Resource allocation scheme for QoS provisioning

Definitions and Assumptions

- The cells are uniformly distributed in a geographical area and consist of a base station with omni-directional antenna.
- Efficient techniques to combat multipath and shadow fading, and delay variations are employed to provide a reliable radio link between the mobile users and the base station.
- A wireless MAC layer responsible for providing reliable data and control channels used to transmit and receive all messages between the base station and mobile users.
- Every cell can use the full available bandwidth spectrum; B Mbps.

Definitions and Assumptions

- Every cell can use the full available bandwidth spectrum.
- Cellular network supports both real-time traffic ;**Class I calls** and non-real-time traffic ; **ClassII calls**.
- Each class of traffic is further categorized into three service types, referred to as call type depending on their average call duration times and bandwidth requirement.
- The total bandwidth available to a cell is.

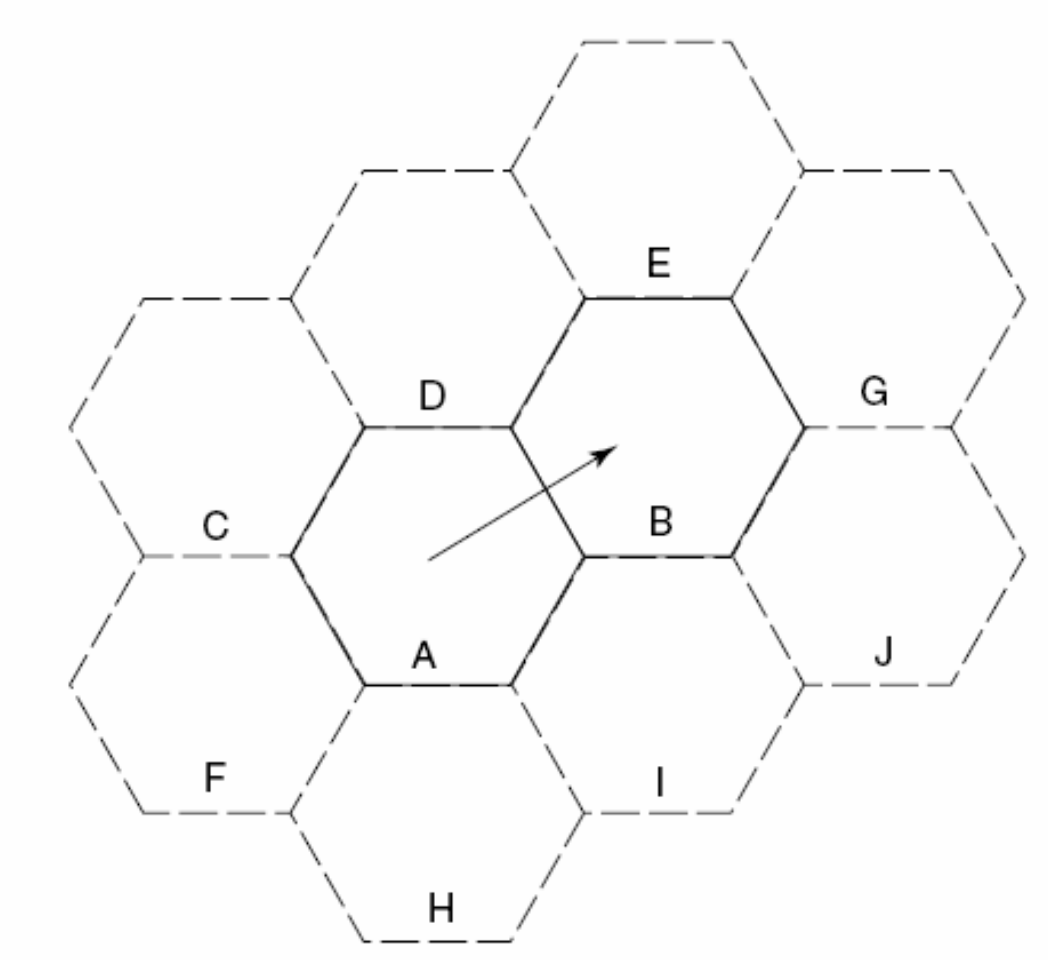
Definitions and Assumptions

- A fraction R_1 of the total bandwidth B is reserved for handoff calls.
- The bandwidth $(1-R_1)B$ is shared by the Class I calls and Class II calls.
- R_h is the fraction of this bandwidth can be used for reservation purpose.
- The mobile user requesting a connection to the network provides information regarding
  - the class and type of traffic,
  - required bandwidth,
  - minimum bandwidth and
  - speed of movement.
- The bandwidth reservation is performed using the cell cluster concept.

