Distributed Lookup: Chord and Dynamo Lecture 13, cs262a

Ion Stoica & Ali Ghodsi
UC Berkeley
October 12, 2020

Today's Papers

Chord: A Scalable Peer-to-peer Lookup Service for Internet Applications,

Ion Stoica, Robert Morris, David Karger, M. Frans Kaashoek, Hari Balakrishnan, SIGCOMM'02

(https://pdos.csail.mit.edu/papers/chord:sigcomm01/chord_sigcomm.pdf)

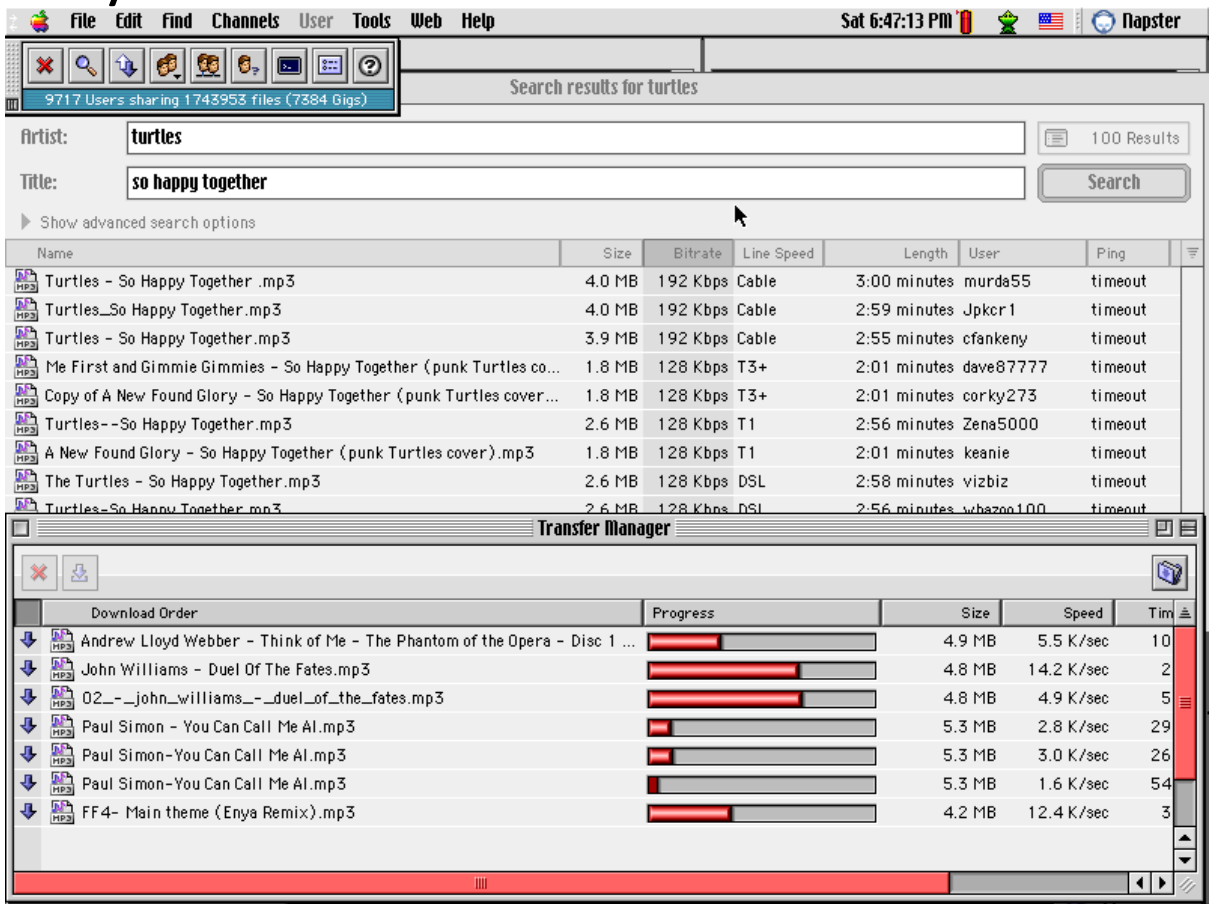
Dynamo: Amazon's Highly Available Key-value Store,

