Load Balancing among Access Points

Master Thesis

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Outline

Outline

The Basic Problem

- What is load balancing?
  - Distribution of load among wireless APs (Access Points).
- Why?
  - Wrong metric.
    - Signal strength.
  - Available capacity not increased
    - due to wrong metric.
- Problem exists and needs solution!!!

Outline

Objectives

- Motivation
  - Use the available capacity
    - optimal way
- Calculate the effectiveness of each algorithm
- Improve an existing algorithm
  - metric
    - rate
    - throughput

Outline

Previous Work
Studies In Load Balancing

- Many Studies.
- Each proposed different approach
  - Software oriented.
    - Centralized structures.
    - Decentrilized structures.
- Software approach
  - No essential change in the access point.
  - Just adding an extra feature.

Outline

Distance
Description

- Distance Algorithm
  - Connect to the closest access point.
    - Closest = stronger signal.
  - Load metric
    - None.
  - Load Balancing
    - Pure luck.
    - Generally, no balancing.
- Excuse for talking about load balancing.

LBA
Description

- Introduce LBA to the APs.
  - Load Balancing Agent.
- Periodically broadcasts the load level of its AP.
  - Load metric: $L = \frac{\sum B_i}{n}$.
    - Load Blanacing index: $\beta = \frac{(\sum B_i)^2}{(n \sum B_i^2)}$.
- Three possible states
  - Overloaded.
  - Under-loaded.
  - Balanced.

LBA
States' Description

- Overloaded
  - Does not accept new stations.
  - Force handover of current stations.
- Under-loaded
  - Willing to accept new stations
    - Roaming from near APs.
    - Entering the network.
- Balanced
  - Only accept new stations entering the network.
- Two goals achieved
  1. Decentralized structure.
  2. No need to modify existing wireless LAN stations.

Theta (θ) Algorithm

Description

- Load estimation procedure
  - based on load metric

$$\vartheta = \sum_{r} \frac{N_r}{r}$$

    - r = rate transmission.
    - N_r = number of stations with transmission rate r.
- Implemented in a software module
  - running on a Linux workstation.

Theta (θ) Algorithm

Description

- Module communicates with APs using SNMP
  - Simple Network Management Protocol.
  - Obtains
    - Number of stations associated with each AP.
    - Corresponding transmission rate from the AP to the stations.
  - Information is retrieved using the SNMP get method.
  - Information retrieval is performed periodically
    - every one minute in the experiments.

Theta (θ) Algorithm

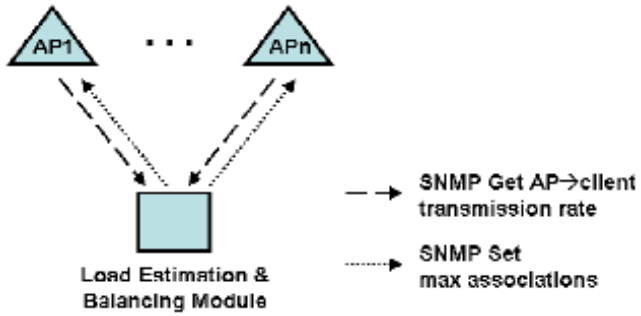


Figure: Communication of the load estimation and balancing module with access points using SNMP. The module obtains the number of stations and the transmission rate from the access point to the station, and sets the maximum number of associations based on the load estimation.

