COMPUTER COMMUNICATION NETWORKS

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Content Distribution

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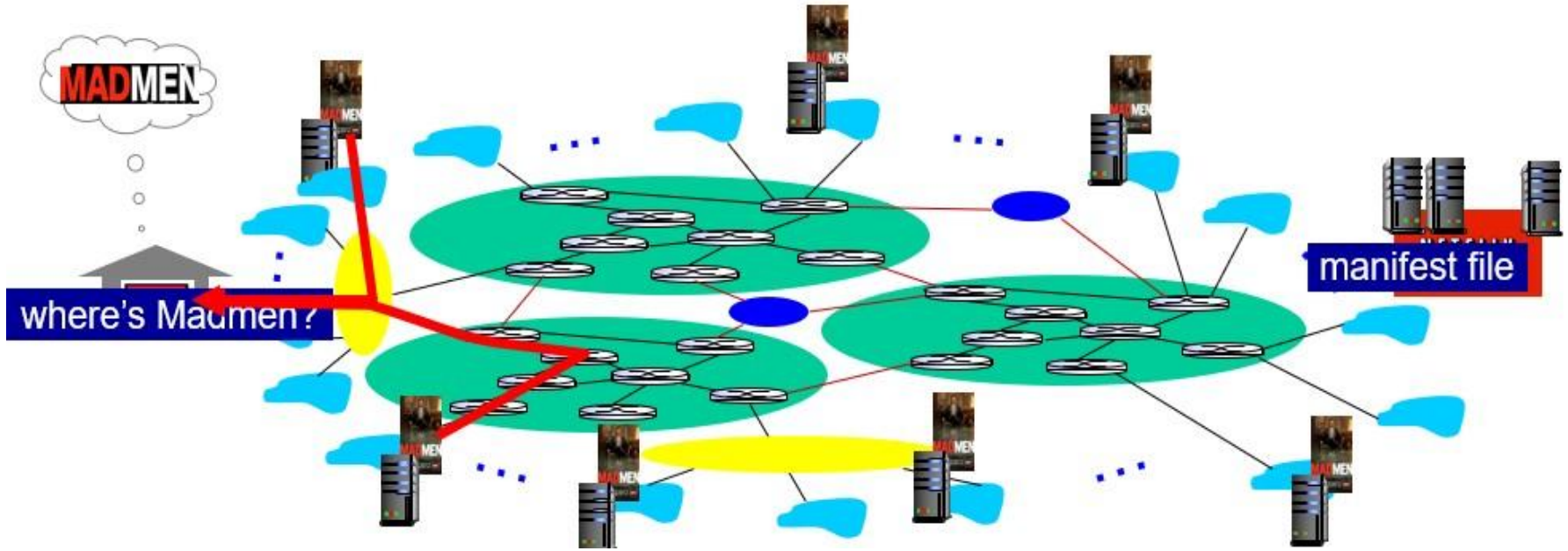
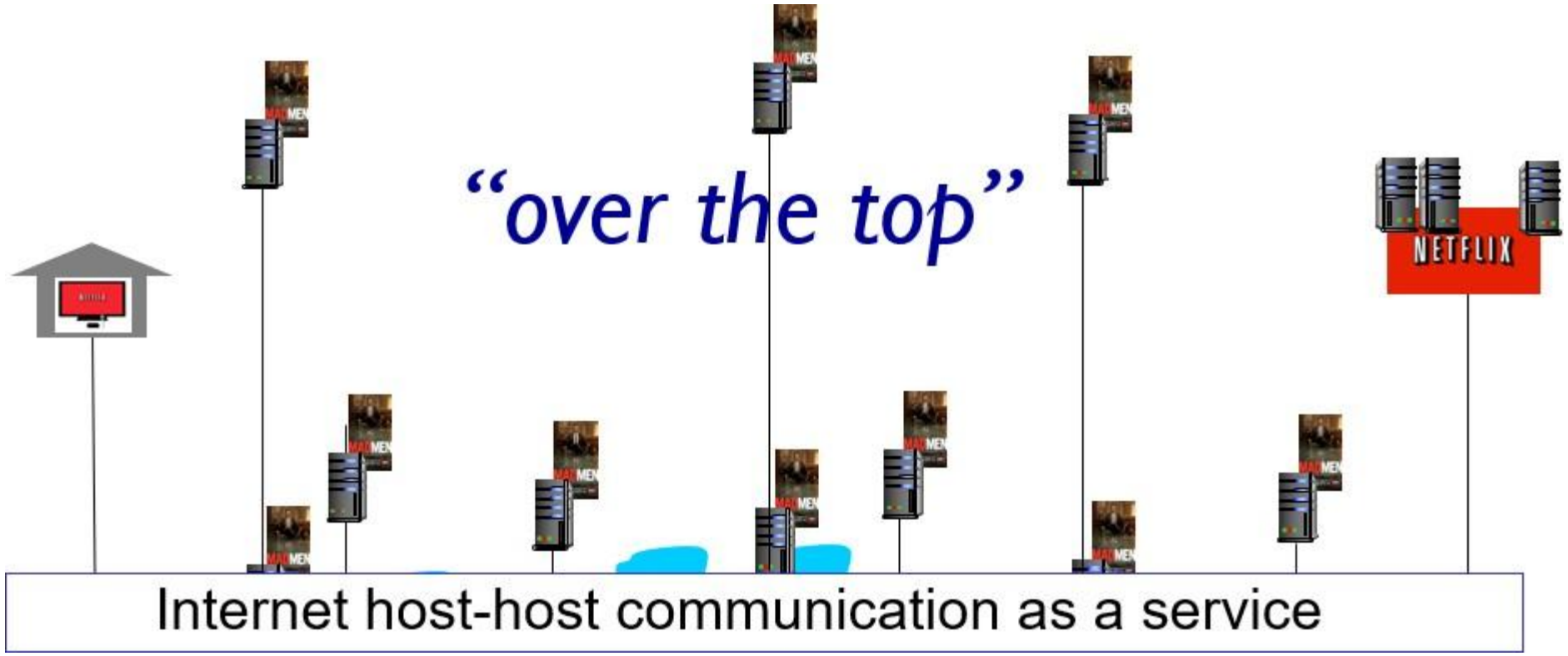
Content Distribution

