Brunet: A structured P2P System for Connectivity-constrained Wide-area Environments

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Structured P2P systems
- Nodes organized into a well-defined topology
  - E.g. ring, hypercube
- Greedy routing
  - Small routing table per node
  - Number of hops: sub-linear with respect to number of nodes
- Data associated with keys
  - Ownership of keys partitioned among nodes
    - Low search cost
- Topology maintenance overhead

Existing research in structured networks
- Efficient and resilient overlay topologies
- Routing under churn
- Proximity aware overlay routing
- Large-scale DHT-based systems
  - Storage, shared spaces, etc
- Our focus: connectivity constraints
  - NATS/firewalls and internet outages

Brunet P2P system
- Self-organizing ring-structured P2P network
- 160-bit node addresses, and data keys
- Nodes autonomously set up and maintain connections
  with neighbors in routing table
- TCP or UDP, NAT traversal
- $O(1/k \log^2(n))$ overlay hops between nodes, for a
  network of size $n$, and $k$ connections per node
- Recursive routing
- Route messages over connections
- Adaptive 1-hop communication

Overlay structure and greedy routing

Decentralized NAT-traversal
- Each key stored at two closest nodes in P2P address space
- Copying/migration of keys in response to node arrival/departure

Distributed Hash Table

Non-transitivity
- Transient BGP outages, router mis-configurations, Internet-1 and Internet-2 hosts
  - Inconsistent view of P2P ring
  - Affects DHT dynamics in response to node arrival/departure
  - Neighbors cannot setup a connection
  - Novel solution:
    - Virtual connections over common connection targets

Project status
- Brunet and DHT: implemented
- C#, open-source P2P library
- Applications: IPOP, Grid appliance
- PlanetLab deployments

Future work
- Handling symmetric NATs
  - Constraint more challenging than non-transitivity
- Secure overlay
  - UDP and SSL
- Support for efficient multicast/anycast
  - Using structured P2P techniques

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