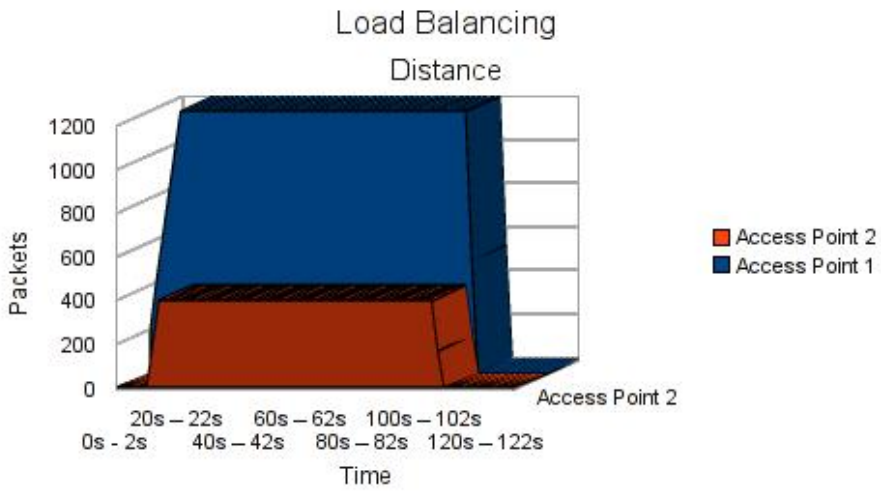
Outline

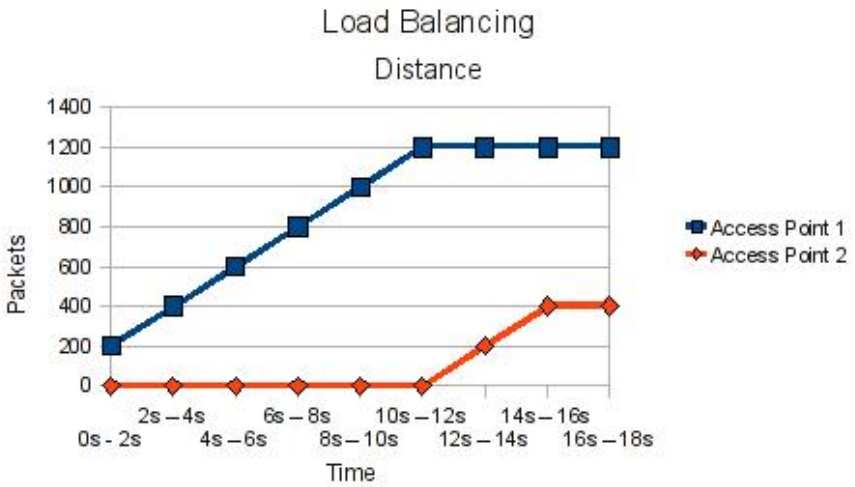
Our Implementation

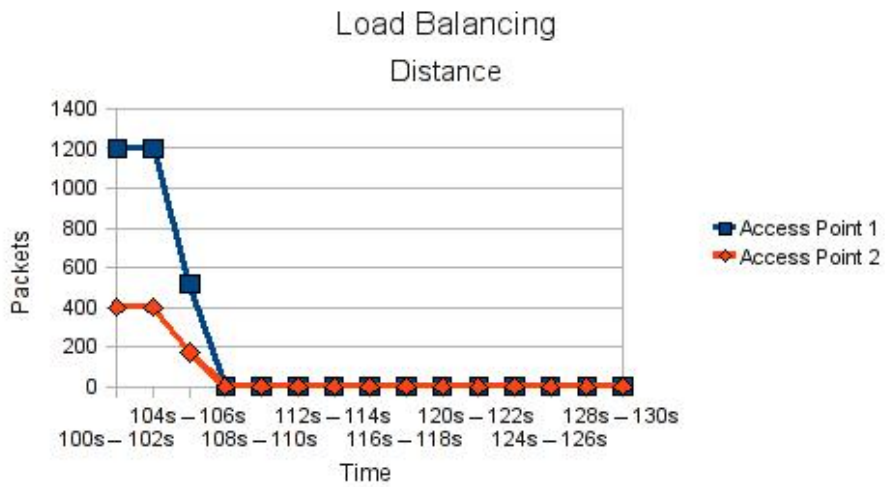
- Simulator
  - OMNeT++
    - Version 4.0p1
    - Version 4.1 released in June 14, 2010
- Basic scenario
  - 2 access points
    - 802.11g
  - 8 clients
    - same rate
    - different rate
  - Video streaming
    - UDP packets

