Timer Interaction in Route Flap Damping

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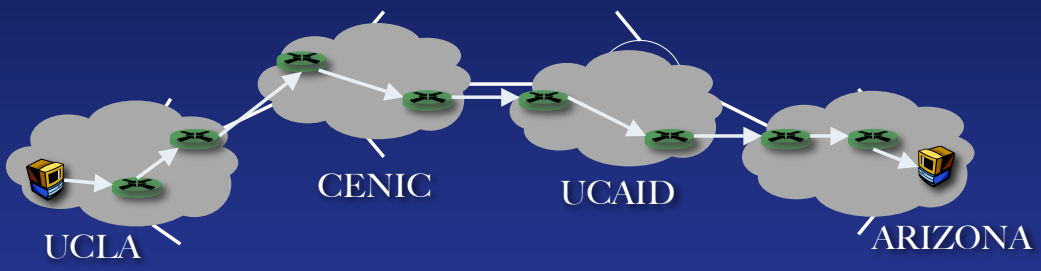
This Talk

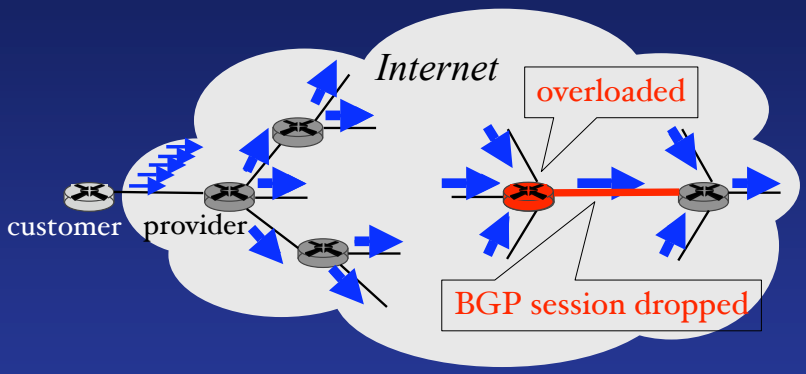
- *Route Flap Damping* is a key mechanism in BGP to maintain global routing stability.
- It's plagued by unintended interactions in the network.
- Robust Damping using root cause notification.

Internet Inter-domain Routing



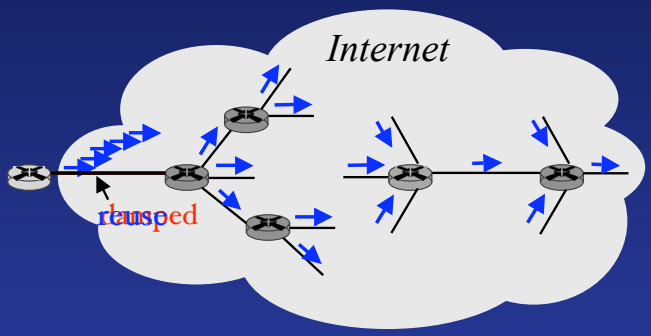
- *Autonomous Systems (AS)*
- *Border Gateway Protocol (BGP)*
- A large scale, loosely coupled global routing system
  - local protocol action ➔ global system behavior

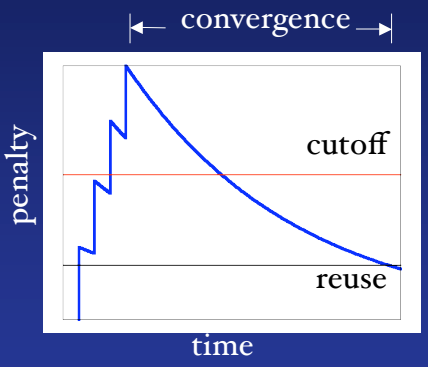
Route Flapping



- Route Flap: a change of path
  - link up and down etc.
  - triggers routing updates in the network
- Frequent flaps destabilize global routing
  - worm attacks, flaky edge networks etc.
  - topology growth will only make it worse in the future
  - "Earthquake ➔ Tsunami" in the Internet

BGP Route Flap Damping





- Convergence Time: from when the path stops flapping to when the entire network learns the stable path
  - Data traffic to customer network may be negatively affected.

