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with Bloom Filters
Reducing Ethernet Broadcast
Overview

Conclusions

Initial results

Reducing Ethernet broadcasting with Bloom Filters

Introduction
A well-known inefficiency in large local area networks

The Address Resolution Protocol (ARP) has not changed

- 802-based switching (VQP)
- Multi-layer traffic classification

Switching devices are becoming increasingly powerful

- Becoming much larger than originally envisaged
- Increasing data rates

Local area networks trend:

Introduction
Reducing Ethernet Broadcast with Bloom Filters

4. Add entry to local ARP cache.
3. Target sends reply directly.
2. Broadcast request on LAN.
1. Check local ARP cache for entry.

Resolution Overview:
- Defined in RFC 826 (November 1982).
- Network to MAC Layer Identifier Resolution.

Address Resolution Protocol (ARP)
Reducing Ethernet Broadcasting with Bloom Filters

- Zipf-like distribution
- Campus Gateway: 2,779,606 messages
- ARP Originators

ARP Originator Distribution
ARP Target Distribution

More even distribution
65,720 distinct addresses
ARP targets
Aims

1. Break existing networks
2. Modify larger set of end-systems
3. Adversely affect data rates

Do:

Do Not:

Reduce broadcasting due to ARP request messages
Reducing Ethernet Broadcast with Bloom Filters

Proposed Solution: Bloom Filters

Problem: Computational and spatial overhead

1. Look up target IP address in remembered addresses
2. If found, send along appropriate port
3. Otherwise, broadcast

Algorithm:

Remember IP addresses seen on a switch's ports

Modify Switch behaviour

Switch Optimisation
Reducing Ethernet Broadcast with Bloom Filters

Problem: False positives cause inaccuracy

1. Pass object through hash function

To add an object:

• Bits to be set in array determined by a hash function

• Objects represented in an m-bit array initially set to zero

An approximation of a set of items

Bloom Filters
Reducing Ethernet Broadcast with Bloom Filters

Example One:

- 148.88.152.251 - 1001 - Port 2

Example Two:

- 148.88.152.153 - 0001 - Ports 2 & 3

Example Three:

- 148.88.153.199 - 0010 - Broadcast

An Example Switch
Reducing Ethernet Broadcasting with Bloom Filters

-- Introduce Bloom filter representing all requests seen

Proposed Solution:

-- Request may NOT reach target

Result:

Problem:

Incorrect Port Selection Problem
• Zipf-like resolution distribution

• Simple hash function for Bloom filters

• Addresses learned from ARP request messages only

• Generated messages one-hundred times the topology size

• Run simulations over increasing network sizes

• Hosts randomly assigned to switches

• Switches arranged in random tree topology
Reducing Ethernet Broadcast with Bloom Filters

Switch ARP Traffic
Reducing Ethernet Broadcast with Bloom Filters

Percent Broadcast at Switch

Percent Broadcasts

End-systems

Perfect Random

Perfect Zipf

Simple Random

Simple Zipf
Reducing Ethernet Broadcasting with Bloom Filters

Average Retries Per Message

End-systems

Perfect Random

Perfect Zipf

Simple Random

Simple Zipf

Average Retries

0.005

0.01

0.015

0.02

0.025

64

128

256

512

1024

2048

4096
Reducing Ethernet Broadcast with Bloom Filters

End-system ARP Traffic

Percent ARP Traffic

- Simple Zipf
- Simple Random
- Perfect Zipf
- Perfect Random
Need to consider security implications

Initial results show promise

Use Bloom filters to alleviate computational and spatial overhead

Reduce broadcasts by learning address to port associations

ARP broadcasts could be problematic in very large LANS

People are building large switched networks

Conclusions