Privacy-Preserving P2P Data Sharing with OneSwarm

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http://oneswarm.cs.washington.edu/

Data sharing

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2. Public (not sensitive)

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3. Public but *without attribution*

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Data sharing

This talk

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Providers

- Sharing provided by:
  - *Centralized* data-centers
  - *Peer-to-peer* networks

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  - No no need to tell a centralized service *what you share or download*

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- Disadvantage of common P2P systems: *anyone can monitor your behavior!*

Previous solutions

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  - Problems:
    - Requires a fraction of clients to be public
    - Discouraged for *performance* reasons

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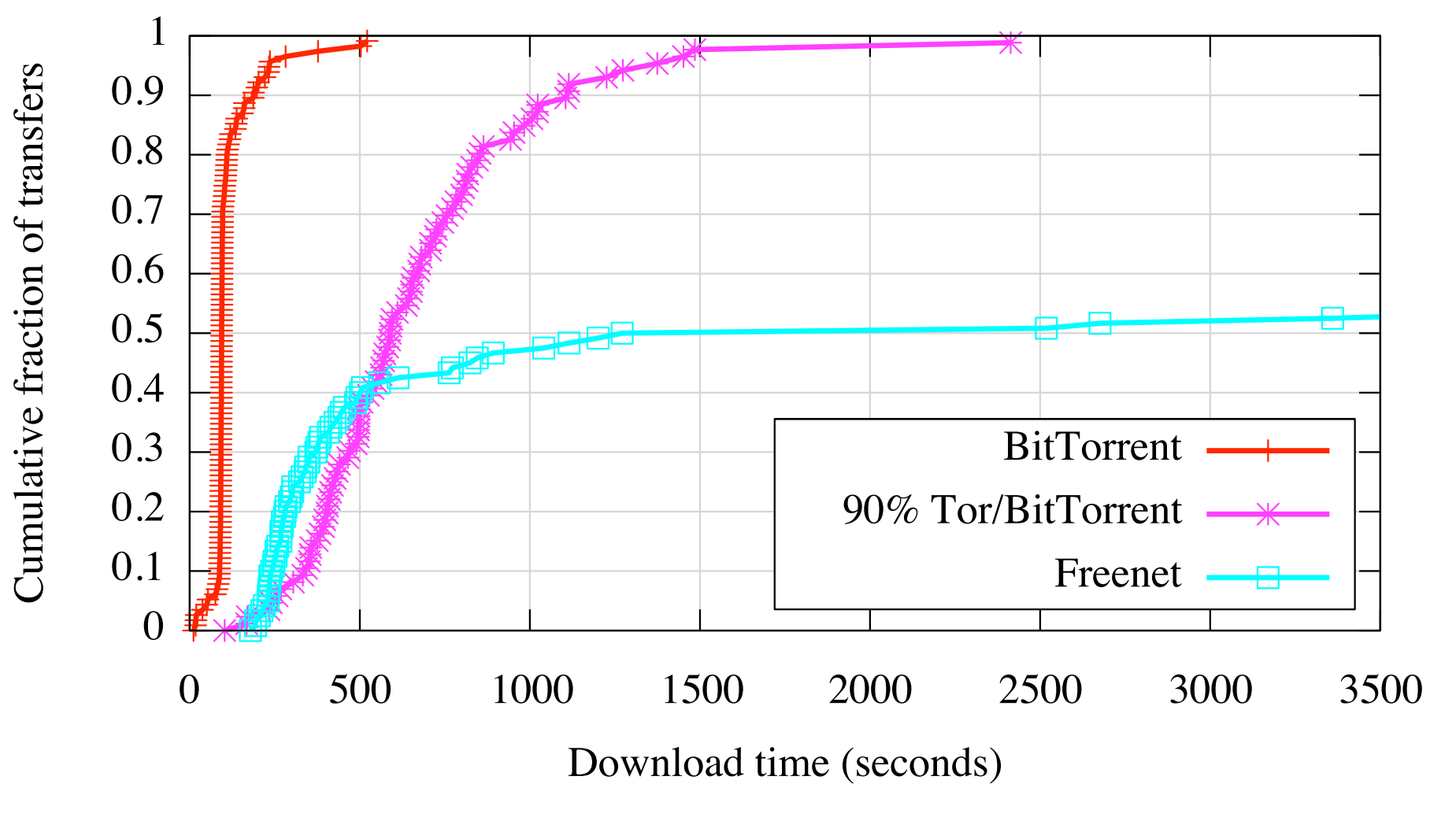
    - Discouraged for *performance* reasons
- Solution 2: *Freenet*
  - Problems:
    - Poor bulk data *performance*
    - Requires users to store other peoples data

Existing systems



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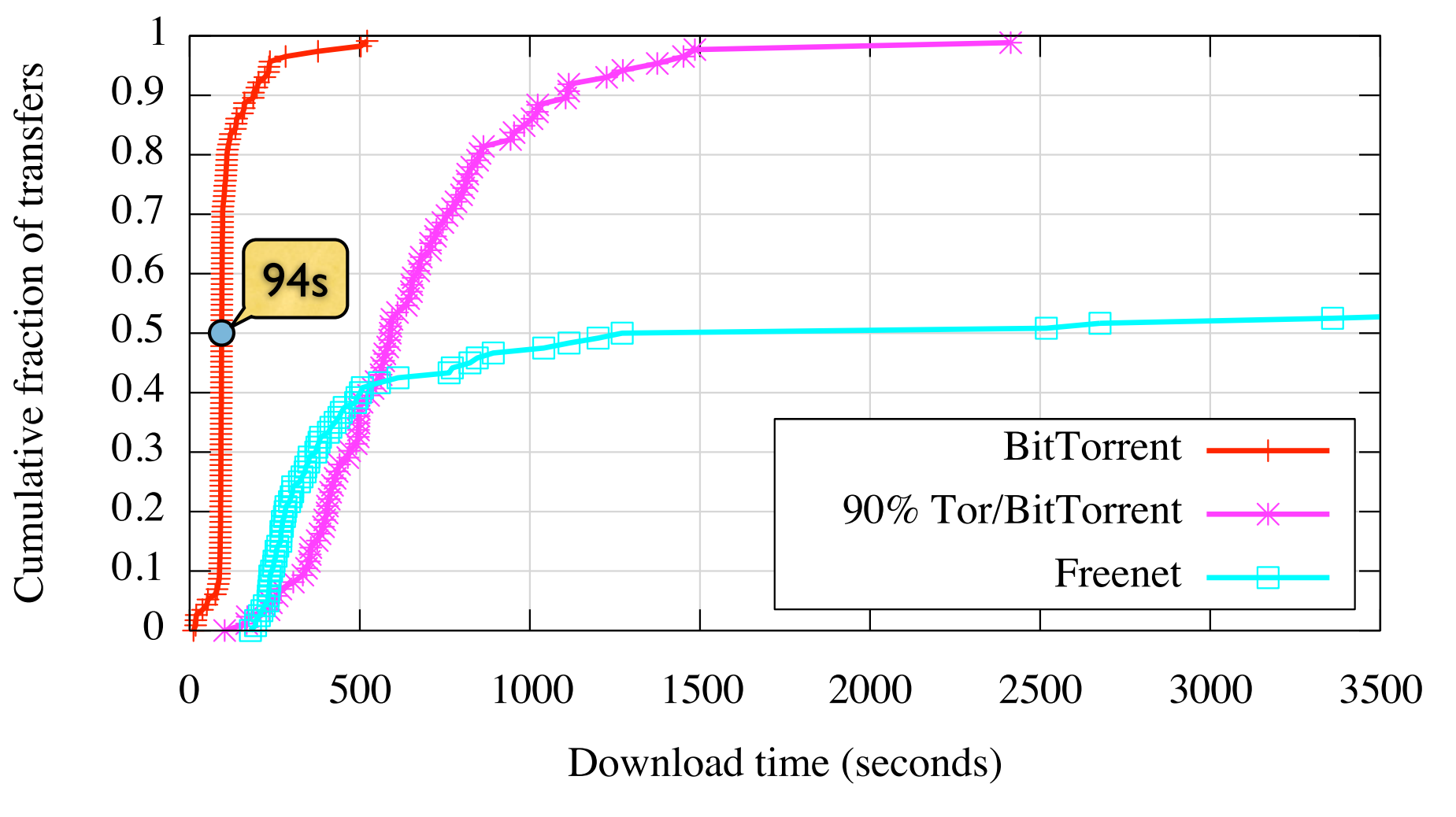

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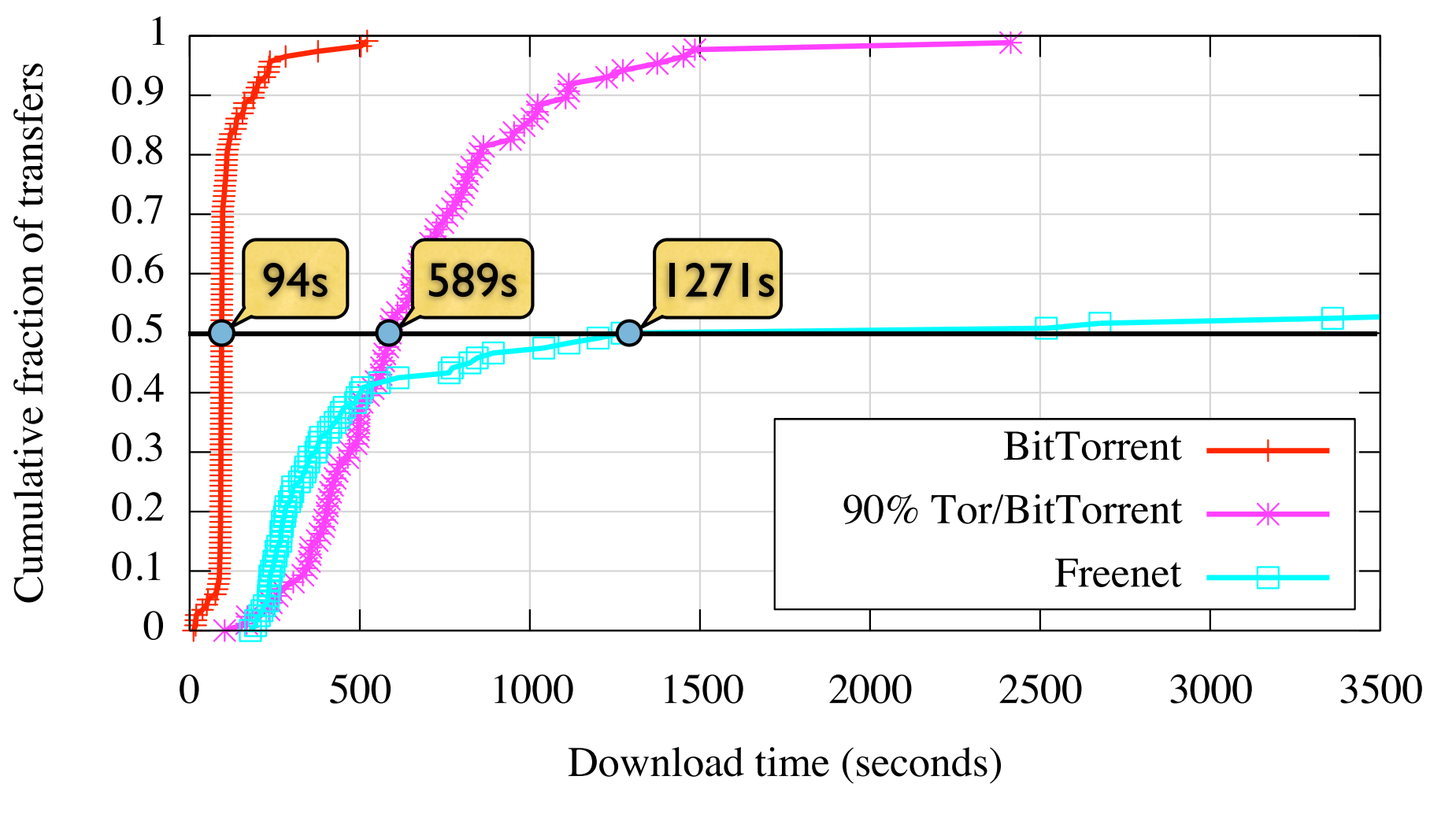

Performance cost for privacy is significant!

OneSwarm

Goal: *Preserve user privacy* while maintaining *high performance*

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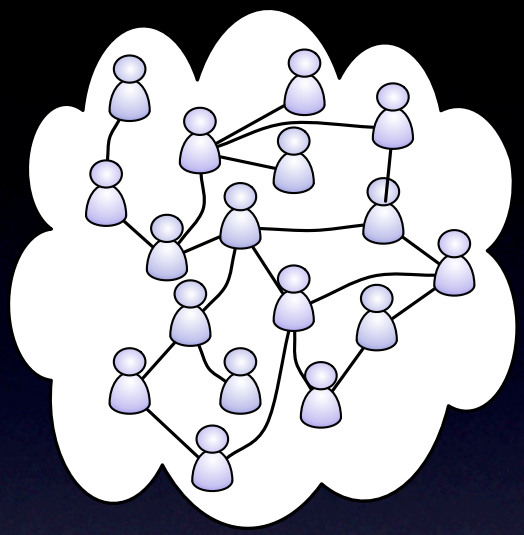
- Client *released* in March 2009
- Autoupdate requests from *hundreds of thousands of unique users*
- Flexible protocol gives users control of *privacy/performance* tradeoff

OneSwarm sketch



Social network

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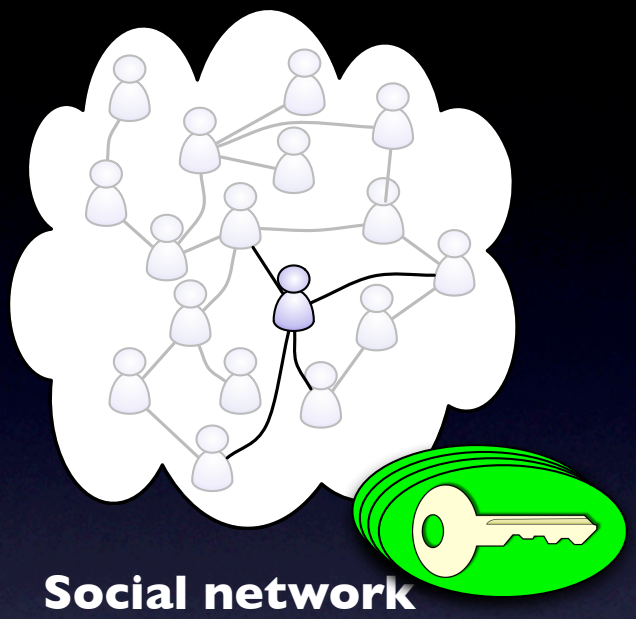

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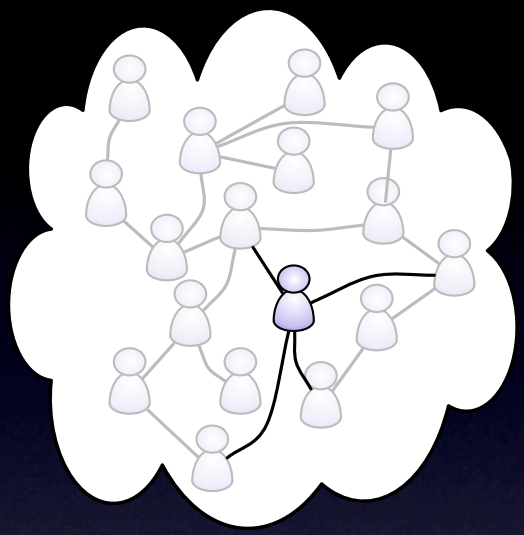