Simulation Events

- There are four driving events in simulation.
  - arrival of a new call connection into the system
  - departure of a call connection from the system
  - hand-off departure from a cell site
  - hand-off arrival in a cell site

Bandwidth reservation in cell cluster



Call arrival process

- It is assumed to be Poisson with rate . The call arrival process
  - Class I and Class II calls is considered to be Poisson with rates λ_I and λ_{II}, respectively.

Call duration

- Exponentially distributed with mean $1/\mu$.
- The call duration time for each call depends on the class and type of call.

Call class & type	Description	Bandwidth requirement	Connection duration
Class I Type 1	Voice	30 Kbps (CBR)	1–10 min
Class I Type 2	Videophone	256-Kbps (CBR)	1–30 min
Class I Type 3	Video on Demand	1–5 Mbps	5 min–5 h
Class II Type 4	E-mail & Fax	10–20 Kbps	10–30 min
Class II Type 5	Data on Demand	64–512 Kbps	5 min–5 h
Class II Type 6	File transfer	1–6 Mbps	1–30 min

Table 1. Multimedia traffic characteristics

Mobile characteristics

- Three different mobile
- characteristics for each call type depending on the mobile users' mobility pattern.
  - stationary,
  - slow-moving or
  - fast-moving.
- The mobility pattern affects the handoff rate.

Calculating dwell time

- Every call has an associated dwell time which is the time a call spends in a cell before handing off to another cell.
- The dwell time of a call depends on its handoff rate.
- Every call has an initial handoff rate *h* which is based on a user's mobility pattern and call class.

Calculating dwell time

- The handoff rate is assumed to be changing with the number of handoffs.
- The effective handoff rate every time a call requests a handoff is given by $h/2^n$, where n is the number of handoffs already experienced by a call.
- Handoffs are assumed to be mobile-assisted.
- A mobile user spends a certain amount of time equal to dwell time in a cell and then hands off to another cell in the cell cluster.
- After a call hands off, dwell time is recalculated based on the new handoff rate.

Calculating dwell time

- Call duration $X = \Sigma d_i$; d_i is the dwell time in cell i
- h_i is the handoff rate in cell i

$$d_1 = (1 - h_1)X$$

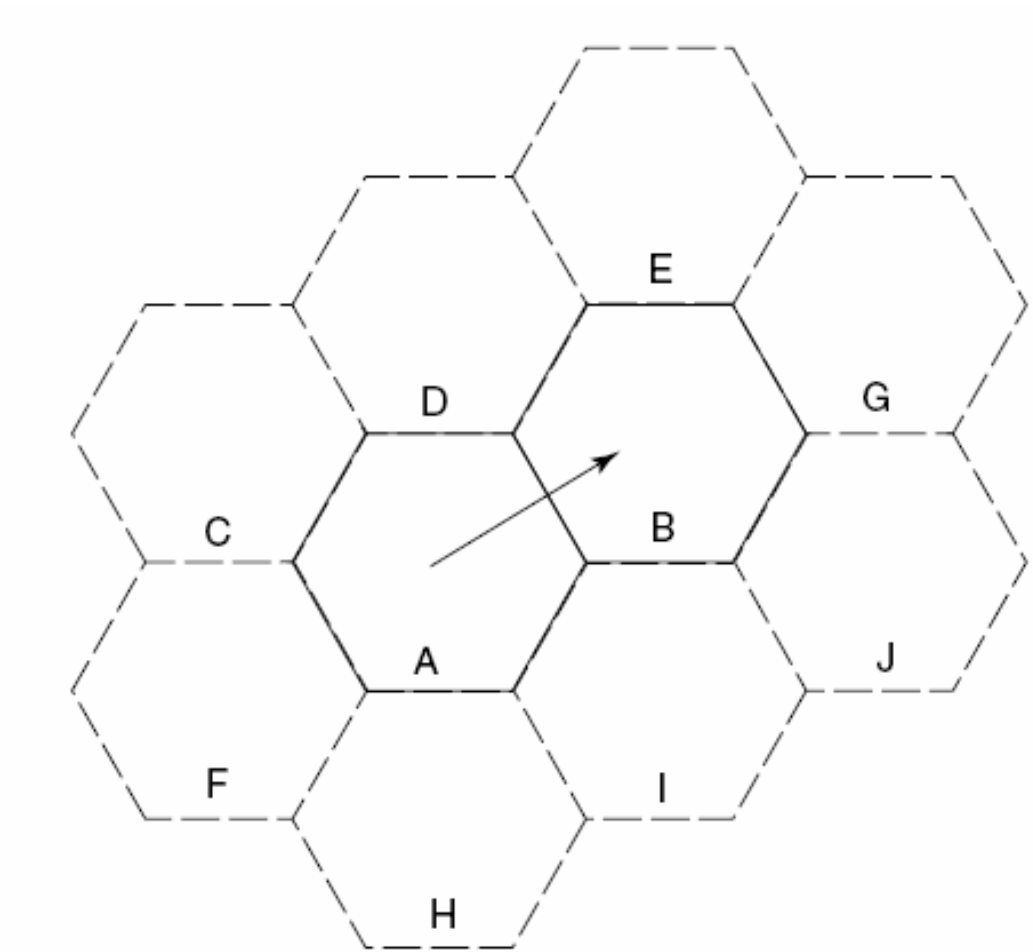
$$d_2 = (1-h_2)(X-d_1) = (1 - h_2)Xh_1$$