- CDN: Stores copies of content at CDN nodes
  - e.g. Netflix stores copies of MadMen
- Subscriber requests content from CDN
  - Directed to nearby copy, retrieves content
  - May choose different copy if network path congested



Content Distribution



OTT challenges: Coping with a congested Internet

- From which CDN node to retrieve content?
- Viewer behavior in presence of congestion?
- What content to place in which CDN node?

Case Study – Google's Network Infrastructure

To support its vast array of cloud services—including search, Gmail, calendar, YouTube video, maps, documents, and social networks—Google has **deployed an extensive private network** and CDN infrastructure.

Google's CDN infrastructure has three tiers of server clusters:

1. Fourteen "mega data centers," with eight in North America, four in Europe, and two in Asia [Google Locations 2016], with each data center having on the order of 100,000 servers.

These mega data centers are responsible for serving dynamic (and often personalized) content, including search results and Gmail messages.

Content Distribution

2. An estimated 50 clusters in IXPs scattered throughout the world, with each cluster consisting on the order of 100–500 servers [Adhikari 2011a].

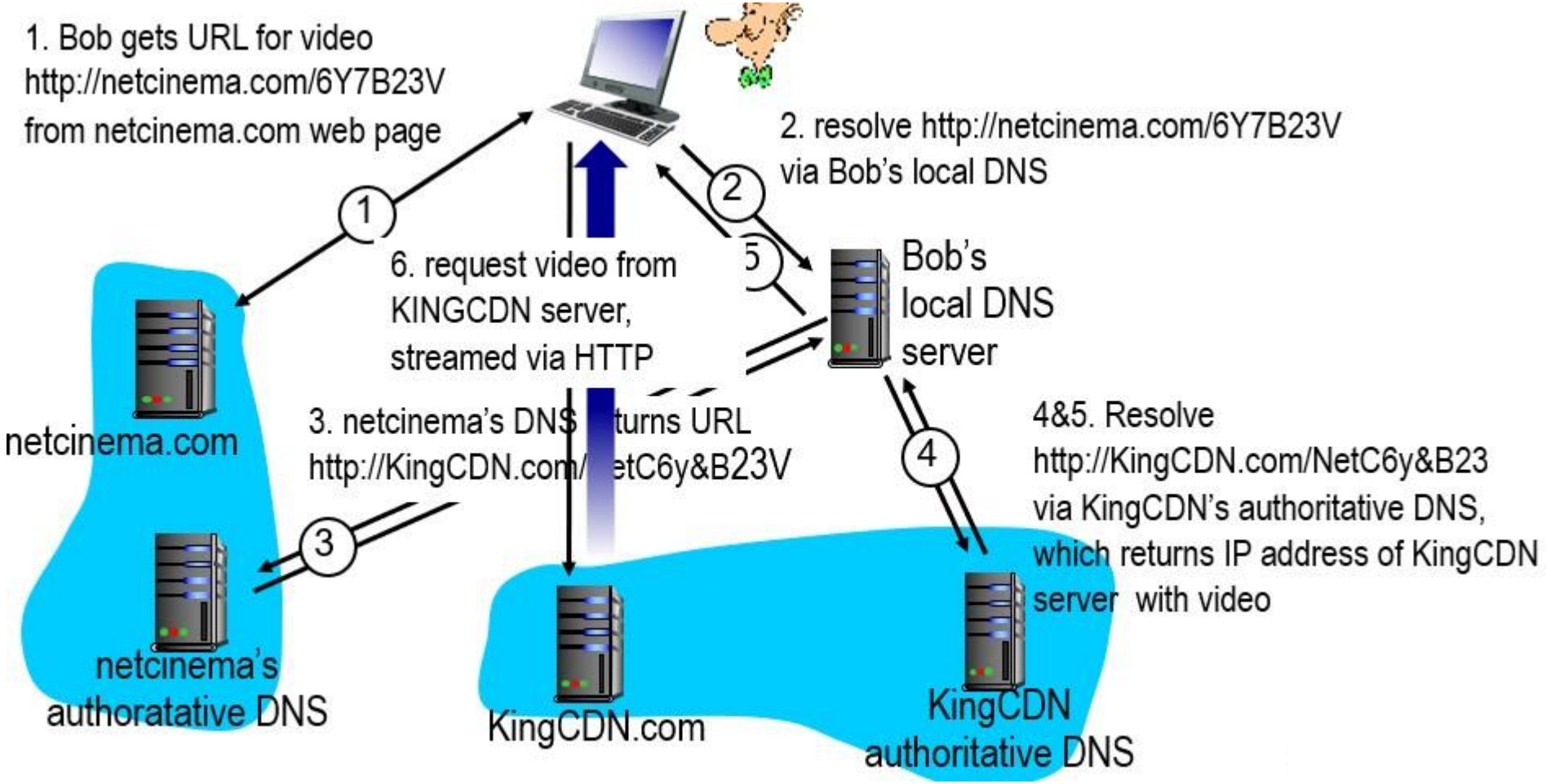
   These clusters are responsible for serving static content, including YouTube videos [Adhikari 2011a].

3. Many hundreds of “enter-deep” clusters located within an access ISP. Here a cluster typically consists of tens of servers within a single rack.

