CLASS BASED PRIORITY SCHEDULING FOR UPLINK TO SUPPORT M2M COMMUNICATIONS IN LTE

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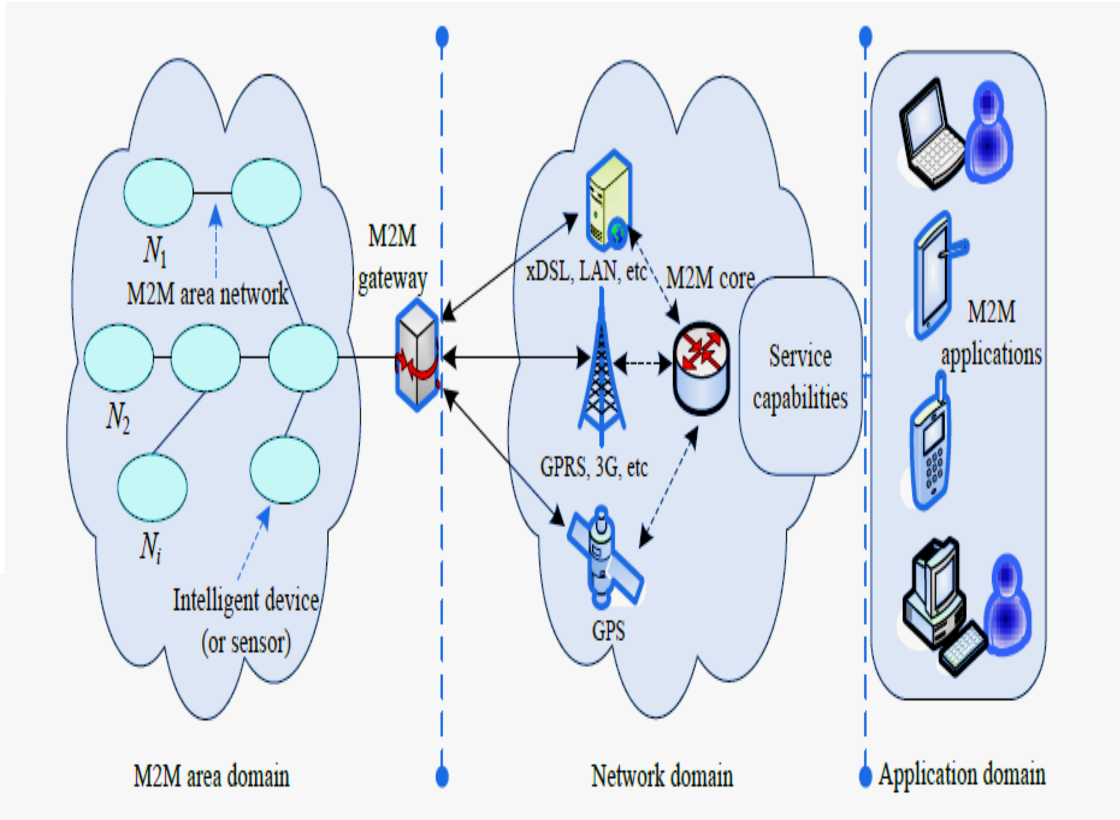
Introduction to IoT

- Internet connects all people, so it is called “the Internet of People”
- IoT connects all things, so it is called “the Internet of Things”

Introduction to M2M

M2M Communication

- M2M covers the networking part of IoT
- M2M Device (Sensors, Meters)
- Communication Network (Cellular Network, Wi-Fi etc)
- Application (Software Program)
- Types of M2M Communications
  - Capillary M2M
  - Cellular M2M

