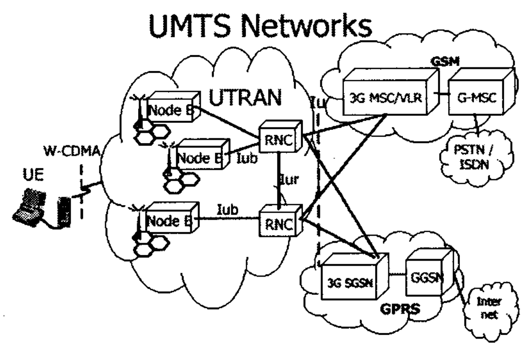

Figure 1 The UMTS networks architecture

[G]

In general systems of mobile phone networks, they also separate the protocol into layers. That overall radio interface protocol architecture is shown in Figure 2. This figure contains only the protocols that are visible in UMTS Terrestrial Radio Access Network (UTRAN) [6].

The physical layer offers services to the MAC layer via transport channels that are characterized by how and with what characteristics data are transferred [11]. The MAC layer, in turn, offers services to the RLC layer by means of logical channels.

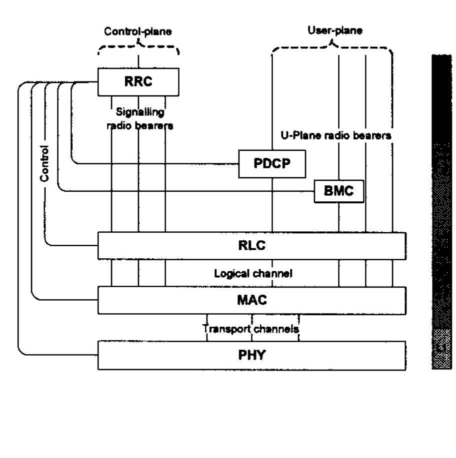

Figure 2 UTRAN radio interface protocol architecture.

[H]

From the technical specification of 3GPP, we can summarize the architectures of MAC layer in each type of channel manipulating entities. In the latest version (release 5)[11], there is a new entity of High speed downlink shared channel manipulating entity (MAC-hs). It is added for its responsibility to manage the physical resources allocated to HSDPA.

[I]

The MAC layer consists of four logical entities.

- **Broadcast channel manipulating entity (MAC-b)** - handles the broadcast channel, as shown in figure 3.

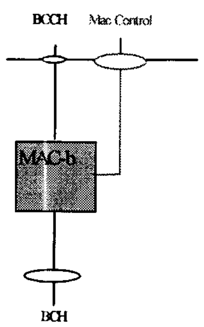

Figure 3 UE side and UTRAN side architecture

- **Common channels and shared channels manipulating entity (MAC-c/sh)** - handles the common channels and shared channels-paging channel (PCH), forward link access channel (FACH), random access channel (RACH), uplink Common Packet Channel (CPCH) and Downlink Shared Channel (DSCH).
- **Dedicated channels manipulating entity (MAC-d)** - handling dedicated channels (DCH) allocated to a UE in connected mode.
- **High speed downlink shared channel manipulating entity (MAC-hs)** - handles the HSDPA specific functions. The functional entities handle all the tasks that are required for Hybrid Automatic Repeat Request (HARQ). It is responsible for generating ACKs or NACKs.

Figure 4 illustrates the connectivity of MAC entities for UTRAN side.

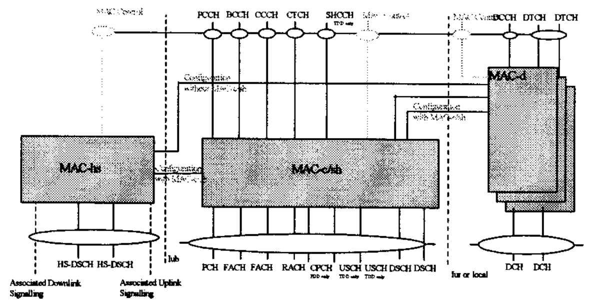

Figure 4 UTRAN side MAC architecture

[J]

The functions of the MAC layer [4] include:

- Mapping between logical channels and transport channels,
- Selection of appropriate Transport Format (from the Transport Format Combination Set) for each Transport Channel, depending on the instantaneous source rate,
- Priority handling between data flows of one UE and between UEs by means of dynamic scheduling.
- Identification of UEs on common transport channels,
- Multiplexing/demultiplexing of higher layer Protocol Data Units (PDUs) into/from transport blocks delivered to/from the physical layer on common transport channels and dedicated transport channels,
- Traffic volume monitoring [10],
- Dynamic Transport Channel switching.
- Data Ciphering,
- Access Service Class (ASC) selection for Random Access Channel (RACH) transmission.