$$d_3 = (1-h_3)(X-d_1-d_2) = (1 - h_3)Xh_1h_2$$

Resource reservation

- When a call arrives in cell A, bandwidth is in cell cluster of A, i.e., cells B, C, D, F, H, and I.
- When the call hands off to cell B, we
  - release the bandwidth reserved in cell B, C, D, F, H and I, and
  - then reserve bandwidth in cell cluster of B i.e., cells A, D, E, G, I, and J.

Bandwidth reservation in cell cluster



Resource renegotiation

- Resource renegotiation can be implemented in a distributed manner and each cell site can make decisions as to how bandwidth is assigned to Class II calls within its service area.
- Resource renegotiation is further facilitated by keeping an ordered list of calls that will undergo bandwidth readjustment. This reduces the overhead imposed by the mechanism. The calls are selected on a priority basis for bandwidth reassignment. The bandwidth assignment mechanism is reversible.
- If the service rate of a call is reduced under heavy traffic load condition, then under low traffic conditions, the same call can receive higher service rates.

New call setup

- The resource allocation scheme for establishing a new call connection is different for Class I and Class II calls.
- For new Class I calls, resource reservation is performed when a call connection is requested, the base station determines the bandwidth ***B*** available to service the calls.

New call setup

- There is no bandwidth reservation for Class II calls.
- When a new call connection is requested, the base station determines the available bandwidth *B*.
  - If *B* is greater than *B*r, the call is accepted in the network.
  - The call is assigned the requested bandwidth.
  - When *B* is less than *B*r, the call is blocked.

