Packet Scheduling for Cellular Networks with Relaying to Support User QoS and Fairness

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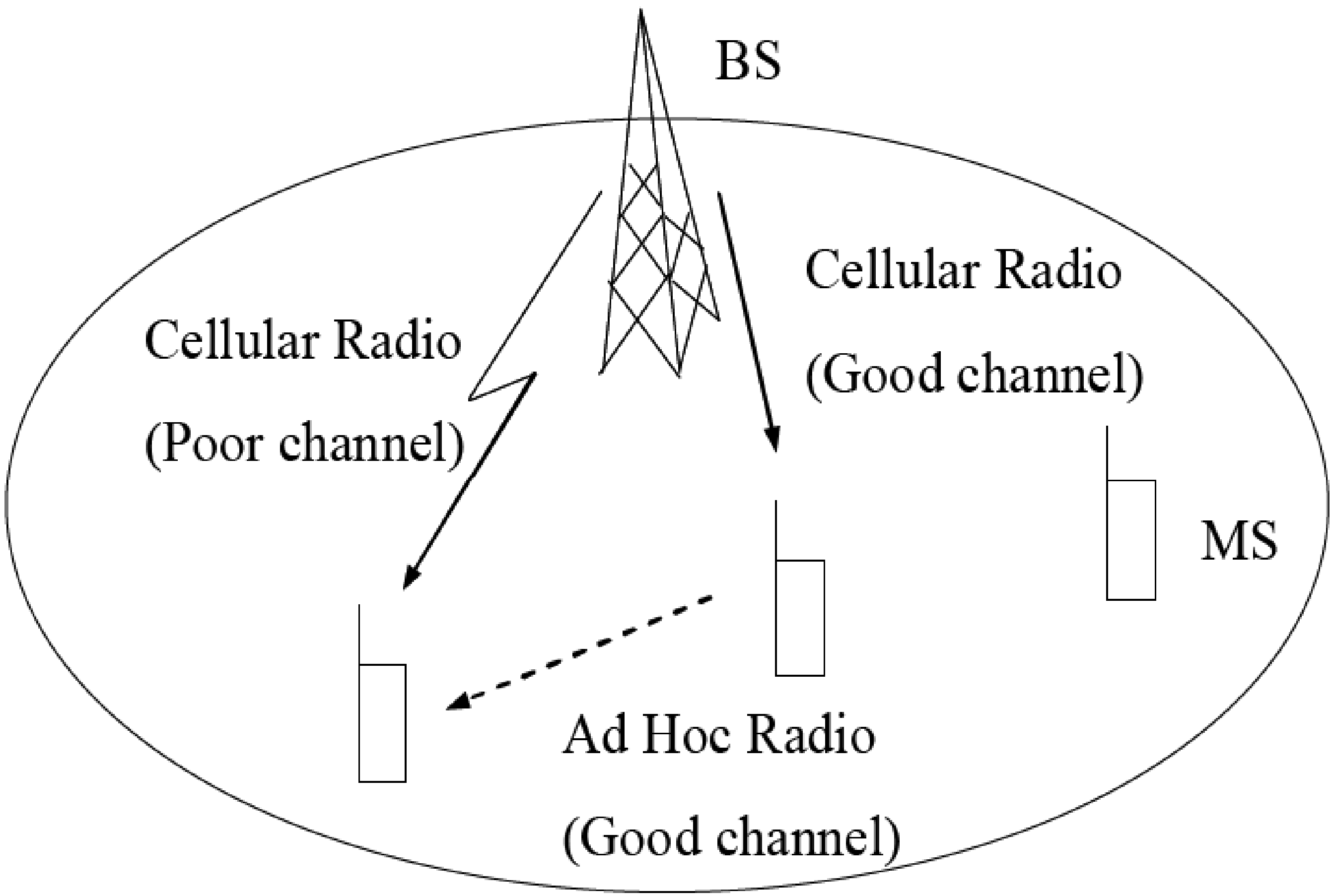
Outline

- Introduction
- System Description
- Downlink Packet Scheduling Algorithm
- Numerical Simulation
- Conclusions

Introduction

- Providing QoS is one of the crucial requirements.
- High priority is given to the delay sensitive packets, while a lot of delay tolerant packets would suffer a long delay with their priorities.
- Users with low signal to noise ratio (SNR) still suffer from low transmission rate, which becomes the bottleneck of scheduling design for system throughput enhancement.