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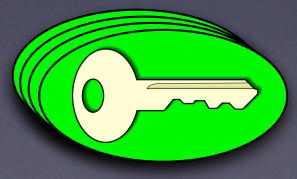

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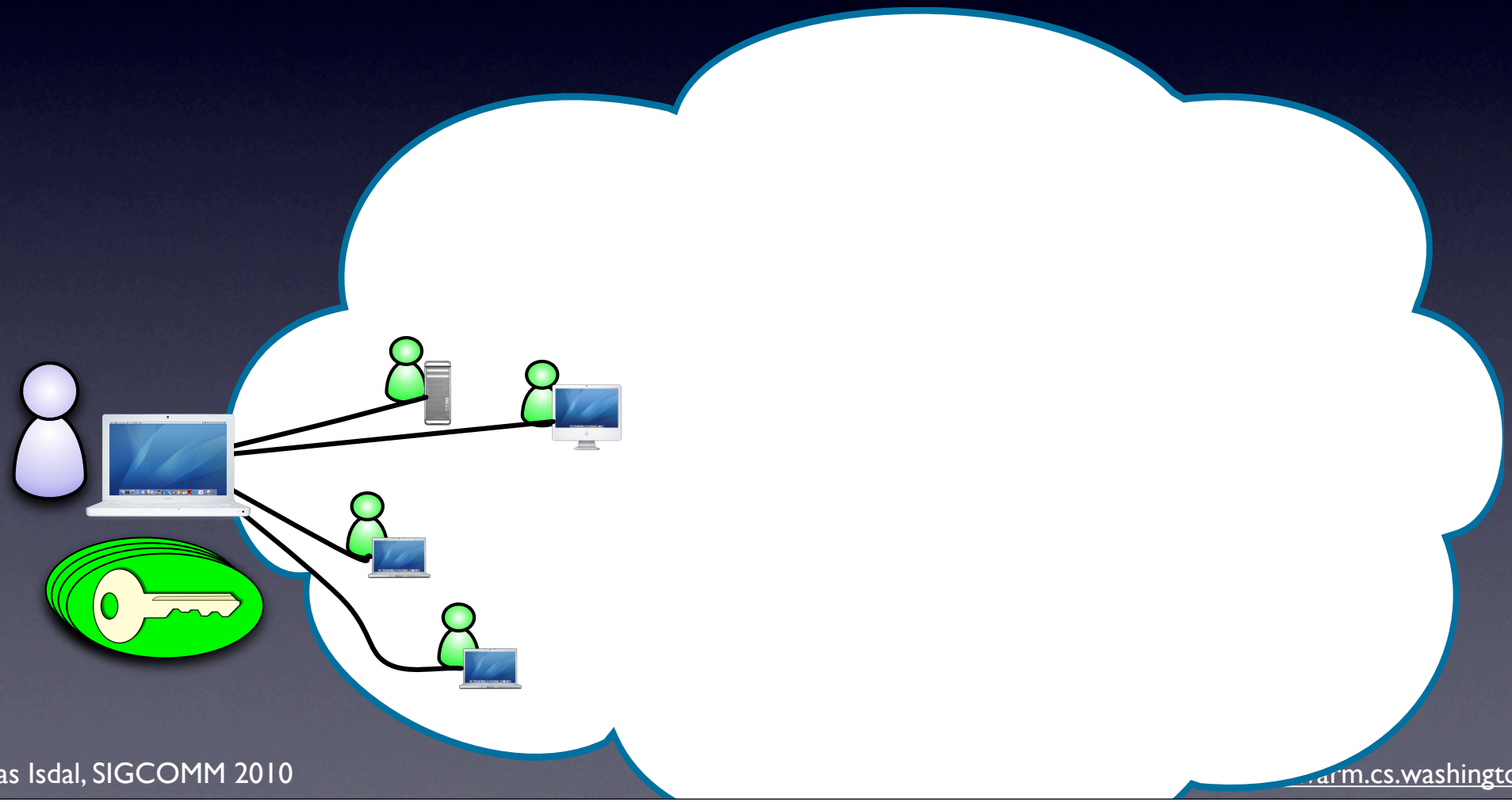

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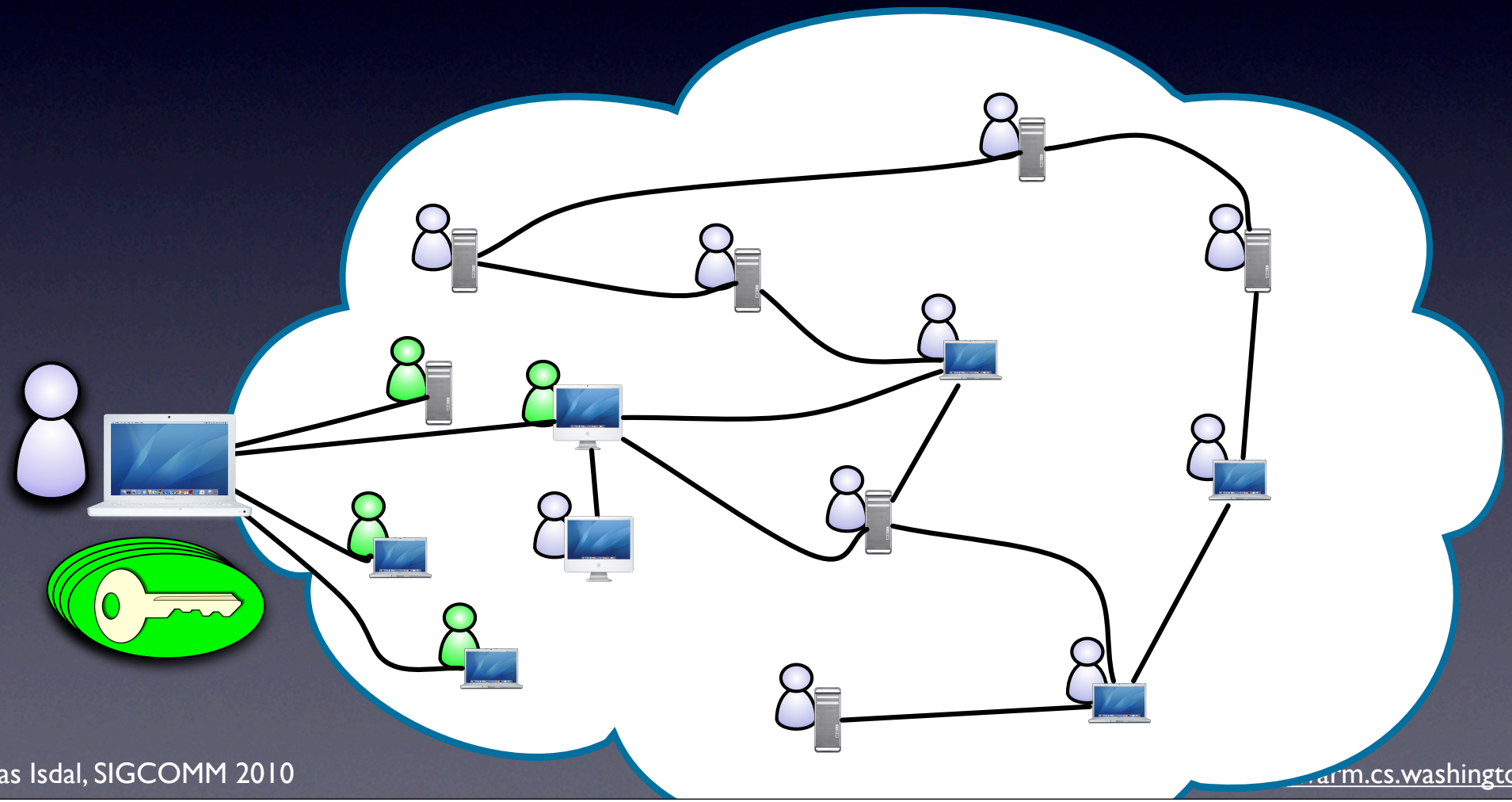

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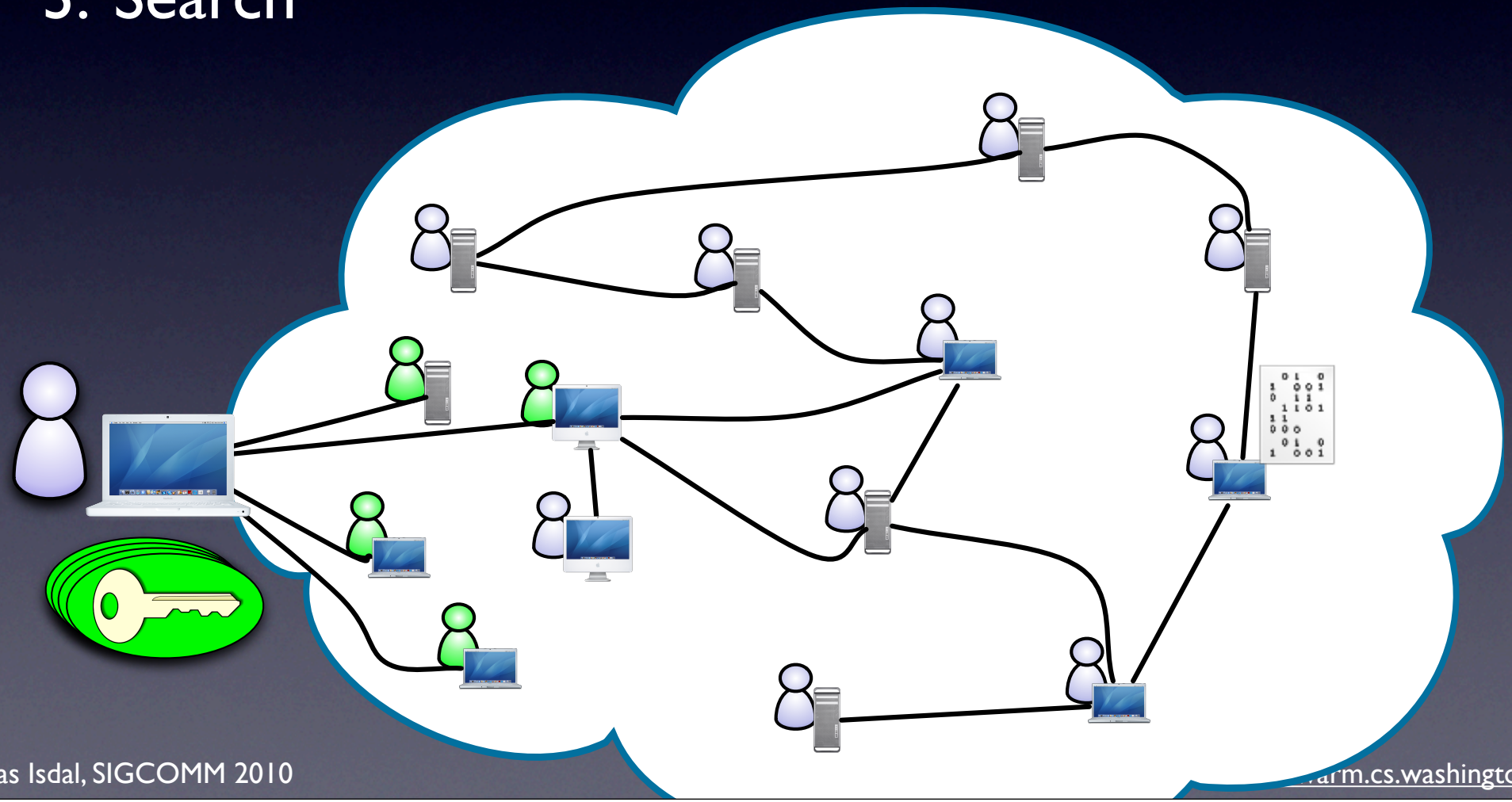

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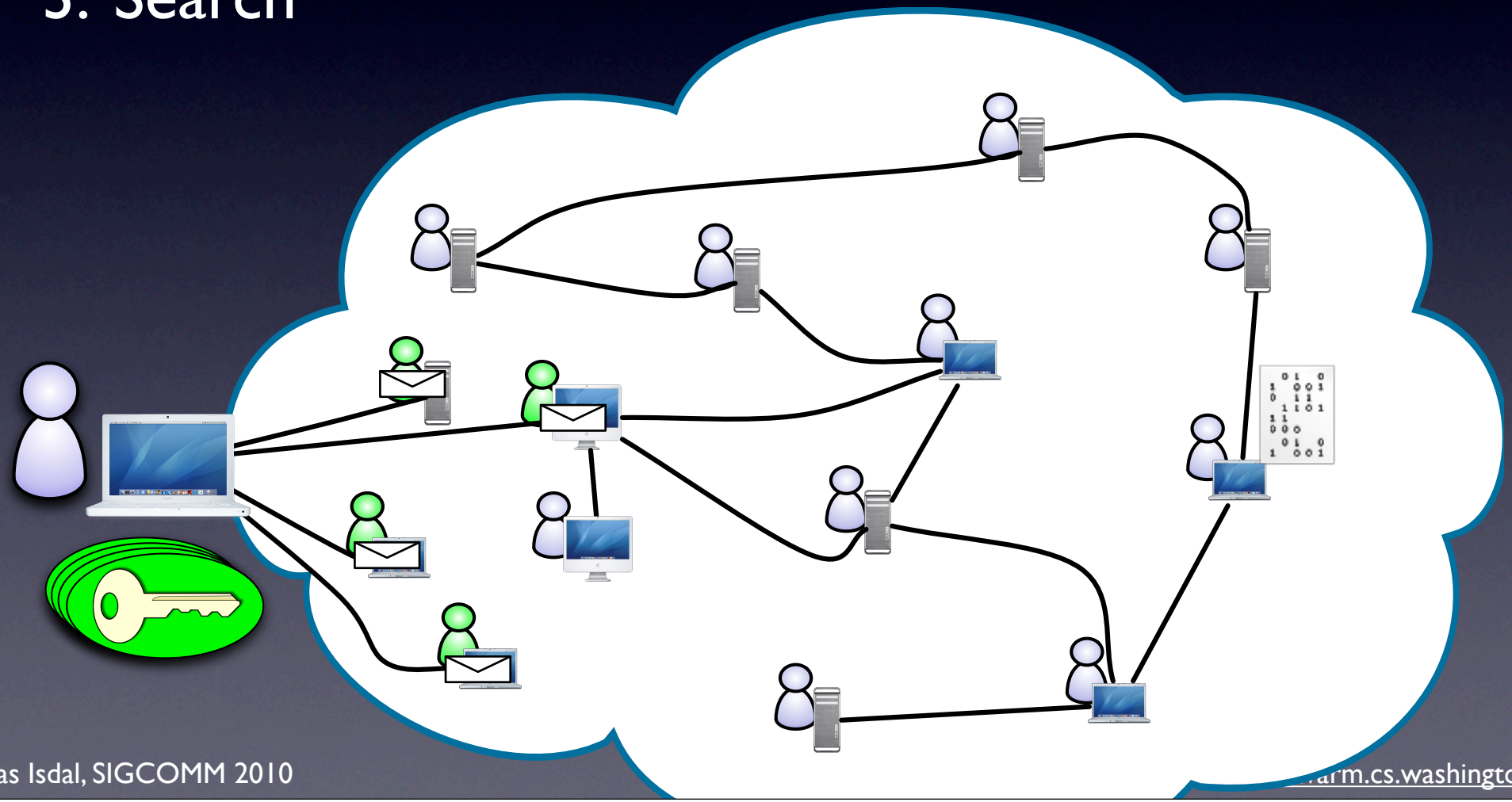

