

Modified LP-DDCA for Integrated Service over Cellular System

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1

Outline

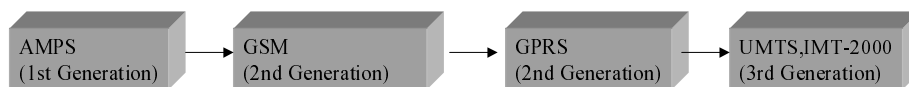
- Introduction
- LP-DDCA and Guard Channel Scheme
- Modified LP-DDCA with single threshold
- Modified LP-DDCA with double thresholds
- Simulation Results
- Conclusions

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2

Introduction

- Wireless mobile telecommunication becomes a trend.
- Mobile Internet and high speed data transfer are the future demands.



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3

Introduction

- Challenges:
 - (1) New call blocking rate
 - (2) handoff forced termination rate.
- (2) is more important than (1) from users' viewpoint.
- Channel assignment schemes can be roughly classified into three types:
 - fixed channel assignment(FCA)
 - hybrid channel assignment(HCA)
 - dynamic channel assignment(DCA)

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4

Introduction

- FCA:
 - a set of nominal channels is permanently assigned to each cell.
 - the same set of channels is reused some distance away.
- HCA:
 - the set of nominal channels assigned to each cell is divided into two subsets A (only for locally used) and B (could be lent).
 - It was found that the optimum ratio depends on the traffic load.

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5

Introduction

- DCA:
 - The channel assignment is determined by the level of received quality in each channel, but not by the position of the mobile.

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6

Introduction

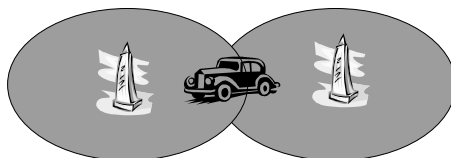
- Integrated Services
 - Packet calls take more time than voice calls, so their handoff probability is often bigger than voice calls.
- Main result:
 - Consider a modified LP-DDCA scheme with priority on handoff calls (data and voice calls) for integrated services over cellular system.

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7

Introduction

- Define packet handoff:
 - Transfer data at the boundaries of cells
 - I.e, no “packet handoff” when crossing the cells boundary but not transferring data.



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8

Introduction

- We define five kinds of performance indices:

$$\text{(voice) handoff forced termination rate} = \frac{\text{blocked handoff calls}}{\text{total handoff calls}}$$

$$\text{new (voice) call blocking rate} = \frac{\text{blocked new calls}}{\text{total new calls}}$$

$$\text{packet handoff forced termination rate} = \frac{\text{blocked packet handoff calls}}{\text{total handoff data calls}}$$

$$\text{packet on blocking rate} = \frac{\text{blocked on requests}}{\text{total on requests}} \quad (\text{Note: it is defined by myself})$$

$$\text{new packet call blocking rate} = \frac{\text{blocked new packet calls}}{\text{total new packet calls}}$$

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9

LP-DDCA and Guard Channel

LP-DDCA: *(Proposed by C-L and P-H Chao, Proc. IEEE GLOBECOM 1993, pp. 293-301)*

- Local Packing Distributed Dynamic Channel Allocation (LP-DDCA) maintains at each base station an Augmented Channel Occupancy (ACO) table for channel assignment.
- An empty column indicates an "available" channel that can be assigned to cell i .

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10

LP-DDCA and Guard Channel

- The content of the ACO matrix is updated by collecting channel occupancy information.

Cellsite	Channel number					# of Free channels
	1	2	3	⋮	M	
i	X		X			0
i1		X				1
i2					X	4
i3		X				0
i4	X					5
i5			X			
⋮						
⋮						
ik	X				X	4

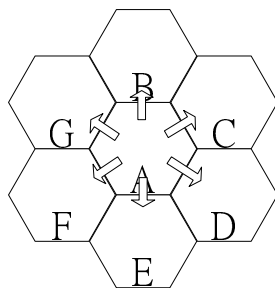
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11

LP-DDCA and Guard Channel

Handling handoff schemes:

- Guard Channel (Proposed by *Yoon, C.H.; Un, C.K.*
Electronics Letters Volume: 25 11, 25 May 1989)



B,C,D,E,F,G may reserve 1/10 channels for A's handoff calls.

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12

Modified LP-DDCA with Single Threshold

Single Threshold Scheme:

- Call termination as a result of handoff failure is considerably less desirable from the user's viewpoint.
- Allow LP-DDCA to preserve channels for handoff calls and assign channels according their priorities.
- Define:
 - GuardChannelThreshold: the number of channels which are preserved for handoffs in a cell.