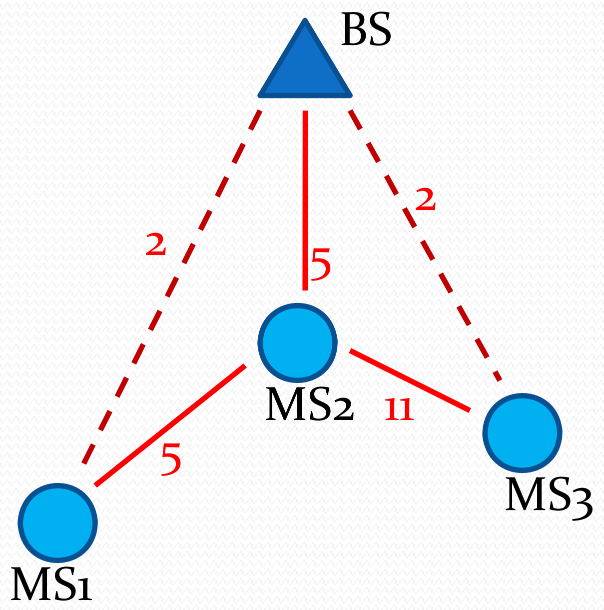
System Description



Downlink Packet Scheduling Algorithm

- Efficiency
  - Channel quality
- QoS
  - Delay bound
- Fairness
  - Average throughput

Efficiency



$$h_{i,j} = \begin{cases} 1 & , if \;\; link \;\; \vec{ij} \;\; is \;\; available \\ 0 & , otherwise \end{cases}$$

h i,j	ms1	ms2	ms3
ms1	1	1	0
ms2	1	1	1
ms3	0	1	1

$$\varepsilon_i(t) = \sum_{j=1}^{N} h_{i,j} R_j(t)$$

rate	ms1	ms2	ms3
ms1	2Mb	2Mb	0
ms2	5Mb	5Mb	5Mb
ms3	0	2Mb	2Mb

QoS

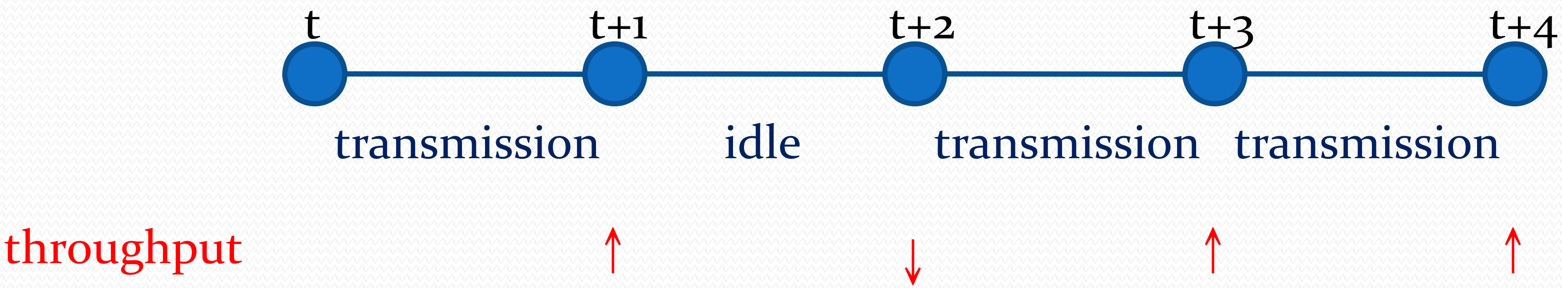
- The longer delay the packet experienced, the fast the packet would be served.

$$U_i(t) = \begin{cases} \min\left(\left(\frac{d_i(t)}{D_S}\right)^2, 1\right) & \textit{for streaming packets} \\ \min\left(\left(\frac{d_i(t)}{D_B}\right)^2, 1\right) & , \textit{for best effort packets} \end{cases}$$

Ds=100msec , DB=500msec

Fairness

- If the throughput of a user is much smaller than others, BS should give more priority to the user.