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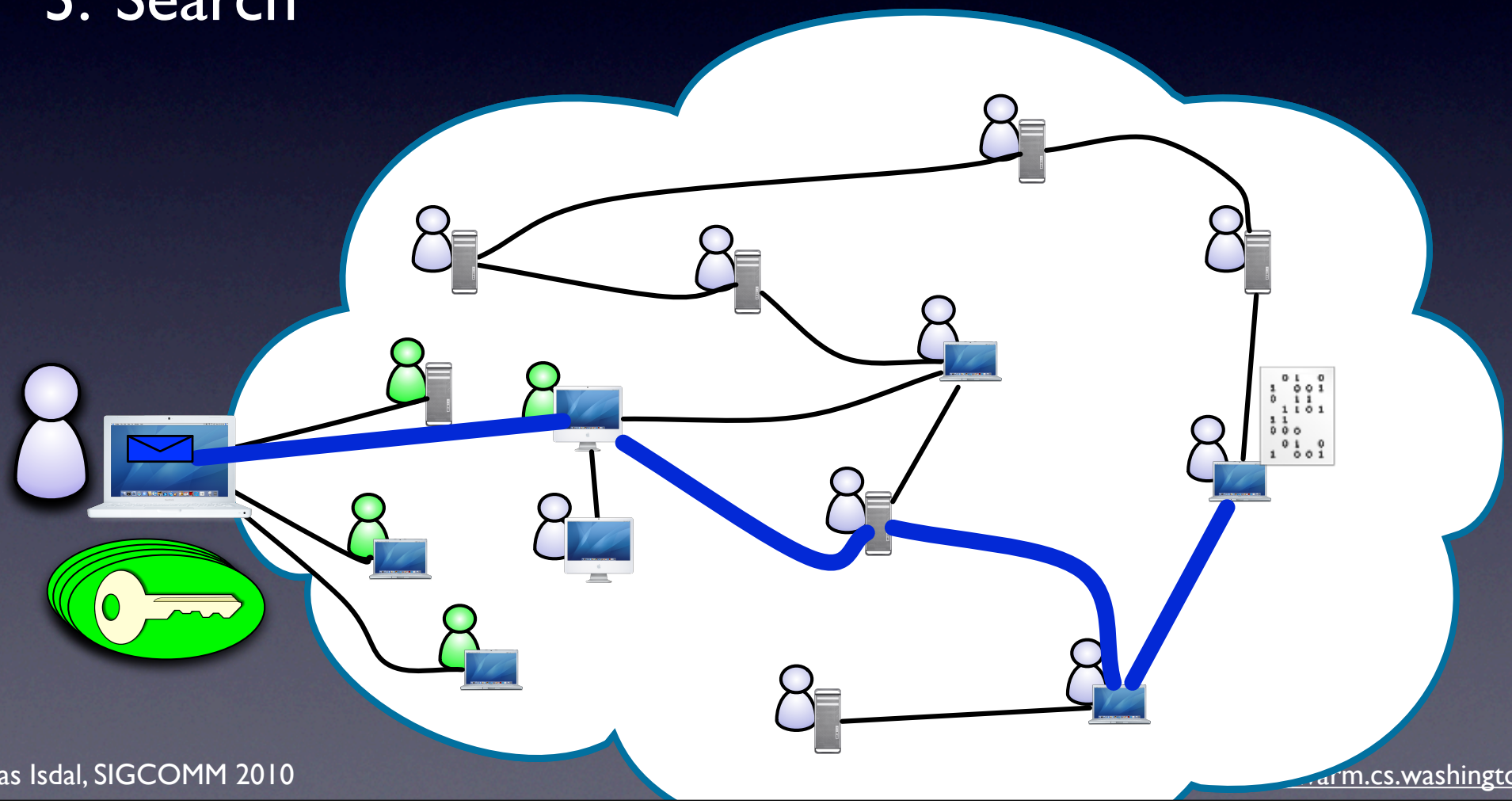

Receiver view

1. Import keys
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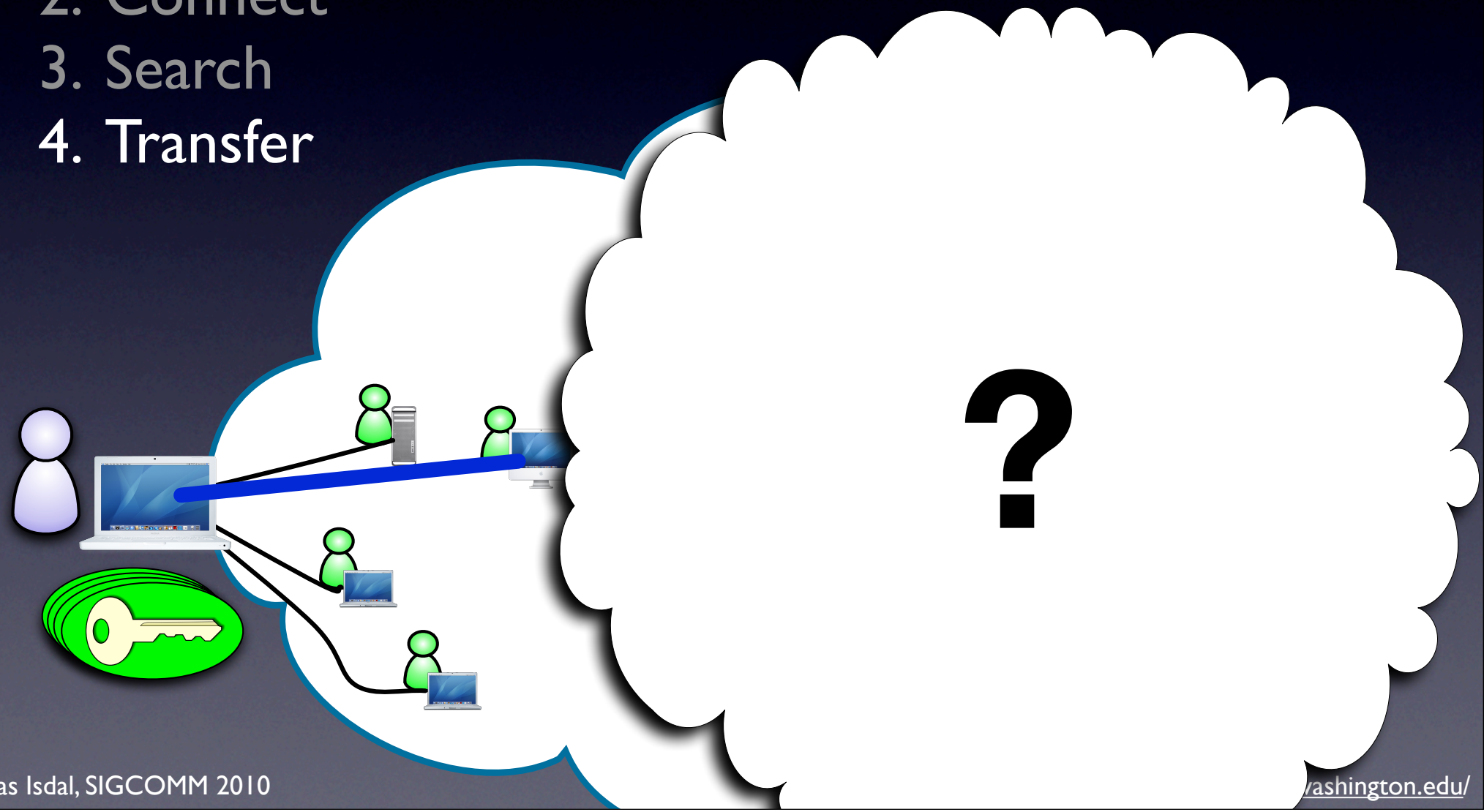

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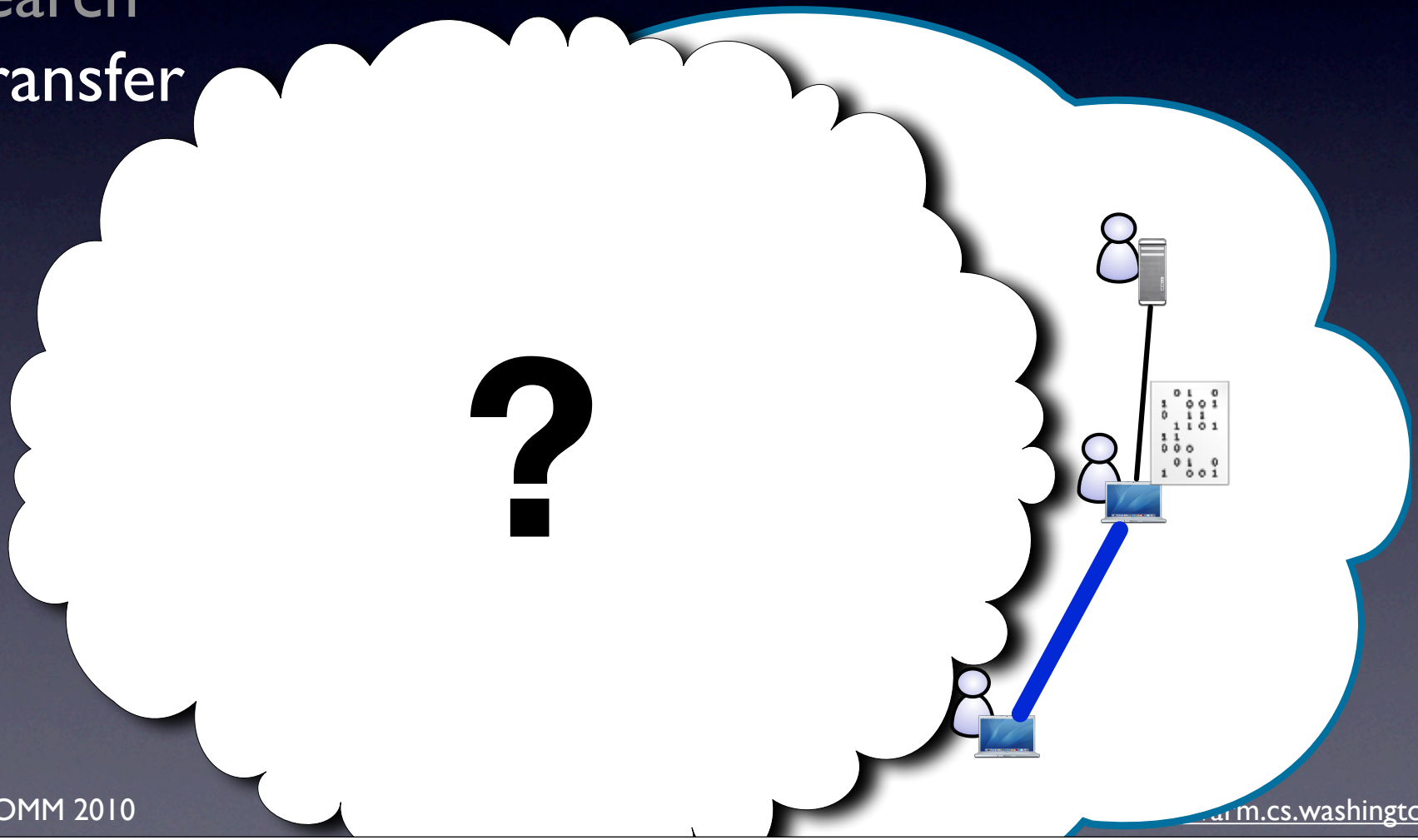

Outline

- Protocol sketch
- *Threat model*
- Design challenges
- Evaluation

Threat model

OneSwarm goal: Protect the users from revealing who is sharing / downloading which items

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- *The Attacker:*
  - Controls a *limited number* of overlay nodes
  - Can do *anything* on nodes it controls
    - inject/sniff traffic, correlate data
- *Cannot:* Sniff / inject traffic into *arbitrary network links*

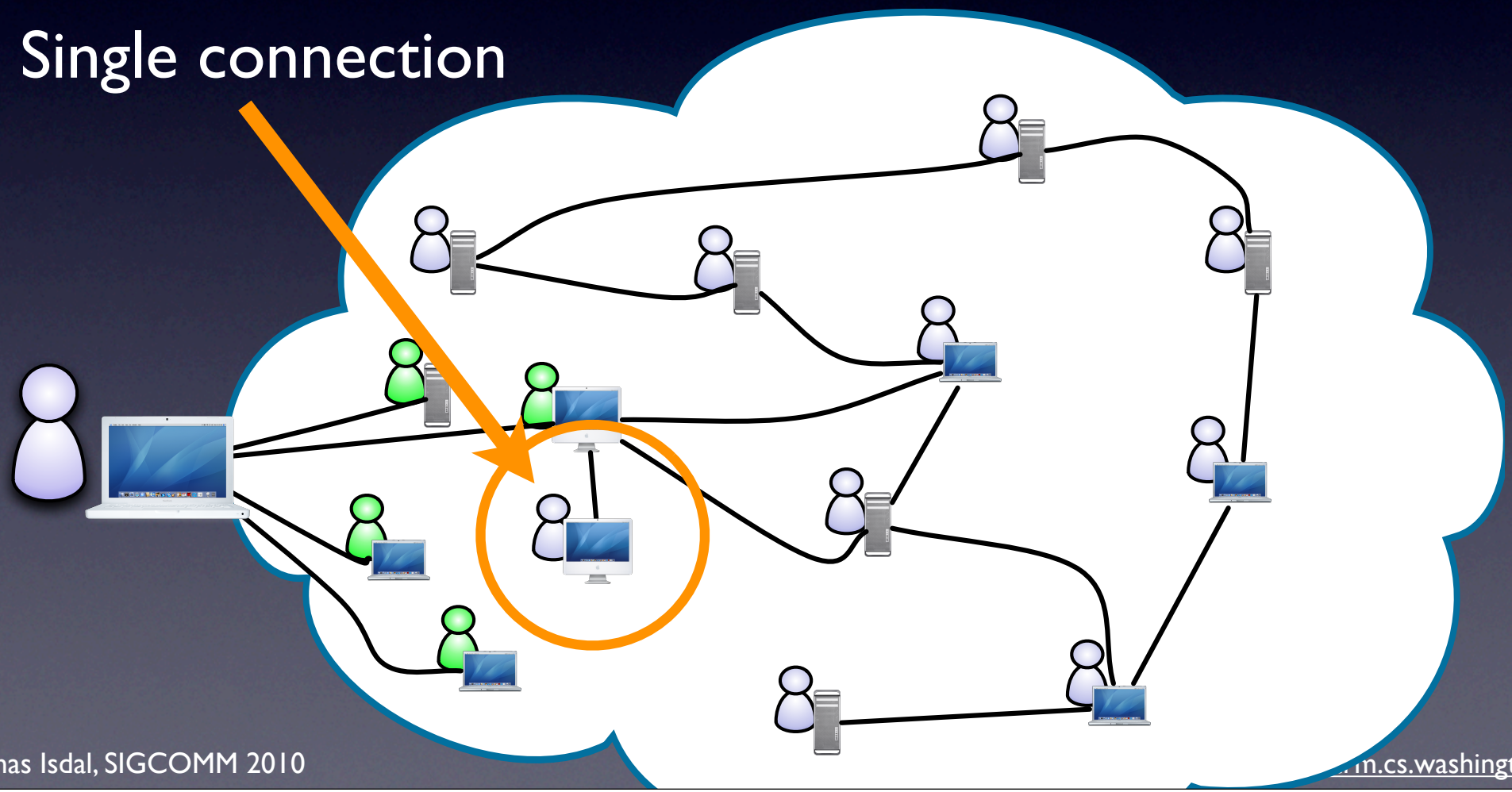
Design challenges

- *Locating mobile peers*
- Robustness despite sparse social networks
- Search without revealing src and dst
- Maintain performance despite long paths