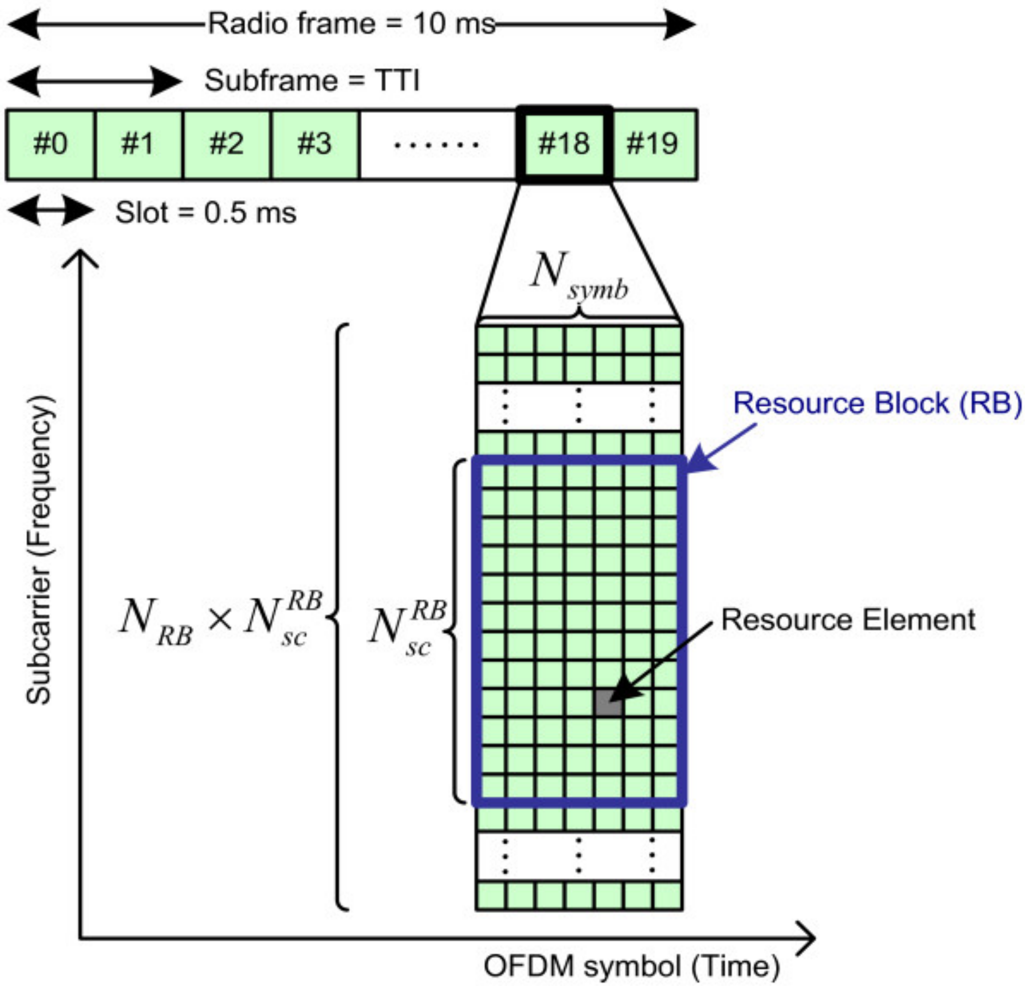


Source: Min Chen, Jiafu Wan and Fang Li, "Machine-to-Machine Communications: Architectures, Standards and Applications", *KSII Transactions on Internet and Information Systems*, vol. 6, no. 2, February 2012.

Characteristics of M2M Traffic

- Low traffic volume
- Higher uplink to downlink ratio
- Low mobility
- Frequency of data sending is high

Resource Block



- One resource block is 0.5ms and contains 12 subcarriers from each OFDM symbol
- One frame is 10ms $\rightarrow$ 10 subframes
- One subframe is 1ms $\rightarrow$ 2 slots

Source: Erik Dahlman, Stefan Parkvall, and Johan Sköld,"4G LTE/LTE advanced for mobile broadband"

Scheduling Issues in Supporting M2M in LTE

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- Bandwidth is limited
- Large number of M2M devices involved
- Inefficiency of present resource schedulers to support M2M flows
  - ✓ Designed for H2H/H2M/M2H
  - ✓ Difference in traffic nature
- Wastage of resources during contiguous allocation in uplink

Problem Statement

Designing of scheduling algorithm, based on the traffic characteristics of H2H and M2M flows, which allocates the resources to M2M flows without affecting or least affecting M2M flows.

