Channel Quality Dependent Scheduling for Flexible Wireless Resource Management

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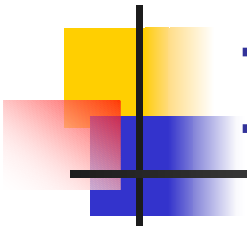
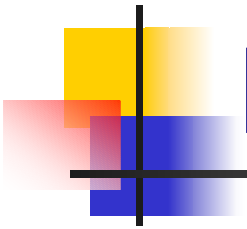


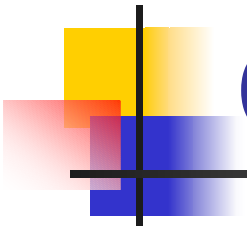
Introduction

- Network operators will have to decide on how to:
  1. optimize the performance of users with different channel qualities
  2. maintain a certain degree of fairness
  3. Preserve overall system performance



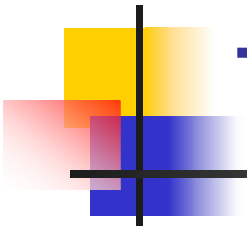
Motivation

- Two problems are not addressed in the pervious work:
  1. users may deliver different amounts of data using the same amount of radio resource
  2. the focus of the previous work has been on providing rate guarantees over sufficiently long time periods, which is not suitable for bursty data traffic



Overview of this paper

- First explore the intricate relations between channel quality, fairness, and performance
- Present a channel-efficiency-based scheduling algorithm to allocate resources with flexibility of adjusting



The system

- The discussions will be on EDGE (Enhanced Data Rates for GSM Evolution) with 400 kbps channels
- The traffic is generated based on an ON/OFF bursty model of web workloads, where the average file size is 8.2kB
- The link layer assumption is 8 time-slots in one 20msec time frame

The system (link adaptation)

MODULATION AND CODING SCHEMES IN EDGE.

Scheme	Modulation	Maximum rate [kb/s]	Data Per Slot [bits]
MCS-9	8PSK	59.2	1184
MCS-8		54.4	1088
MCS-7		44.8	896
MCS-6		29.6 / 27.2	592/544
MCS-5		22.4	448
MCS-4	GMSK	17.6	352
MCS-3		14.8 / 13.6	296/272
MCS-2		11.2	224
MCS-1		8.8	176

