Brocade: Landmark Routing on Peer to Peer Networks

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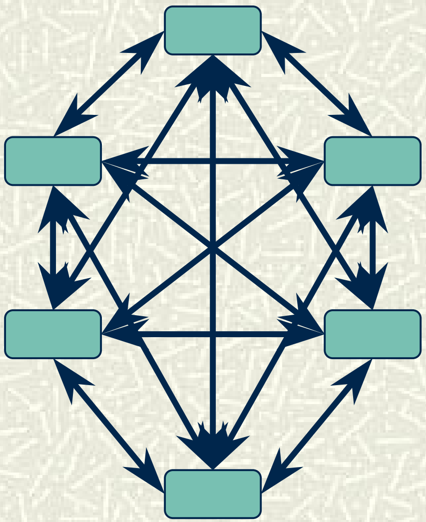
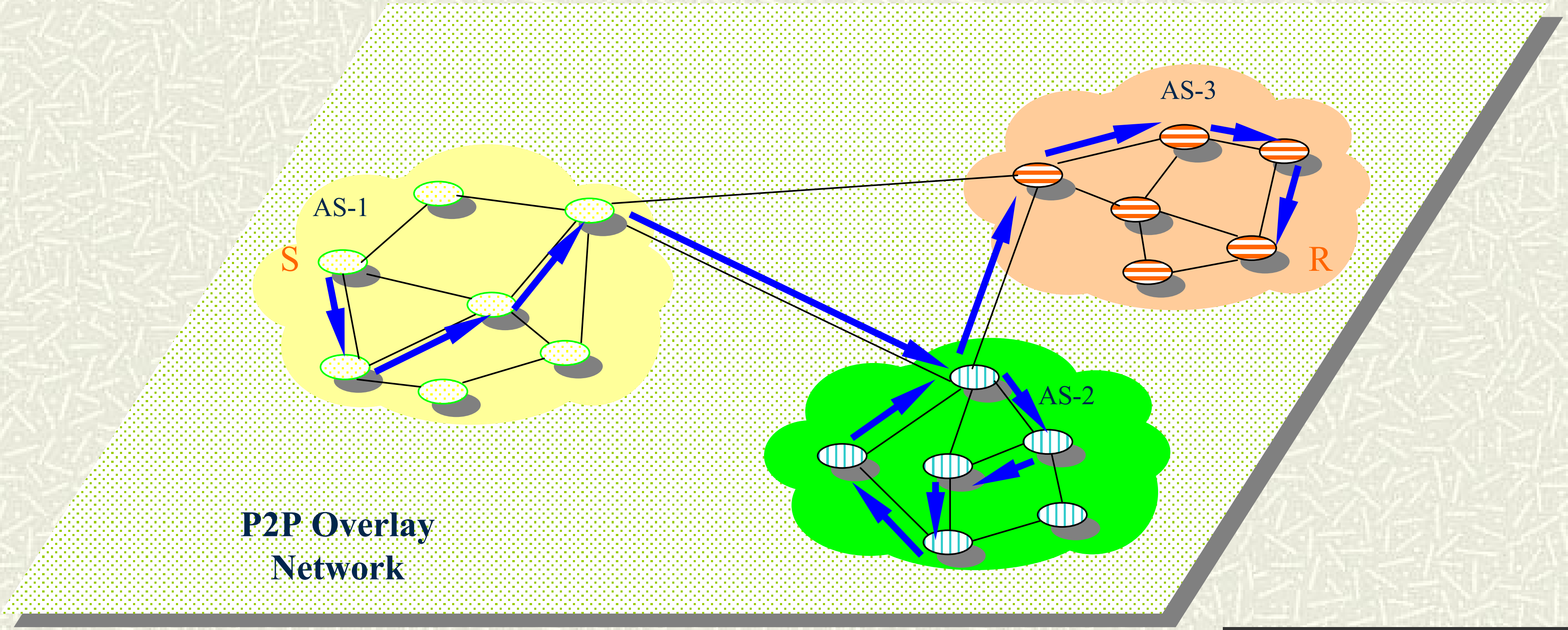
State of the Art Routing

- High dimensionality and coordinate-based P2P routing
  - Decentralized Object Location and Routing: Tapestry, Pastry, Chord, CAN, etc…
  - Sub-linear storage and # of overlay hops per route
  - Properties dependent on random name distribution
  - Optimized for uniform mesh style networks