Fairness

- User throughput *Ti(t)* is updated as follows

$$T_i(t+1) = \left(1 - \frac{1}{t_w}\right) T_i(t) + \frac{1}{t_w} \phi_i(t)$$

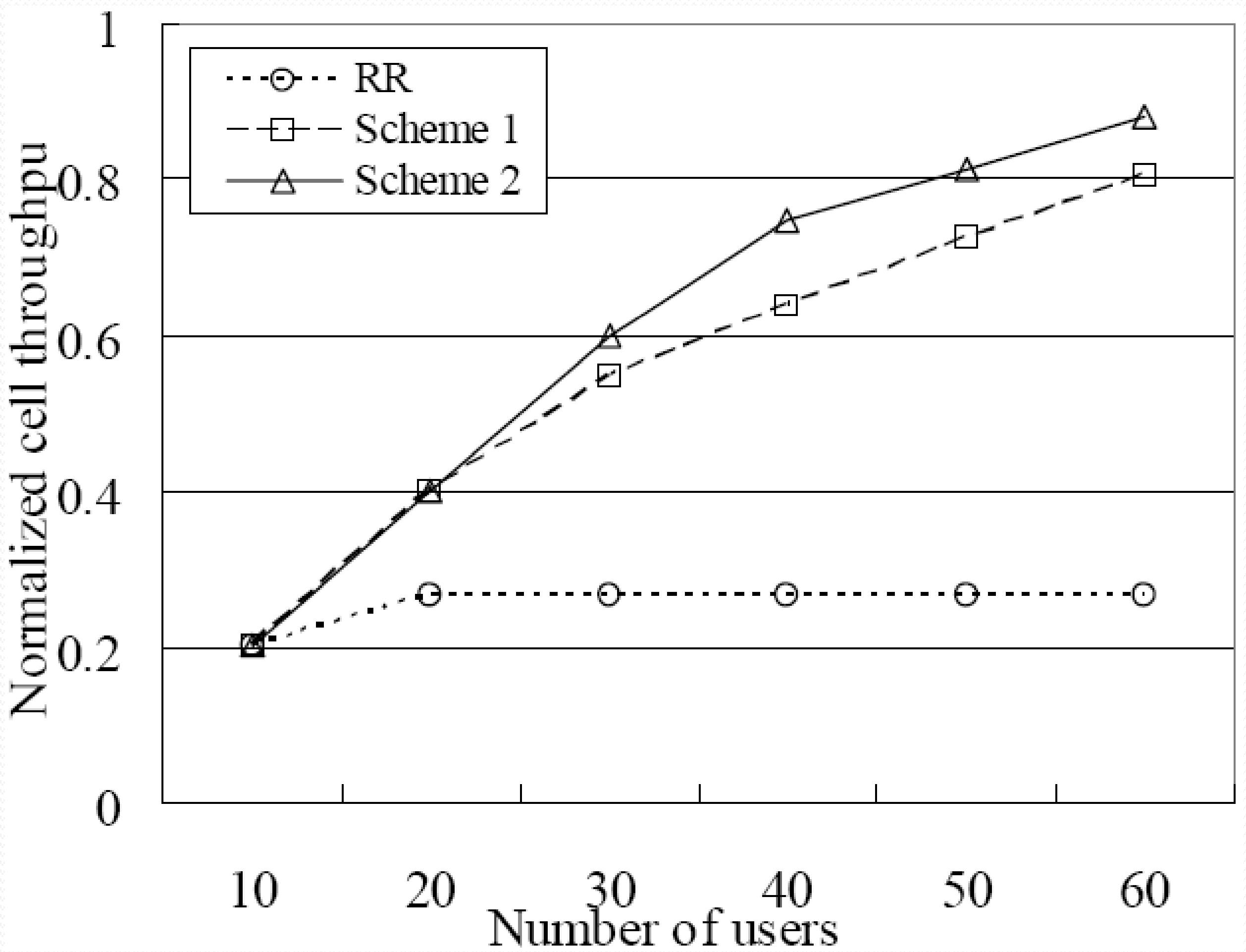
$$\phi_i(t) = \begin{cases} \varepsilon_i(t) & ,if\ user\ i\ is\ scheduled \\ 0 & ,otherwise \end{cases}$$