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13

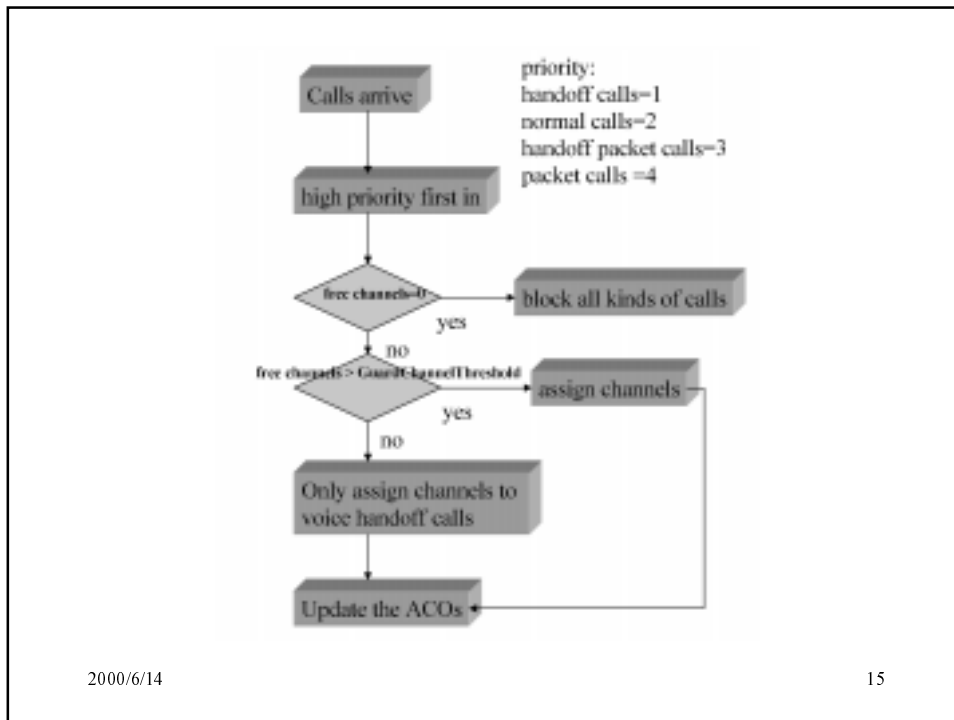
Modified LP-DDCA with Single Threshold

- When new calls arrive, we prioritize the calls.
- If the cell has less channels than GuardChannelThreshold.
 - ❖ then only voice handoff calls are allowed to be served, and block all other kinds of calls
 - ❖ else assign channels according to their priorities and LP-DDCA if there are more channels than n.
- Update the ACOs.

(Note: When new data calls or handoff data calls are blocked, they will often retry at the next second. According to TCP/IP, when data are not sent to the destination, the data will be retransmitted.)

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14



Modified LP-DDCA with Single Threshold

- This strategy only provides protections for voice handoff calls.
- Develop two thresholds for voice handoff calls and packet handoff calls.

2000/6/14 16

Modified LP-DDCA with Double Thresholds

Double Thresholds Scheme:

- Since concepts as microcells are proposed, cells will be getting smaller.
- Packet handoff rate is bigger than voice calls.
- Define a new threshold to protect handoff packet calls.

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17

Modified LP-DDCA with Double Thresholds

- Define:
 - LowThreshold: channels for voice and packet handoffs
 - HighThreshold: channels only for voice handoffs

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18

Modified LP-DDCA with Double Thresholds

- When calls arrive, channels is assigned according to the following rules.
- When calls arrive, we prioritize the calls.
- If the cell has less channels than LowThreshold + HighThreshold.
 - then only handoff calls are allowed to be served, and block all other kinds of calls.
 - else if there are less channels than HighThreshold in the cell, block the new voice calls and new packet calls.

