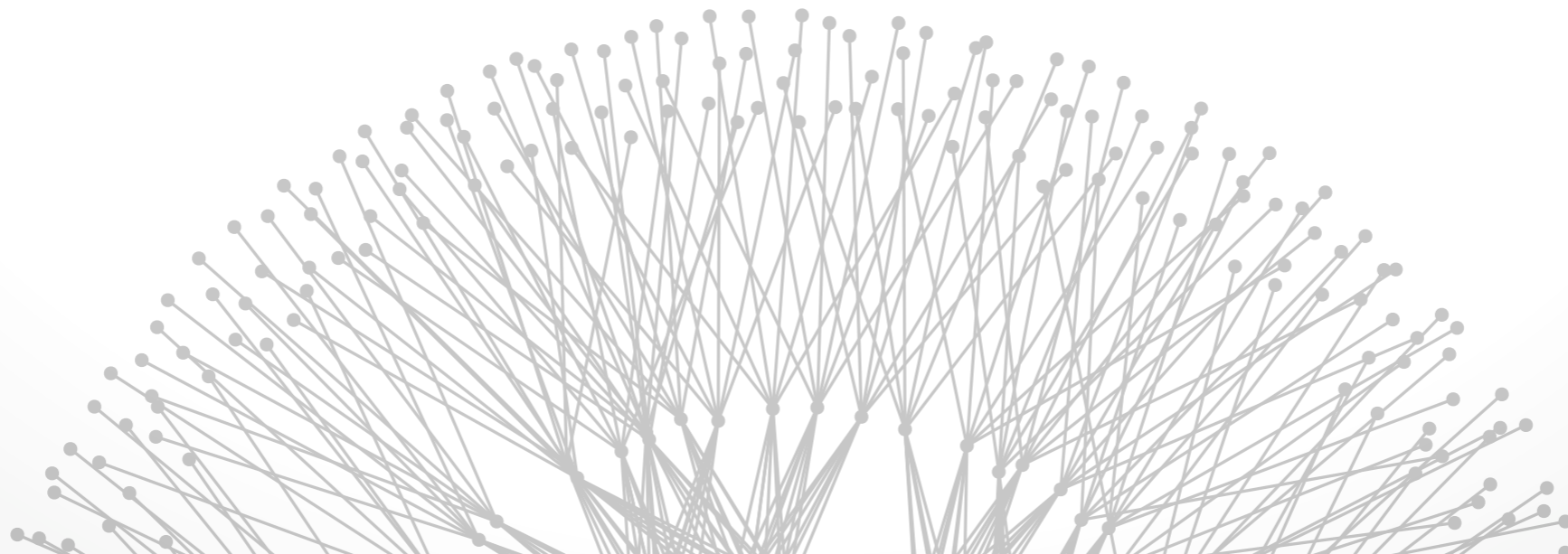


Overlay & Peer-to-peer Systems

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CS 538 October 20 2011





Peer-to-peer system: participants have the same functionality and role in the system

- ...as opposed to client-server architecture
- Commonly used to imply file sharing but also used in other contexts (e.g., “BGP peering session”)
- At transport level: peer = both client and server

Overlay network: a virtual network whose links are end-to-end paths in another network

Peer-to-peer networks: Intersection of the above two

- Or, can also mean “file sharing systems”

In the beginning...



Napster (1999)

- Centralized index server to find the right peer
- Peer-to-peer file transfer

Gnutella (2000)

- Fully decentralized P2P indexing: scoped flooding
- Problems?