Schedule policy

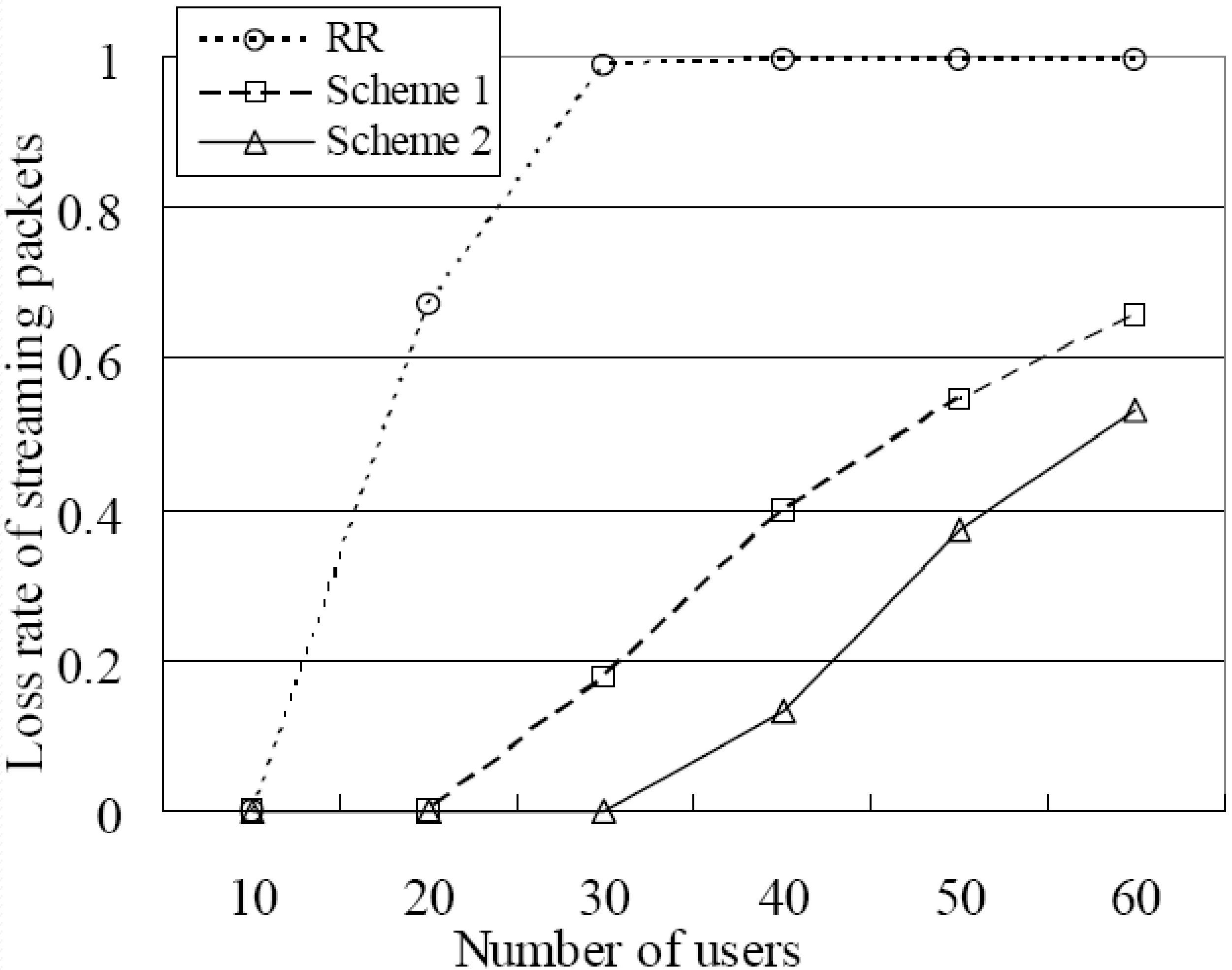
- The higher transmission rate
- The longer delay
- The worse throughput

Numerical Simulation

- RR: Round Robin scheduling, BS schedules for each user in order.
- Scheme 1: proposed scheduling scheme without relaying.
- Scheme 2: proposed scheduling scheme with ad hoc relaying.

