

**THE HONG KONG POLYTECHNIC UNIVERSITY**  
**DEPARTMENT OF COMPUTING**  
**EXAMINATION**

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Course : MSc Scheme - 61030

Subject : COMP5527 Mobile Computing and Data Management

Group : 201, 202, 204, 2888

Session : 2010 / 2011 Semester II

Date : 20 May 2011

Time : 18:30-20:30

Time Allowed: 2 Hours

Subject Lecturer: Cao Jiannong

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This question paper has 4 pages.

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**Instructions to Candidates:**

Answer ALL the questions.

**Do not turn this page until you are told to do so!**

**Department of Computing**  
**Hong Kong Polytechnic University**  
**Comp5527 Mobile Computing and Data Management**

**1. (20 marks)** Answer the following multiple choice questions (you can make more than one choice)

i) Which of the following is/are true?

- a) Android is a software platform and operating system for mobile devices based on Linux.
- b) Signal hops from frequency to frequency at fixed intervals in FHSS modulation scheme.
- c) In a Bluetooth piconet, if a stand-by device wants to communicate and there are already 7 active slaves, one slave has to switch to stand-by mode.
- d) 3G have three levels of mobility support with different data rates ranging from 128kps to 2Mbps.
- e) Through an ad hoc mode of WLAN, the users can share documents and devices directly. This is basically a client/server network.

(5 marks)

ii) Which of the following is/are true?

- a) WAP is a standard for the delivery and presentation of Internet content to mobile devices.
- b) In push-based wireless data dissemination, the number of users that can be supported depends on the uplink bandwidth.
- c) One challenging issue in data broadcast is to maximize the capacity of servers.
- d) Disk-based broadcast program is usually expensive to generate compared with item-based broadcast program since it needs to organize the data items into disks.
- e) Point to point and publish-subscribe are two messaging models of Java Message Service.

(5 marks)

iii) Which of the following is/are true?

- a) In data broadcast, the overall average waiting time is equal to the overall average access time plus one.
- b) (1, m) indexing broadcasts the index every fraction  $1/m$  of the broadcast data items but suffers from large overhead on the length of index.
- c) Delta consistency means the deviation in values or time is bounded by a threshold.
- d) One method to implement client-initiated cache consistency is the time-to-live mechanism. Each cached record is assigned a TTL (time to live) and the client only polls for updated data item after the TTL expires.

- e) In path cache schema, a node only records the data path when it is closer to the source node than the caching node.

(5 marks)

iv) Which of the following is/are true?

- a) Bayou is a transparent replication system.
- b) In prefetching, the cached items may be useful in future, but not needed currently. It utilizes the otherwise idle processing power or bandwidth.
- c) A location-dependent query is such a query whose result depends on the location where the query is issued.
- d) A spatial database is a database storing the locations of moving objects.
- e) B-tree and B<sup>+</sup>-tree are the most often used indexing structures for spatial databases.

(5 marks)

## 2. (20 marks)

- a) What are the three distinct characteristics of mobile wireless computing? Explain why. (7 marks)
- b) Handoff can be either hard or soft. Explain why TDMA can support only hard handoff but CDMA allows for soft handoff. (7 marks)
- c) Describe the characteristics of the two popular mobile computing models: mobile client-server model and mobile peer-to-peer model. (6 marks)

## 3. (20 marks)

Data broadcast is an important technology in mobile data dissemination.

Given the following data set

Group	A	B		C			
Data	4	10	16	1	12	7	13
	5	14	17	2	19	8	11
	6	15	18	3	20	9	21
Access probability	4/21	1/21	1/21	1/84	1/84	1/84	1/84

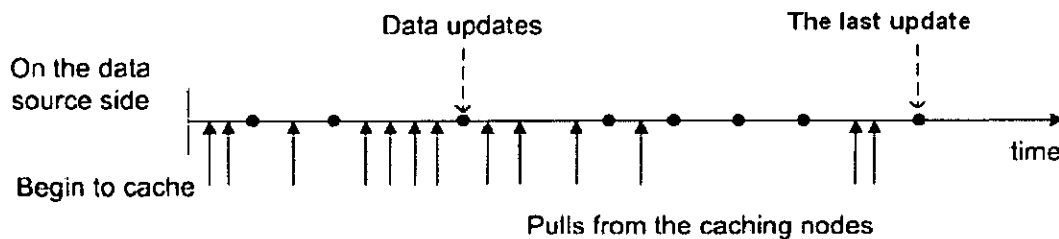
- a) Design a data broadcast schedule using the Circular Multi-disk Model. (8 marks)
- b) Design a data broadcast schedule using the Skewed disk Model. (4 marks)

- c) PIX cost function is a metric to determine data replacement in broadcast disk caching. For the following data broadcast schedule, assuming that the cache is of size 4, and a data item access sequence is 1, 3, 5, 6, 18, 15, 5, 4, describe the change of cache status. (8 marks)