Distance

Charts - Same rate - UDP

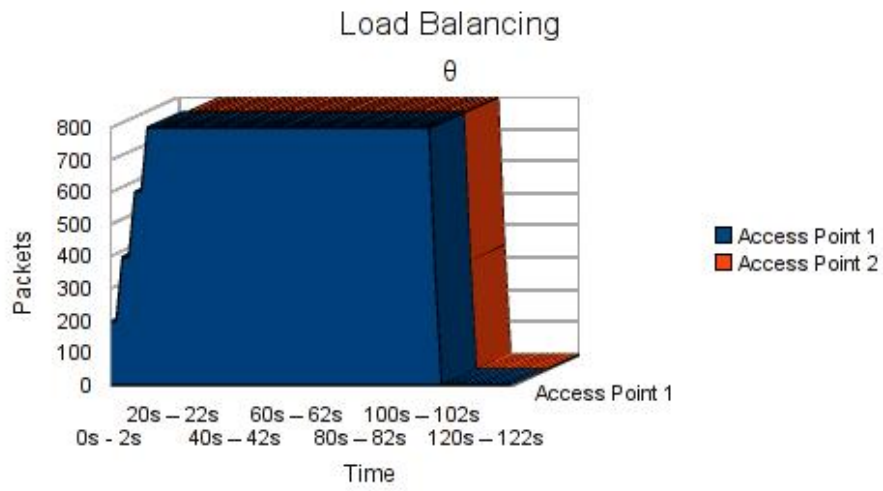


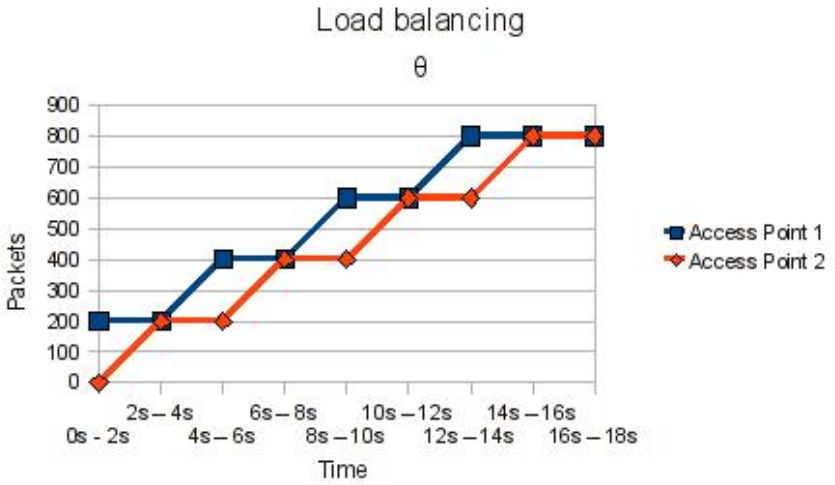


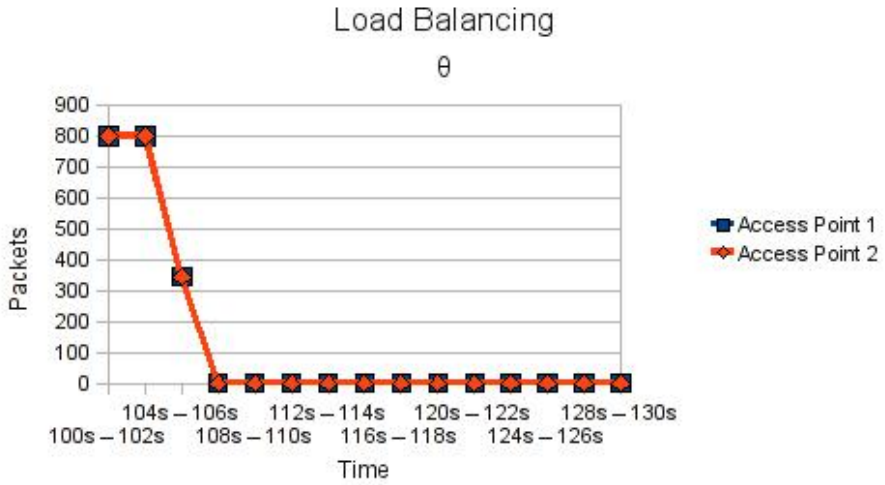


Theta Algorithm

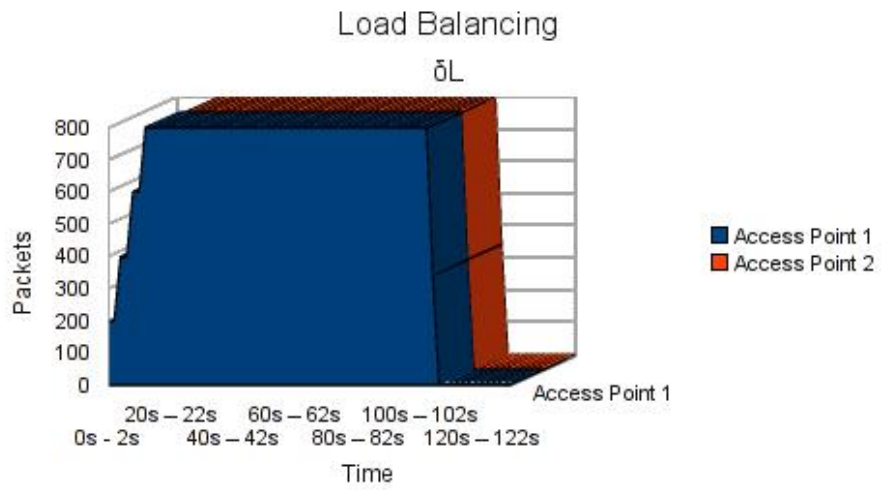