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19

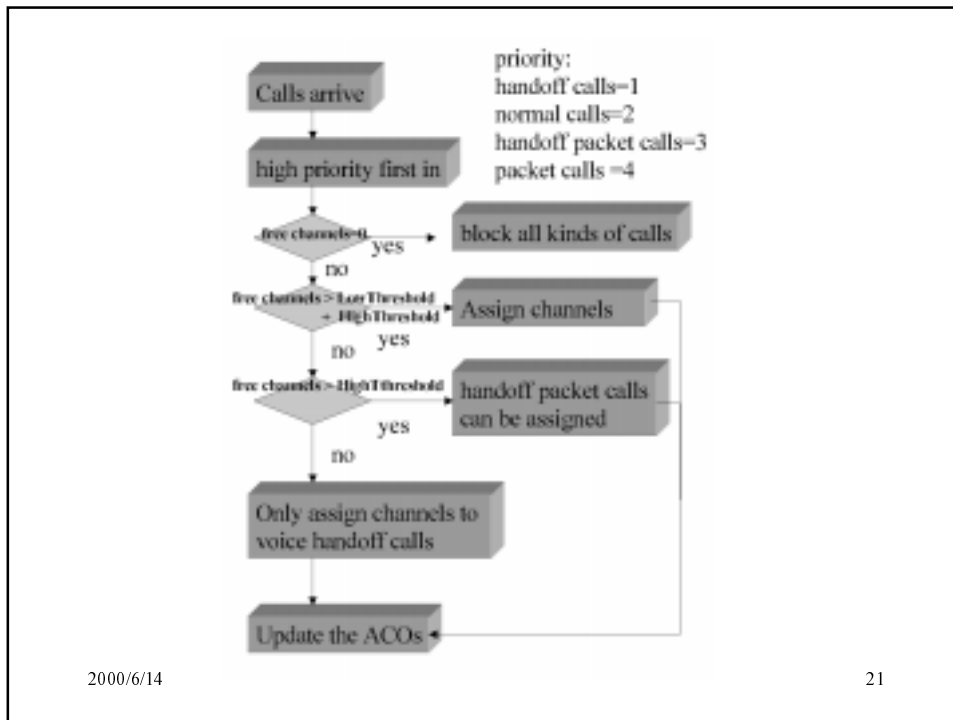
Modified LP-DDCA with Double Thresholds

- else if there are more channels than HighThres-hold channels in the cell, assign channels according to their priorities
- Update the ACOs.
- This method decreases handoff packet block rate, and also decreases the retrying probability at the boundaries of cells.

(Note: When new data calls or handoff data calls are blocked, they will often retry at the next second. According to TCP/IP, when data are not sent to the destination, the data will be retransmitted.)

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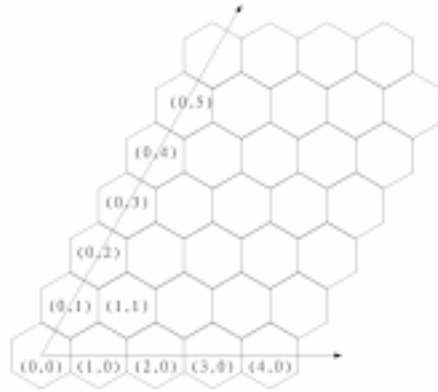
20



- ## Simulation Results
- New calls
 - Poisson arrive
 - Mean holding time: 3min
 - New packet calls
 - Poisson arrive
 - Mean session time: 30 min
 - Mean on time: 3min
 - Mean off time: 3min
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Simulation Results

- The simulated cellular system contains 16*16 hexagonal cells.



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23

Simulation Results

- There are totally 70 channels in system.
- We assume that

$$\frac{\text{total_handoff_voice_calls}}{\text{total_voice_calls}} = \frac{1}{10} \text{ or } \frac{1}{20}, \rightarrow 0$$

(note: tune the cellsize to achieve 1/10, 1/20, $\rightarrow 0$)

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24

Simulation Results

- The overall traffic (x-axis) includes voice calls and packet calls.
- For example:

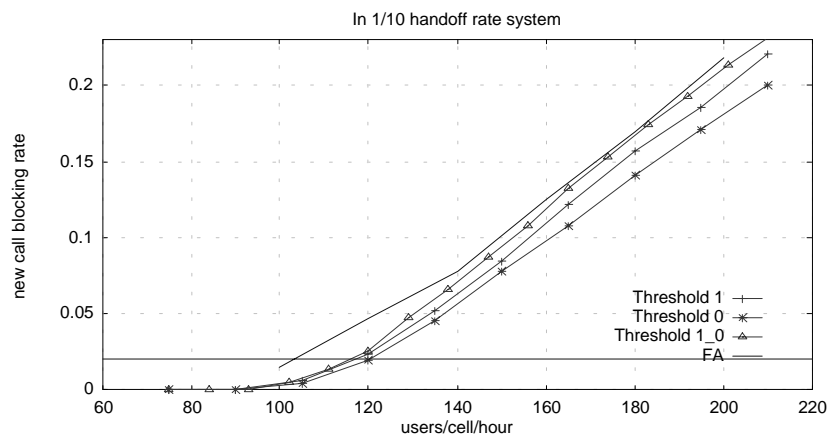
$$8 \frac{\text{packet_call}}{\text{cell_hour}} \times 0.5 \text{hour} \times \frac{1}{2}$$

$$= 40 \frac{\text{voice_call}}{\text{cell_hour}} \times \frac{1}{20} \text{hour}$$

