Scheduling Algorithm Design in Wireless Networks

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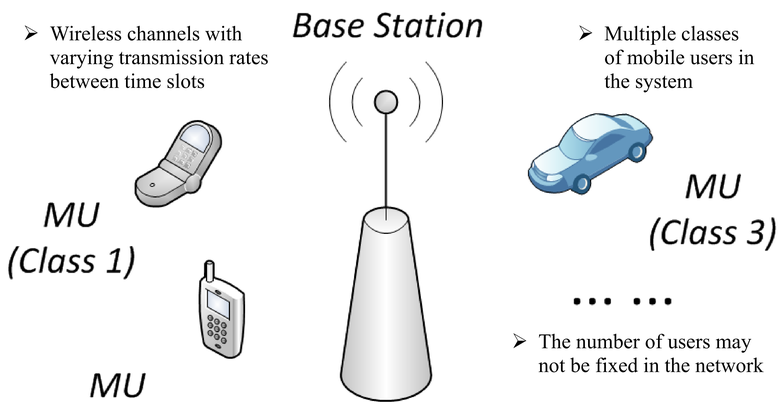
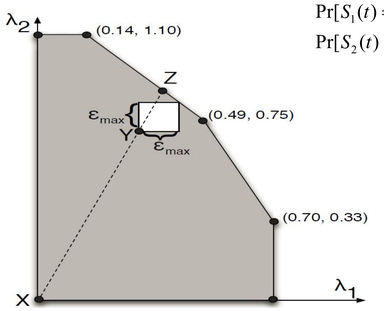
Wireless Network

- Wireless channels with varying transmission rates between time slots
- Multiple classes of mobile users in the system
- The number of users may not be fixed in the network
- Base station schedules which user to transmit in each time slot

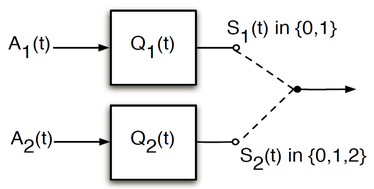


System Capacity Region (CR)



$\Pr[S_1(t)=0]=0.3, \quad \Pr[S_1(t)=0]=0.7$

$\Pr[S_2(t)=0]=0.2, \quad \Pr[S_2(t)=1]=0.5, \quad \Pr[S_2(t)=2]=0.3$



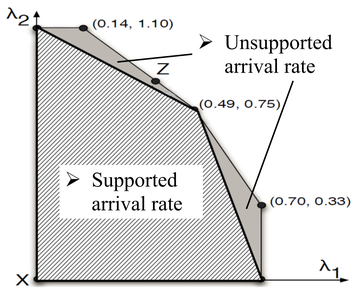
$E\{A_1(t)\} = \lambda_1$

$E\{A_2(t)\} = \lambda_2$

- A: arrival rate
- S: transmission rate

- CR is the maximum data arrival rate that the system can support.

Algorithm Stability Region (SR)



- Unsupported arrival rate
- Supported arrival rate

- SR is the maximum data arrival rate that *a certain scheduling algorithm* can support.
- Unsupported arrival rates (gray area) exit in CR if SR (shadowed area) is smaller than CR
- Scheduling algorithm is **throughput-optimal** if SR is identical to CR
- System is unstable when arrival rates (point Z) lie beyond SR. Queue size goes to infinity when unstable.

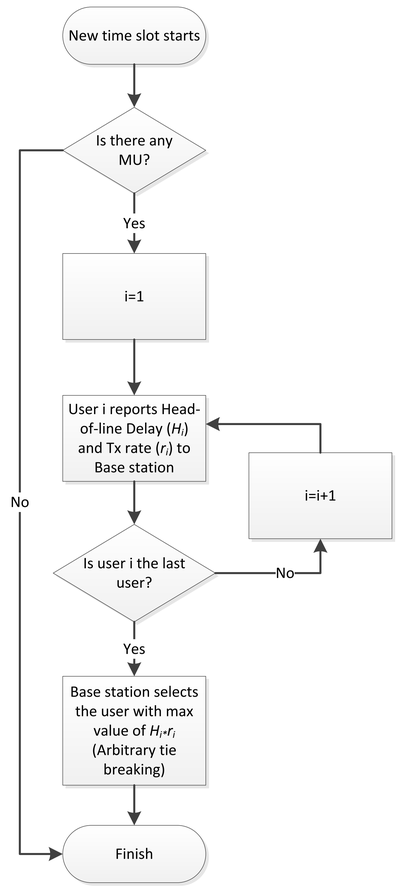
Motivation

- **Flow-level Dynamics:** there are unfixed number of users in the system
- Classic queue length based MaxWeight scheduling (Q-MW) is not throughput-optimal with Flow-level Dynamics
- Current solutions (MR, F-D-MW) require sophisticated system information

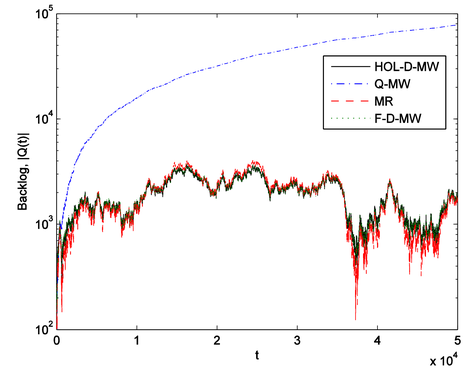
Objective & Solution

- How to design a scheduling algorithm for the systems with flow-level dynamics?
  - 1). throughput-optimal
  - 2). easy for implementation
- **Head-of-Line Delay based Scheduling Algorithm (HOL-D-MW)**

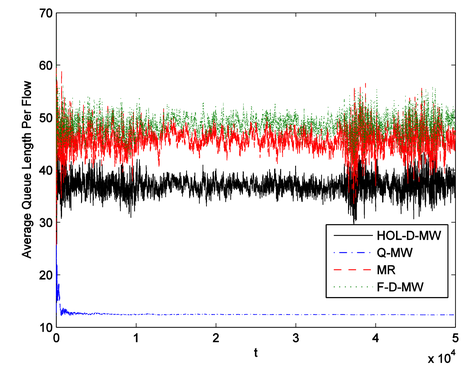
$$\{i\}^*(H_i(t), r_i(t)) = \arg\max_i \; H_i(t) * r_i(t)$$



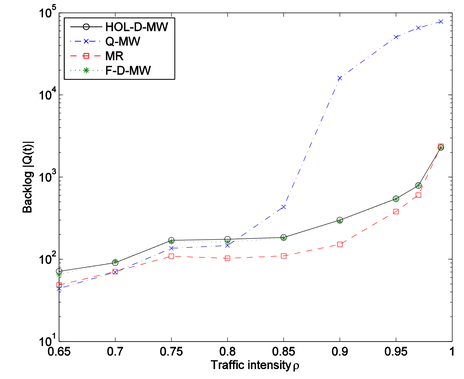
Evaluation



- Traffic arrival rate is almost on the edge of system CR
- HOL-D-MW has infinite total queue size in the system
- HOL-D-MW is throughput optimal because the system is
- Q-MW is not throughput optimal



- Traffic arrival rate is almost on the edge of system CR
- HOL-D-MW has infinite average queue size



- Traffic arrival rate keeps increasing to the boundary of system CR
- Q-MW has a growing queue size without control

Bibliography

1. **Y. Chen, X. Wang, L. Cai, HOL Delay Based Scheduling in Wireless Networks with Flow-Level Dynamics, IEEE Globecom 2014.**