Mobile peers

- Peers publish IP:port in DHT
- *Allow revocation* of location updates:
  - Publish IP:port *separately* for each peer
  - Encrypt and sign updates
  - Removing a peer:
    - ➡ Disallow incoming connections
    - ➡ *Stop location updates* for that peer

Sparse social networks



Relying on social networks

- Many users have a *sparse social network*
  - ➡ Poor reliability
  - ➡ Poor performance
  - ➡ Privacy issues
- Early adopters suffer

Early adopters

http://oneswarm.cs.washington.edu/

Early adopters

Solution: *Community Servers*

- Source of *untrusted* peers

http://oneswarm.cs.washington.edu/

Untrusted peers

- *Long term* relationships with *few* untrusted peers
- *Delay* responses to foil timing attacks
- *Probabilistic forwarding* of queries
- *Deterministic* random behavior to limit information leakage from repeated queries

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Peers can be *trusted* / *untrusted* per data object

Design challenges

- Locating mobile peers
- Robustness despite sparse social networks
- *Search without revealing src and dst*
- Maintain performance despite long paths

Flood with delay

Goal: locate data without revealing source or destination

- *Flood* searches into the overlay
- Only forward searches using *spare capacity*
- Searches are *delayed* at each hop
  - ➡ Require users send *cancel* message on incoming response to *stop flood* propagation

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Property: No guarantee that all objects can be found by all users at all times

Response delay

- *Hash*: 160bit content hash
- *Text*: return items matching "britney s"
- *Delay response* towards *untrusted* peers:
  - Random reply delay *seeded by hash*
  - *Multiple replies* if multiple matches

Design challenges

- Locating mobile peers
- *Robustness despite sparse social networks*
- *Search without revealing src and dst*
- *Maintain performance despite long paths*

Multi-path

- End-to-end capacity *limited by slowest link*
- Paths *fail if any node* on the path *disconnects*

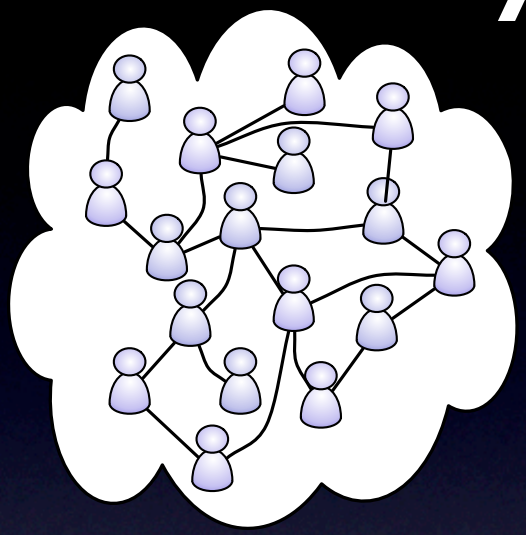
➡ *Use multiple paths to the same source, send cancel after "n" responses (default=20)*

- Eliminate "*find fastest path*" problem
- Distribute forwarding load
- Resilience to path failures

Data transfer

- BitTorrent used in the overlay as basis for the data transfer protocol
  - *Multiple sources* handled naturally
  - *Peer* in BitTorrent→*Path* in OneSwarm
  - *Swarming* downloads

System overview



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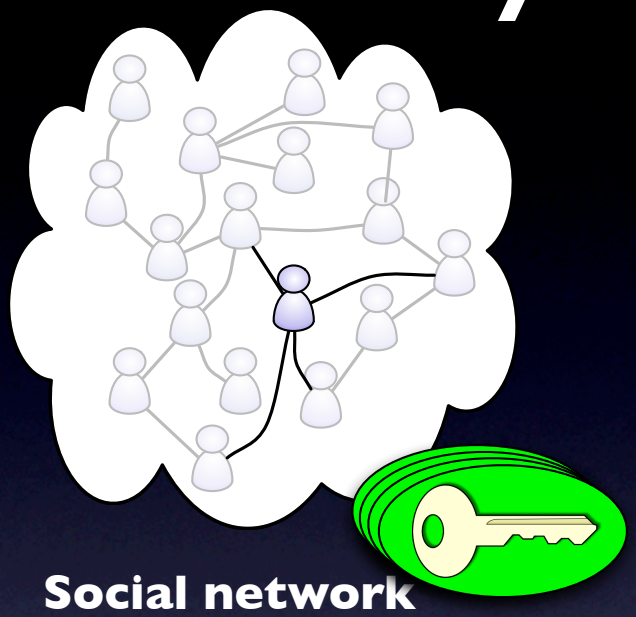

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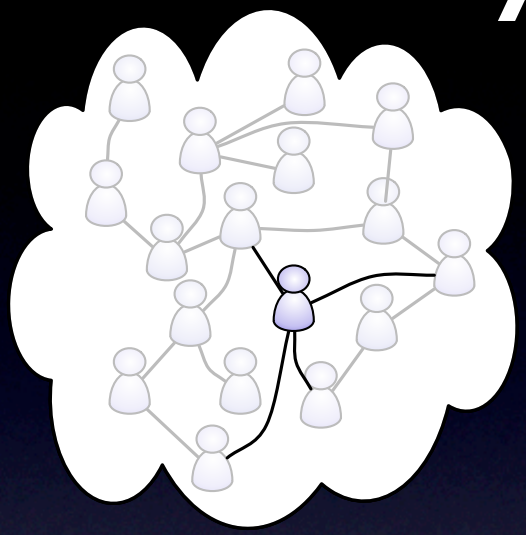

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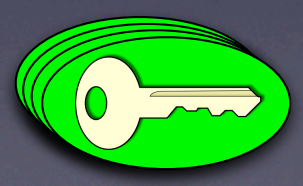

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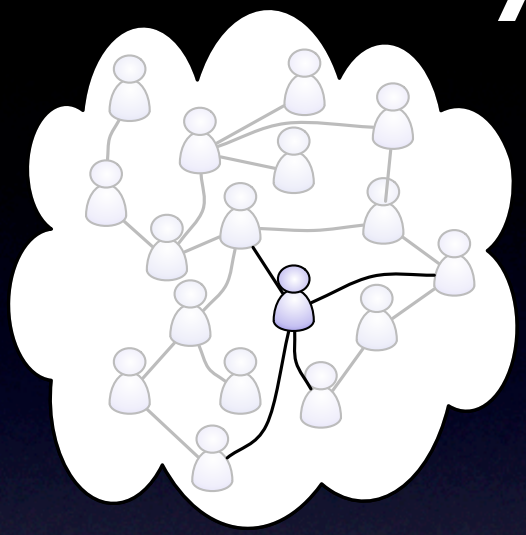
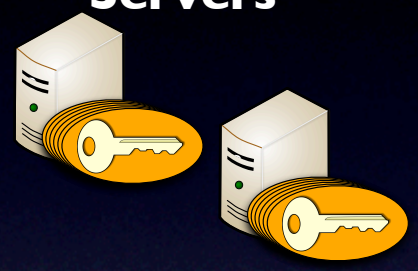


Social network

Community Servers



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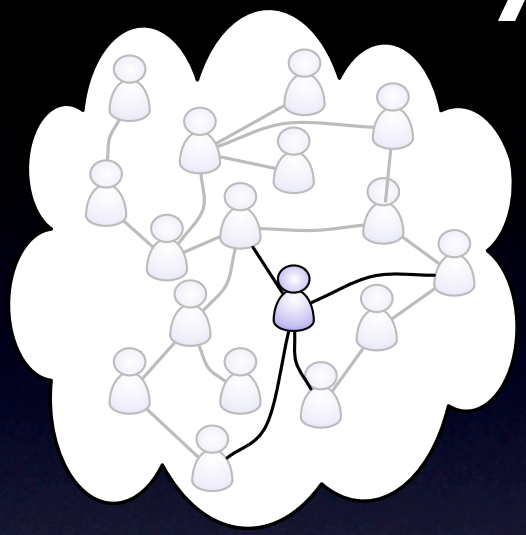

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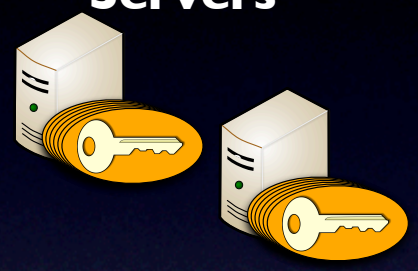

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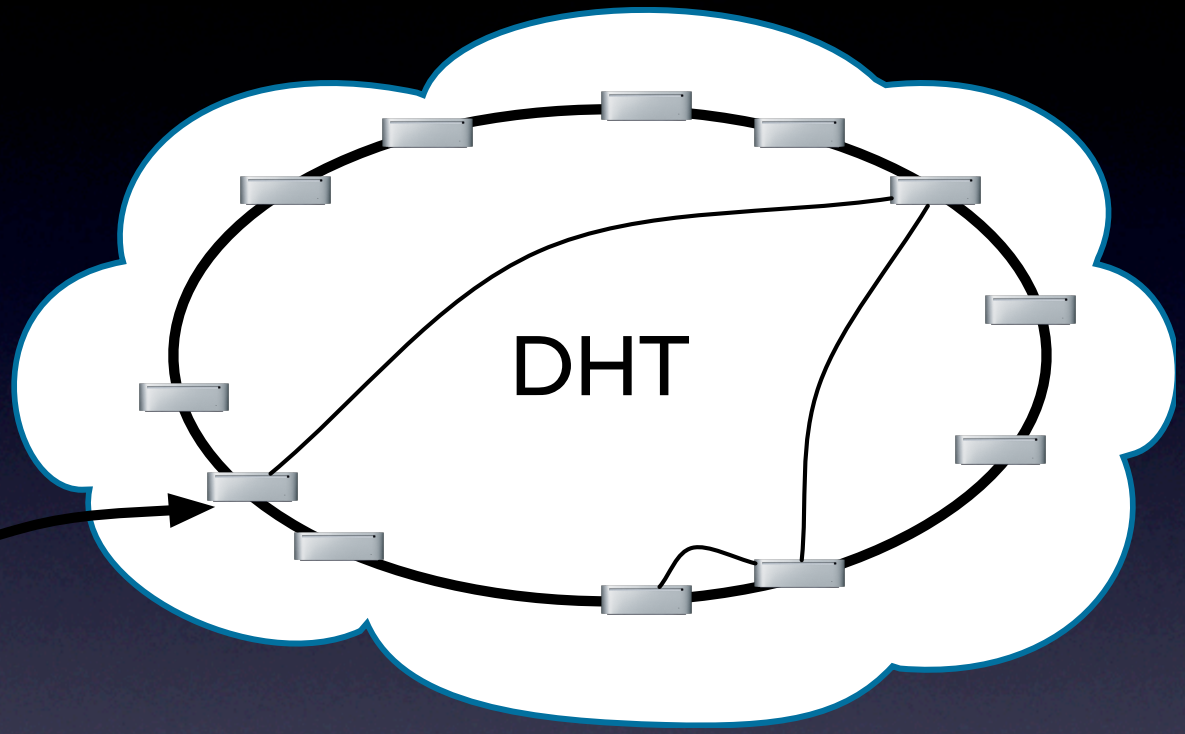

lookup()

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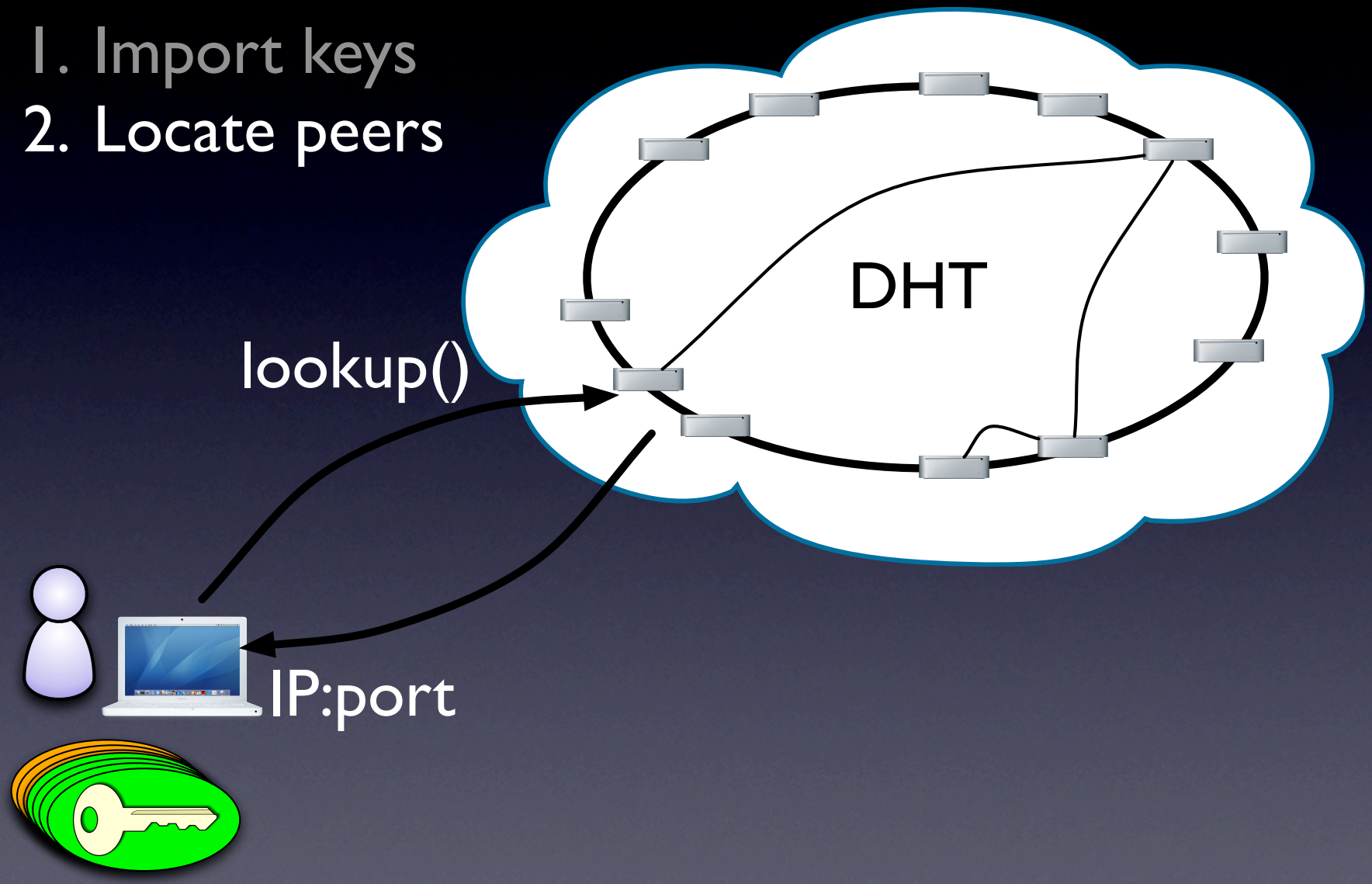