Charts - Same rate - UDP

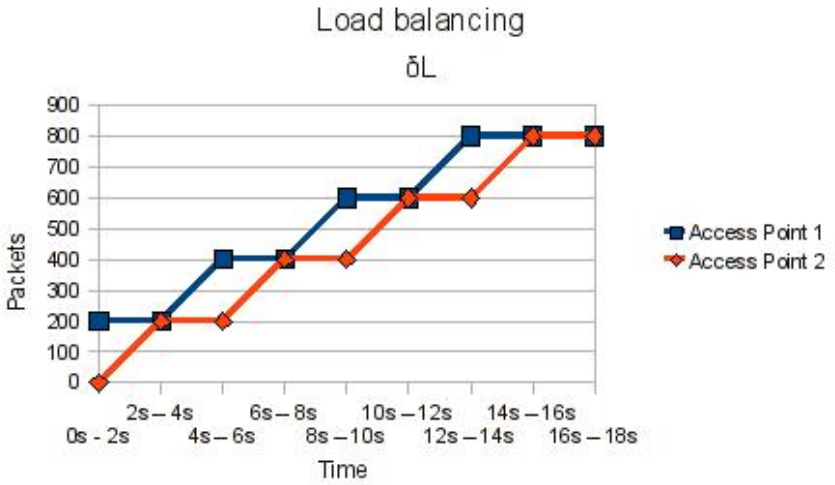


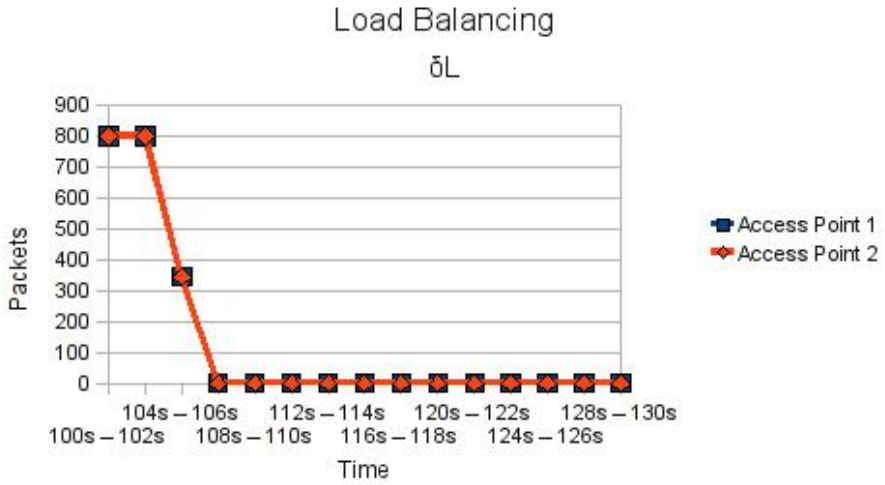




LBA
Charts - Same rate - UDP







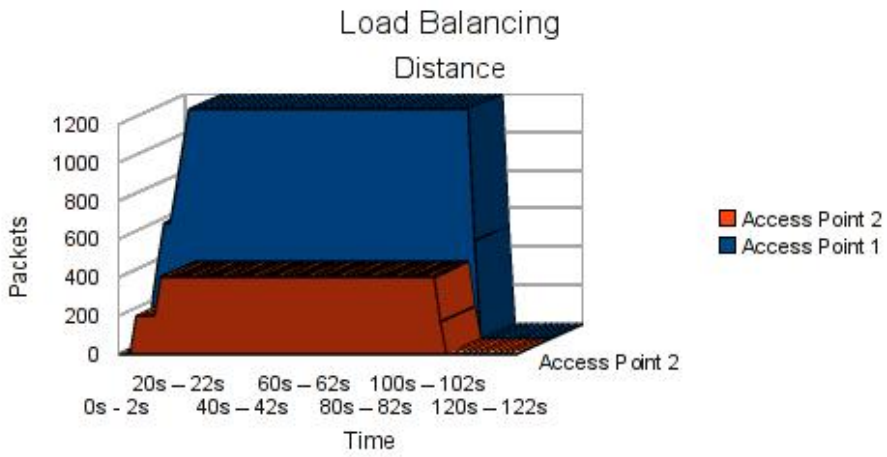
Various Rates

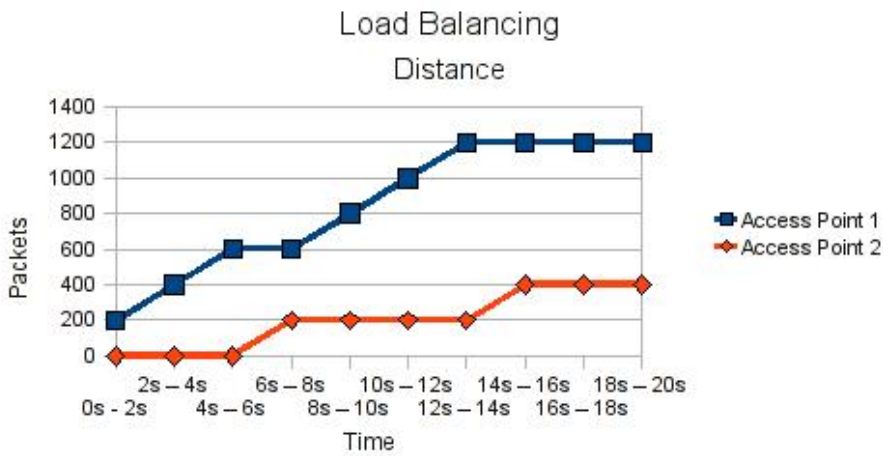
