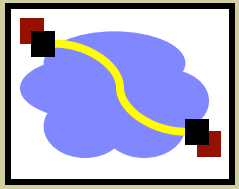
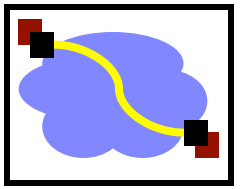


416 Distributed Systems

Mar 1, Peer-to-Peer

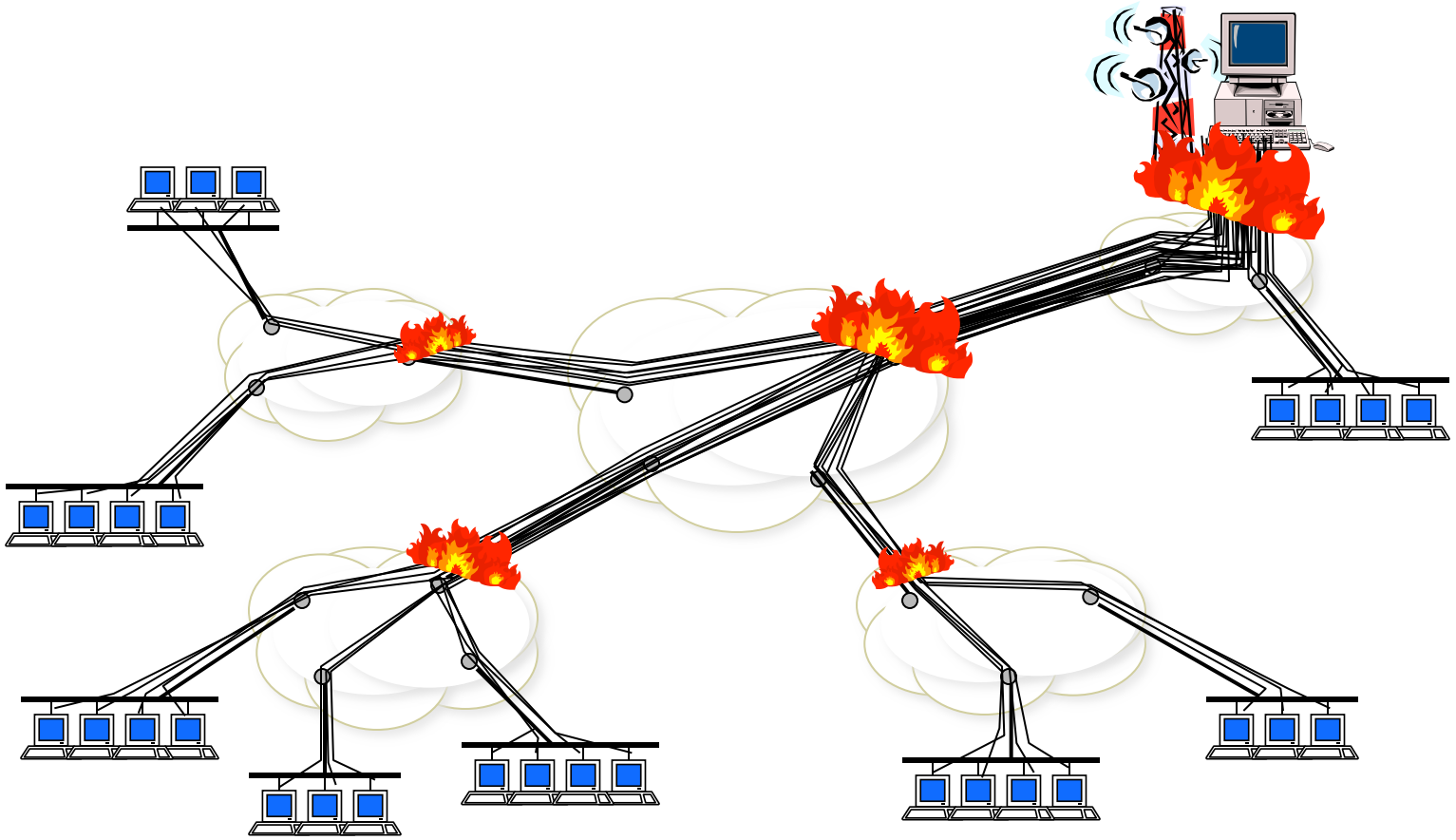
Outline



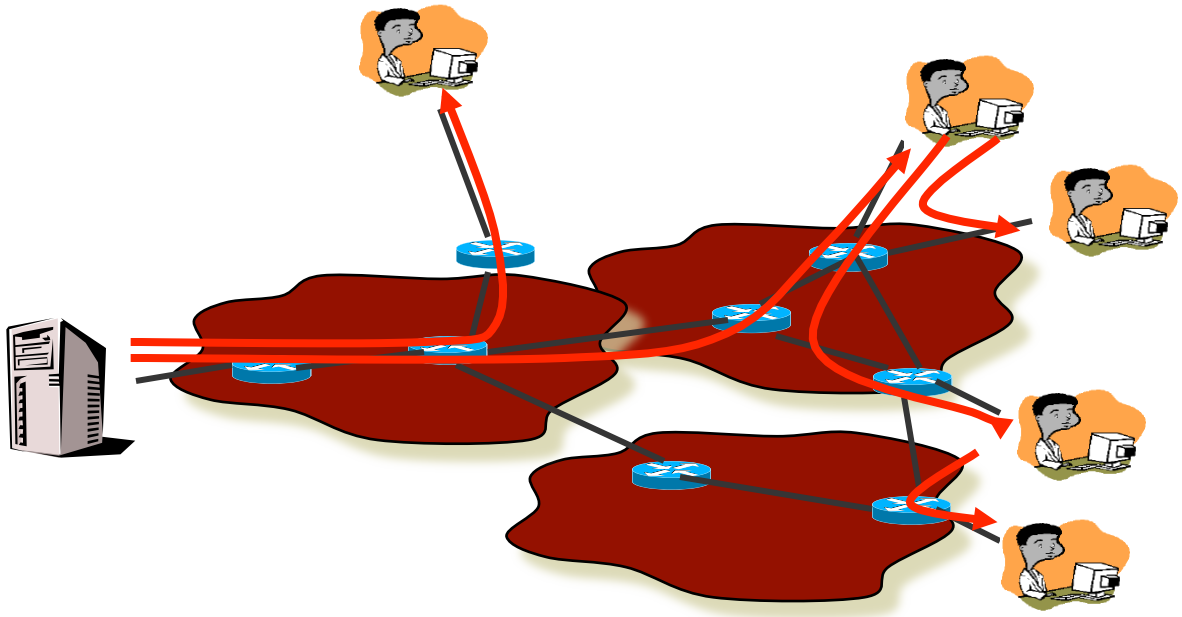
- P2P Lookup Overview
- Centralized/Flooded Lookups
- Routed Lookups – Chord