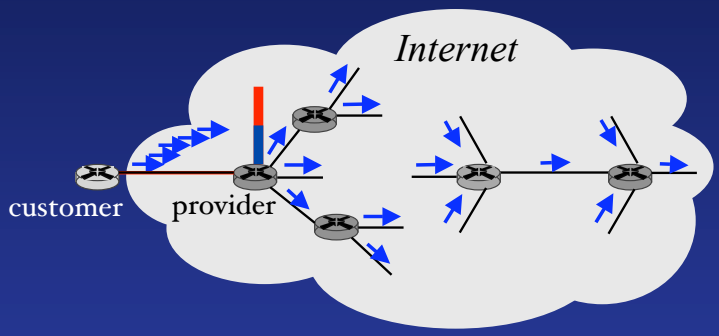
Block (damp) frequent flaps

- Increase penalty, if route flaps
- Decay penalty exponentially

Damping in Network Operation

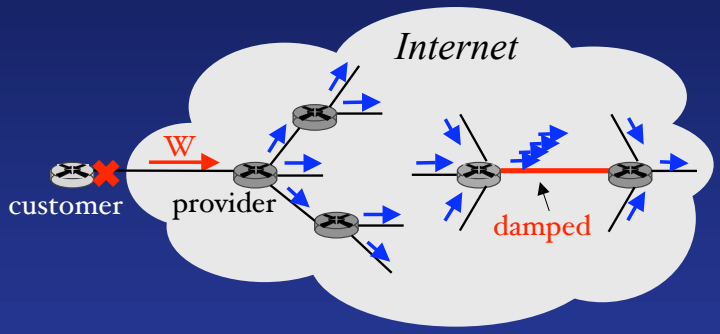
- A key mechanism in maintaining global routing stability.
  - proposed by router vendors in mid 90s
  - specified in RFC 2439
  - implemented by all major vendors
  - we still see update spikes during worm attacks
- Our survey shows that it's enabled by some ISPs, but not all.
- A main reason is customer's complaint of unexpected long convergence time.
  - focus of this work

The Intended Behavior



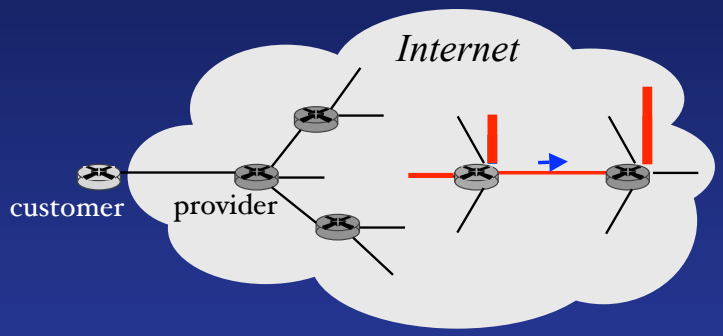
- The convergence time depends on the reuse timer at the origin router.
- Persistent flaps are suppressed without extra delay.

Path Exploration



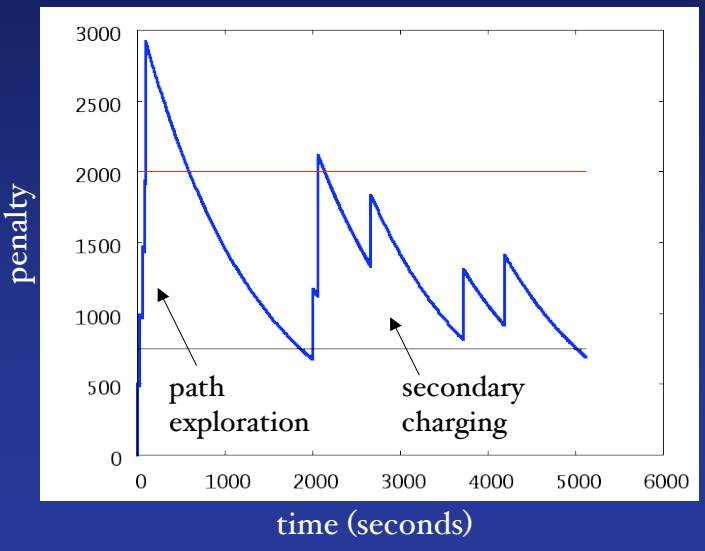
- A single withdrawal may trigger false damping *in the network*
  - BGP explores alternate paths after a withdrawal.
  - More often in a denser topology.