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25

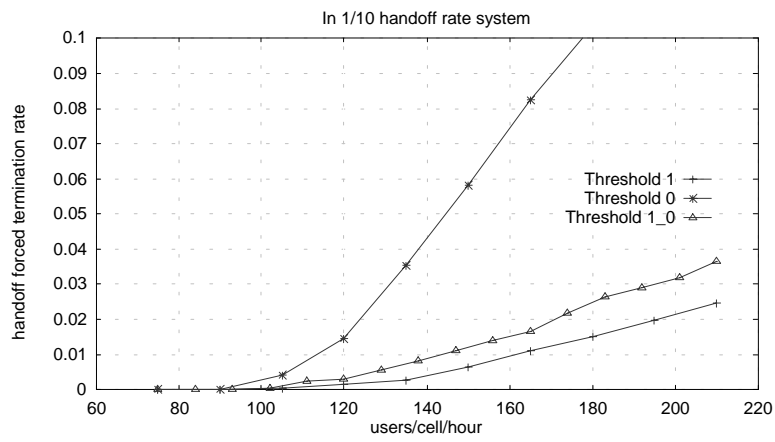
Simulation Results



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26

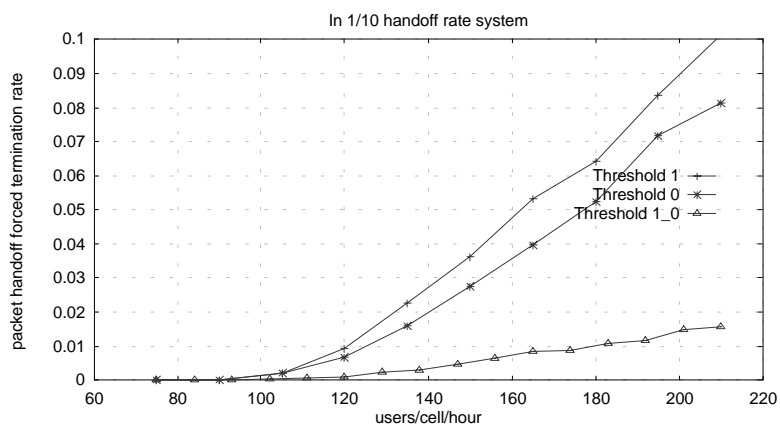
Simulation Results



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27

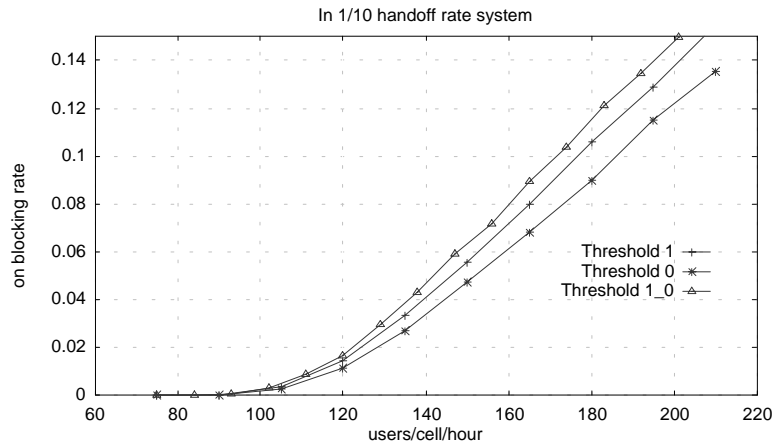
Simulation Results



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28

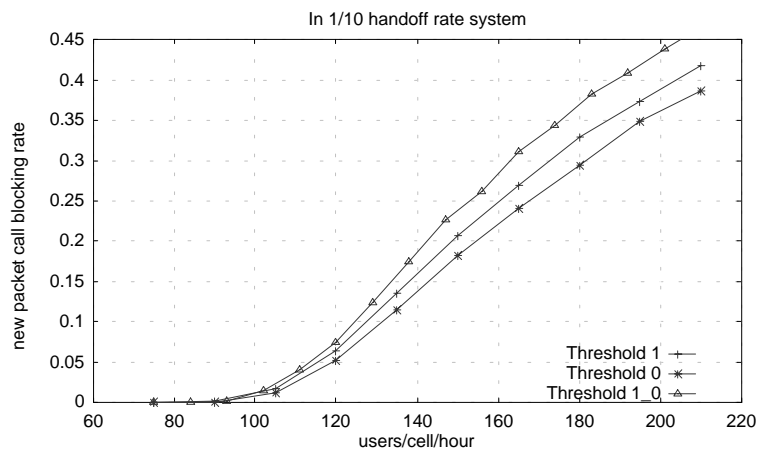
Simulation Results



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29

Simulation Results



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30

Conclusions

- We propose priority with thresholds in LP-DDCA to improve the probability of successful handoffs.
- Because of reserving channels for handoffs, new voice call and new packet call blocking rate slightly increases.
- Double thresholds could decrease voice handoff force termination rate and packet handoff forced termination rate.

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31

Conclusions

- There is tradeoff for handoff forced termination rate and new call blocking rare.
- **Handoff packet calls could also be protected.**

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32