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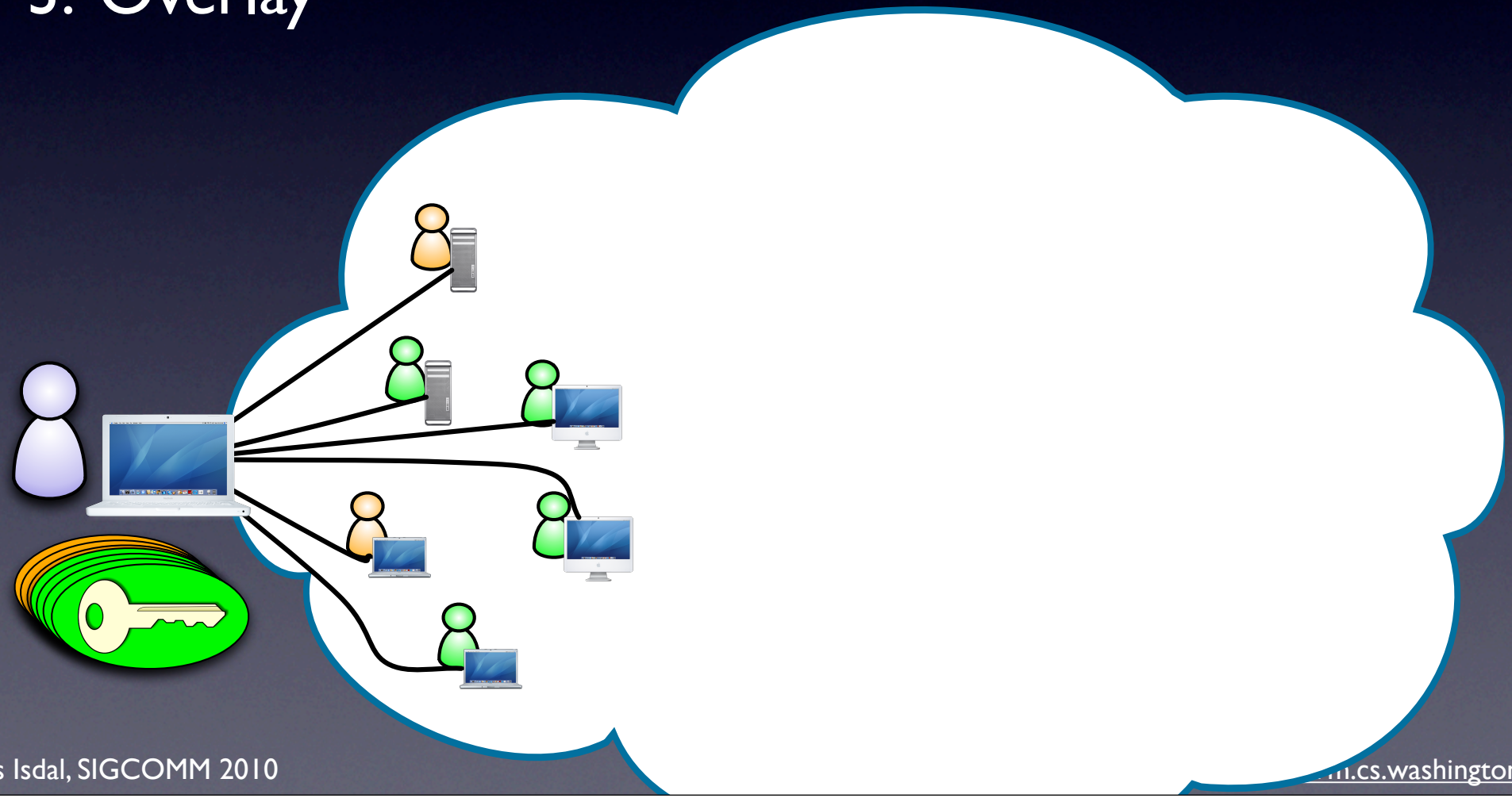

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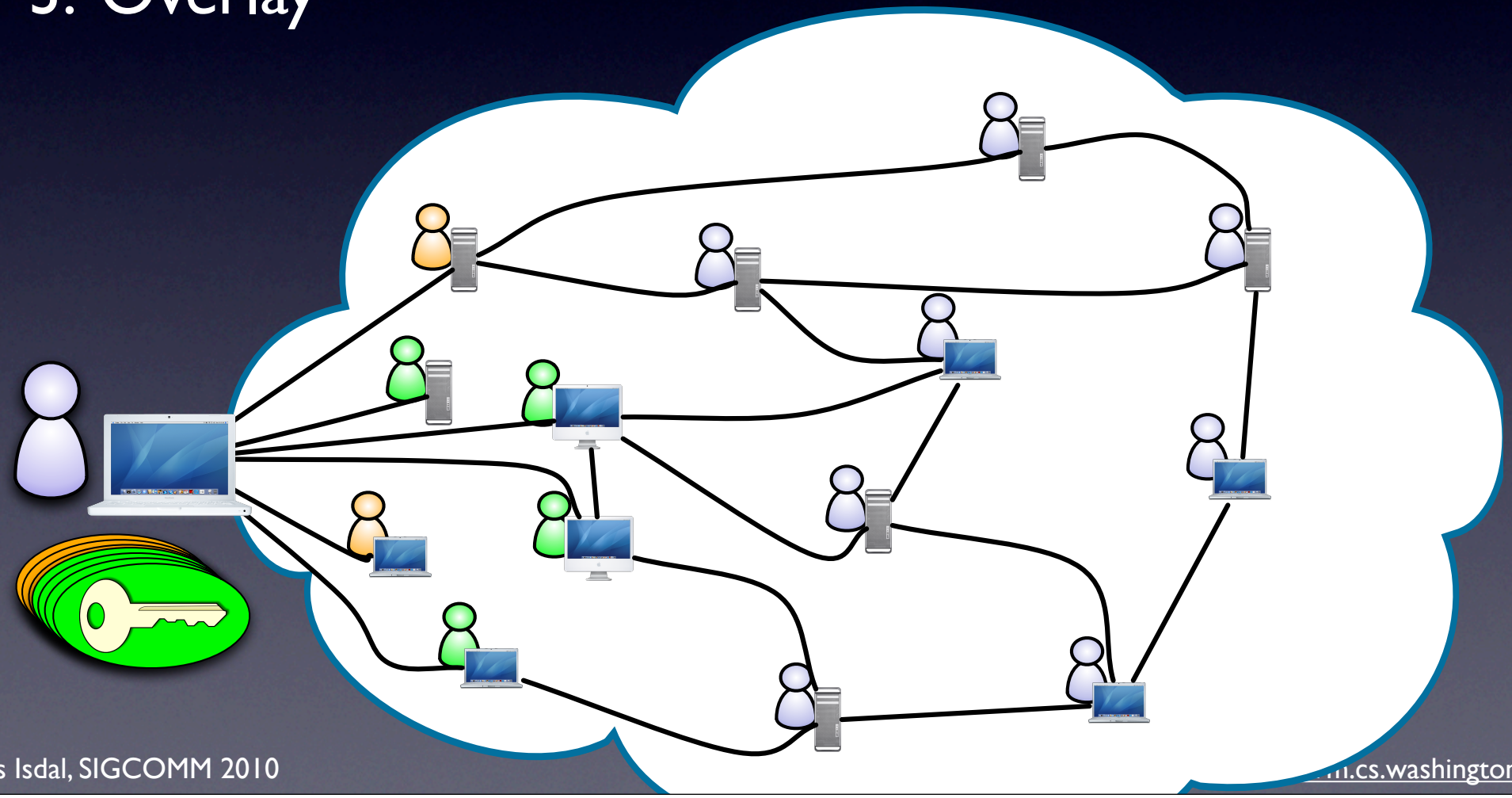

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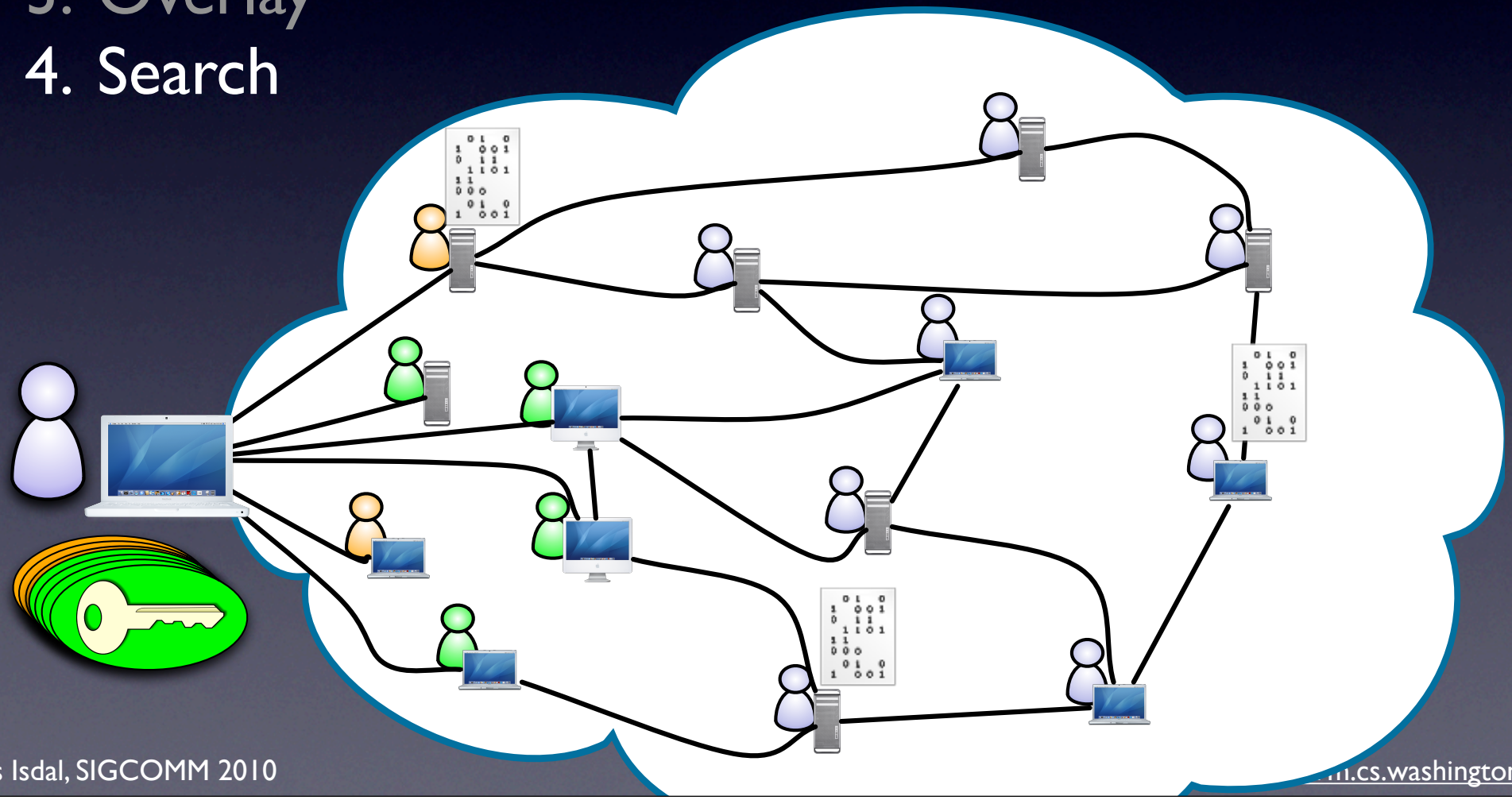

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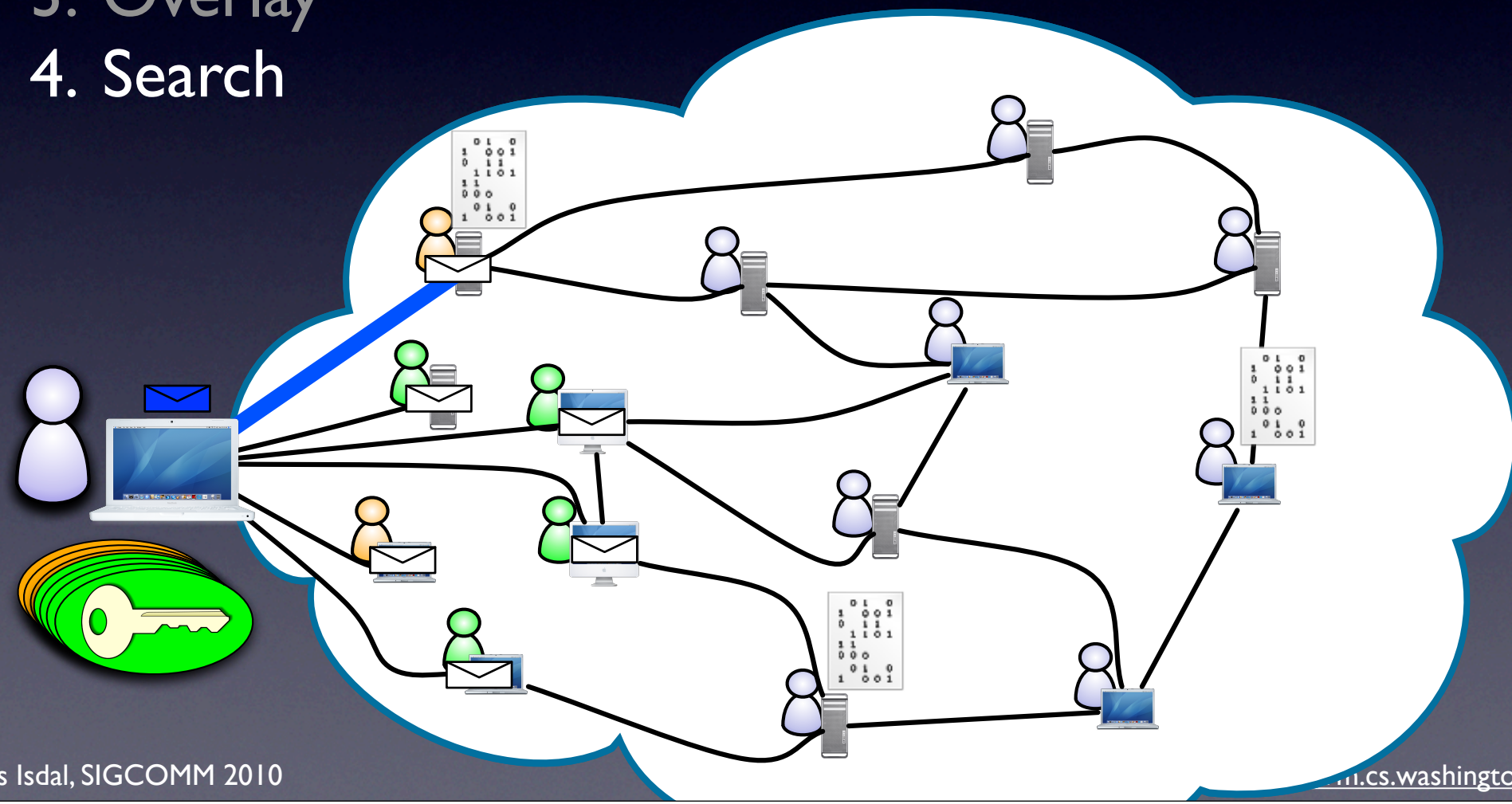