- Clients connect in various rates

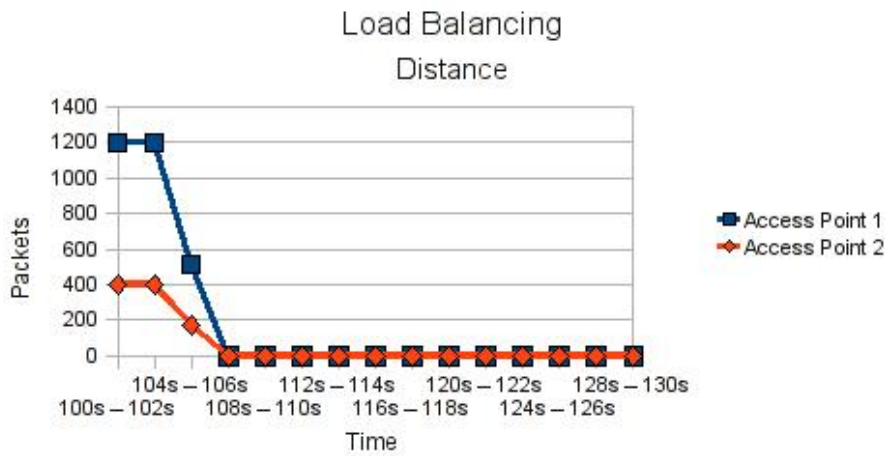
Client	Rate (Mbps) - AP1	Rate (Mbps) - AP2
Client1	54	24
Client2	24	11
Client3	11	2
Client4	24	54
Client5	54	24
Client6	24	11
Client7	11	2
Client8	24	54

