IIT Kharagpur
SMARTPHONE COMPUTING
and
APPLICATION (CS60009)
End-semester Examination (Fall 2016-2017)

Duration: 3 Hrs **FM: TBD**

1. Answer all questions **[5x2=10]**

   (a) What is Levy Walk? Does human walk follow Random Way Point (RWP) or Brownian Motion (BM)?

   (b) What is Bursty Spot Model (BSM)?

   (c) Draw the architecture of MicroCast and describe working of each component in one sentence.

   (d) Define Reception Rate and give the relation between cellular network rate and local network rate (from Microcast).

   (e) In the context of *Tesselation*, arrange the following steps in their correct order: (i) Session block generation, (ii) Traffic attribution, (iii) Culling of traffic markers, (iv) OSN ID extraction.

2. (a) What are the four fundamental statistical features of human mobility? Are they independent or dependent on each other? **[4x0.5]+1**

   (b) Consider the distance matrix given below. Each entry (i,j) in the matrix represent the distance between i and j. The graph is undirected. Considering the *least-action-trip-planning* LATP algorithm, determine the order in which the vertices are visited and also the total distance covered when the start vertex 1) s=p2 and 2) s=p3. Assume the distance function to be d^{-a} where the value of a is infinite.
   Explain your answer briefly. **[2+2]**

	p1	p2	p3	p4	p5	p6	p7	p8
p1	-	6	5	8	∞	∞	∞	∞
p2	6	-	4	7	5	∞	8	∞
p3	5	4	-	∞	7	6	8	∞
p4	8	7	∞	-	∞	5	∞	8
p5	∞	5	7	∞	-	5	∞	7
p6	∞	∞	6	5	5	-	∞	6
p7	∞	8	8	∞	∞	∞	-	9
p8	∞	∞	∞	8	7	6	9	-

3. (a) Fill in the blanks : **[1.5]**

   i. COMBINE is based on _____ level stripping. (TCP/HTTP / FTP)

   ii. WLAN offers much _____ speeds than WWAN. (higher/lower/same)

   iii. A user who is very keen not to deplete their battery would set Ks to a _____ value. (smaller/larger/zero)

   (b) What are the requirements that a practical accounting scheme should ideally have ? Explain. **[3]**

(c) i. A node wants to download 4000 kB of data and can afford a cost of 1500 units. The system allows collaborative download and there are 5 other nodes in the system who have sent their bid and their WWAN speeds. They are specified in the table given below. The initiator node will recruit 3 collaborators. If the initiator uses threshold-based group selection criteria then which of these nodes will be selected as collaborators by the initiator. The file is divided into 8 chunks

	Bid	WWAN Speed
Node A	0.2 units/kB	20 kB/sec
Node B	0.8 units/kB	10 kB/sec
Node C	0.3 units/kB	15 kB/sec
Node D	0.2 units/kB	17 kB/sec
Node E	0.35 units/kB	8 kB/sec

of equal size. Once the 3 collaborators are selected they will download parts of the file for the initiator. If the work-queue algorithm is followed then how much cost will be incurred by the initiator for downloading the whole file. **[1.5+4]**

ii. What are the two basic group selection criteria ? Which one of these group selection criteria can be posed as an optimization problem and how ? Briefly Explain what the terms stand for ? Also, for the conservation group selection criteria explain how initiator calculates the total cost ? **[1+3+1]**

4. (a) Consider a network of 4 phones. Each phone has a download speed and download cost as shown below: Consider that a file of 240 kb is to be viewed in this network

Phone 1	5 kbps	Rs 1/kb
Phone 2	15 kbps	Rs 2/kb
Phone 3	30 kbps	Rs 5/kb
Phone 4	30 kbps	Rs 5/kb

and segment size is 30 kb. Initially, there is no backlog in any device and at any point of time, there can be maximum backlog of 2 (value of K). Once a download in a device is started, it is not cancelled by the system and rescheduling of download task not started is done, only in case any of the device is free.

i. Use a timeline of download task per second for each phone and explain your answer. **[3]**

ii. Give out the time and cost incurred in downloading the file in a MicroCast environment. **[2]**

(b) Explain the steps of encoding and decoding used in MicroCast. **[1+1]**

5. This question is based on the TailEnder system. The question has 2 parts:

(a) Consider the TailEnder scheduling algorithm. What are the conditions under which a request is enqueued instead of being transmitted immediately? Please explain the meaning of any notation that you use in your answer. **[2]**