Reality

- Transit-stub topology, disparate resources per node
- Result: Inefficient inter-domain routing (b/w, latency)



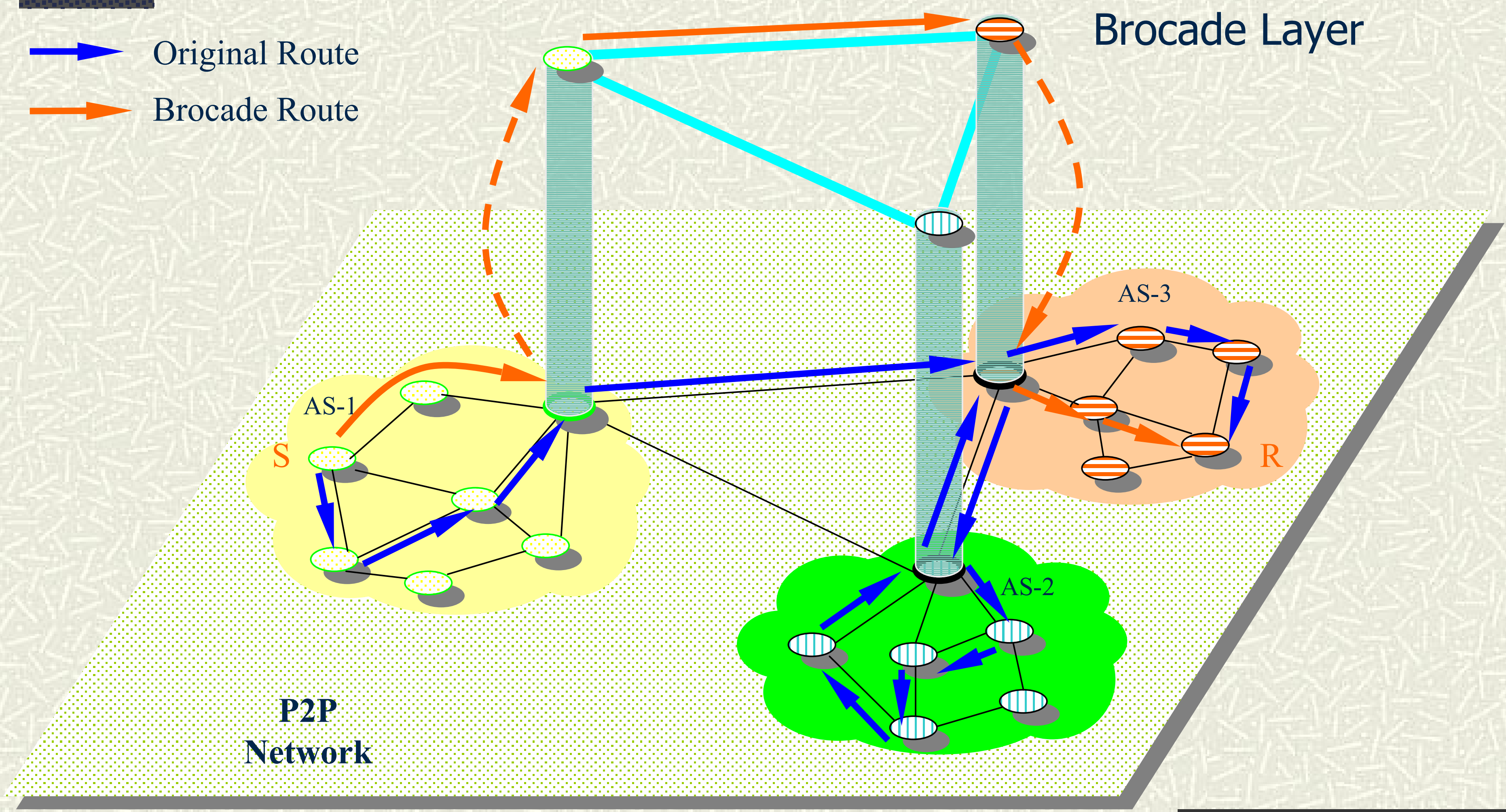
Talk Outline

- Motivation
- Brocade Architecture
- Brocade Routing
- Evaluation
- Summary / Open Questions