Distance

Charts - Various rates - UDP

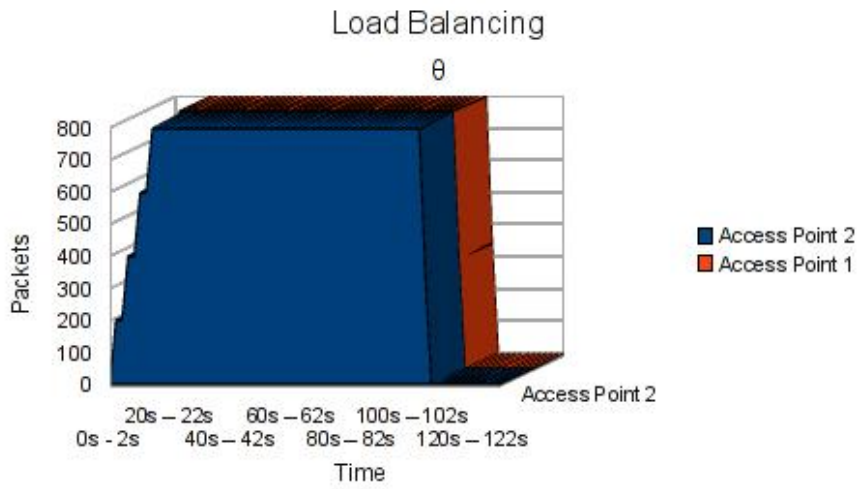


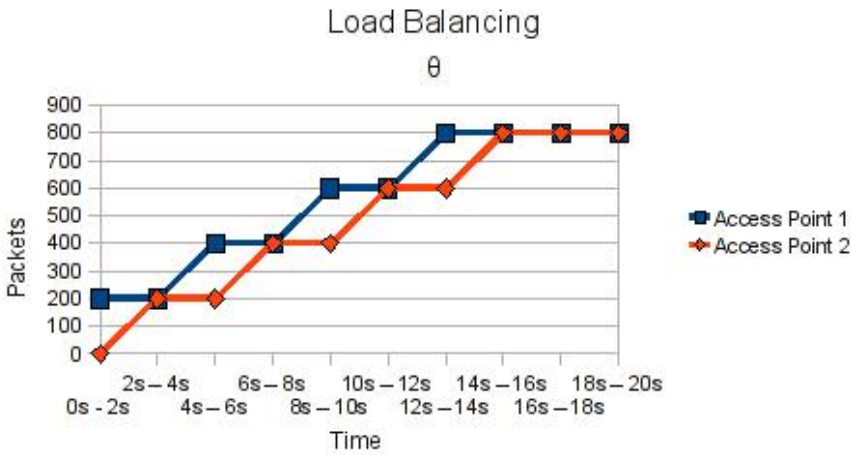


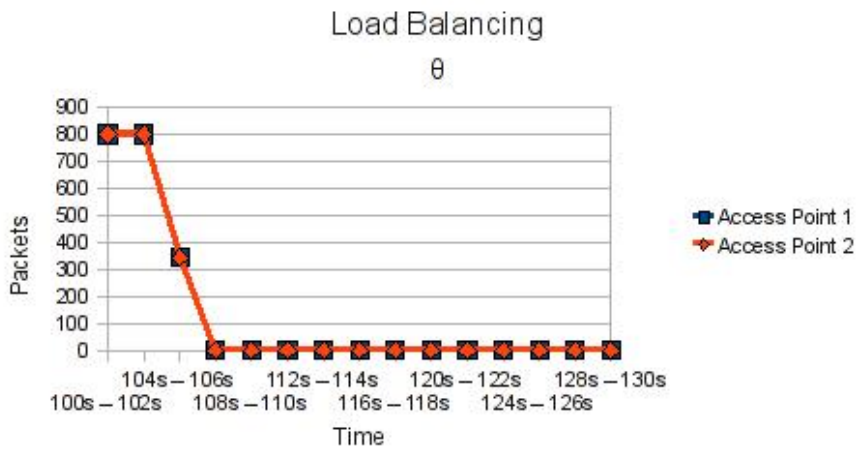


Theta Algorithm

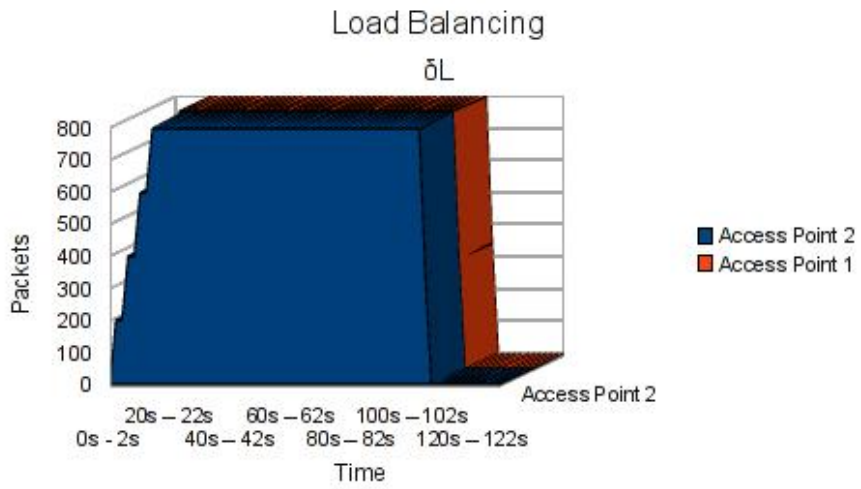
Charts - Various rates - UDP

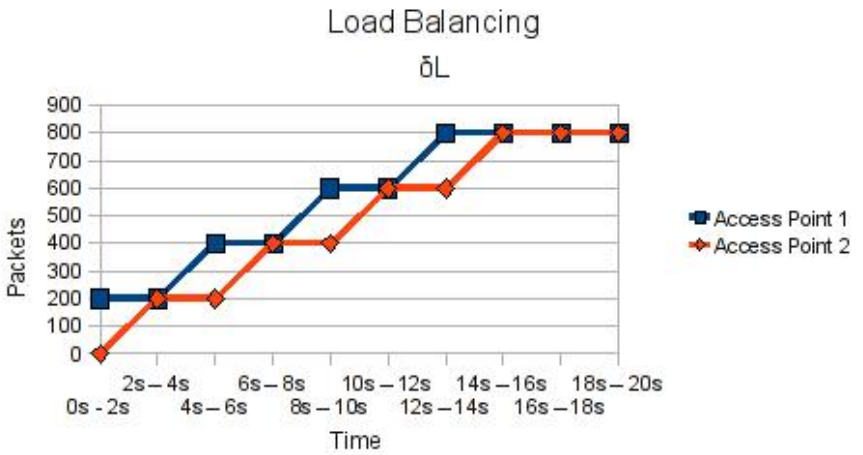


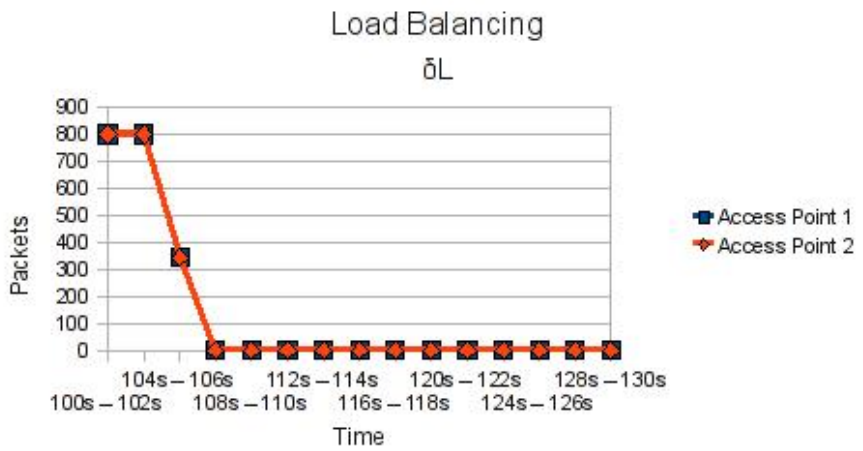




LBA
Charts - Various rates - UDP







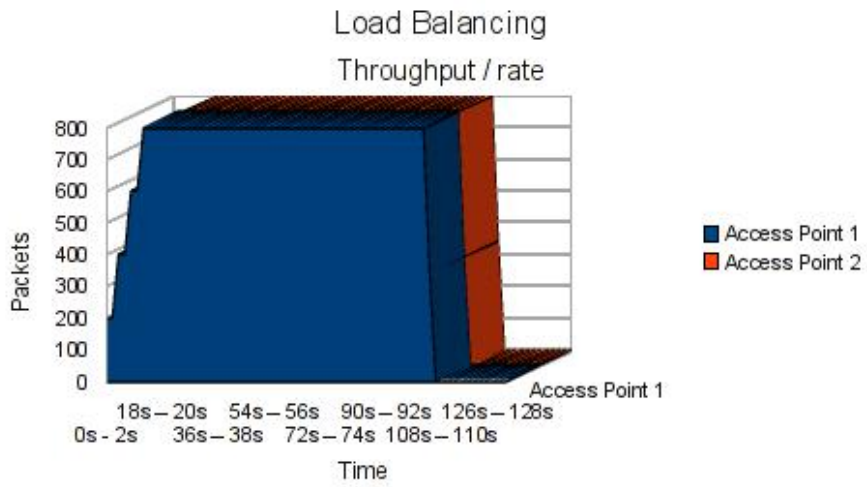
Outline

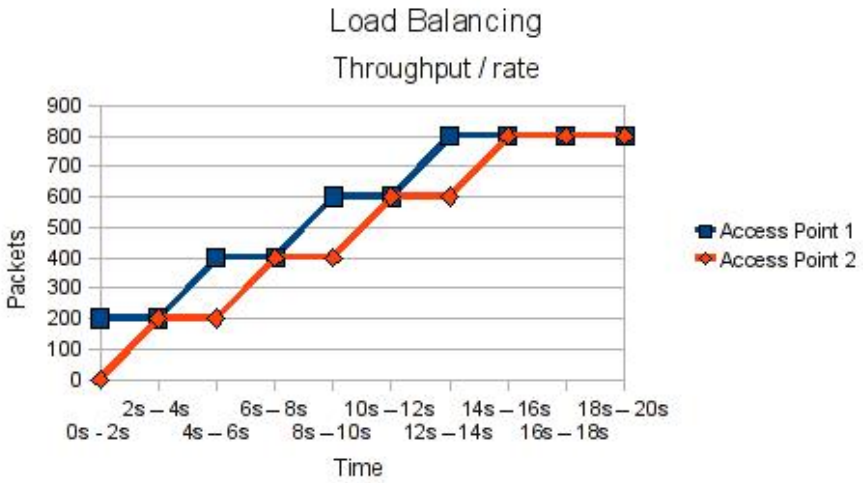
Main Thoughts