Giuseppe DeCandia, Deniz Hastorun, Madan Jampani, Gunavardhan Kakulapati, Avinash Lakshman, Alex Pilchin, Swaminathan, Sivasubramanian, Peter Vosshall, and Werner Vogels, SOSP'07

(www.allthingsdistributed.com/files/amazon-dynamo-sosp2007.pdf)

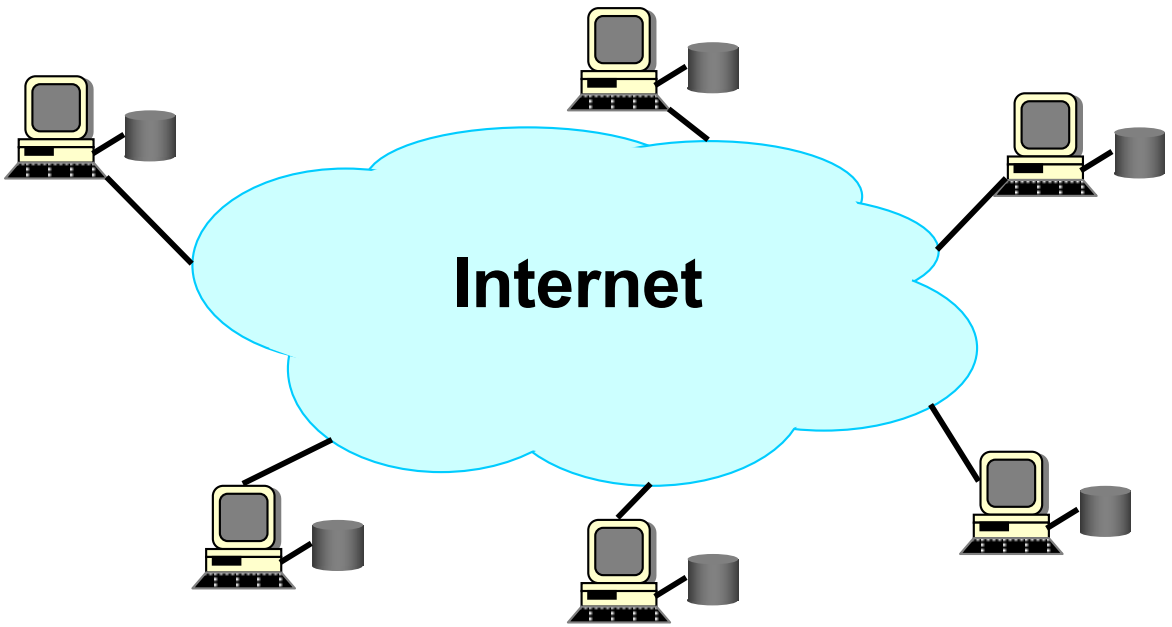
How Did it Start?

- A killer application: Napster (June 1999)
  - Free music over the Internet
  - February 2001: 26.4 million users worldwide



How Did it Start?

- A killer application: Napster
  - Free music over the Internet
- Key idea: share the content, storage *and* bandwidth of individual (home) users