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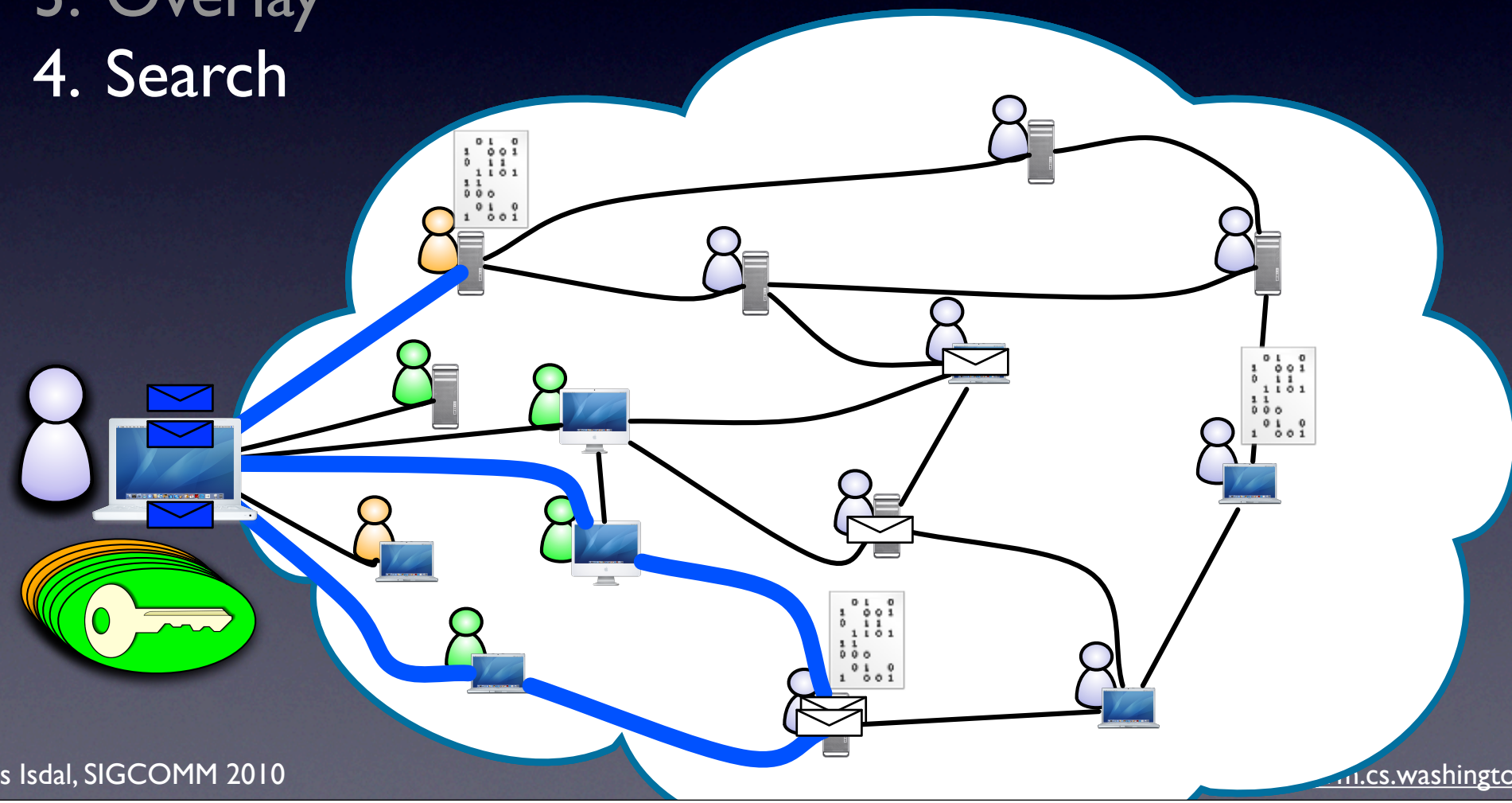

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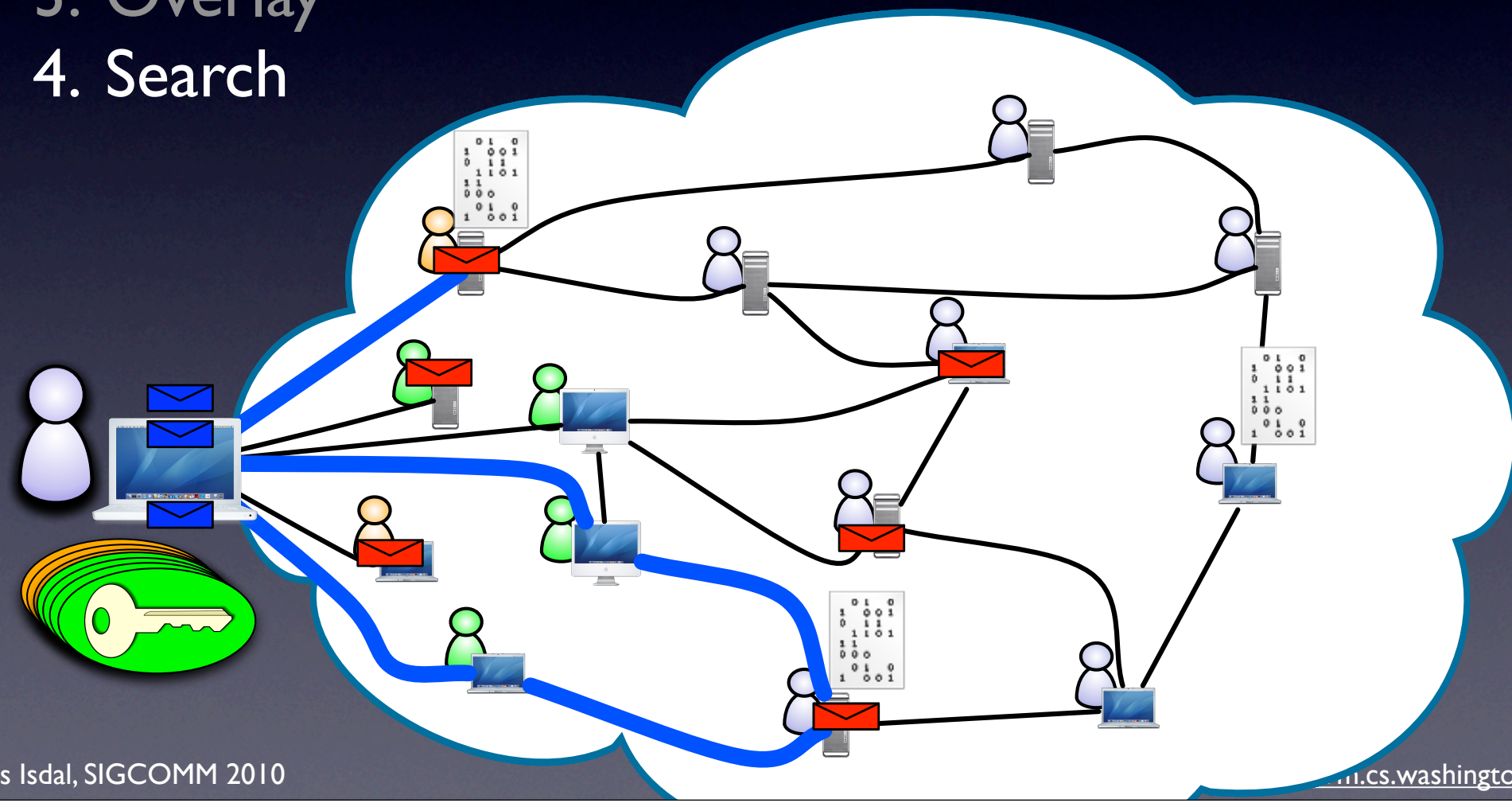

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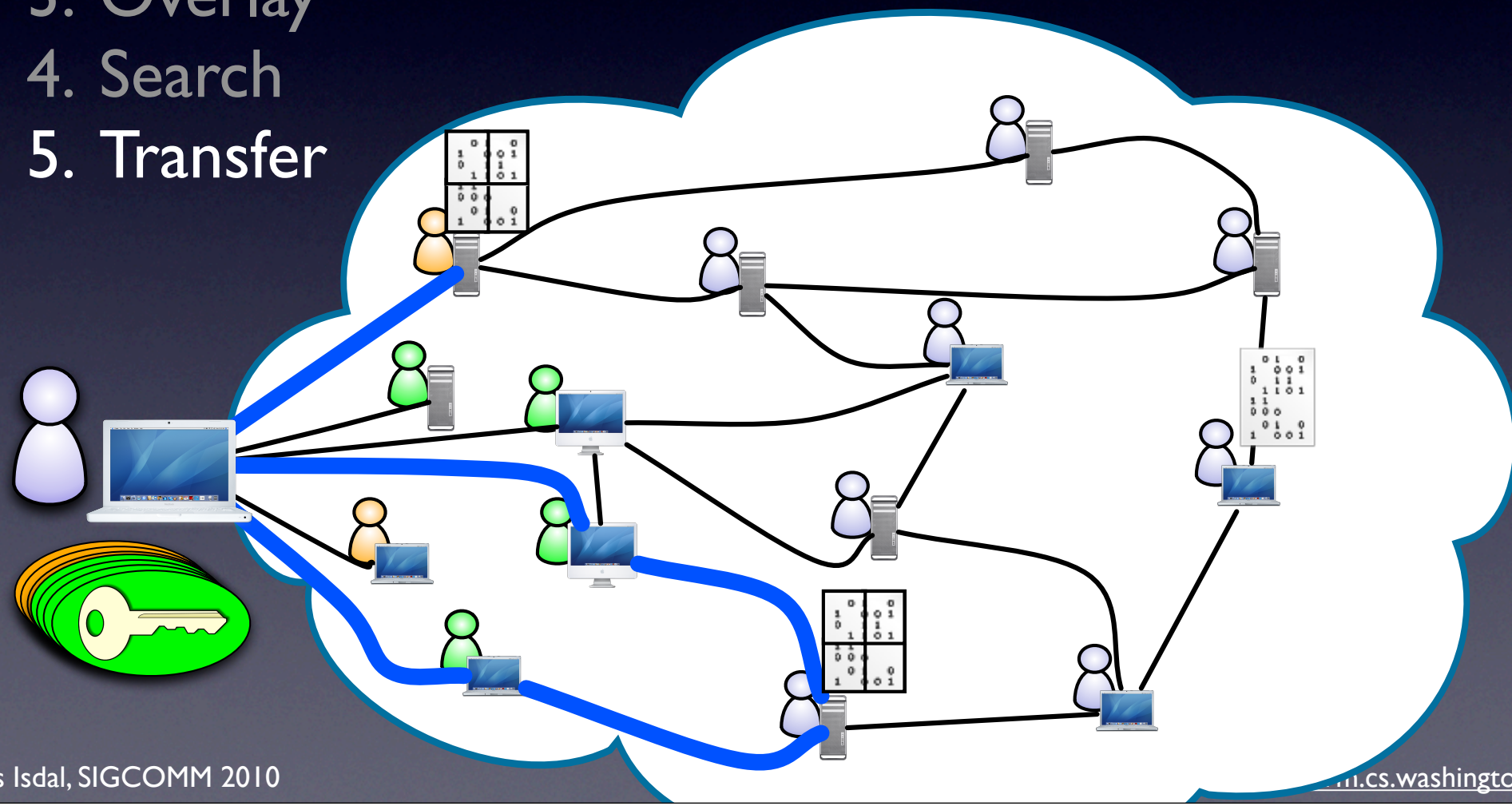

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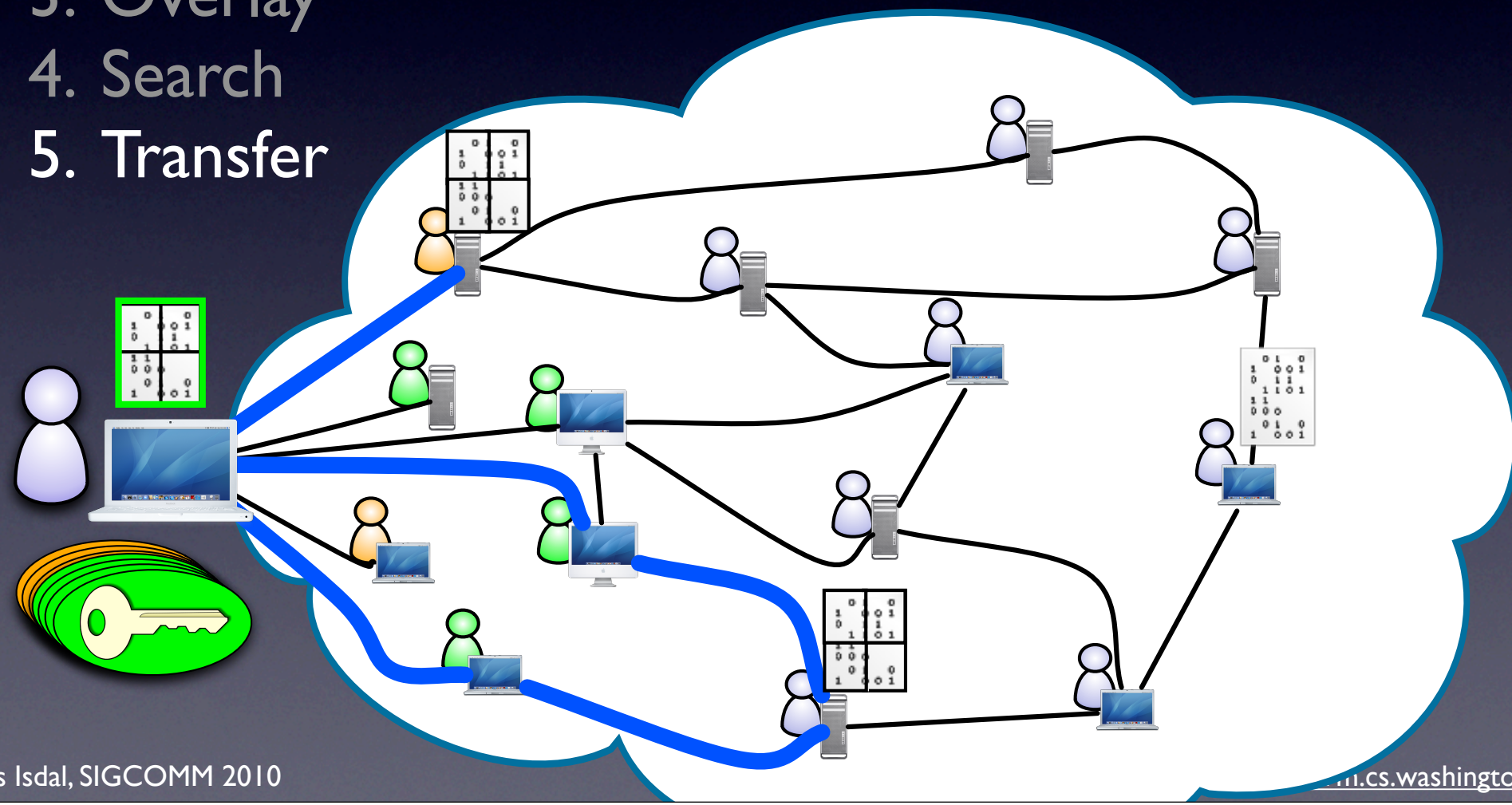