Brocade: Landmark Routing

- Goals
  - Eliminate unnecessary wide-area hops for inter-domain messages
    - Eliminate traffic going through high latency, congested stub links
    - Reduce wide-area bandwidth utilization
  - Maintain interface: RouteToID (*globally unique ID)*

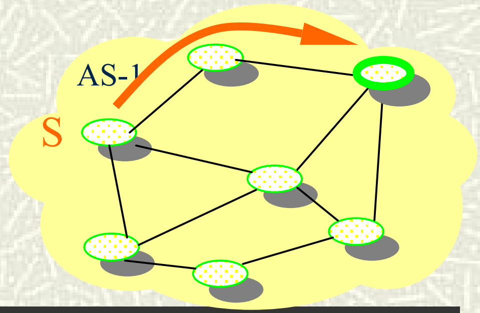
Brocade Architecture



Mechanisms

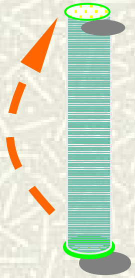
- Intuition: route quickly to destination domain
  - Organize group of supernodes into secondary overlay
  - Sender (S) sends message to local supernode SN1
  - SN1 finds and routes message to supernode SN2 near receiver R
    - SN1 uses Tapestry object location to find SN2
  - SN2 sends message to R via normal routing

Classifying Traffic



- Brocade not useful for intra-domain messages
  - P2P layer should exploit some locality (Tapestry)
  - Undesirable processing overhead
- Classifying traffic by destination
  - *Proximity caches*:
    Every node keeps list of nodes it knows to be local
    Need not be optimal, worst case: 1 relay through SN
  - *Cover set:*
    Supernode keeps list of all nodes in its domain.
    Acts as authority on local vs. distant traffic

Entering the Brocade



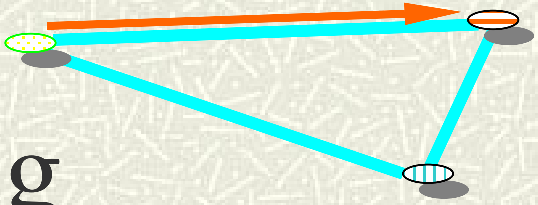
- Route: Sender → Supernode (Sender)?
- IP Snooping brocade
  - Supernode listens on P2P headers and redirects
  - Use machines close to border gateways

  +: Transparent to sender   –: may touch local nodes
- Directed brocade
  - Sender sends message directly to supernode
  - Sender locates supernode via DNS resolution:

    *nslookup **supernode.cs.berkeley.edu***

  +: maximum performance   –: state maintenance

Inter-supernode Routing

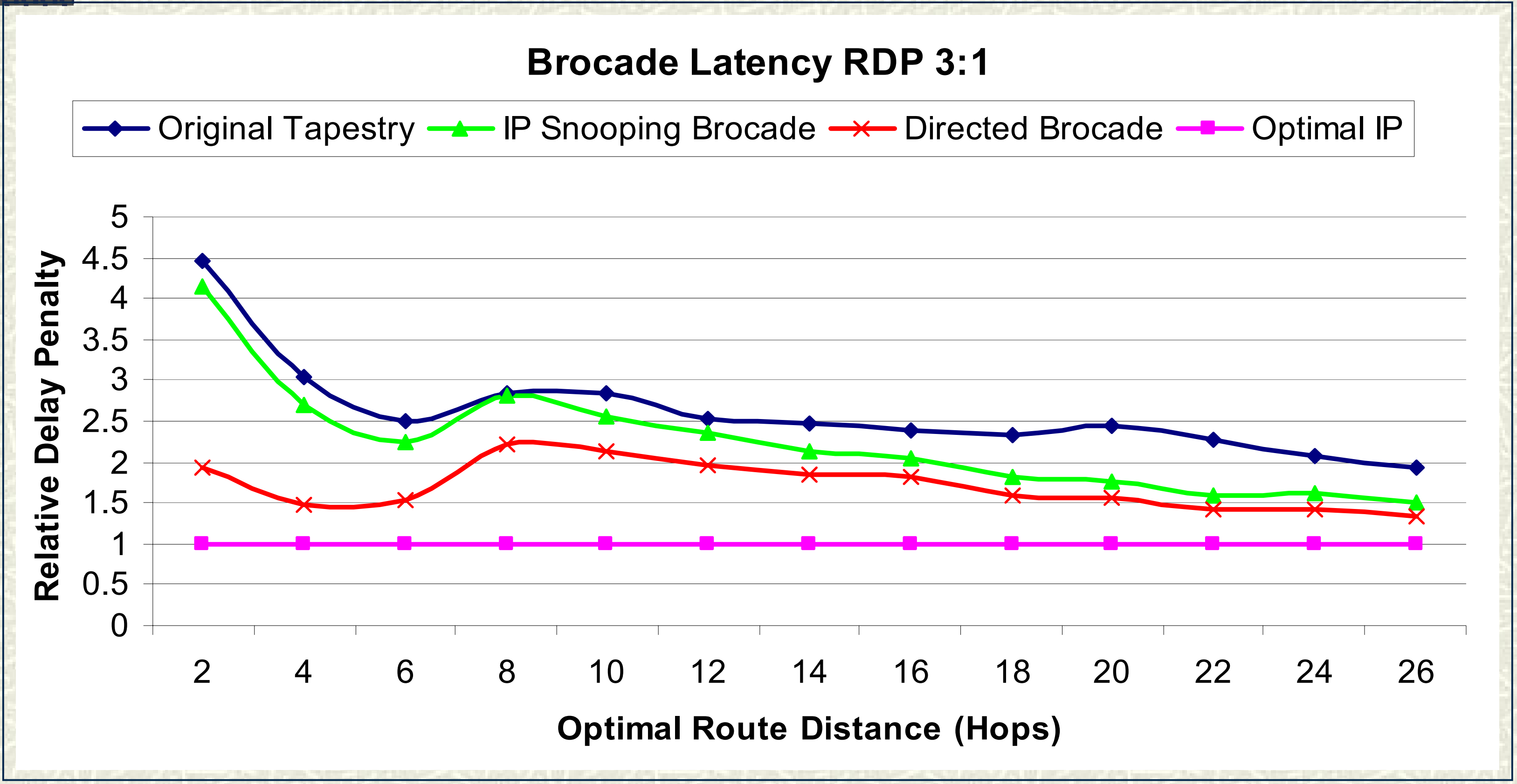


- Route: Supernode (sender) → Supernode (receiver)
  - Locate receiver's supernode given destination nodeID
  - Use Tapestry object location
- Tapestry
  - Routing mesh w/ built in proximity metrics
  - Location exploits locality (finds closer objects faster)
- Finding supernodes
  - Supernode "publishes" cover set on brocade layer as locally stored objects
  - To route to node *N*, locate server on brocade storing *N*

Feasibility Analysis

- Some numbers
  - Internet: ~ 220M hosts, 20K AS's, ~10K nodes/AS
  - Java implementation of Tapestry on PIII 800: ~1000 msgs/second
- State maintenance
  - AS of 10K nodes, assume 10% enter/leave every minute
  - Only ~1.7*5 ➔ 9% of CPU spent processing publish on Brocade
  - If inter-supernode traffic takes X ms, Publishing takes 5 X
  - Bandwidth: 1K/msg * 1K msg/min = 1MB/min = 160kb/s
- Storage requirement of Tapestry
  - 20K AS's, Octal Tapestry, $\lceil Log_8(20K^2) \rceil$ = 10 digits
  - 10K objects (Tapestry GUIDs) published per supernode
  - Tapestry GUID = 160 bits = 20B
  - Expected storage per SN: 10 * 10K * 20B = 2MB