[K]

Implement details and sub-functions of the MAC protocol's entities (eg. MAC-c/sh) must be analyzed and concluded in each entity. Processes that should occur in functional statements before specify it in the protocol software structure need to be summarized in procedure work in object oriented method. For example, we show the step of Transport Format Combination selection in UE.

[L]

From MAC functions, we analyze them by using events detection method to conclude the sub-functions in MAC protocol's entity that are assigned following the MAC protocol's channel structure. Then experiment them by initiating some events of data transmission flow through their paths and channels.

MAC-c/sh has a responsibility to manipulate the control and shared channels. The main functions are used to multiplexing the TCTF field of MAC's PDU, and TFC field selection is listed below.

- **TCTF MUX** - insertion for uplink channels and detection and deletion for downlink channels) of the TCTF field in the MAC header, and map between logical and transport channels respectively,
- **Add/read UE Id** - the UE Id is added for CPCH and RACH transmissions,
- **UL: TF selection** - selected based on TF availability determined from status information on the CSICH,
- **ASC selection** - indicates the ASC associated and may indicate the ASC associated with the PDU to the Physical Layer,
- **Scheduling /priority handling** - transmit the information received from MAC-d on RACH and CPCH based on logical channel priorities,
- **TFC selection** - Transport format and transport format combination selection according to the transport format combination set (or transport format combination subset) configured by RRC is performed.

The functional diagram is shown in Figure 5 [11]

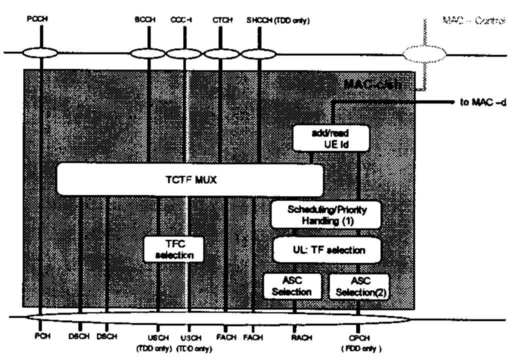

Figure 5 UE MAC-c/sh functional architecture

[M]

In this process of work, we could design the finite state machine of protocol process that matching with MAC's functional entities from the previous step. The state transition designing need to specify the protocol state variables and possible events scheduling that will occur in process.

For example process, Transport Format Combination (TFCS) is one of data examination methods in MAC protocol that could explain with the state transition.

Transport format combination selection in UE

The UE shall continuously monitor the state for each TFC based on its required transmit power versus the maximum UE transmit power. A given TFC can be in any of the following states:

- Supported state,
- Excess-power state,
- Blocked state.

The following diagram, as shown in Figure 6, illustrates the state transitions for the state of the given TFC:

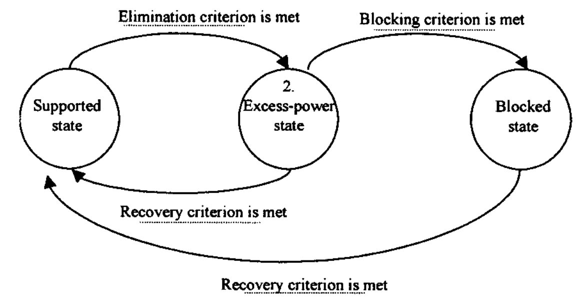

Figure 6 State transitions for the state of a given TFC.

The above rules for TFC selection in the UE shall apply to DCH, and the same rules shall apply for TF selection on RACH and CPCH.

[N]

When specify the state transition of MAC's functional entity, we could design the Protocol Data Units of MAC protocol and MAC header's field to carry interaction data for support each protocol's process

A MAC PDU is a bit string, with a length not necessarily a multiple of 8 bits. Bit strings are represented by tables in which the first bit is the leftmost one on the first line of the table, the last bit is the rightmost on the last line of the table, and more generally the bit string is to be read from left to right and then in the reading order of the lines[10].