Content Distribution

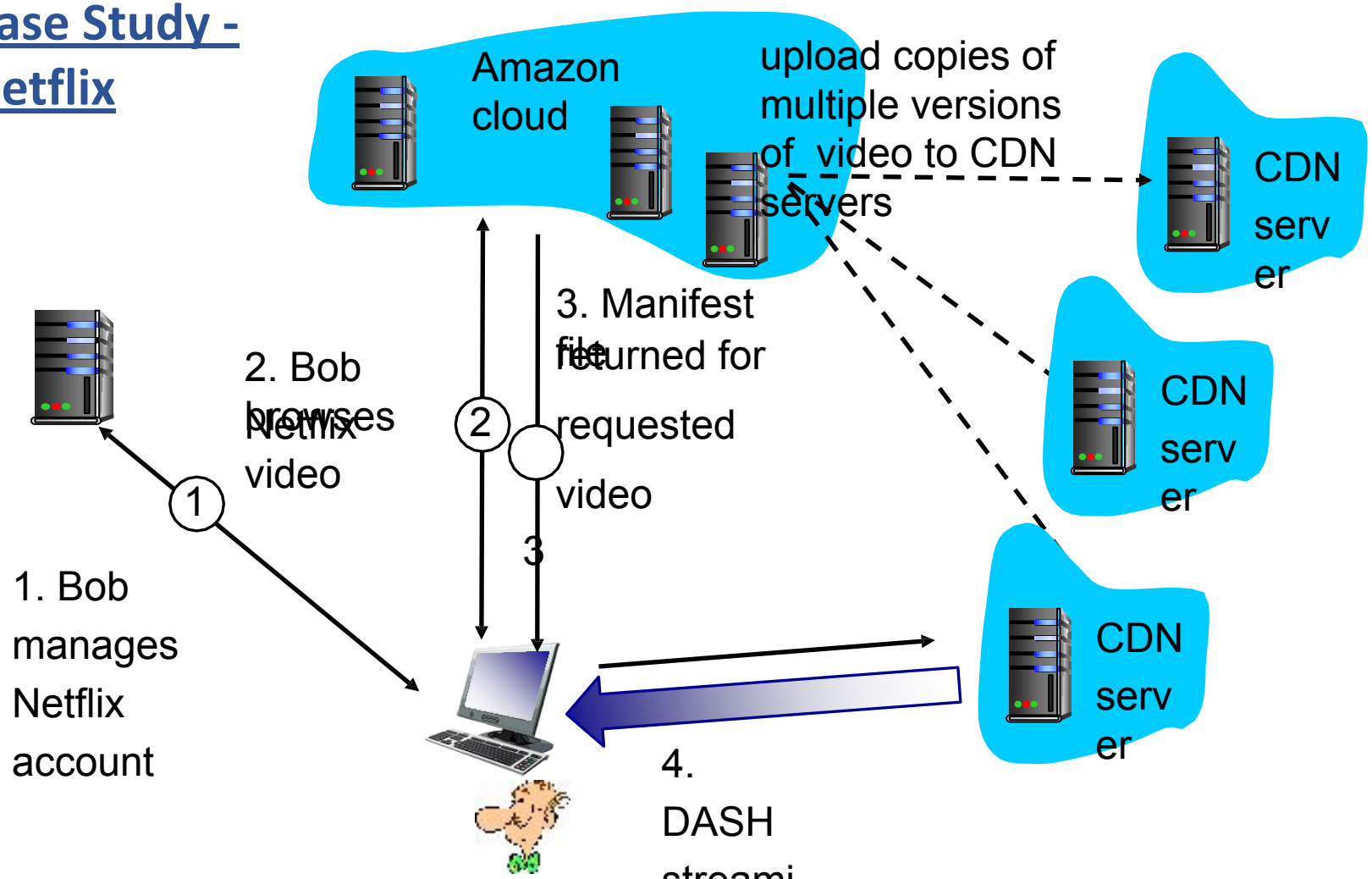
Bob (client) requests video http://netcinema.com/6Y7B23V

