Mitigation Techniques

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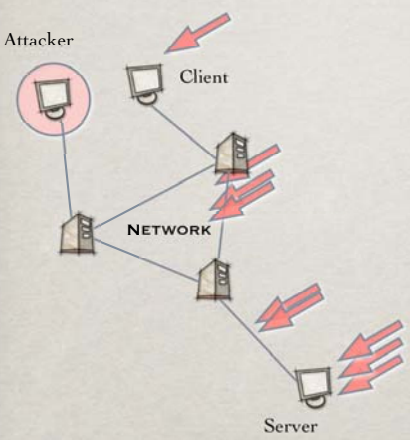
Introduction

The "Worm Space"

Network as a Victim

TCP Congestion Control



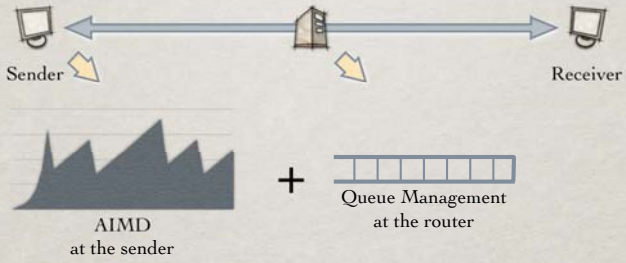
Worms

- Intent
- Propagation
- Vulnerability
- Victim

Network as Victim

- **Protocol Attacks**
  - Misbehaving Receiver Attack
  - The Shrew Attack
- **Packet Flooding attacks**
  - DoS on Network (TCP Congestion Control)
- DoS on Hosts (Under-provisioned Host)

TCP Congestion Control



The Queue drops packets

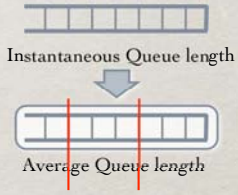
TCP treats packet drops as a congestion signal

TCP Congestion Control Detailed

DropTail Queueing

- End to End Latencies are high
- Synchronization of flows

RED Queueing



Probabilistic Dropping

RED Queueing

- High bitrate flows
  Punished by **proportionally** dropping more packets.
- Responsive flows
  Punished by signalling **more** congestion events.
- Mixed flows
  Attack traffic (High Bitrate)
  + Benign Traffic (Responsive)
  Responsive traffic suffers the most.

Attacking TCP

Weaknesses in TCP

Previous Related Presentations

How to Attack TCP?

- Usage of network traffic which is **Unresponsive** and **High Bitrate**
  - Single or multiple sources
- Not a network attack...
  - Most TCP SYN floods
  - Misbehaving TCP Receiver and Shrew

Past Presentations

- Attack traffic analysis
  - Spectral Analysis (Fourier,PCA,Wavelets)
  - Network Telescopes and Backscatter
  - Statistical Classification
- Signature Detection
  - Snort, Bro, Signal Processing, AI

Mitigation

Aggregate Congestion Control (ACC)

Local ACC ⟷ Pushback

"Controlling High Bandwidth Aggregates in the Network"
Computer Communications Review
Ratul Mahajan, Steven M. Bellovin, Sally Floyd, John Ioannidis
Vern Paxson and Scott Shenker

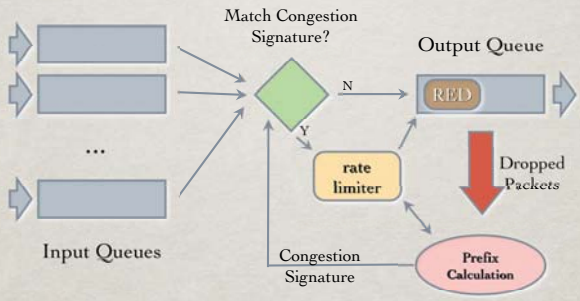
Aggregate Congestion Control

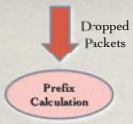
- Differentiate attack and benign traffic
  - Network level "Congestion Signature"
  - Rate limit traffic matching "congestion signature"
- Collateral Damage
  - Benign traffic matching congestion signature