(b) A user queries for "Android app development"on Bing. The first 5 search results appear in the following order: (1) developer.android.com, (2) codeproject.com, (3) tutorialspoint.com, (4) wikipedia.org, (5) vogella.com. Assume that the user tosses a fair coin 5 times consecutively, and visits the first k pages (in order of their ranks)

where k is the number of heads. Assume that tail energy is 40 units, and the energy required to fetch k pages is given by $(k/2)$ units. If the total energy required to receive a document is 60 units (including ramp-up energy, tail energy, and transfer energy required to receive a requested document), calculate the expected energy savings in the following cases: **[2x3=6]**

i. The first 2 pages (in order of rank) are prefetched.

ii. The first 4 pages (in order of rank) are prefetched.

iii. All 5 pages are prefetched, but the tail energy is now 112 units and the total energy requirement increases to 120 units.

6. Consider the Bartendr system for energy-aware cellular data scheduling. The dynamic programming algorithm for computation of the minimum energy schedule is as follows:

```
Initialization:
for t = 1 to M do
   E_{0,t} = 0
end for

Computing optimal schedules:
for k = 1 to N do
   for t = k to M do
      E_{k,t} = Compute_E_{k,t}()
      Last_{k,t} = l value for which the previous quantity was minimized
   end for
end for
```

In the above algorithm, $E_{k,t}$ is the minimum energy required to transmit k frames in t time slots, and $Last_{k,t}$ stores the slot number where the k^{th} frame is scheduled.
Explain how the function **Compute**_$E_{k,t}()$ is implemented. Explain the meaning of any new notation that you use. Also, comment on the complexity of the algorithm. **[3+2]**

7. Answer the following questions in the context of *Tesselation*:

(a) The following is a table with details of 3 session blocks: **[2.5+2.5]**

Session Block	Traffic-marker Pairs	Duration
S1	(u_1,m_1), (u_2,m_2)	5 units
S2	(u_1,m_3), (u_2,m_1)	10 units
S3	(u_3,m_1)	15 units

i. Calculate the *uniqueness* of each of the traffic-marker pairs seen in the table.

ii. Calculate their *persistency* as well, if possible. If not possible, justify.

(b) State the criterion for selecting the *activity fingerprint* F_i for user u_i. **[1]**

(c) The activity fingerprint of a user u_1 is given by $F_{u_1} = \{a_1, a_2, a_3\}$. The list of services used by 4 other users u_2, u_3, u_4, and u_5, are given by:
$S_{u_2} = \{a_1, a_2, a_4, a_5\}$, $S_{u_3} = \{a_1, a_2, a_3, a_5\}$, $S_{u_4} = \{a_1, a_3\}$, $S_{u_5} = \{a_1, a_2, a_3, a_4\}$
Compute the uniqueness of fingerprint F. **[3]**

8. Answer the following questions in the context of *OverLay* – a system for practical augmented reality.

(a) What do you mean by two objects A and B being *spatially invariant*? Why is conditional spatial invariance called *conditional*? **[2+1]**

(b) What clustering algorithm is used for preparing the secondary matching database during learning from retrieval? What is the advantage and disadvantage of using this secondary database? **[1+2]**

(c) OverLay uses linear programs to minimize errors in which two kinds of positions? **[2]**

(d) *"We consider the rotational distance from any tag i as $|P_i - P_U|$ mod $2\pi + E^R_*(i)/2$. We include only half of the error term to ..."*. Why is only half of the error term included? **[1]**

9. Answer the following questions in the context of *Glimpse* – a system for continuous, real-Time object recognition on mobile devices.

(a) Mention the factors which dictate the selection of parameter p in the following equation: $p = l/n$, where n is the total number of frames in a duration, and l out of them are to be selected from the active cache. **[2]**

(b) Suppose that the absolute difference for pixel values (x, y) between frames i and j in grayscale is given by $a_{i,j}(x, y)$. How do you compute the frame difference metric $d_{i,j}$? What is the complexity of this computation? **[2+1]**

(c) The frame selection problem can be mapped to an existing problem – name this problem. Can you comment on the complexity of the dynamic program that solves this problem? **[1+1]**

(d) Suppose that $H[n, l]$ is the optimum value of a partition arrangement with n frame differences and l partitions. Please write the recursive formulation for computing $H[n, l]$. **[2]**

End