Types of Applications

Type/Class	C1	C2	C3	C4	C5	C6	C7	C8
Real Time	1	1	1	1	0	0	0	0
Reliability	1	1	0	0	1	1	0	0
Priority	1	0	1	0	1	0	1	0

Applications Example:

Real Time :

Reliability :

Priority :

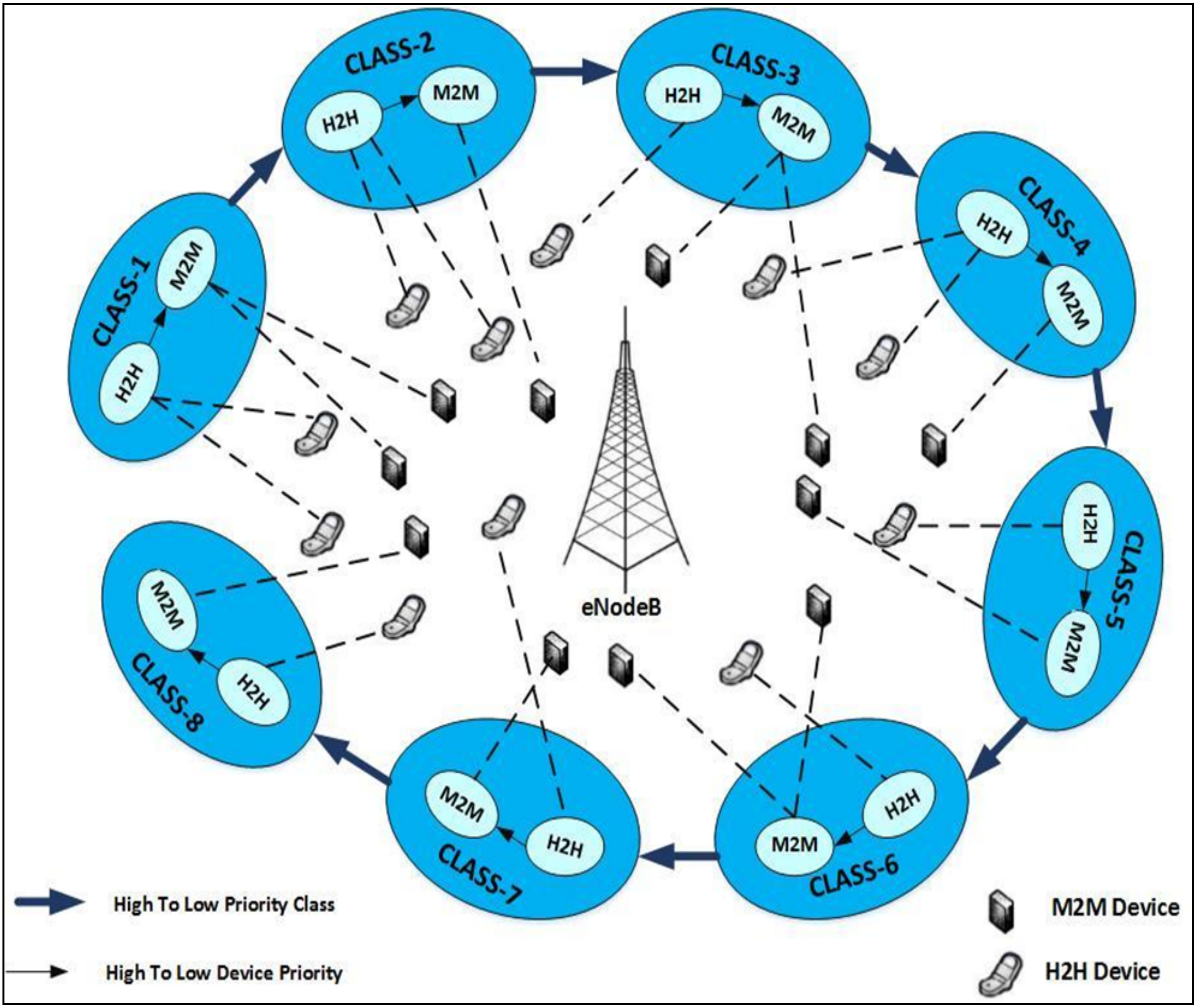
Approach

- Assign priorities to each request based on the belonging class
- Minimum amount of RBs to be allocated to a request is MGBR*TTI
- Constraint on number of RBs to be allocated to M2M requests:

$$\sum_{i=1}^{N} RB_{mi} \leq L_m$$

where L_m is maximum number of RBs to be assigned to M2M requests

Class Based Priority Scheduling



Properties:

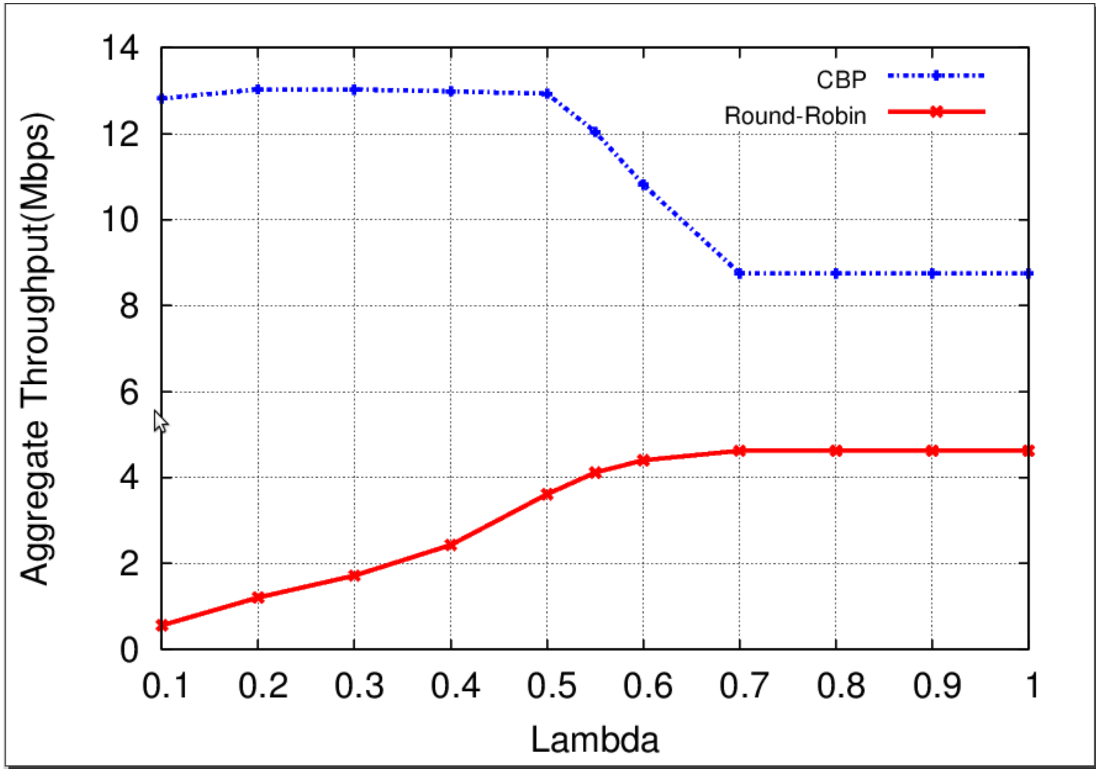
- Each class contains h2h & m2m traffic.
- Classes can goes to 'n'.

Simulation Parameters

Parameter	Values
System Bandwidth	20 MHz
Subcarrier per RB	12
RB Bandwidth	180 kHz
# of active users in cell	9, 12, 18, 24, 30, 36, 42, 48, 90
# of RBs	100
TTI Duration	1ms
Simulation time	1 sec
Simulator	NS3

Calculation of λ

- Upto λ=0.5, H2H throughput is unaffected
- After λ=0.7, both start converging
- λ should be chosen between 0.4 and 0.5



System Throughput Of RR & CBP Schedulers[1]