- video stored in CDN at http://KingCDN.com/NetC6y&B23V



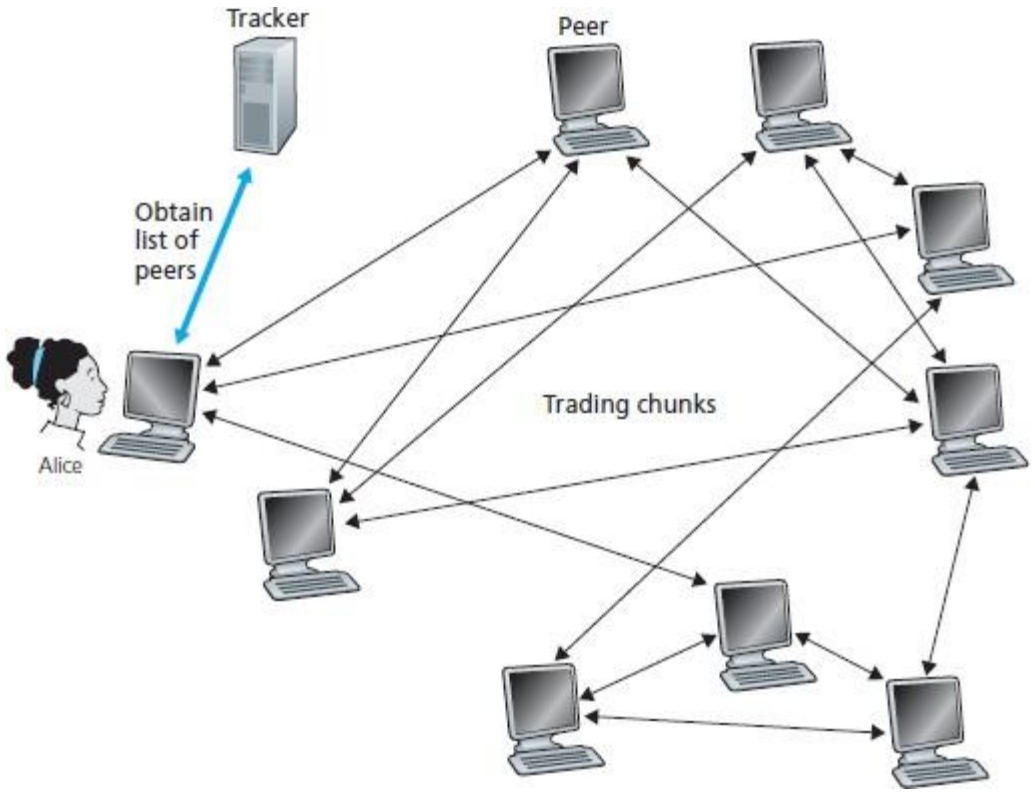
Content Distribution

Case Study - Netflix



Content Distribution

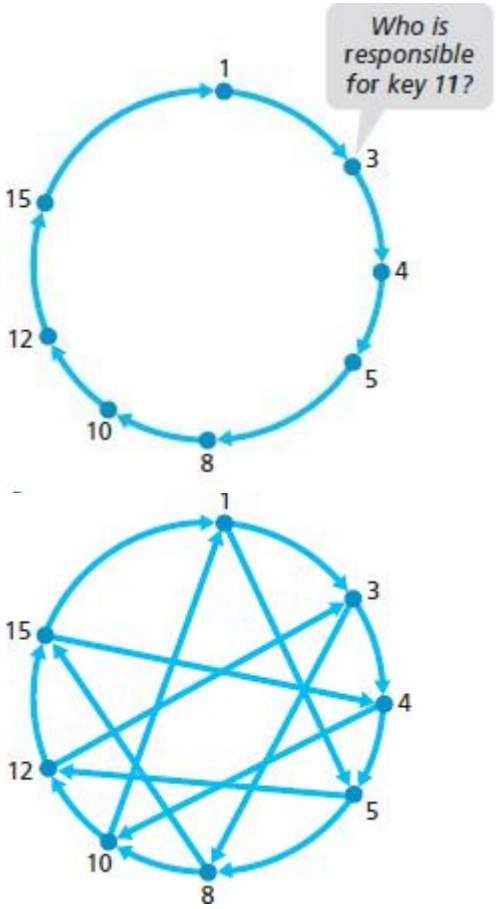
Bit torrent:



- Tracker gives the list of peers for trading
- Peer establishesTCP with peers in the list
- Download and upload chunks
- Rarest first strategy
- Unchoked peers
- Optimistically unchoked peers

P2P Application

Circular DHT:



- Queries are based on <key, value> pair
- Each peer has an ID
- Hash function converts content ID into key
- Key is stored in peer with the closest ID
- Peers are connected in a circular topology
  - Connections are logical not physical
- Each peer knows its immediate and shortcut neighbors
- Peer searches for the key only among its neighbors
- Neighbor list is updated when peers leave and join