Outline

- Protocol sketch
- Threat model
- Design challenges
- *Evaluation*

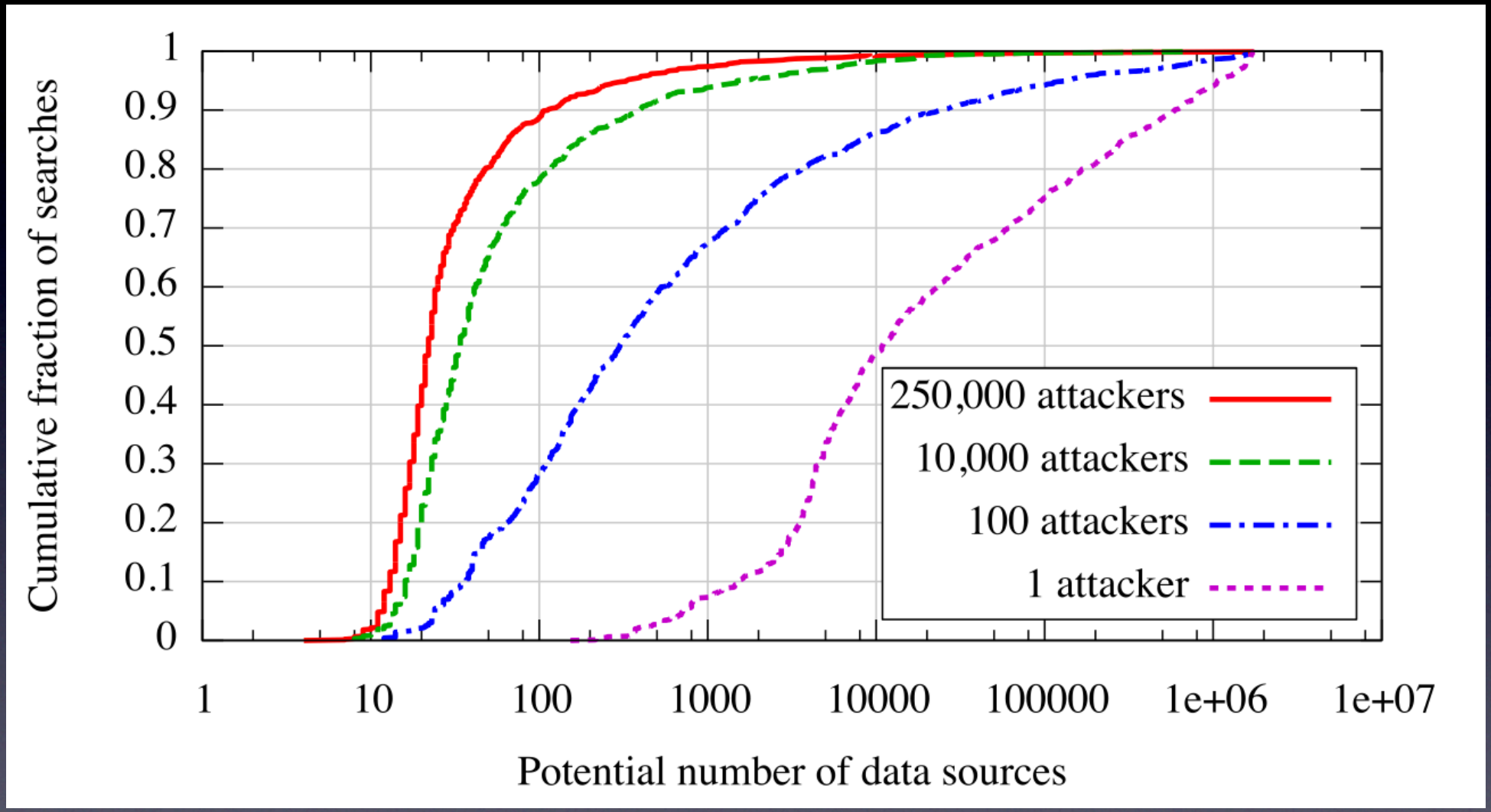
Timing attack

- Combination of social graph and untrusted peers
- Attackers search for content in the overlay
  - *Monitor delay* between search and response
- How many users *could* have sent the reply within the recorded time?
- To quantify attacker effectiveness we use:
  - Connectivity oracle
  - Link latency oracle

Timing attack setup

- *Synthetic* OneSwarm overlay
- Based on social graph of *1.7 million* last.fm users
- Attackers are connected using a *public community server*
- Last.fm users with less than 26 friends use same community server to augment their connectivity graph

Timing uncertainty



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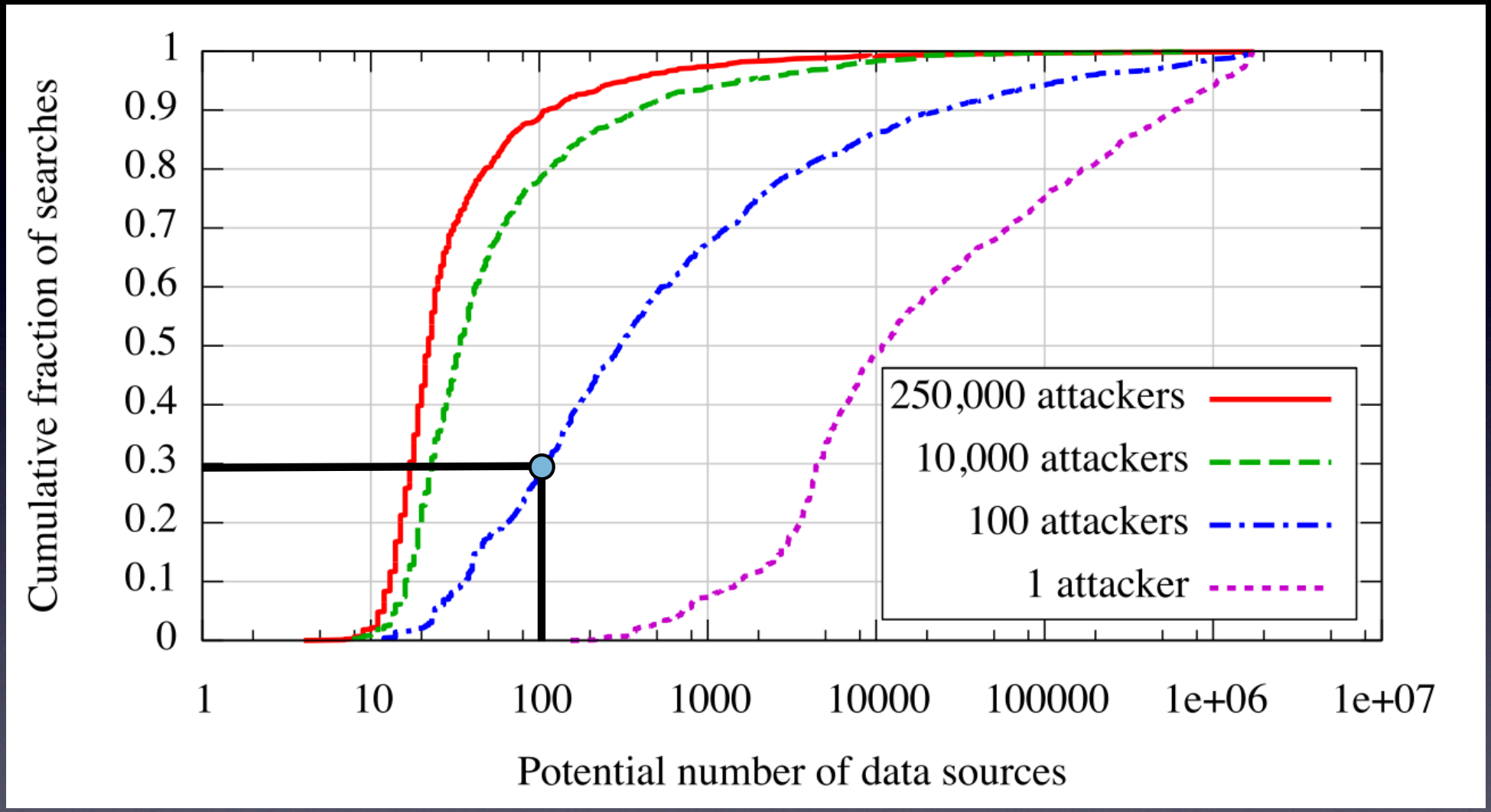

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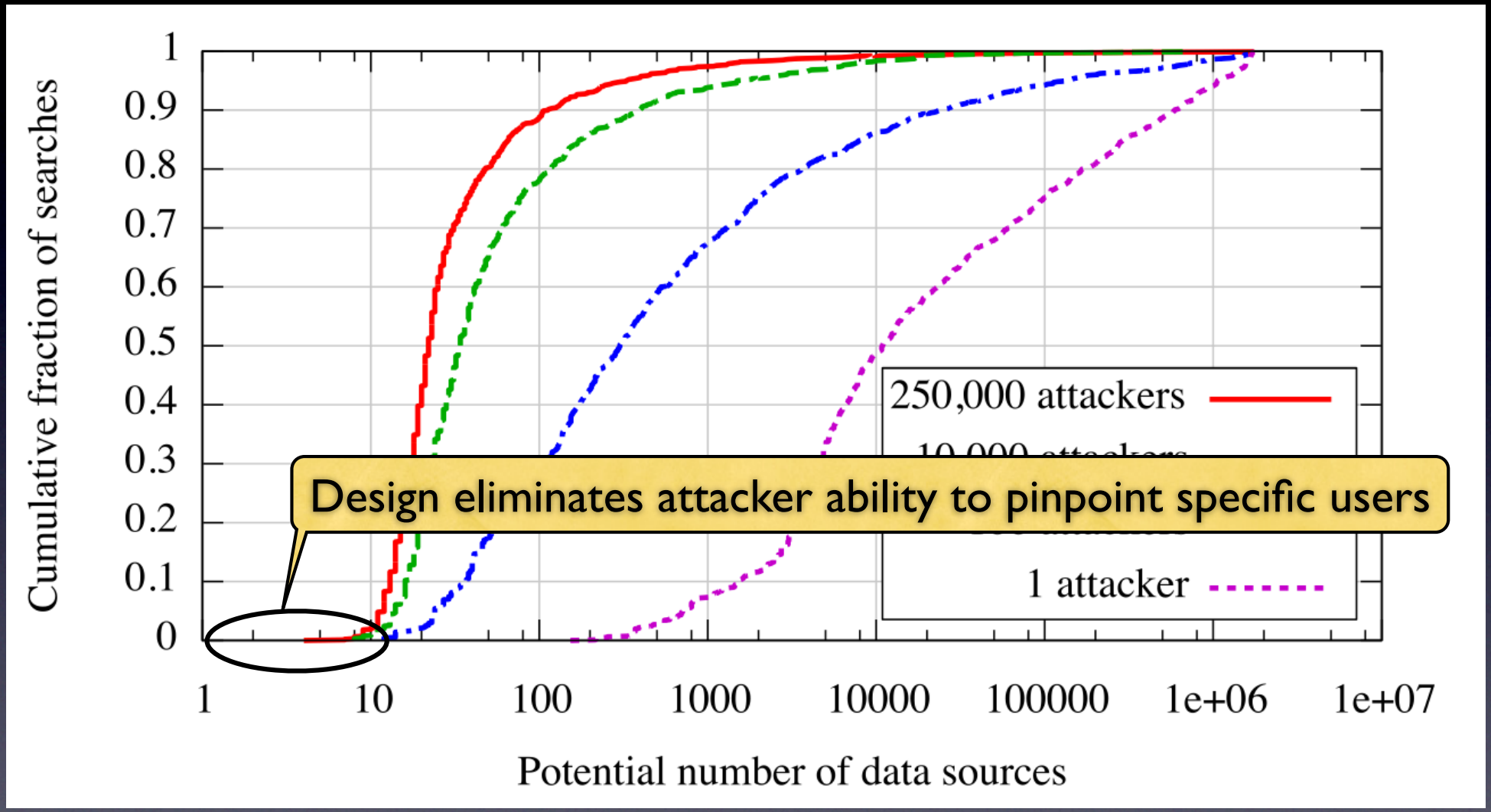

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Performance

- *Comparison* with existing systems
  - OneSwarm (using community server)
  - BitTorrent
  - BitTorrent over TOR
  - Freenet
- 20MB file from 120 PlanetLab nodes

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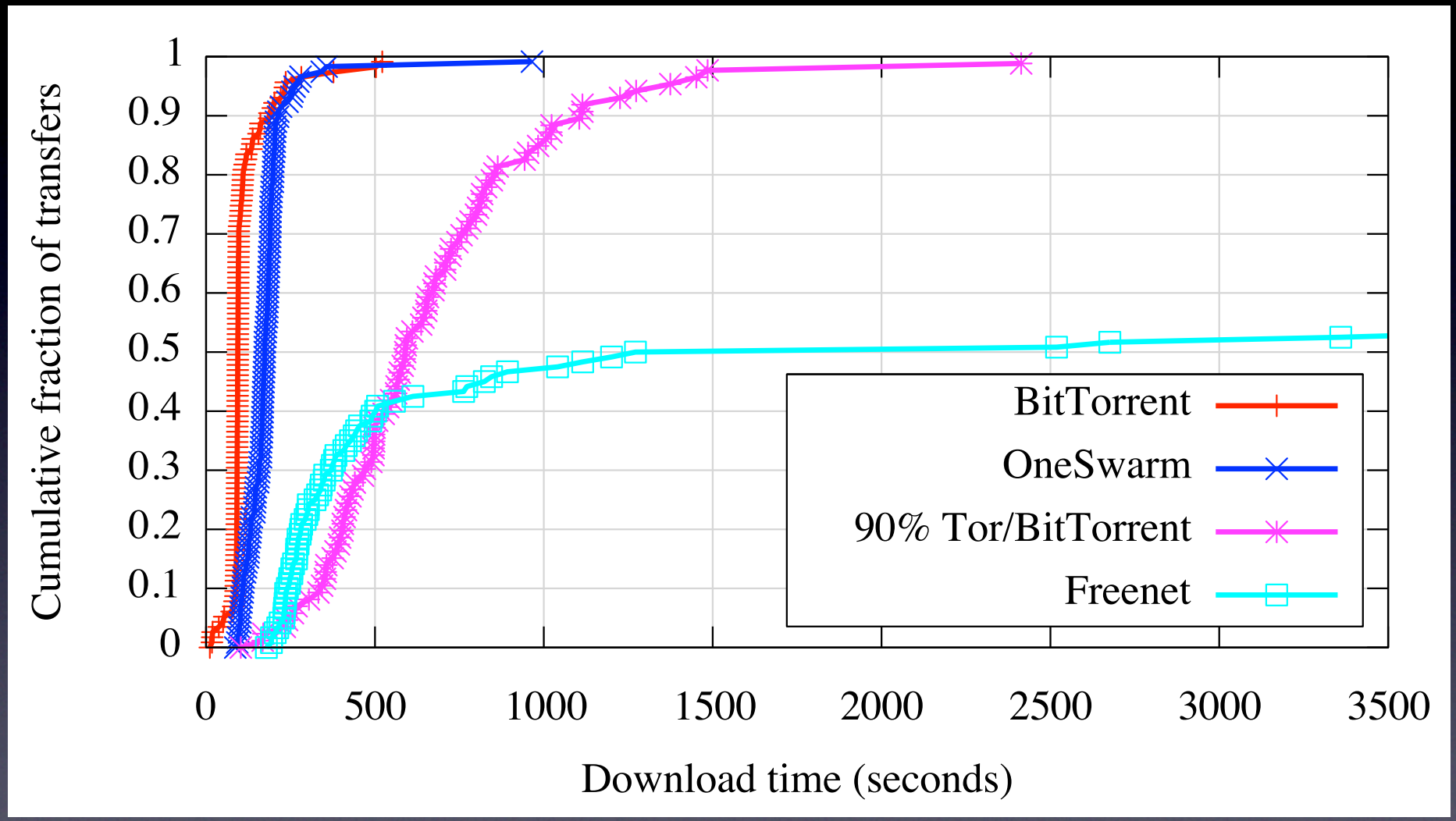
For OneSwarm: PlanetLab nodes part of public mesh, no two experiment nodes talk directly to each other