Freenet (1999)

- Goal: censorship-resistant key-value content store
- Routing: heuristic clustering of similar keys

Key properties of a DHT



Hashtable interface (fast $put(k,v)$, $get(k)=v$)

- Unlike Freenet, guarantees results (and quickly)

Scalable

- Low memory / communication
- Uses **consistent hashing**: transfers in expectation $1/n$ of objects when a node leaves/joins

Resilient

- Still works if, say, 50% of the nodes suddenly fail

Decentralized

DHTs: carefully structured

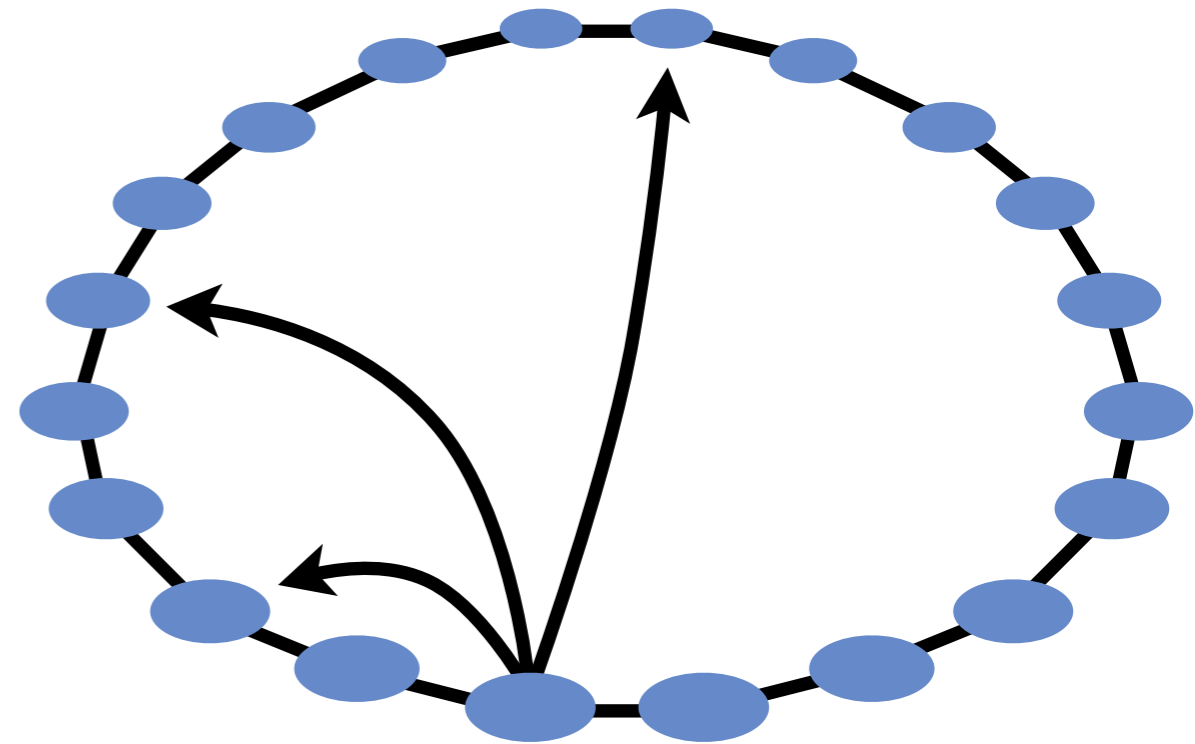


Greedy routing based on distance in keyspace

(Where did we see greedy routing before?)

- Geographic routing
- Small world models
- Grid / torus

What do we need the DHT topology to look like for this to work? ... work well?