Scaling Problem

- Millions of clients ⇒ server and network meltdown

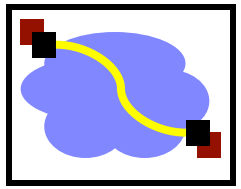


P2P System



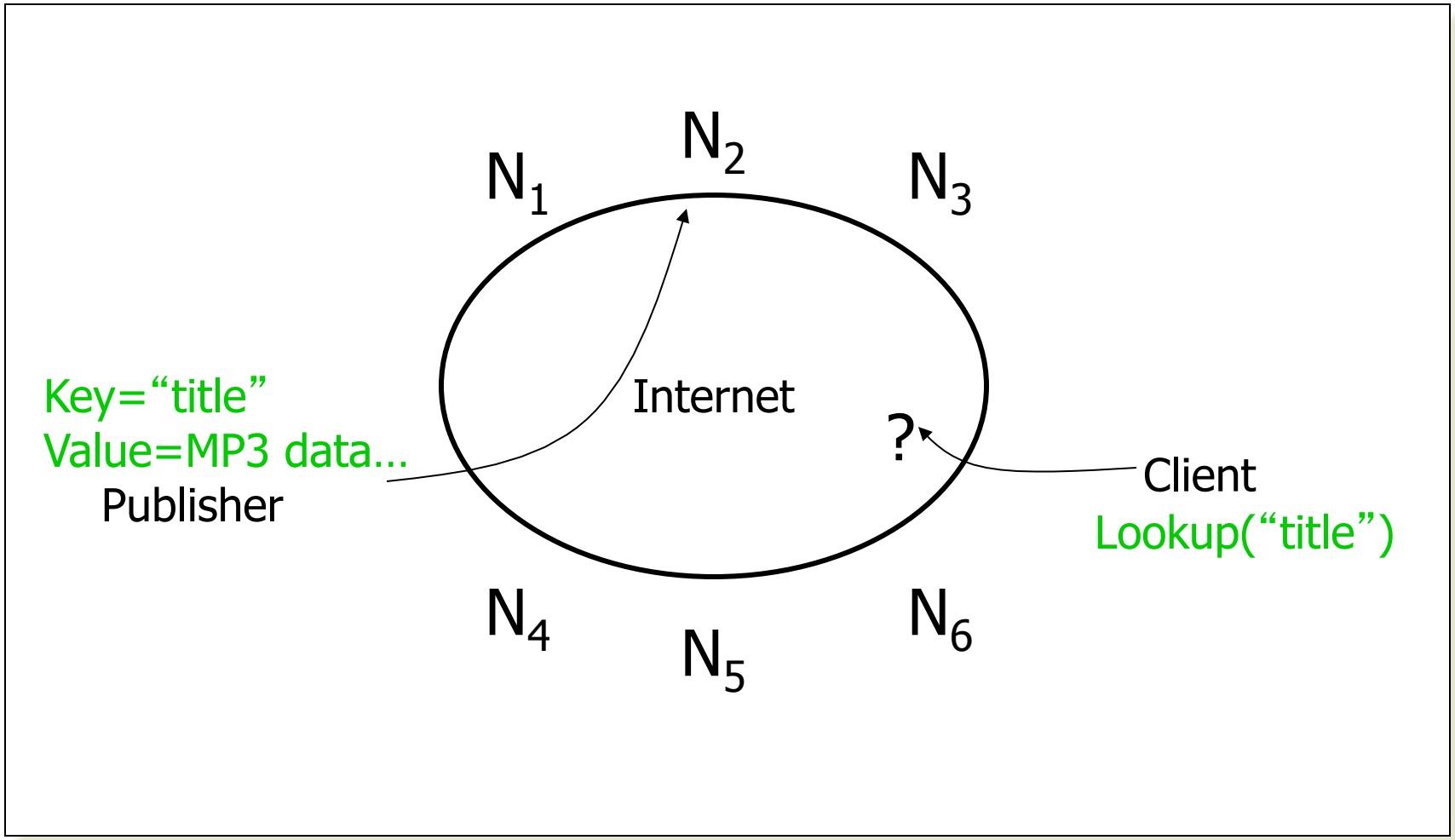
- Leverage the resources of client machines (peers)
  - Traditional: Computation, storage, bandwidth
  - Non-traditional: Geographical diversity, mobility, sensors!

Peer-to-Peer (storage) Networks

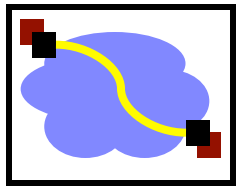


- Typically each member stores/provides access to content
- Basically a replication system for files
  - Always a tradeoff between possible location of files and searching difficulty
  - Peer-to-peer allow files to be anywhere → searching is the challenge
  - Dynamic member list makes it more difficult
- What other systems have similar goals?
  - Routing, DNS

The Lookup Problem

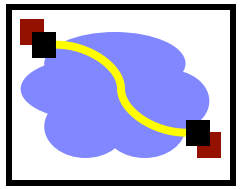


Searching



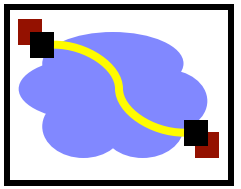
- Needles vs. Haystacks
  - Searching for top 40, or an obscure punk track from 1981 that nobody's heard of?
- Search expressiveness
  - Whole word? Regular expressions? File names? Attributes? Whole-text search?

Framework



- Common Primitives:
  - **Join**: how do I begin participating?
  - **Publish**: how do I advertise my file?
  - **Search**: how to I find a file?
  - **Fetch**: how to I retrieve a file?