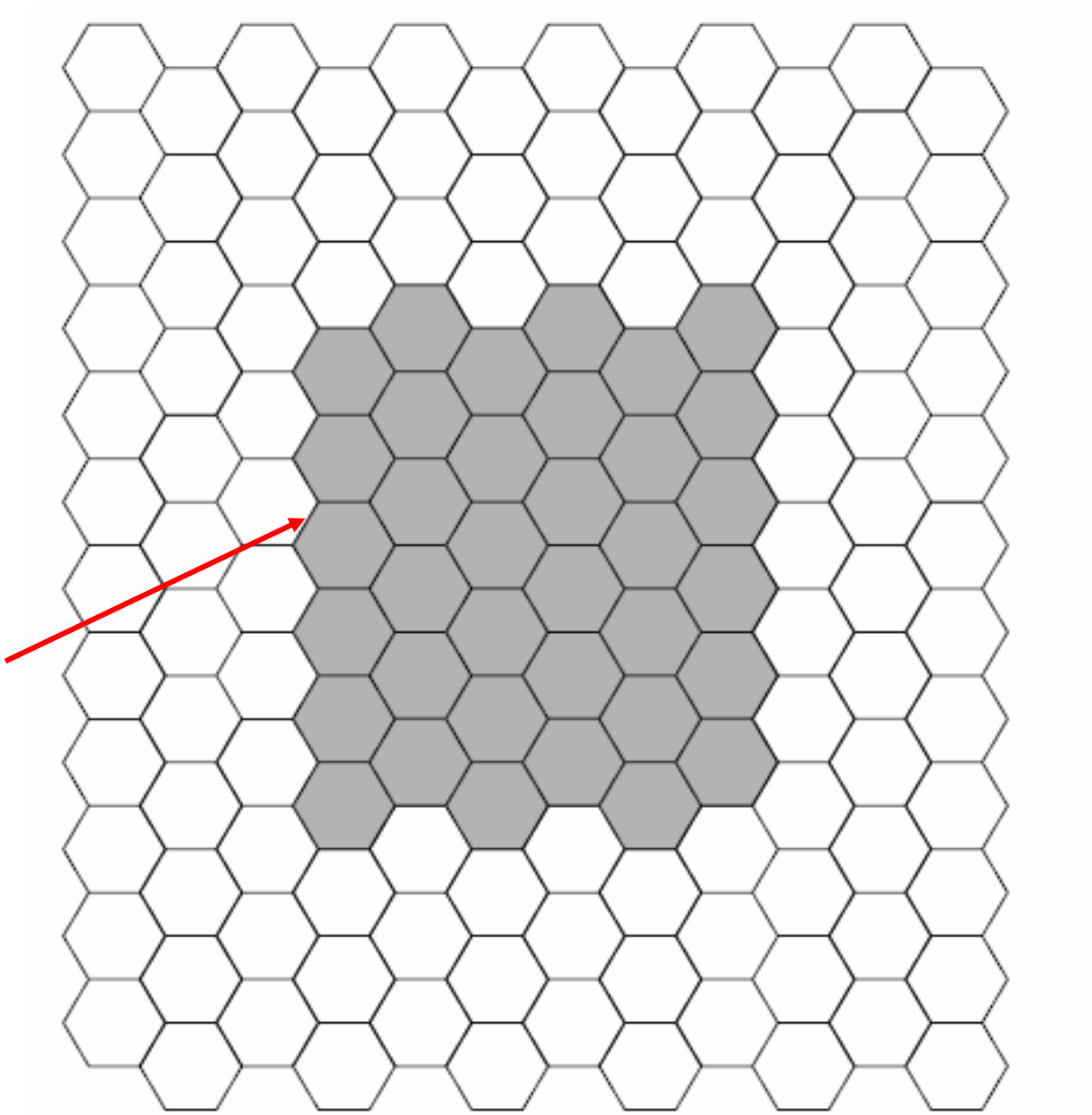
Handoffs

- Keeping the handoff dropping rate to a minimum is an important issue in designing resource allocation schemes.
- Different policies to service the handoffs depending on the class of traffic.
- For handoff of Class I calls,
  - Initially attempt to assign bandwidth to the call using the available bandwidth.
  - If enough bandwidth is not available to service the handoff request,
    - Try to assign the bandwidth already reserved in the target cell.
    - If the reserved bandwidth in the target cell has been used by calls from other cells, try to make available enough bandwidth to service the handoff by re-assigning bandwidth to existing Class II calls in the cell.

Simulation environment

- The cellular network consists of 144 cells
- Data is collected from 36 cells in the center to avoid the border effect.
- Each cell has a base station with an omni-directional antenna.
- The coverage area of each cell and its base station is referred to as the cell site.
- Cells are hexagonal in shape and have a radius of 250 meters.
- The capacity of each cell is 20 Mbps. Each cell has the complete frequency spectrum available to it
- The cell cluster comprises a cell and its adjoining cells.

Where data is collected



Simulation environment

- The total bandwidth is shared between the real-time and non-real time traffic.
- Mobile Stations (MS) are uniformly distributed within the coverage area of each cell.
- MS are portable mobile units which are allowed to roam anywhere within the network.
- Call handoffs are simulated to be Mobile Assisted HandOffs (MAHO). Only inter-cell handoffs are used.
- The total simulation time is 2500 seconds to represent the traffic statistics.