Performance and Analysis of WiMAX Network with Different QoS Scheduling Algorithms

Master of Science Thesis

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Content

• Introduction
• The IEEE 802.16 Standard
• WiMAX Modeling in OPNET
• Scheduling Algorithms
• Simulations and Results Analysis
• Contributions and Future Work

Introduction

Motivation:
• Verify the correctness of WiMAX model in OPNET
• Implement the different scheduling algorithms
• Compare the performance of the network with different scheduling algorithms
• and verify which algorithm is suitable to a specific traffic class

IEEE 802.16 Standard

• Introduction
• IEEE 802.16 Standard
• WiMAX Modeling in OPNET
• Scheduling Algorithms/Architectures
• Simulation and Results Analysis
• Conclusion and Future Work
IEEE 802.16 Standard

- Scheduling Services
  - UGS: Unsolicited Grant Service (e.g. Voice)
  - rtPS: real-time Polling Service (e.g. Video)
  - nrtPS: non-real-time Polling Service (e.g. FTP)
  - BE: Best-effort (e.g. HTTP)

- QoS Architecture
  - The scheduler in BS is not specified in the standard

WiMAX Modeling in OPNET

WiMAX Model Structure

- Data Plane
  - Data transmission
  - Receive and manage all packets
  - Transfer control packet to control plane

- Control Plane
  - BS Control
    - Admission control
    - Scheduling Bandwidth request
  - SS Control
    - Setup teardown uplink connection

WiMAX MAC Process Model

- Data Plane
  - Data transmission
  - Receive and manage all packets
  - Transfer control packet to control plane

- Control Plane
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    - Scheduling Bandwidth request
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MAC Throughput:

\[
\text{Bits in frame} - \text{MAC overhead} \over \text{Frame size}
\]

MAC overhead = Preamble + FCH + UL-MAP + Packet header + Contention subchannel

Validation – compare the theoretical and simulation maximum throughput

MAC Throughput = Bits in frame - MAC overhead / Frame size

\[
\text{Throughput} = \frac{\text{Bits in frame} - \text{MAC overhead}}{\text{Frame size}}
\]
Scheduling Algorithm - WRR

- Principle: based on Weight
- Weight = \( \frac{\text{Min reserved traffic rate}}{\sum q_i} \)
- QoS parameter: Min reserved traffic rate

- \( q_1 \) : 50%
- \( q_2 \) : 20%
- \( q_3 \) : 30%

Whole Bandwidth

1st round: \( q_1 \)
2nd round: \( q_2 \)
3rd round: \( q_3 \)

Scheduling Algorithm - EDF

- Principle: Earliest Deadline scheduled
- Deadline = Max latency = Max delay
- QoS Parameter: Max latency

- \( d_1 \) : 20ms
- \( d_2 \) : 40ms
- \( d_3 \) : 10ms

Whole Bandwidth

1st: \( q_3 \)
2nd: \( q_1 \)
3rd: \( q_2 \)

Scheduling Algorithm - MDRR

- Based on Deficit Round-Robin
- Deficit counter: the remaining credits of queue
- Principle: Deficit counter is enough to transmit a packet

- \( \text{dc}_1 \) : 200
- \( \text{dc}_2 \) : 450
- \( \text{dc}_3 \) : 100

Whole Bandwidth

1st packet size = 300 -> \( q_2 \), \( \text{dc}_2 = 450 - 300 = 150 \)
2nd packet size = 200 -> \( q_1 \), \( \text{dc}_1 = 200 - 200 = 0 \)

Scheduling Algorithm - UPS

- Uplink Packet Scheduling
- Strict scheduling Algorithm
- Integrate different scheduling algorithms

Simulation and Results Analysis

Scenario 1: real-time Polling Service (rtPS)
- Service Class and QoS parameter: Max-latency
  - Gold1: 30ms
  - Gold2: 70ms
Simulation and Results Analysis

Scenario 1: real-time Polling Service (rtPS)
- Backlog: packets waiting transmission at Subscriber Station (SS)
- EDF performs better for rtPS

(2) Backlog v.s. Simulation Time

Scenario 2: non-real-time Polling Service (nrtPS)
- Service Class and QoS parameter: Min-reserved-traffic-rate
  - Silver1: 1.5Mbps
  - Silver2: 0.5Mbps
- WRR performs better for nrtPS

(1) Delay
(2) Throughput

Scenario 3: Mixed-traffic Scenario
- UGS+rtPS+nrtPS+BE connections
- UPS v.s. MDRR

(1) rtPS Average Delay
(2) rtPS Average Throughput

Summary

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</tr>
</tbody>
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- UPS performs better than MDRR
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Contributions and Future Work

Contributions

- Verify the correctness of the OPNET WiMAX model
- Implement various scheduling algorithms/architectures for WiMAX
- Examine and verify EDF is suitable for rtPS, WRR is suitable for nrtPS
- Examining the UPS outperforms MDRR

Future Work

WiMAX Model part:
- Optimize the backoff mechanism for BE traffic in WiMAX model

Algorithm part:
- Optimize UPS algorithm to provide fairness between different traffics

Simulation part:
- Observe more different and complex scenarios
- Analyses other performance metrics, like bandwidth utilization

Thanks for your attention!

Questions?