Outline



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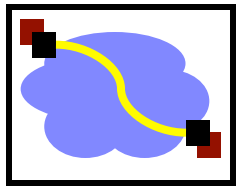
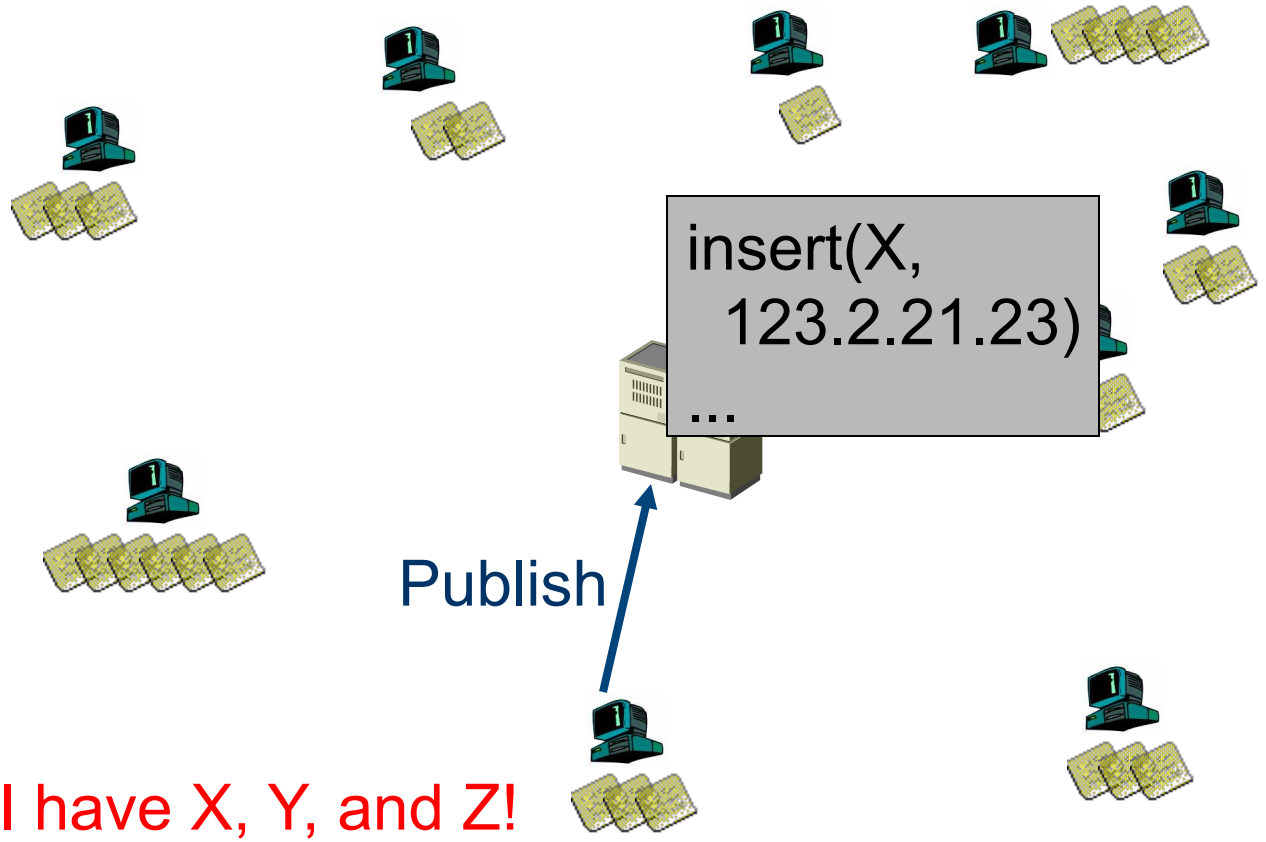
Napster: Overiew