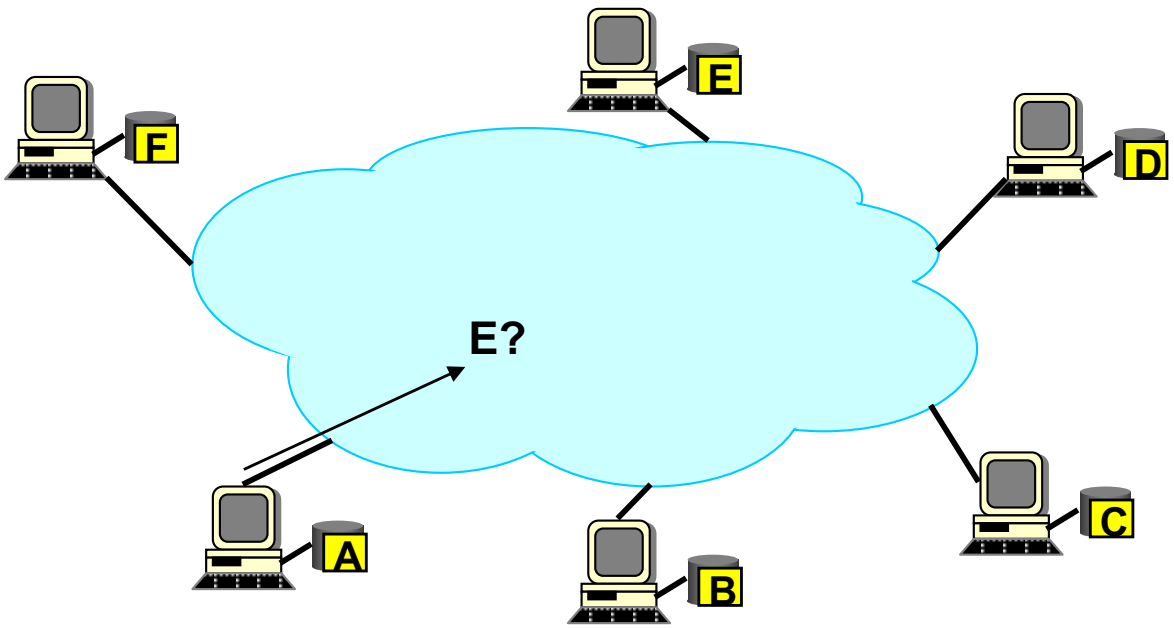


Model

- Each user stores a subset of files
- Each user has access (can download) files from all users in the system