The impact of the differences in channel qualities

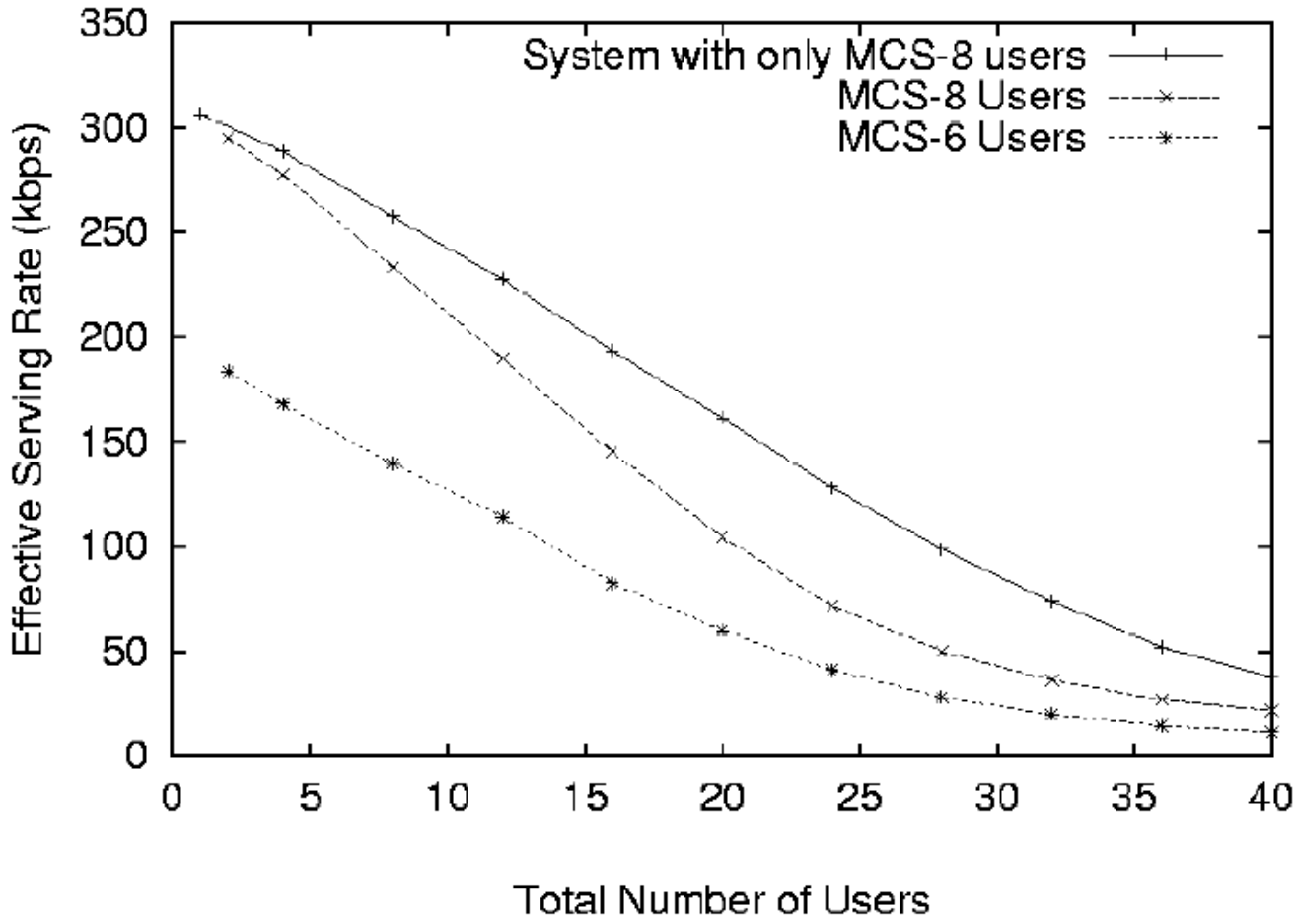


Fig. 2. Average effective serving rate.

Average channel usage

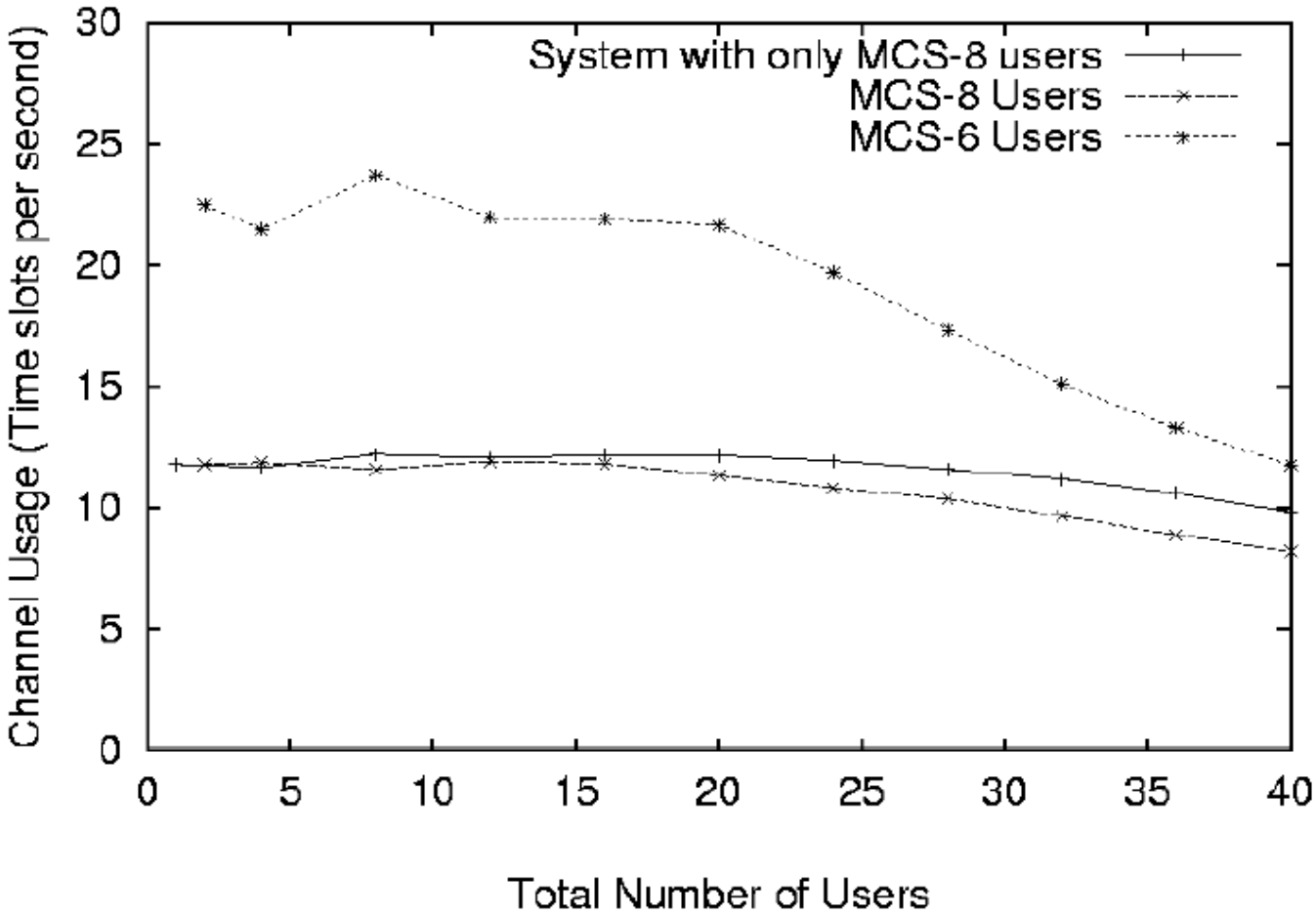
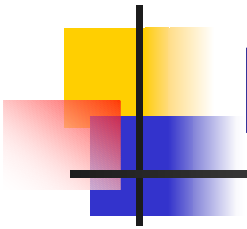