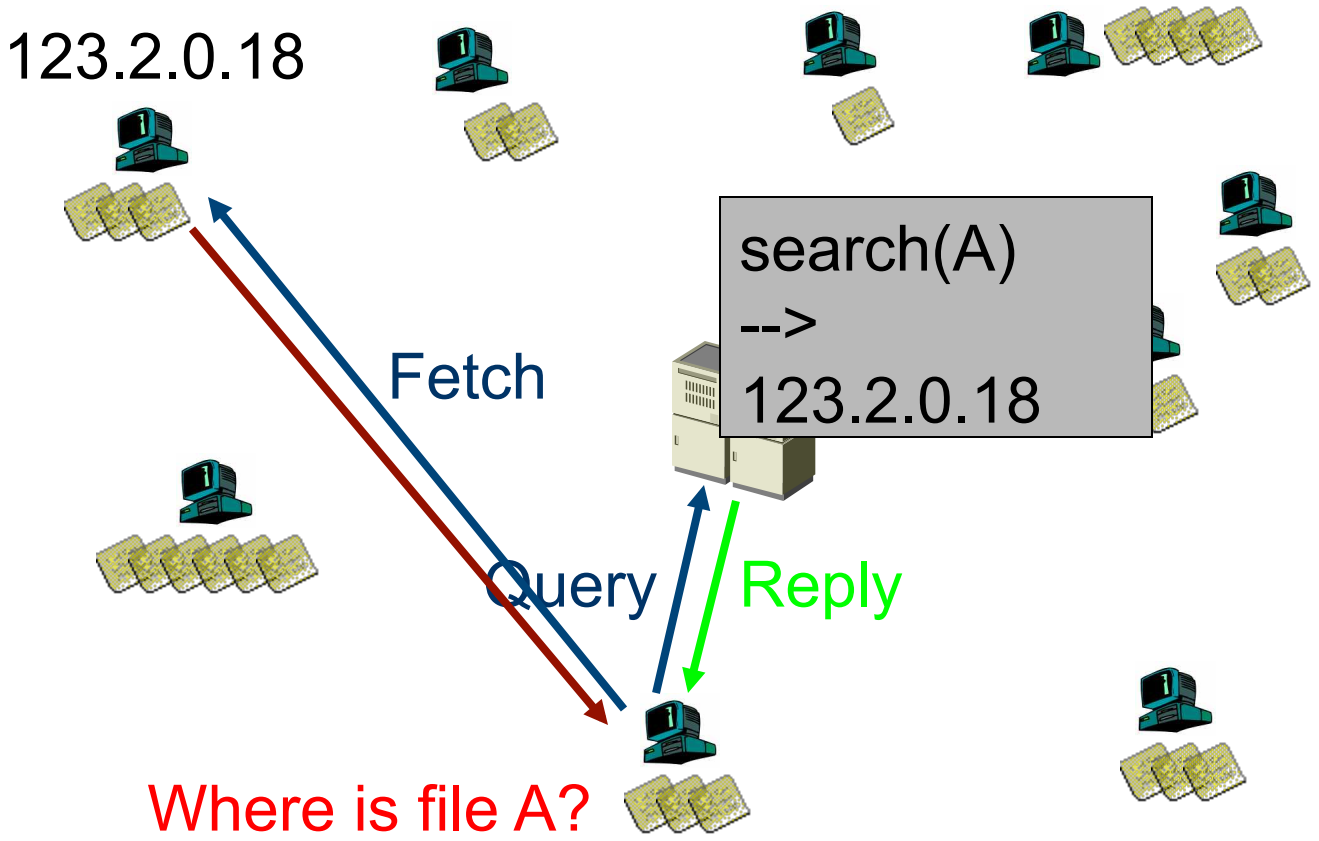


- Centralized Database:
  - **Join:** on startup, client contacts central server
  - **Publish:** reports list of files to central server
  - **Search:** query the server => return someone that stores the requested file
  - **Fetch:** get the file directly from peer