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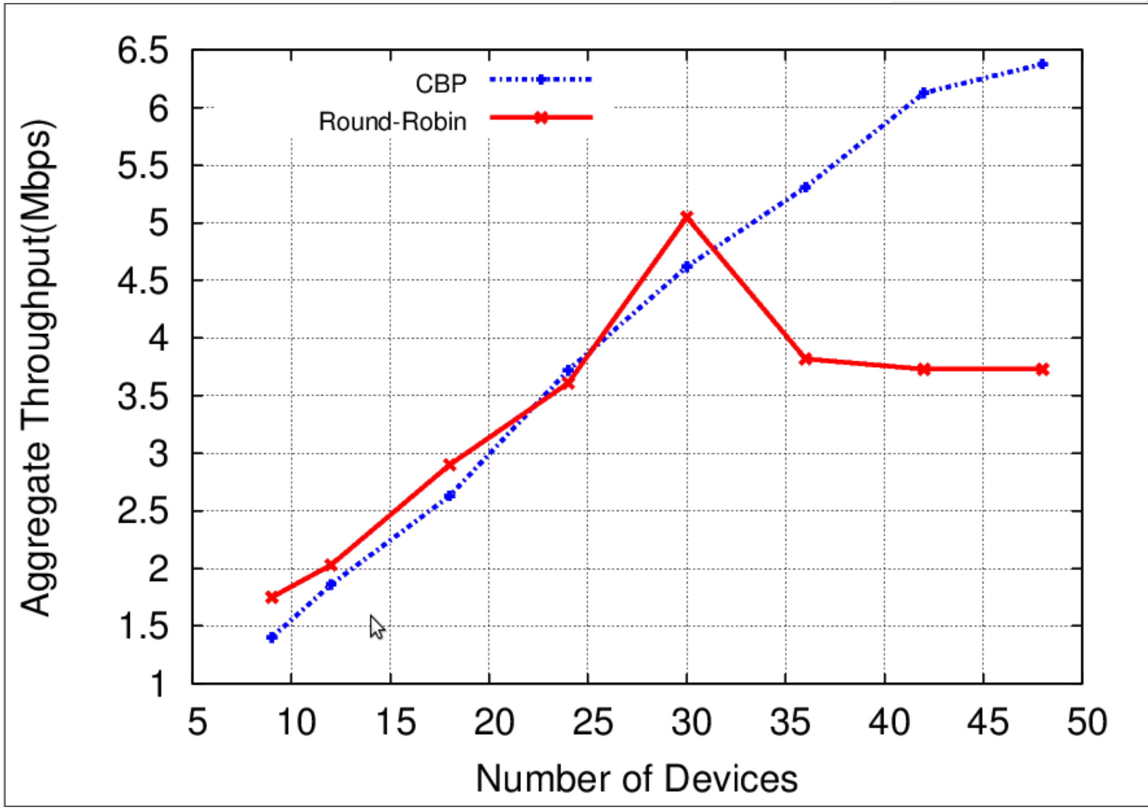
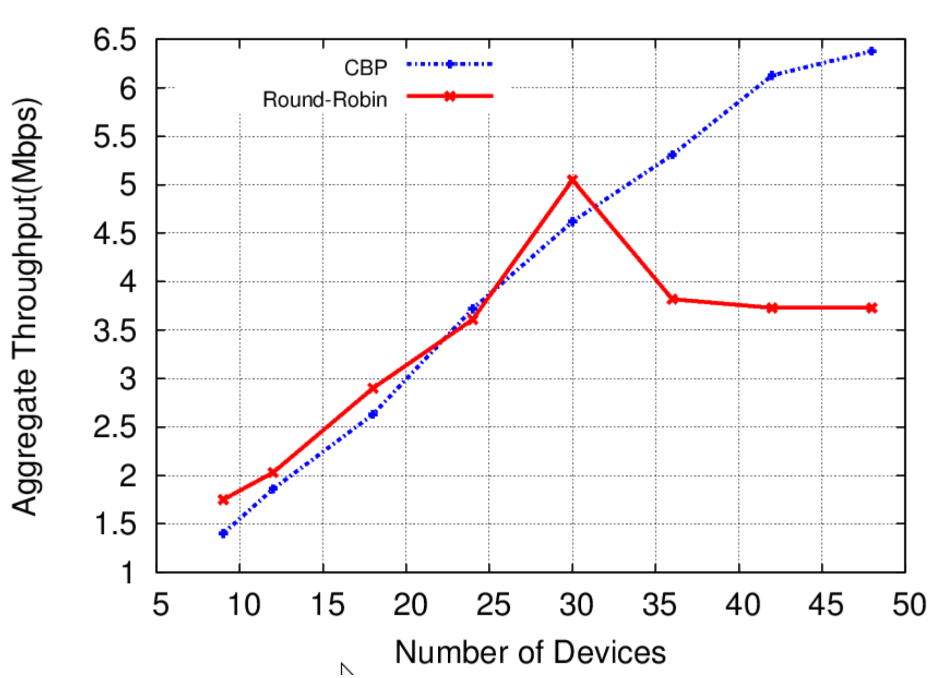
- Total number of devices: 9, 12,18,24,30,36,42,48
- Number of H2H devices: N/3
- Number of M2M devices: 2N/3