Improving Theta Algorithm

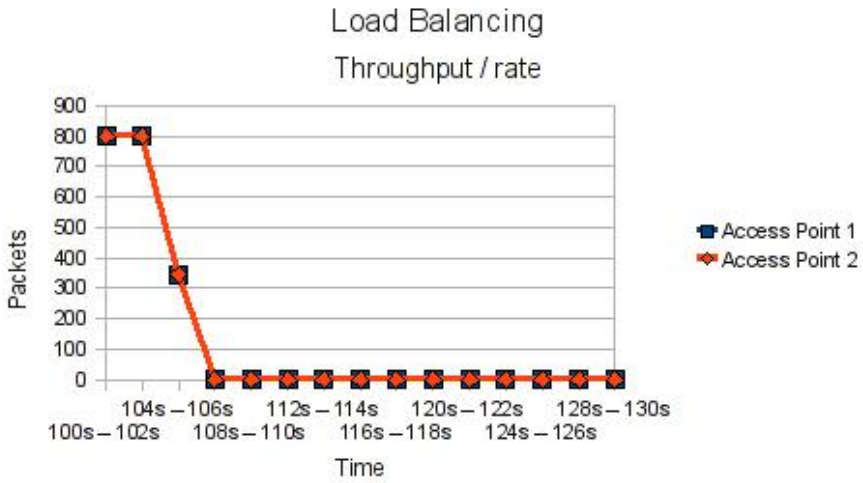
- Improve the algorithms proposed
  - especially the Theta algorithm.
- We introduce a slightly different algorithm
  - New theta:
$$\vartheta = \sum_r \frac{N_r B_r}{r}$$
  - B_r = Throughput of each access point
    - corresponds to the specific client with rate r.
  - N_r = number of stations connecting to each access point at rate r.
- Main difference
  - Taking under consideration both throuhput B_r AND rate r.