Secondary Charging



- Reuse messages re-charge penalty values at other routers
  - different routers may reuse at different time.
  - prolong convergence time

Example

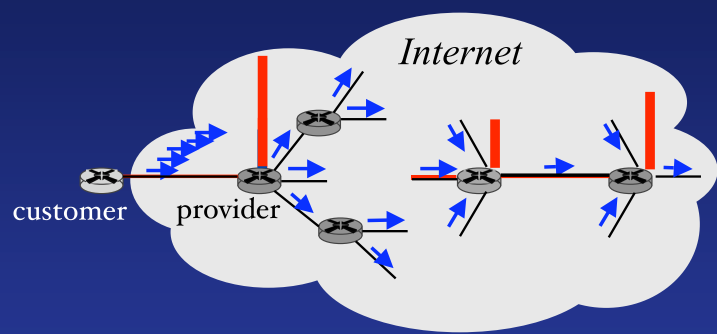


Convergence time:

Secondary charging (60% - 70%)

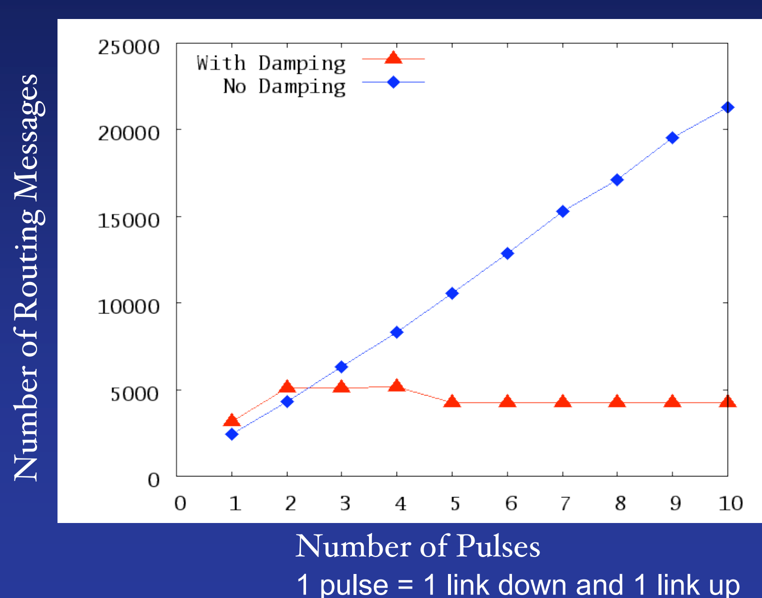
Path exploration (30% - 40%)

Muffling Effect

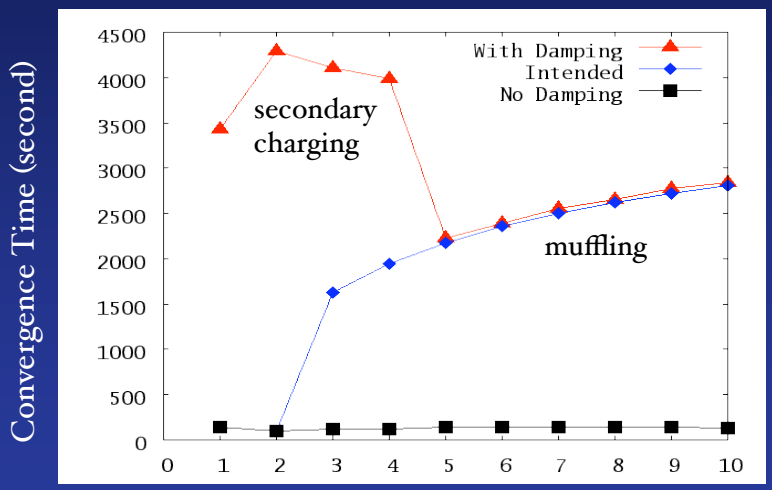


- Under persistent flaps, the provider will have the highest penalty value.
- Convergence time is determined by when the provider releases its route, i.e., the intended behavior.