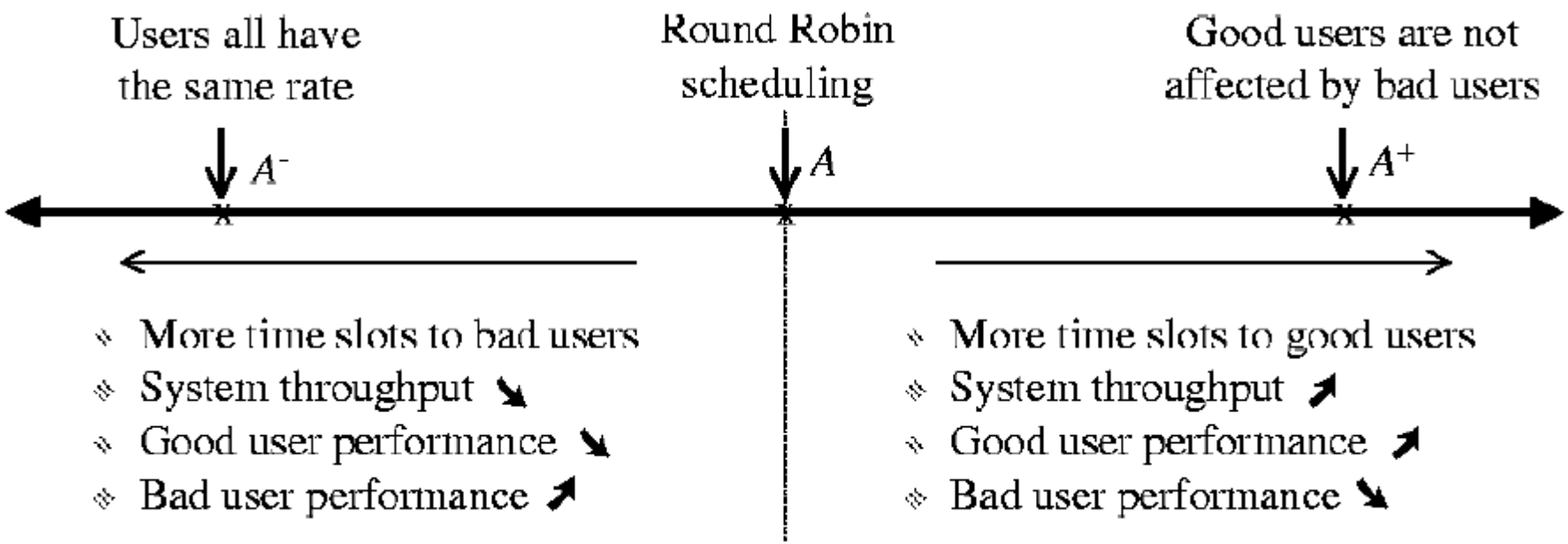
Fig. 3. Average channel usage.