Depending on the provided service, MAC SDUs are bit strings with any non-null length, or bit strings with an integer number of octets in length. An SDU is included into a MAC PDU from first bit onward.

In the UE for the uplink, all MAC PDUs delivered to the physical layer within one TTI are defined as Transport Block Set (TBS). It consists of one or several Transport Blocks, each containing one MAC PDU. The Transport Blocks shall be transmitted in the order as delivered from RLC.

MAC PDU (non-HS-DSCH)

A MAC PDU consists of an optional MAC header and a MAC Service Data Unit (MAC SDU), see Figure

described to allow us to develop protocol software in the future.

[P]

[1] T.Farley and Mark VanderHoek, "Mobile Phones –The Basics", UK Internet Solution Ltd., 2001, http://www.galaxyphones.co.uk/communications.asp

7. Both the MAC header and the MAC SDU are of variable size.

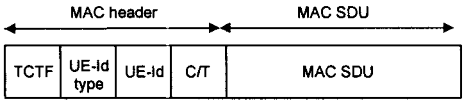

Figure 7 MAC PDU

MAC-d PDU (HS-DSCH)

For HS-DSCH the MAC-d PDU format equals the MAC PDU format for the non HS-DSCH case.

MAC PDU (HS-DSCH)

In case of HS-DSCH a MAC PDU consists of one MAC-hs header and one or more MAC-hs SDUs (see Figure 8) where each MAC-hs SDU equals a MAC-d PDU.

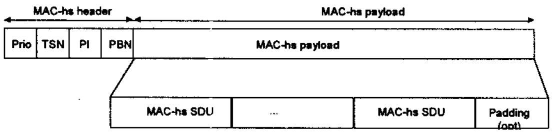

Figure 8 MAC-hs PDU.

[O]

MAC protocols are the important key to moderates access to the shared medium by defining rules that allow these devices to communicate with each other in an orderly and efficient manner. MAC protocols therefore play a crucial role in enabling this paradigm by ensuring efficient and fair sharing of the scare wireless bandwidth. This demand of the network is known as the Quality of Service (QoS) guarantee. These requirements have led to novel and complex MAC protocols that can support multimedia traffic. Because of very expensive costs of the 3G protocol stack that use for upgrading our mobile phone systems, it necessary to start with the conceptual design framework of MAC protocol to decrease this expenses. This paper presents a design framework of MAC protocol for third generation mobile phone systems. In this framework, MAC architecture and mode of operations and well as MAC entities are investigated. A design protocol state transition is described to allow us to develop protocol software in the future.

[P]

[1] T.Farley and Mark VanderHoek, "Mobile Phones –The Basics", UK Internet Solution Ltd., 2001, http://www.galaxyphones.co.uk/communications.asp

[2] GSM Association. , "An Introduction to the General Packet Radio Service", GSM Association, Last Updated Thursday, November2001, http://www.gsmworld.com/technology/yes2gprs.html

[3] African Cellular Inc., "CDMA Development Group White Paper: 3G Systems", December 2001, http://www.cellular.co.za/3GPP2 Mac-Layer CDMA 2000/seminar1/CDMA & 3G.htm

[4] H. Holma and A. Toskala, "WCDMA for UMTS Radio Access For Third Generation Mobile Communication", John Wiley & Sons, Ltd., England, p 1-67, pp 117-147 ,April, 2001

[5] Rodger E. Ziemer, "3G CDMA – WCDMA and cdma2000", IEEE Communications Society Distinguished Lecturer Program, 2001

[6] Ericsson Radio Systems AB, "WCDMA White Paper", Ericsson Corp., 2002, http://www.ericcsson.com

[7] A. Chandra V. Gummalla and John O. Limb, "Wireless Medium Access Control Protocols", IEEE Communications Surveys GEORGIA INSTITUTE OF TECHNOLOGY, 2000, http://www.comsoc.org/pubs/surveys

[8] "Third Generation (3G) Wireless White Paper", Trillium Digital Systems Inc., March 2000, http://www.trillium.com

[9] 3GPP2, "CDMA2000 - MAC c.S-0003-A-1", July, 2001, http://www.3gpp2.org

[10] 3GPP TS 25.301.500: "Radio Interface Protocol Architecture", March, 2002, http://www.3gpp.org

[11] 3GPP TS 25.321.500: "MAC Protocol Specification", March, 2002, http://www.3gpp.org