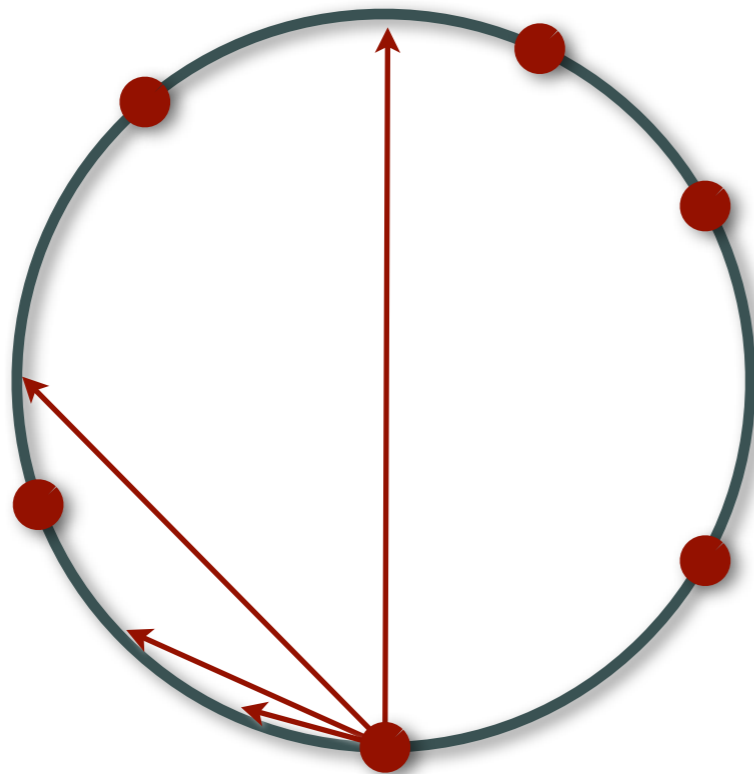


What's missing from this Chord topology?

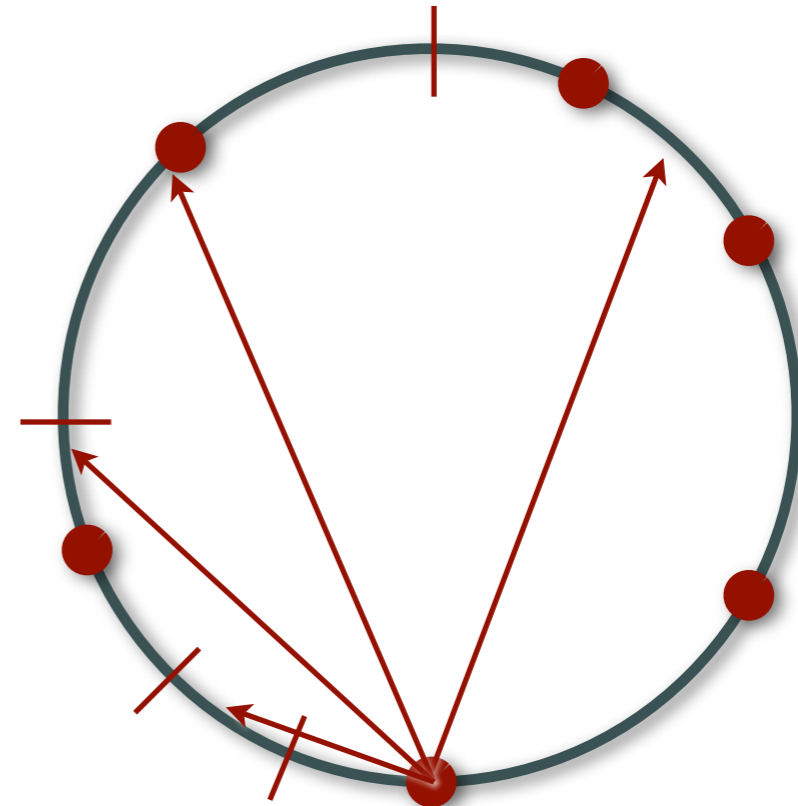
DHTs: check your understanding



Standard Chord topology



Randomized topology



Randomized topology still guarantees $O(\log n)$ lookup hops. Why?