Theta Algorithm

Charts - Same rates - UDP

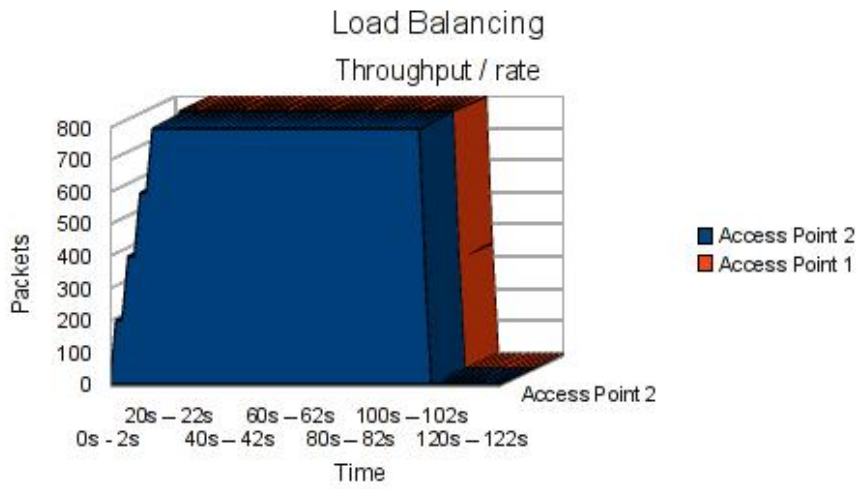


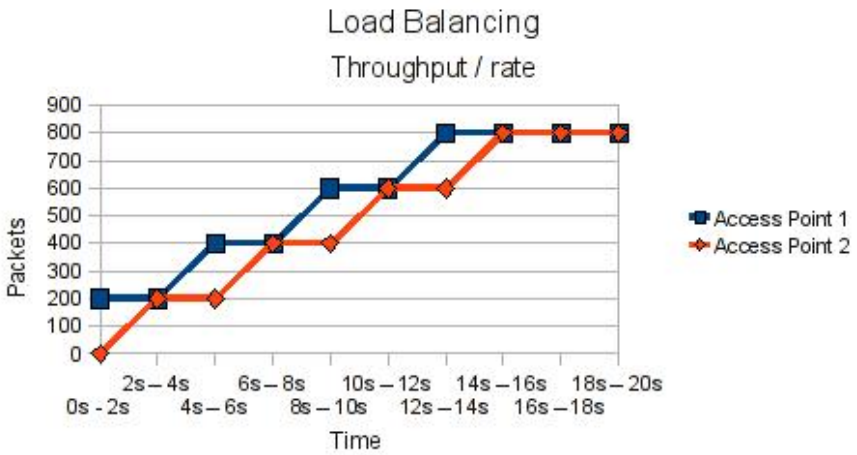


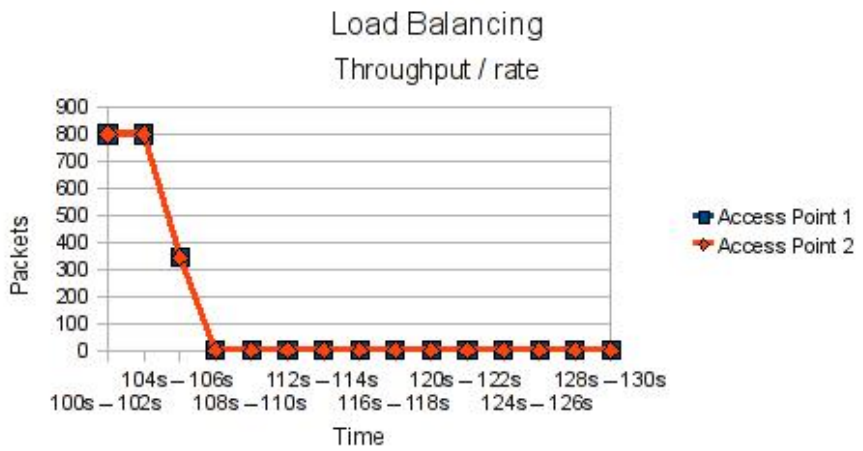


Theta Algorithm

Charts - Various rates - UDP







Summary

- Load balancing becomes a great problem.
- APs and stations need to be improved on this matter.
- Looking for the less invasive way to accomplish this goal.

Future Work

- Improve the Theta algorithm
  - Throughput *and* rate are equally important to balance the load among the access points available.
- More access points
  - Study implementations with more load distribution.

Articles For Further Reading I

Velayos, H. Aleo, V. Karlsson, G.
Load balancing in overlapping wireless LAN cells
Communications, 2004 IEEE International Conference on. Pages: 3833-3836, Vol.7, 20-24 June 2004.

Vasilios A. Siris and Theodoros Dionisiou
Load Balancing among Access Points in Multi-Rate Wireless LANs

Murad Abusubaih and Adam Wolisz
An Optimal Station Association Policy for Multi-Rate IEEE802.11 Wireless LANs
Proceedings of the 10th ACM Symposium on Modeling, analysis, and simulation of wireless and mobile systems. Pages: 117-123, 2007.

Articles For Further Reading II

Velayos, H. Mas, I. Karlsson, G.
Overload Protection for IEEE 802.11 Cells
Quality of Service, 2006. IWQoS 2006. 14th IEEE International Workshop on. Pages: 149-158, 19-21 June 2006