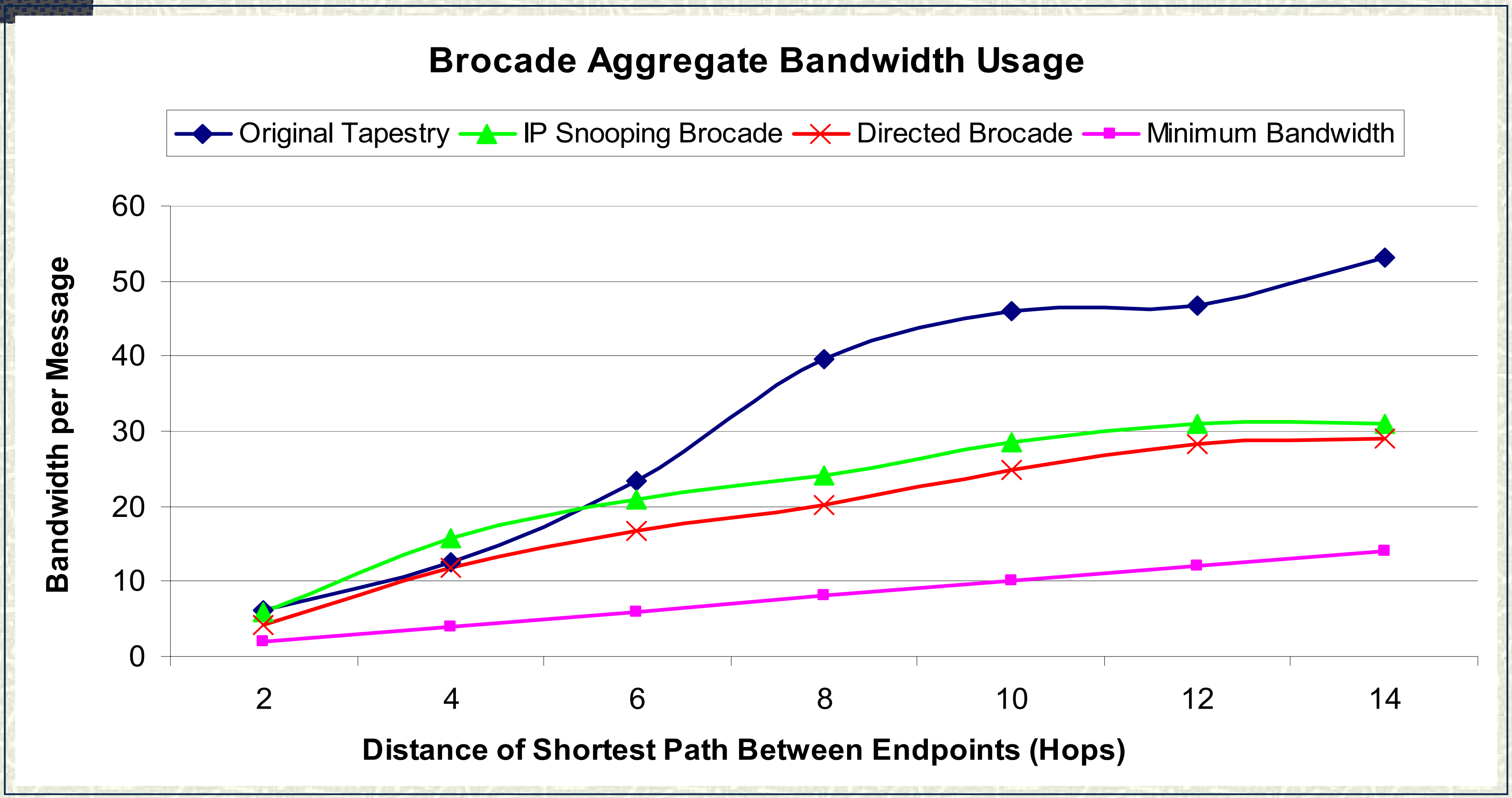
Evaluation: Routing RDP



Local proximity cache on; inter-domain:intra-domain = 3:1

Packet simulator, GT-ITM 4096 T, 16 SN, CPU overhead = 1

Evaluation: Bandwidth Usage



Local proximity cache on

Bandwidth unit: (SizeOf(Msg) * Hops)

Brocade Summary

- P2P systems assume uniformity
  - Extraneous hops through backbone to domains
  - Routing across congested stubs links
- Constrain inter-domain routing
  - Remove unnecessary routing through stubs
  - Reduce expected inter-domain hops
  - Limit misdirection in less congested backbone
- Result: lower latency, less bandwidth utilization

Ongoing Questions

- Performance at what cost?
  - Keep virtualization and level of indirection, named routing
  - May lose some fault-tolerance (how much?)
- Making P2P real
  - Deployment issues?
  - Impact of BGP routing policies on performance?
- Future/ongoing work
  - Fault-tolerant supernodes
  - Finer-grain node differentiation?
  - Brocade as replacement for BGP?

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HTTP://www.cs.berkeley.edu/~ravenben/tapestry