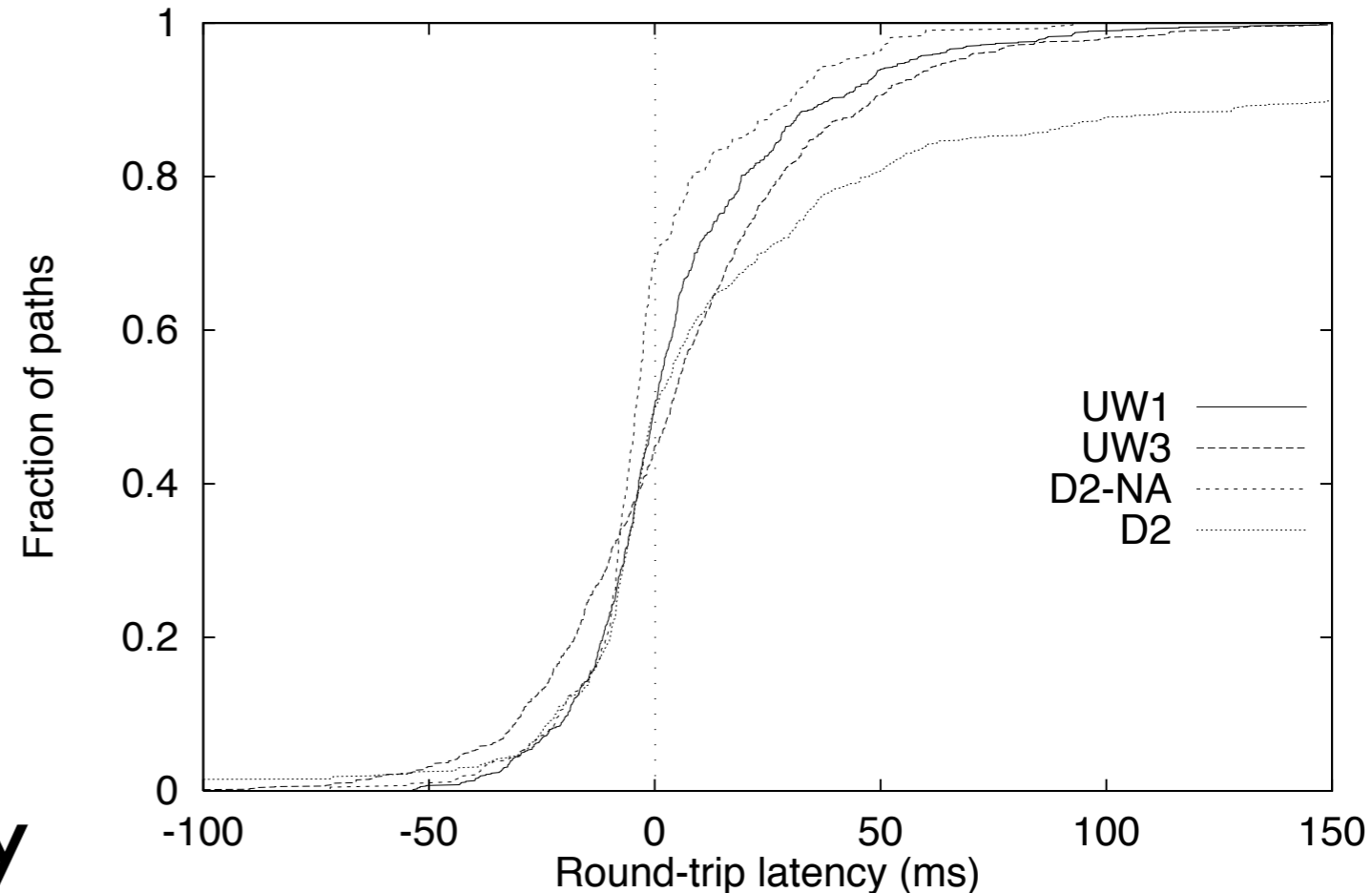
Why would you do something other than the deterministic Chord topology?

In the other beginning...



Internet routing is suboptimal

[Savage et al '99, "E2E effects of Internet path selection"]



Improve it with an overlay

Key: Internet does not obey the triangle inequality

- Can happen: $d(a,b) + d(b,c) < d(a,c)$



Common theme of many overlay networks: provide more advanced services than the Internet provides

- Much easier to deploy new functionality at hosts
- The Internet doesn't even know what's happening to it

Examples

- **RON**: more reliable, efficient routing
- **DHT**: flat name routing and key-value store
- **i3**: indirection, mobility, middlebox support, ...
- **Content distribution**: a kind of time-delayed multicast



Deployed systems

- Content distribution: Akamai, CoralCDN
- Swarming: DHT for BitTorrent distributed tracker
- File sharing: DHTs in Kad, Overnet/eDonkey
- Amazon Dynamo
- Storm botnet: command & control delivered via DHT

Big impact on many research systems & papers

- Many ideas from DHT / overlay research incorporated into other work, if not entire DHT system

Next up...



Pratch and Henry on the Sybil attack in DHTs