4	10	1	4	16	12	4	10	7	4	16	13
5	14	2	5	17	19	5	14	8	5	17	11
6	15	3	6	18	20	6	15	9	6	18	21

#### 4. (20 marks)

- a) In server-initiated cache invalidation, there are four mechanisms: stateless asynchronous, stateless synchronous, stateful asynchronous and stateful synchronous. Describe the advantages and disadvantages of these four mechanisms. (10 marks)
- b) In Predictive Caching Consistency protocol (PCC), the source node does not push the update to the caching nodes every time a data item is updated. Instead, it pushes only when at least  $Th$  caching nodes will pull this data item. The source node predicts the expected number of pulls between the latest and the forthcoming update based on recorded history. Given the following history, for  $Th=1.7$  and 2 respectively, explain whether push is needed at the last update.

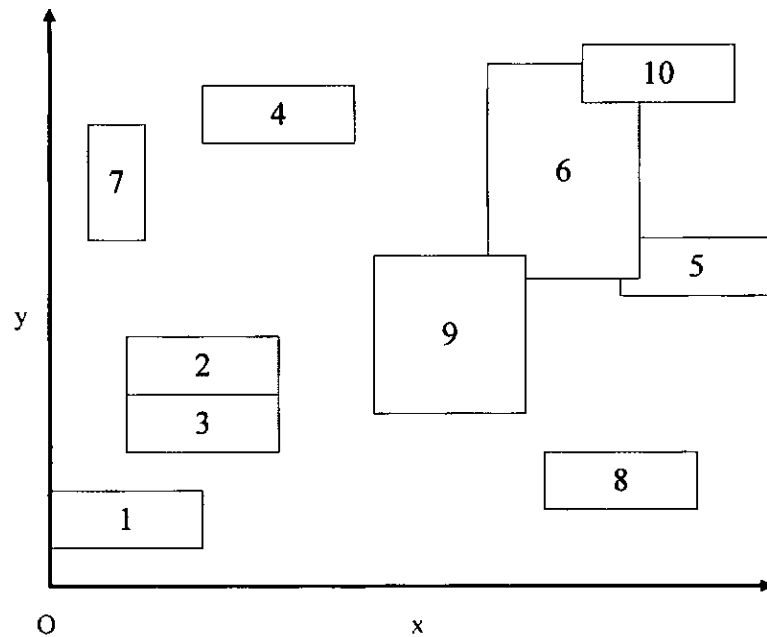


We use  $p(v|h)$  to denote the probability that given the history  $h$ , a number of  $v$  caching nodes will pull the data. You may use the following information: (10 marks)

$$\begin{aligned}
 &p(1|214312)=0.3, \quad p(2|214312)=0.3, \quad p(3|214312)=0.3, \quad p(4|214312)=0.1 \\
 &p(0|21431002)=0.1, \quad p(1|21431002)=0.4, \quad p(2|21431002)=0.1, \quad p(3|21431002)=0.1 \\
 &p(4|21431002)=0.1 \\
 &p(0|011000100130)=0.2, \quad p(1|011000100130)=0.3, \quad p(3|011000100130)=0.2 \\
 &p(1|011000100130)=0.4, \quad p(3|011000100130)=0.6
 \end{aligned}$$

#### 5. (20 marks)

In a location-dependent application, spatial database is used to store the location information of objects. R-Tree and R+-Tree are two kinds of index structures to organize the location information for efficient query and update. A rectangle area is described using the coordinators of the lower-left point and the upper-right point. The following diagram shows the 2D-location information of objects to be used for answering the questions of this problem.



Object ID	The coordinators of the lower-left point	The coordinators of the upper-right point
1	(0, 2)	(8, 5)
2	(4, 10)	(12, 13)
3	(4, 7)	(12, 10)
4	(8, 23)	(16, 26)
5	(30, 15)	(38, 18)
6	(23, 16)	(31, 27)
7	(2, 22)	(5, 28)
8	(26, 4)	(34, 7)
9	(17, 9)	(25, 17)
10	(28, 25)	(36, 28)

- Build and draw the R-Tree and R+-Tree index of the location information showing in the above diagram. Notice the R-Tree and R+-Tree in this question should meet the following requirements: 1) all nodes should have at most four sub-trees; 2) all non-leaf nodes should have at least two sub-trees; 3) all leaf nodes are in the same level. (8 marks)
- With the R-tree built in a), describe the steps to search the points in the rectangle area with the lower-left point (5, 8) and the upper-right point (11, 11). (6 marks)
- With the R+-tree built in a), describe the steps to search the points in the rectangle area with the lower-left point (28, 25) and the upper-right point (30, 27). (6 marks)

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