Simulation (Message Count)



Simulation (Convergence Time)

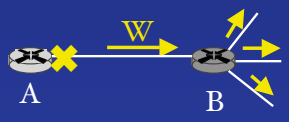


Solution

- Damping penalty should increase only after a real ***flap***, not every ***update***.
  - Path exploration, secondary charging and potentially other interactions cause multiple updates per flap.
- Solution: Explicit root cause notification

Root Cause Notification (RCN)

- Root cause is the original event that triggers the update.
  - rcn = {location, status, sequence number}
- Attach rcn to every update
  - updates triggered by the same event carry the same rcn.



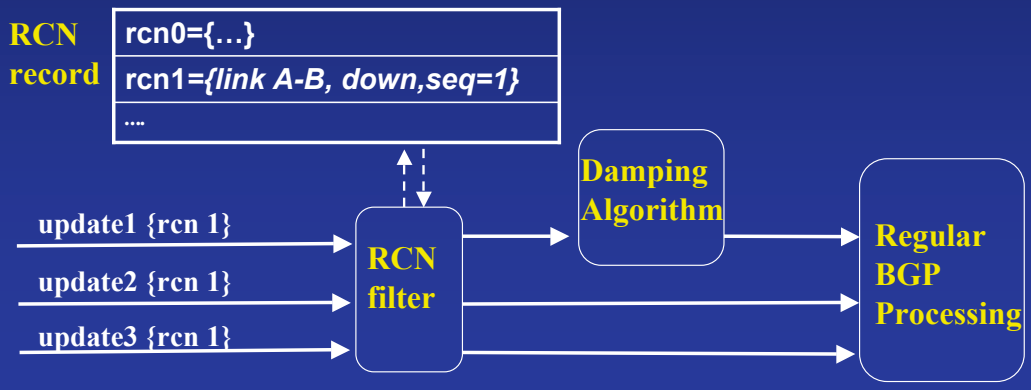
rcn = {location = A-B, status = down, seq = 1}

Original Damping

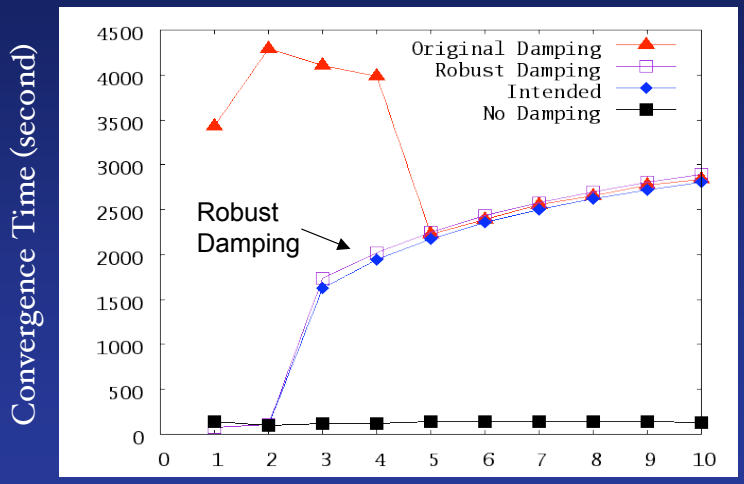
- Every update is passed to the damping module and causes penalty increase.

Robust Damping

- Only updates with new root causes are passed to damping module
  - Every flap is penalized only once.



Simulation Result



Number of Pulses
1 pulse = 1 link down and 1 link up

Summary

- Understand convergence time during damping
  - With a few flaps, secondary charging and path exploration exacerbates convergence time.
  - With persistent flapping, muffling effect makes convergence time match intended.
- Design of Robust Damping
  - eliminate undesired timer interactions.
- Stabilize global routing under stress
  - Other factors in reality, e.g., routing policy

Thanks !