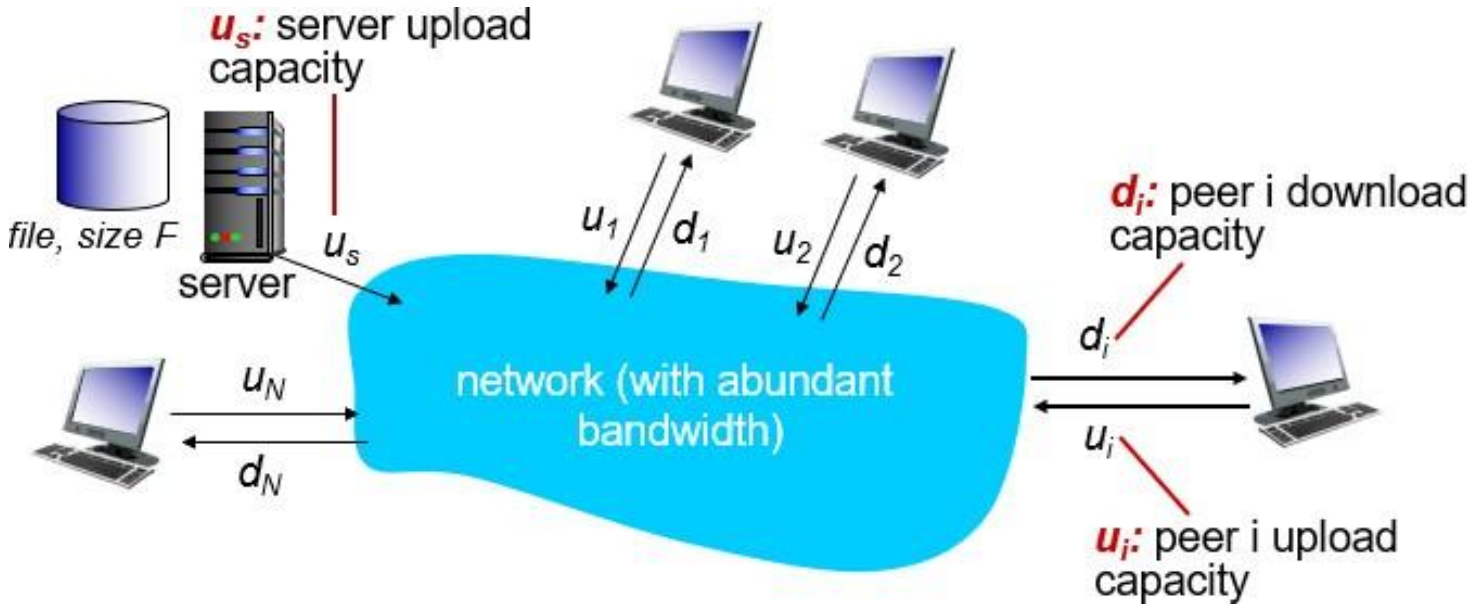
P2P Application Layer Protocol

- What are the requirements of the P2P applications?
  - Peer discovery and port discovery
  - Key-value distribution
  - File discovery
  - Retrieving the file from the peer hosting the object
- For each of the above objectives the following have to be specified:
  - Message format
  - Transport layer protocol
  - Secure communication (if any) should be negotiated

File Distribution: Client Server vs P2P

Question: How much time to distribute file (size *F*) from one server to *N peers*?

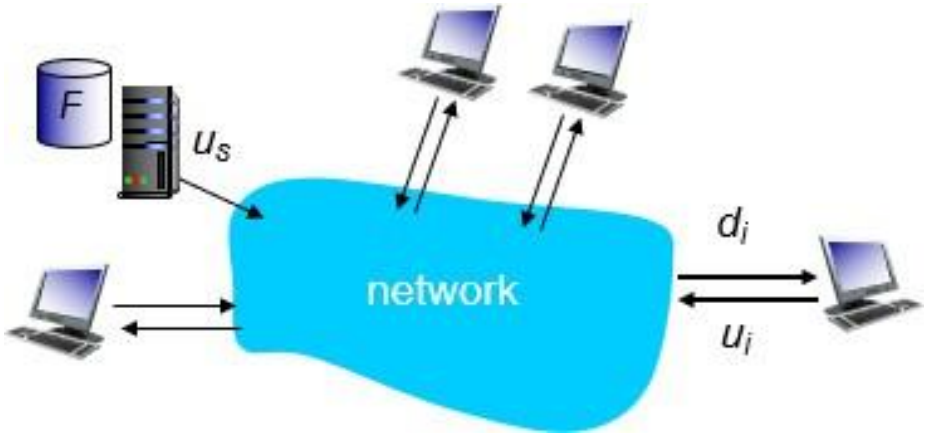
- Peer upload/download capacity is limited resource



File Distribution: Client Server vs P2P

Server transmission: must sequentially send (upload) *N* file copies:

- Time to send one copy: F/u_s
- Time to send N copies: NF/u_s



Client: each client must download file copy

- d_{min} = min client download rate
- m

time to distribute F to N clients using client-server approach $D_{c\text{-}s} \geq max\{NF/u_s, F/d_{min}\}$