Results

- The poor channel quality of MCS-6 users not only make themselves suffer, but also penalize the MCS-8 users.
- The performance degradation of MCS-8 users is in part due to the burstiness of the traffic. (equal weights)
- Both types of users complain to the operators

Options of scheduling algorithms



An efficiency-based scheduling algorithm (1/3)

- The algorithm keeps track of how efficiently a mobile station is utilizing radio resources:
  efficiency
  = actual amount of data delivered / maximum amount of data that can be delivered with the same resource

An efficiency-based scheduling algorithm (2/3)

- Performance metric:

$$r_i = efficiency * R_i * r$$

R is the amount of resource assigned, r is the best rate achievable

- The proposed weight calculation:

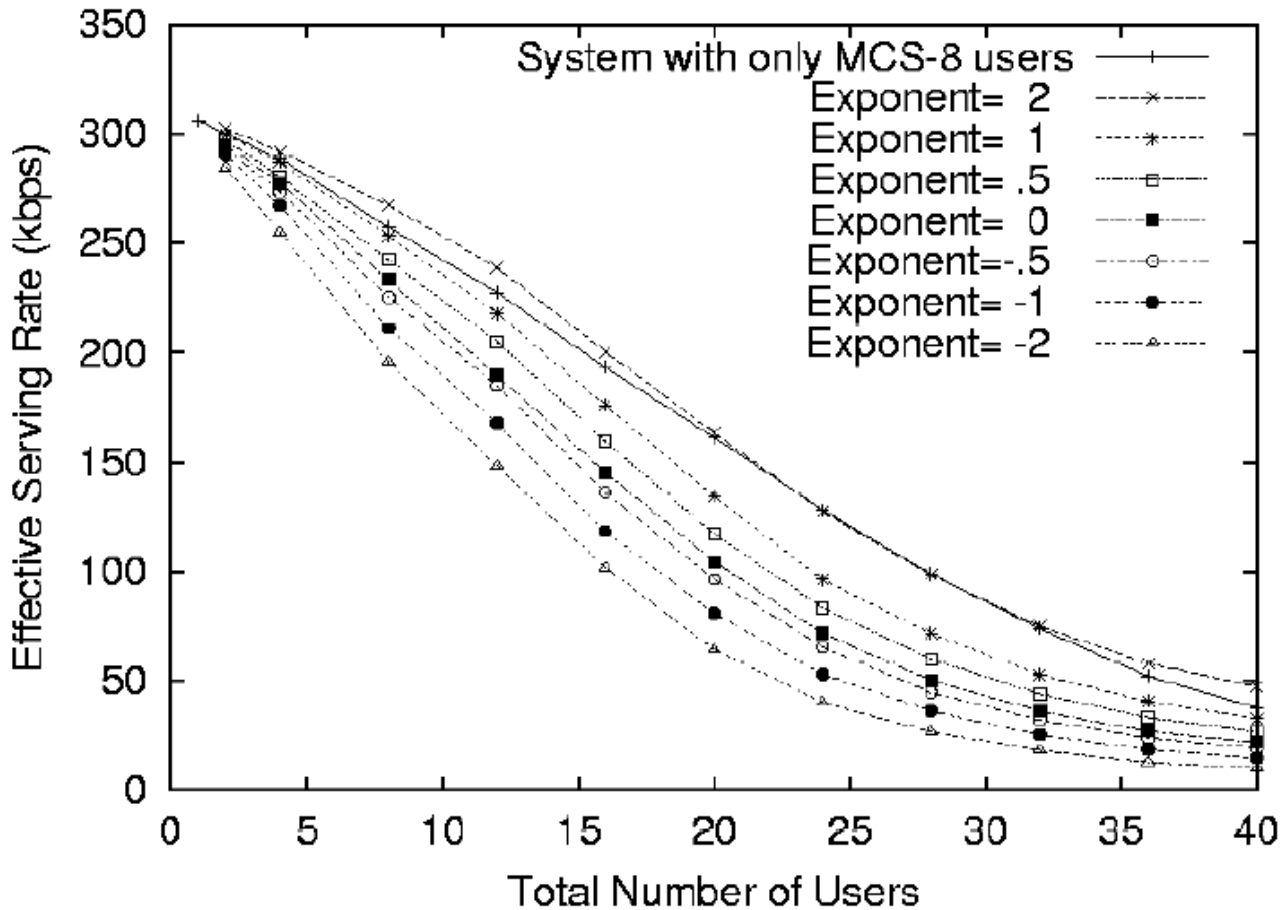
$$Wi = efficiency_i^{exponent}$$

- By adjusting the value of *exponent*, this algorithm can move its operating point along the axis shown before

An efficiency-based scheduling algorithm (3/3)