Local ACC

- Detecting aggregates at the "local" router.
  - triggered on "sustained congestion" (drop rate > P_{high} for K seconds)

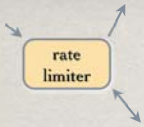
Local ACC Setup





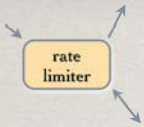
Detecting Aggregates

- Destination Address Prefixes
  - Empirically found to be a better fit
  - Find prefixes with...
    - High Aggregates
    - Least Collateral Damage



Rate Limiting

- Many Challenges
  - How much?
    till ambient drop rate at output queue is P_{target}.
  - False positives and negatives
- Rate limit "congesting" flows by same amount (Limit > max "non-congesting" flow)
- Flash Crowds: bound no. of rate limited flows



Rate Limiting

Contd...

- Measure **arrival rates** of rate limited flows
- Revisit rate-limiting periodically
  - Remove potentially benign flows from limiter
  - Avoid sudden changes in rate limits (?)
- Rate limited packets also go through RED

Simulations

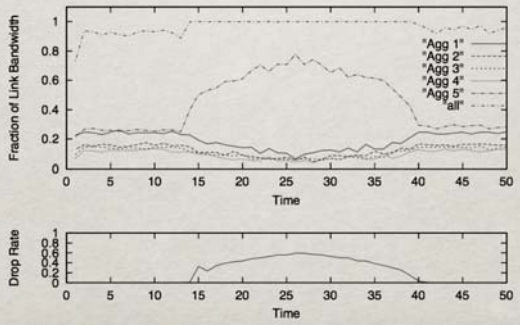
Local ACC

- 5 aggregates
  - aggregates 1-4 are CBR flows
  - we change aggregate 5's rate

Simulations

Local ACC

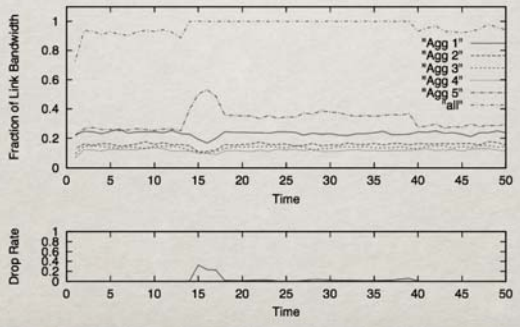
- Without Local ACC



Simulations

Local ACC

- With Local ACC



A Packet Dropped is a Packet Lost

So why not drop it right in the beginning?

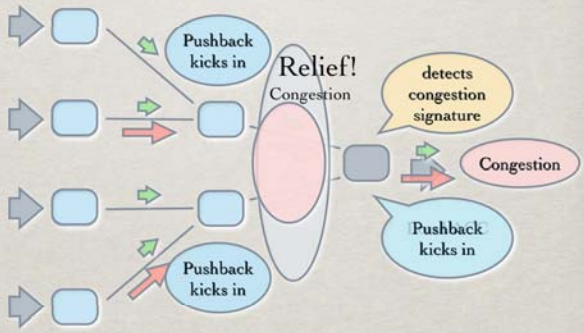
Pushback

- Rate limiting is propagated upstream
- Triggered when an aggregate's arrival rate is high for several seconds

Local ACC **Pushback**

"Congestion Signature"

Pushback



Pushback Contd...

- Congestion Contributing Links
  - Aggregate's arrival rate division
  - Max - Min division
- Pushback requests to upstream routers
  - Rate limit traffic **going to congested router**

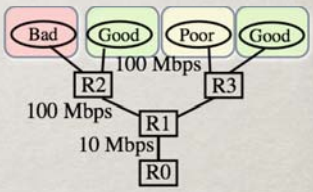
Pushback Contd...