UDP Traffic

System Throughput Of RR & CBP Schedules[2]

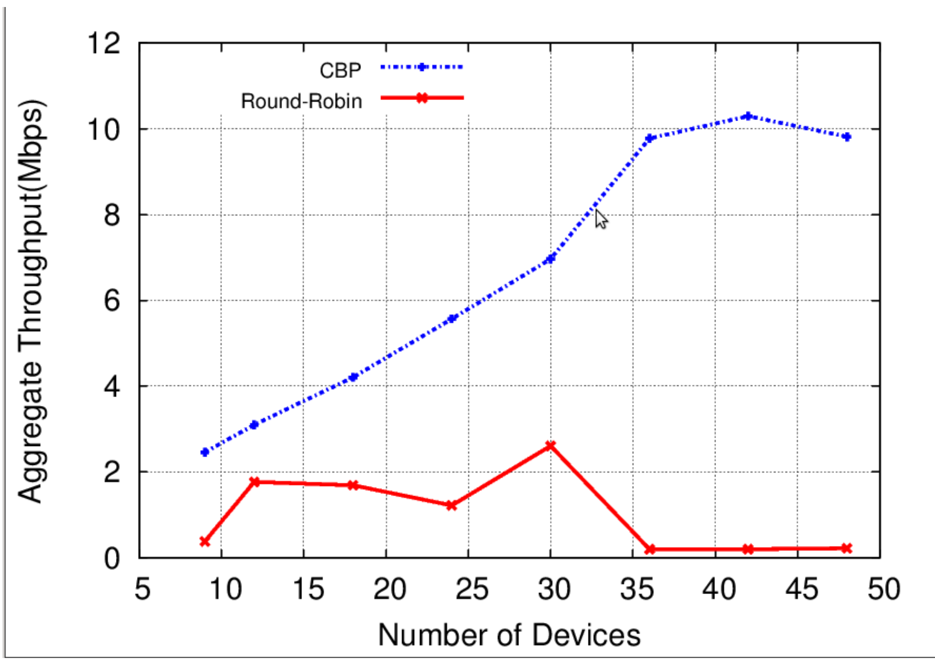


TCP Traffic Parameters:

- PktIntervalTime :

TCP+UDP Traffic Parameters:

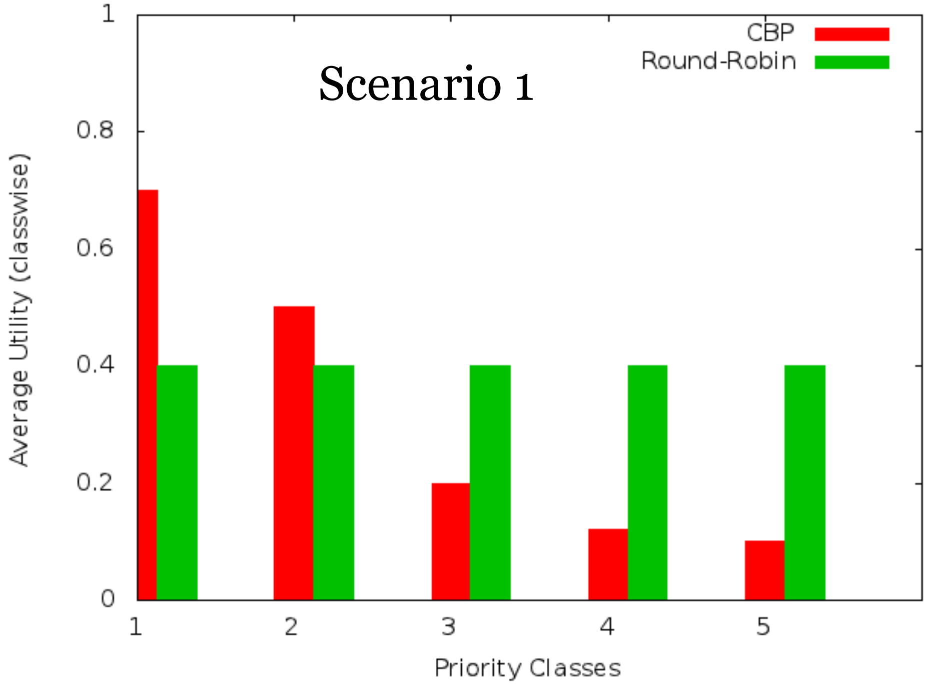
- Utility Matrix :



Distribution of Classes

Priority Class	Scenario 1 (% of UEs)	Scenario 2 (% of UEs)
Class 1	20	40
Class 2	20	30
Class 3	20	10
Class 4	20	10
Class 5	20	10

Classwise Utility Comparison

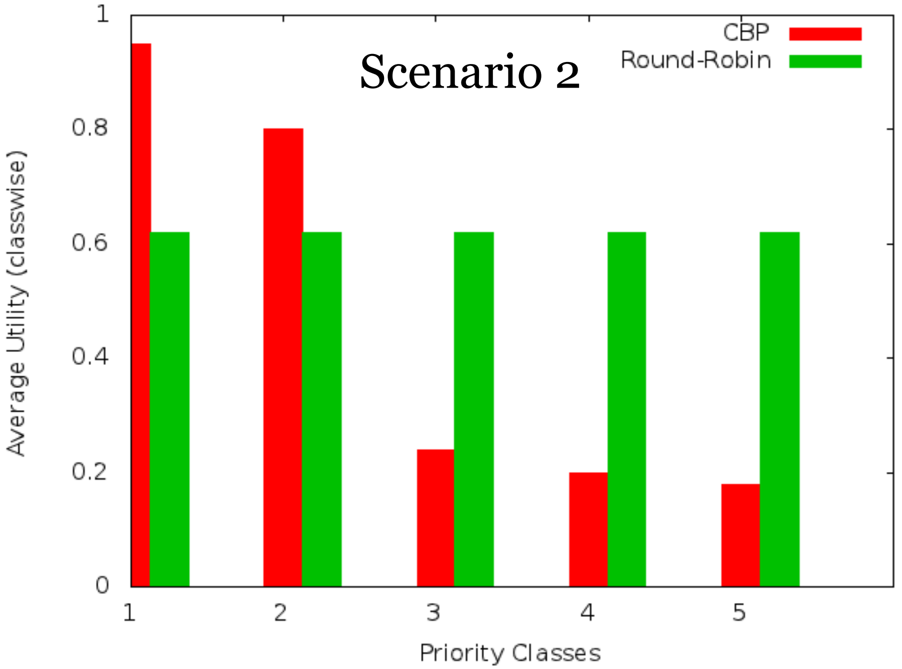


Scenario-1:

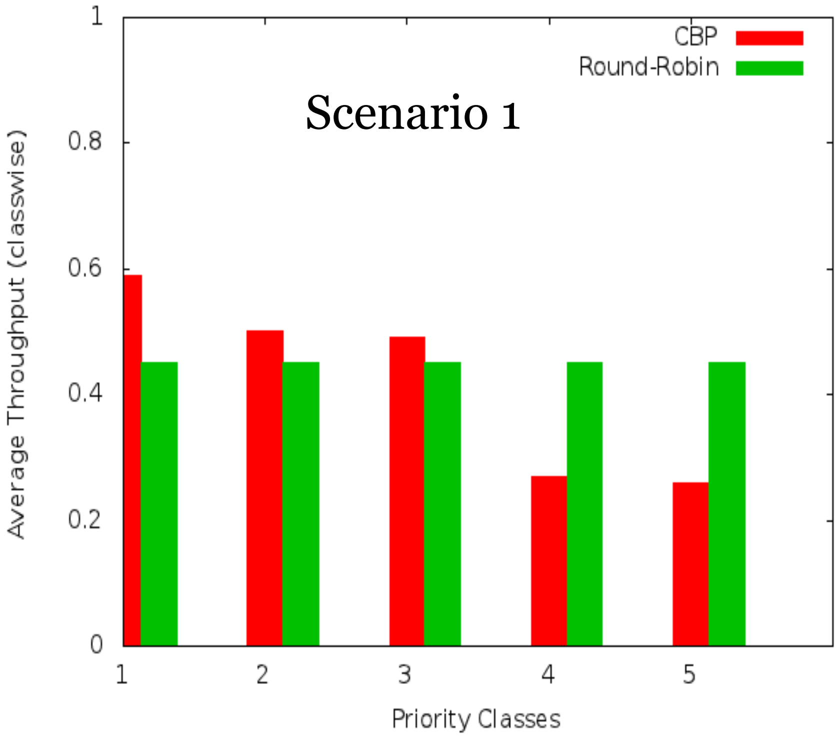
❖ Utility Matrix :

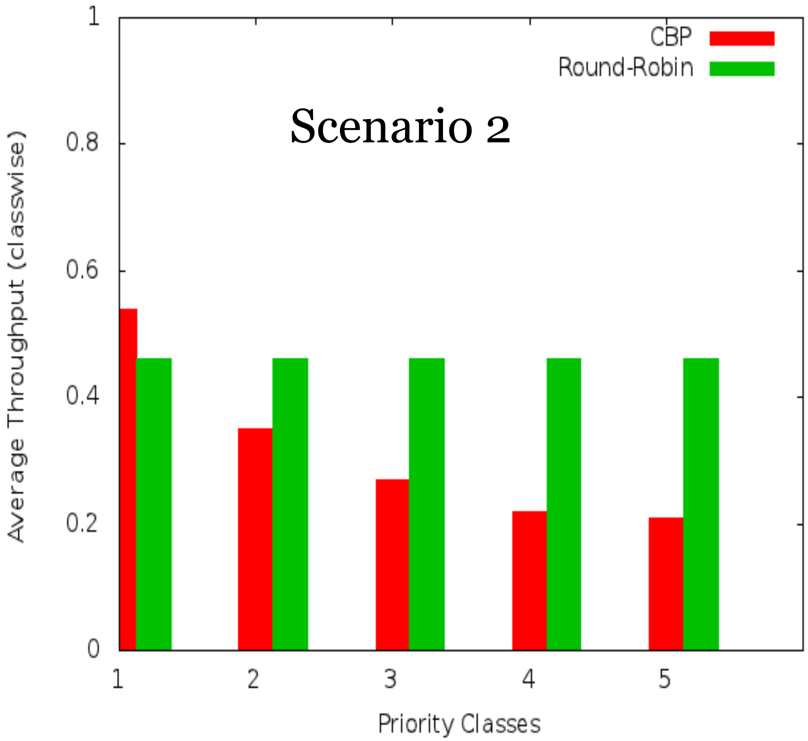
Scenario-2:

❖ .



Classwise Throughput Comparison





Conclusion and Future Work

- Efficient Radio resource allocation schemes for M2M flows are needed
- λ can be taken in between 0.4 and 0.5
- Proposed CBP algorithm compared with RR
  - ✓ For TCP, UDP and mixed traffic
  - ✓ Average per class throughput
  - ✓ Average per class utility
- As future work
  - ✓ Simulate for large number of devices with more specific M2M applications
  - ✓ Compare with Proportional fair algorithm
  - ✓ Reduction in signaling overhead

References

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