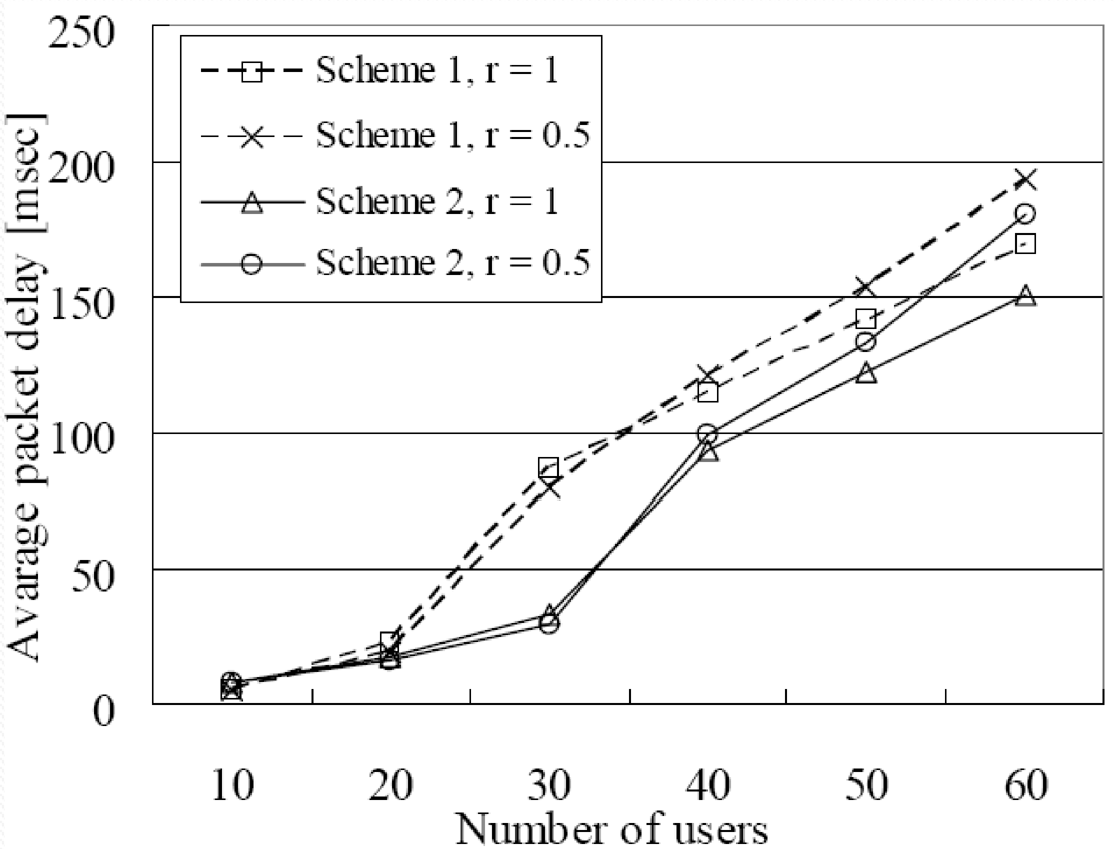


RR
Scheme 1
Scheme 2
Normalized cell throughpu
0
0.2
0.4
0.6
0.8
1
10
20
30
40
50
60
Number of users



RR
Scheme 1
Scheme 2
Loss rate of streaming packets
0
0.2
0.4
0.6
0.8
1
10
20
30
40
50
60
Number of users

- *r is* denoted as the ratio of streaming packets compared with best effort packets



Conclusions

- This paper proposed scheduling algorithm by considering the constraints of user transmission rate, user throughput, and packet QoS.
- Simulation results shows that the proposed scheme can improve the total system throughput performance and achieve better packet loss and delay capacity.