increases linearly in N

File Distribution: Client Server vs P2P

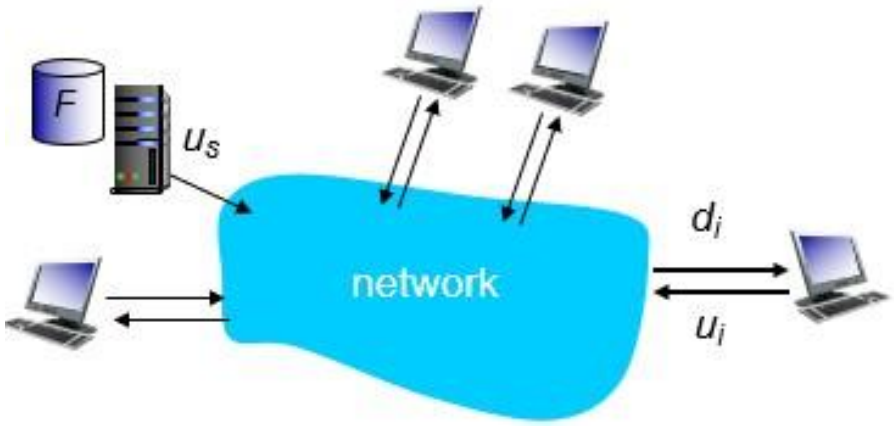
Server transmission: must upload at least one copy

- time to send one copy: F/u_s

Client: each client must download file copy

- min client download time: F/d_{min}

Clients: as aggregate must download NF bits
max upload rate (limiting max download rate) is $u_s + \sum u_i$



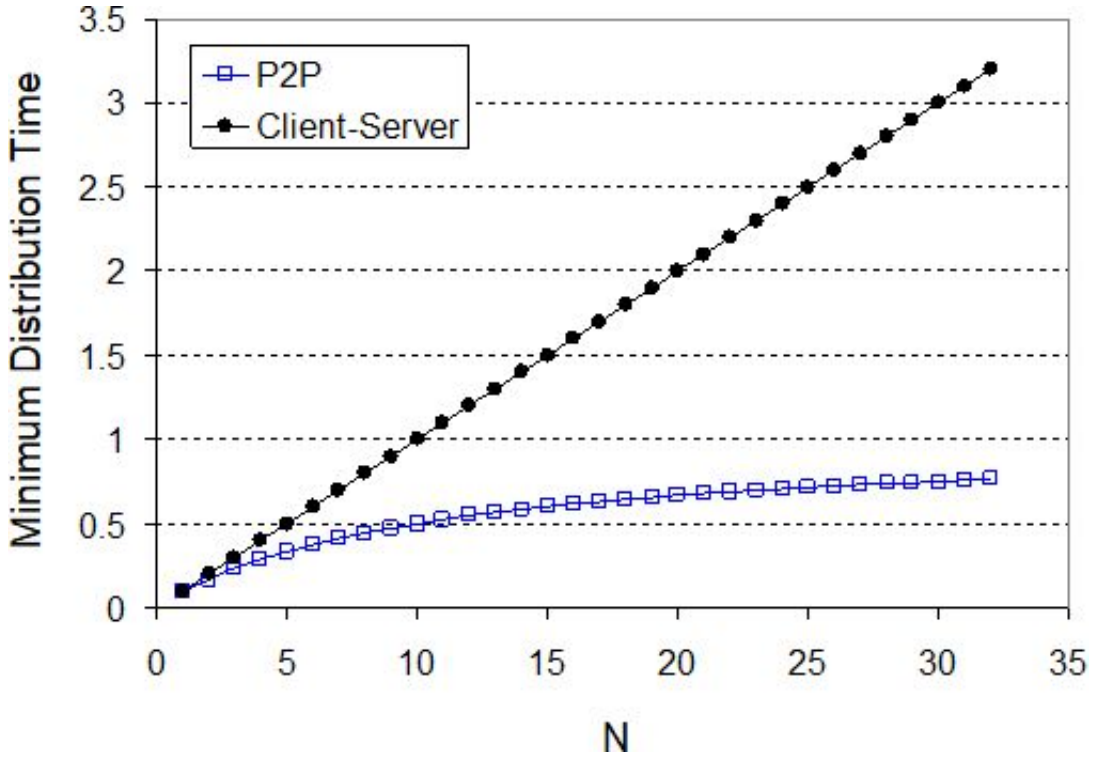
time to distribute F to N clients using P2P approach

$$D_{P2P} \geq max\{F/u_s, F/d_{min}, NF/(u_s + \sum u_i)\}$$

increases linearly in N …
… but so does this, as each peer brings service capacity

File Distribution: Client Server vs P2P

Client upload rate = u, F/u = 1 hour, $u_s = 10u$, $d_{min} \geq u_s$



THANK YOU

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