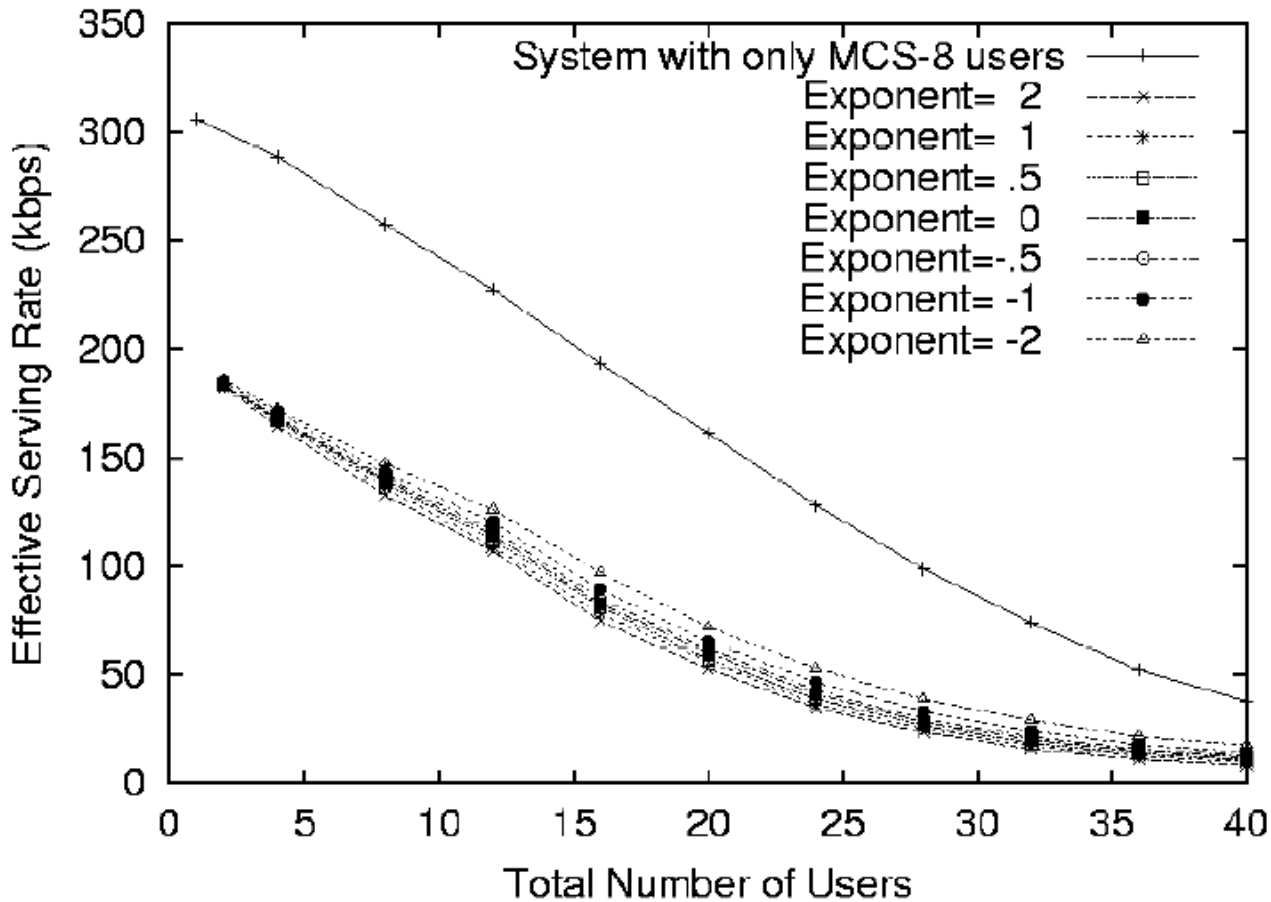
- At *exponent* = -1, the weight fo a mobile is proportional to the reverse of its *efficiency*, i.e., all the users should receive exactly the same rate
- When exponent is greater than 0, the system assigns higher weights to good users hence improves the performance

Simulation (1/2)

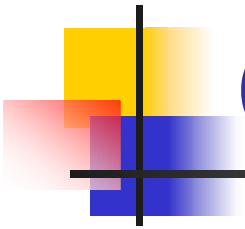


a) Effective Serving Rates of MCS-8 Users

Simulation (2/2)



b) Effective Serving Rates of MCS-6 Users



Conclusion

- The paper illustrated how the situations in cellular systems, where users with different channel qualities may deliver different amounts of data using the same amount of resources
- And the proposed scheme can effectively adjust the resource assignments, which is an invaluable feature for service providers