Main Challenge

- Find where a particular file is stored



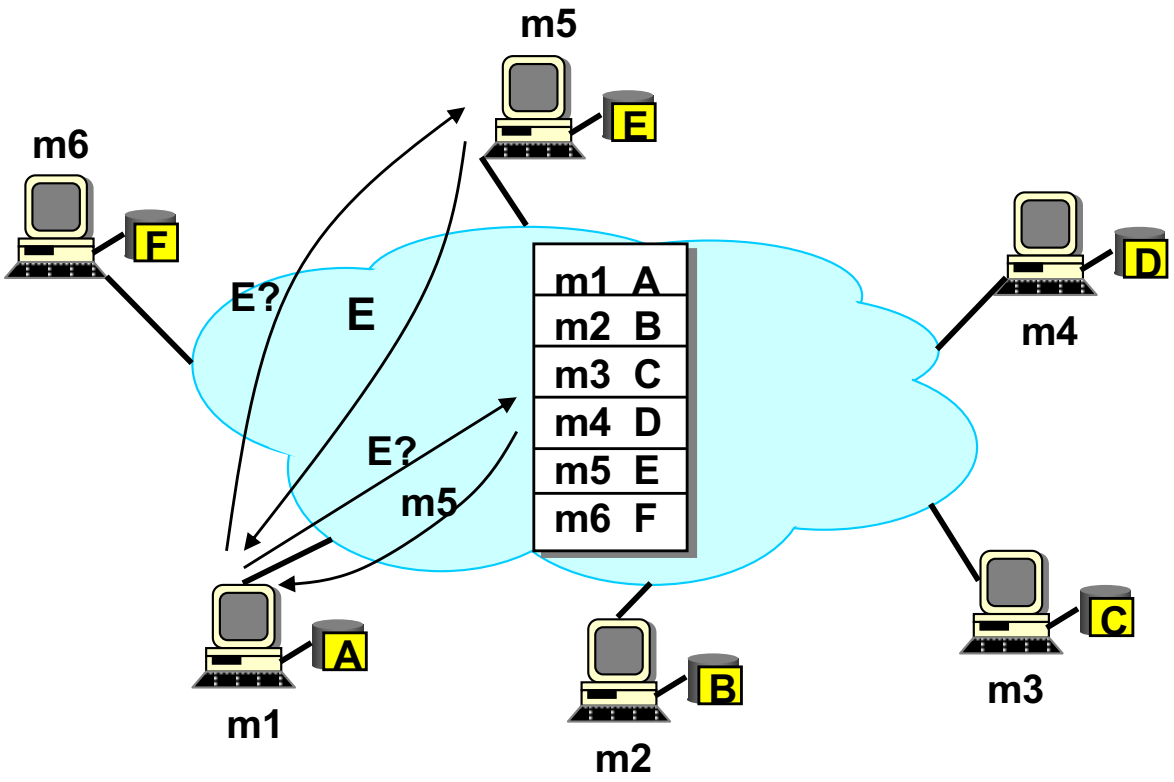
Other Challenges

- Scale: up to hundred of thousands or millions of machines
- Dynamicity: machines can come and go any time

Napster

- Assume a centralized index system that maps files (songs) to machines that are alive
- How to find a file (song)
  - Query the index system → return a machine that stores the required file
    - Ideally this is the closest/least-loaded machine
  - ftp the file
- Advantages:
  - Simplicity, easy to implement sophisticated search engines on top of the index system
- Disadvantages:
  - Robustness, scalability (?)

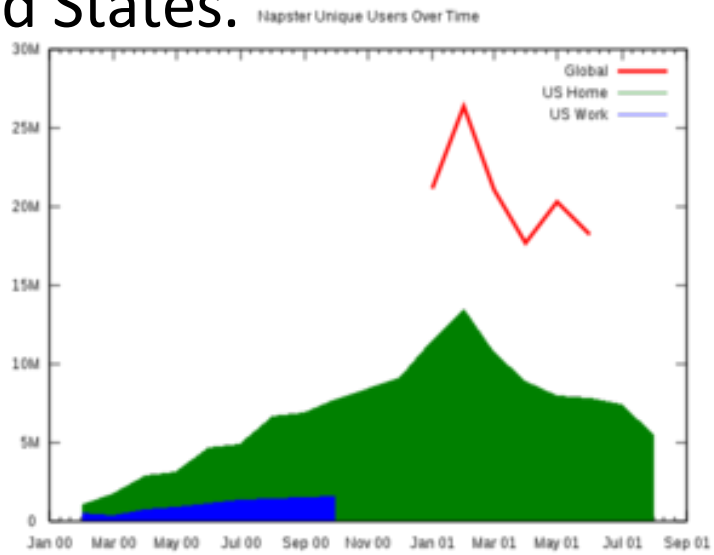
Napster: Example



How Did Napster end?

- A killer application: Napster
  - Free music over the Internet

- March 13, 2000: Metallica filled lawsuit against Napster
  - A demo of their song "I Disappear" had been circulating across the network before it was released, and it was played on several radio stations across the United States.
- July 11, 2001: Napster shut down