- Upstream routers send **feedback messages**
  - includes "total arrival rate for aggregate"
- Pushback refresh messages
  - Downstream routers calculate new rates
  - Auto terminate pushback rate limiting
- Attacking pushback by rotating on-off flow

Simulations

Pushback

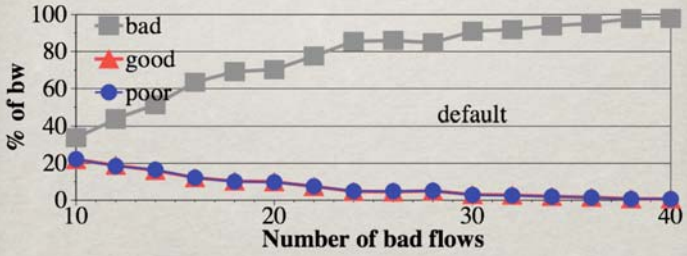
- Vary no. of bad flows
- Experiments
  - no ACC
  - Local ACC
  - Local ACC with Pushback



Simulations

Pushback

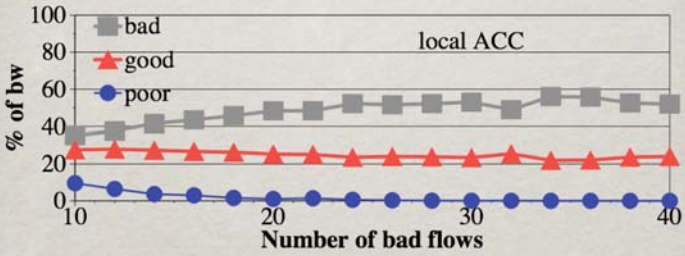
- No ACC



Simulations

Pushback

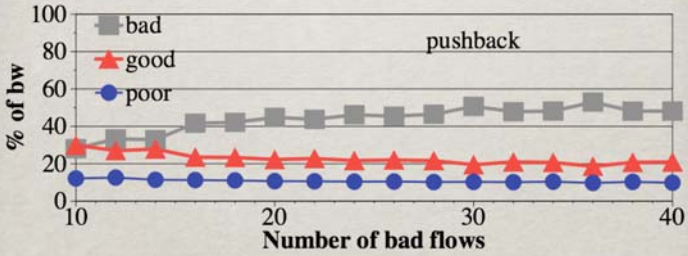
- Local ACC



Simulations

Pushback

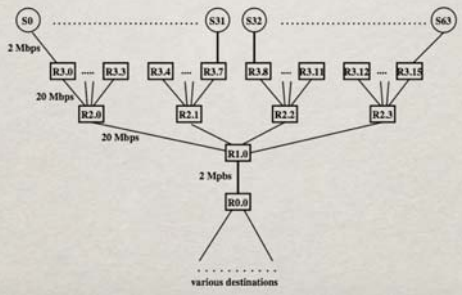
- Local ACC + Pushback



Simulations

Pushback

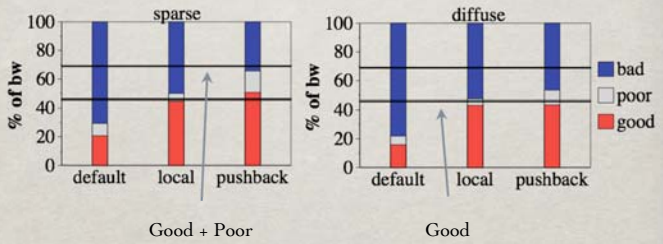
- Comparing sparse and diffuse DDoS attacks



Simulations

Pushback

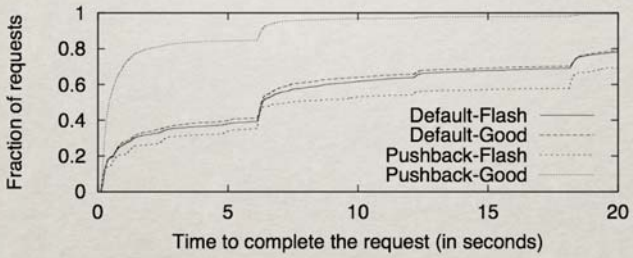
- Sparse vs Diffuse DDoS



Simulations

Pushback

- Handling Flash Crowds



Discussion

- Fear of Collateral Damage
- Studies using actual traffic traces
- Possibility of using Local ACC itself for a DoS attack
- Security of Pushback Protocol itself
- Any more comments...?