Download time



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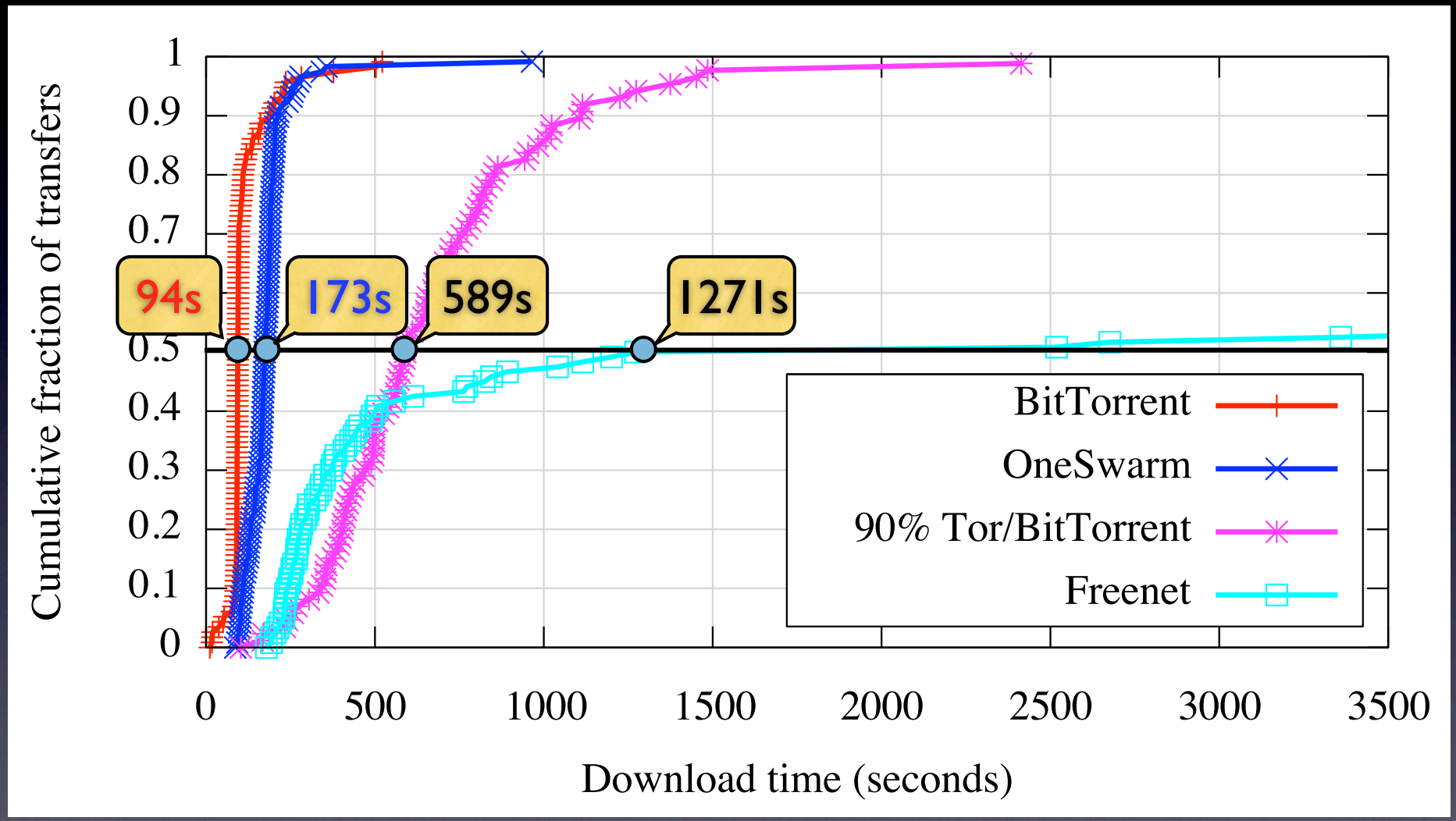

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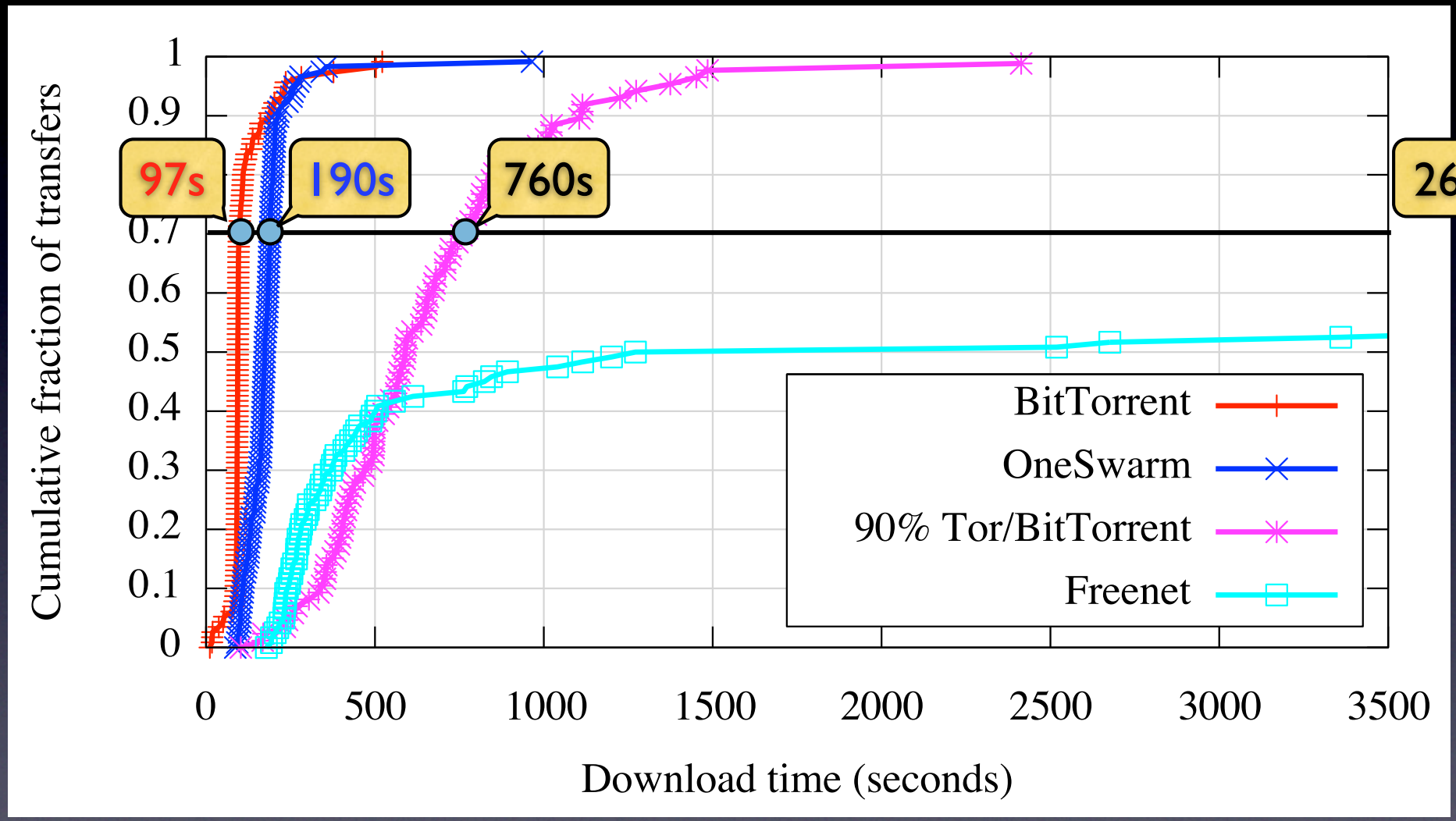

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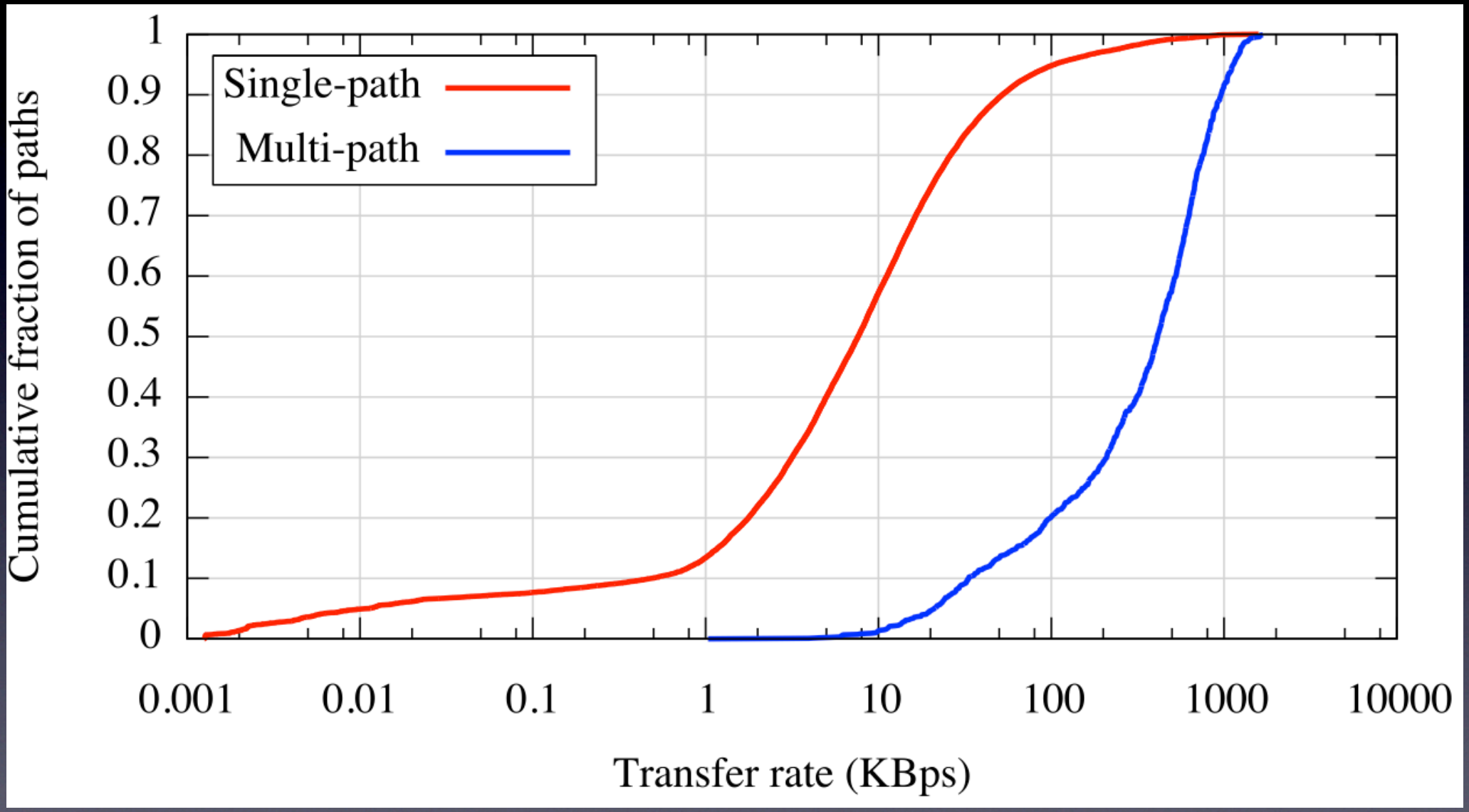
Multi-path

- 120 Planetlab nodes connected to the public OneSwarm mesh
- Compare throughput for:
  - *All paths* discovered
  - The *shortest path* (first response)

Multi-path transfers



Average: multipath: 457KB/s, shortest path: 29KB/s

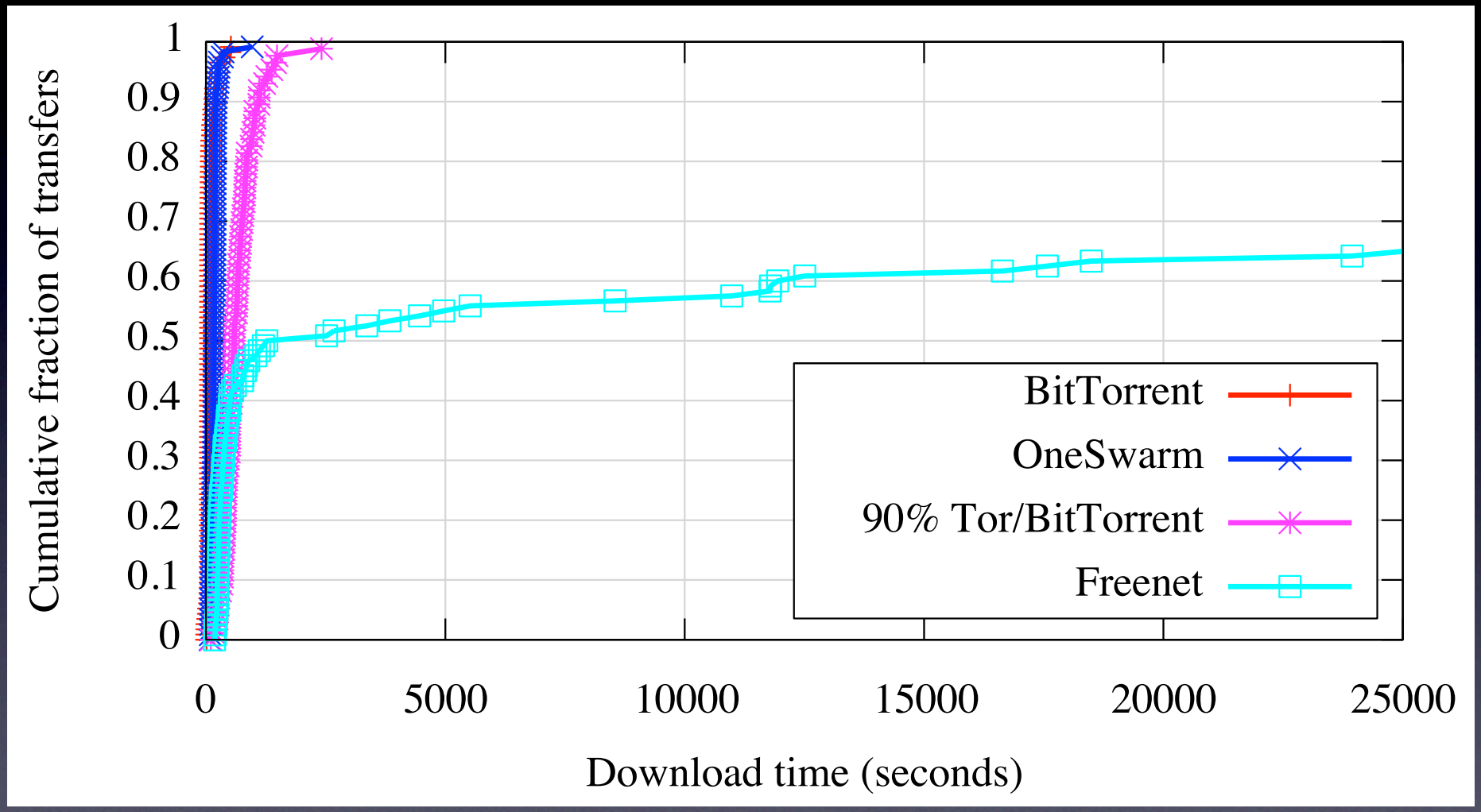
OneSwarm

- Gives users *control* of how they share data
- Maintains good *performance*
- *Trusted/untrusted peer* combination improves robustness
- Join the *100,000s* that have downloaded the OneSwarm client at:

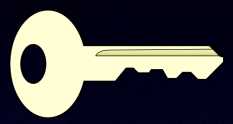
http://oneswarm.cs.washington.edu/

Extra slides

Performance zoom out



External material



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