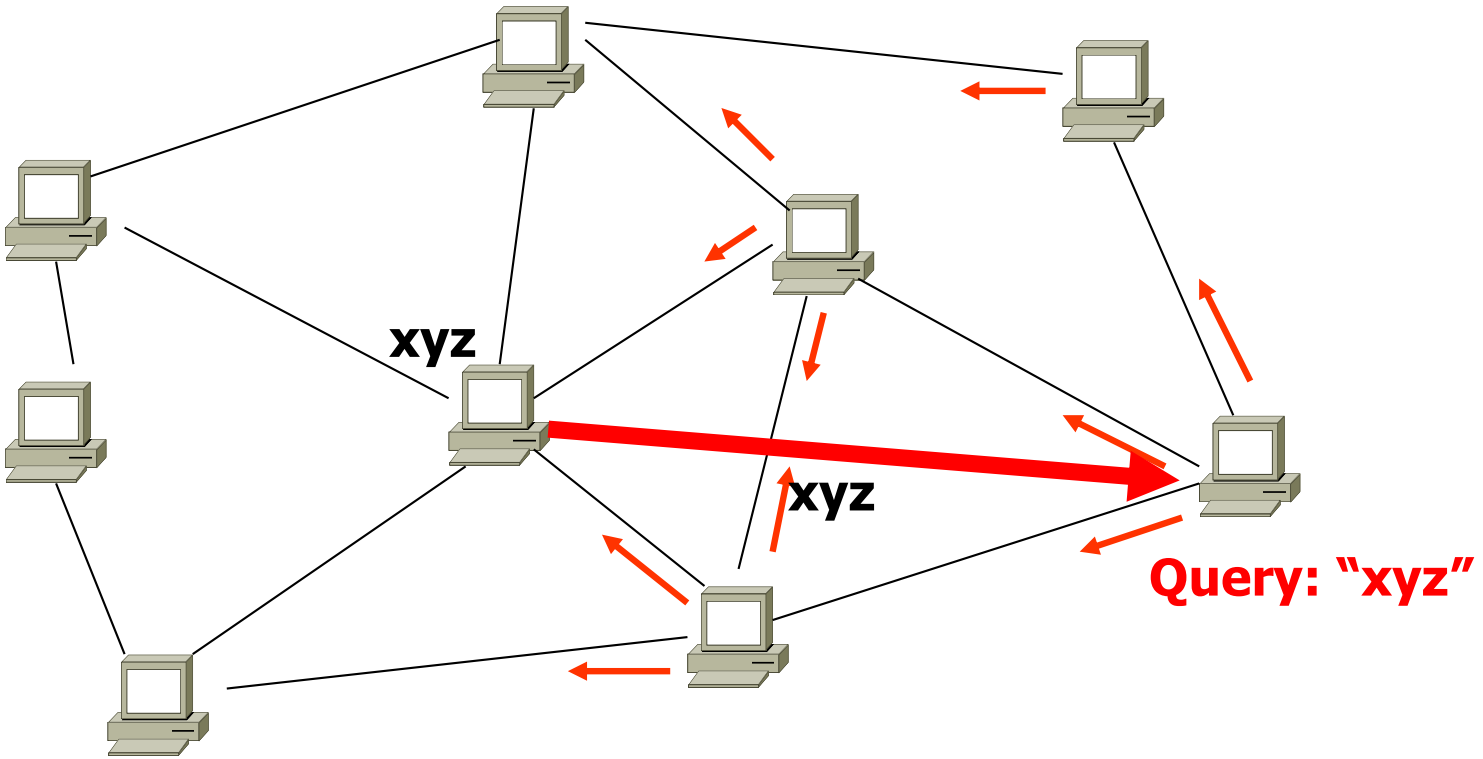


Gnutella

- Distribute file location
- Idea: flood the request
- Hot to find a file:
  - Send request to all neighbors
  - Neighbors recursively multicast the request
  - Eventually a machine that has the file receives the request, and it sends back the answer
- Advantages:
  - Totally decentralized, highly robust
- Disadvantages:
  - Not scalable; the entire network can be swamped with request (to alleviate this problem, each request has a TTL)

Gnutella

- Ad-hoc topology
- Queries are flooded for bounded number of hops
- No guarantees on recall



Distributed Hash Tables (DHTs)

- Abstraction: a distributed hash-table data structure
  - insert(id, item);
  - item = query(id); (or lookup(id);)
  - Note: item can be anything: a data object, document, file, pointer to a file…
- Proposals
  - CAN, Chord, Kademlia, Pastry, Tapestry, etc
  - All happened around the same time!
  - I was just finishing my PhD and looking for the next thing to do…