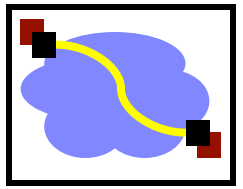
Napster: Publish



Napster: Search

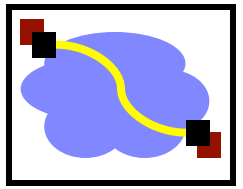


Napster: Discussion



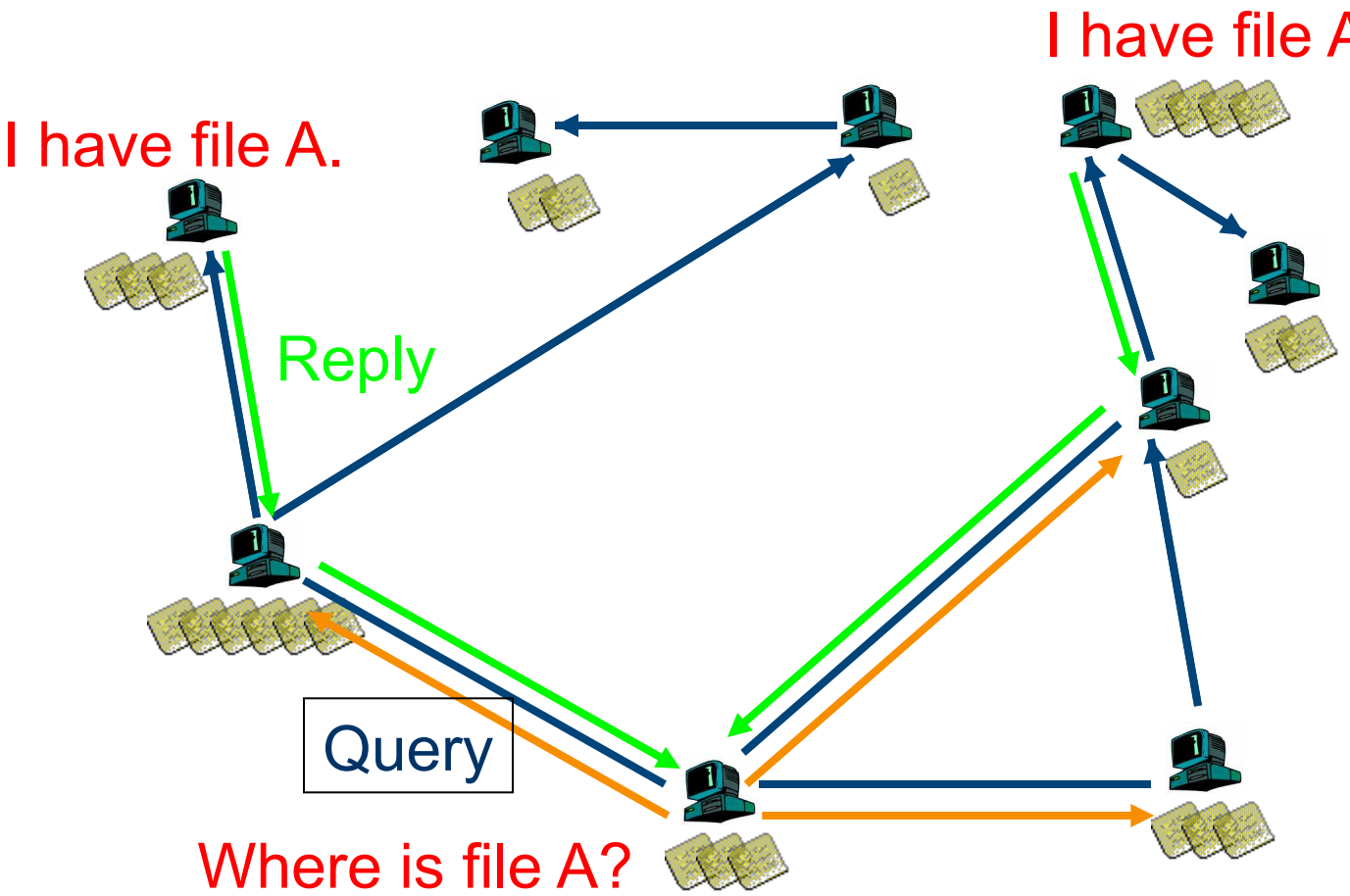
- Pros:
  - Simple
  - Search scope is O(1)
  - Controllable (pro or con?)
- Cons:
  - Server maintains O(N) State
  - Server does all processing
  - Single point of failure

“Old” Gnutella: Overview

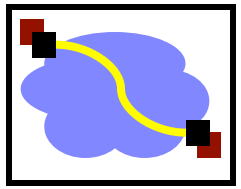


- Query Flooding:
  - **Join**: on startup, client contacts a few other nodes; these become its “neighbors”
    - “unstructured overlay”
  - **Publish**: no need
  - **Search**: ask neighbors, who ask their neighbors, and so on... when/if found, reply to sender.
    - TTL limits propagation
  - **Fetch**: get the file directly from peer

Gnutella: Search

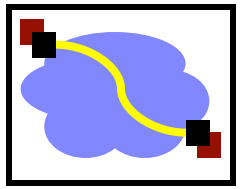


Gnutella: Discussion



- Pros:
  - Fully de-centralized
  - Search cost distributed
  - Processing @ each node permits powerful search semantics
- Cons:
  - Search scope is O(*N*)
  - Search time is O(???)
  - Nodes leave often, network unstable
- TTL-limited search works well for haystacks.
  - For scalability, does NOT search every node. May have to re-issue query later; no guarantee that it will find the file!

Flooding: Gnutella, Kazaa



- Modifies the Gnutella protocol into two-level hierarchy
  - Hybrid of Gnutella and Napster
- Supernodes
  - Nodes that have better connection to Internet
  - Act as temporary indexing servers for other nodes
  - Help improve the stability of the network
- Standard nodes
  - Connect to supernodes and report list of files
  - Allows slower nodes to participate
- Search
  - Broadcast (Gnutella-style) search across supernodes
- Disadvantages
  - Kept a centralized registration → allowed for law suits ☹