The Application Layer

File distribution and P2P

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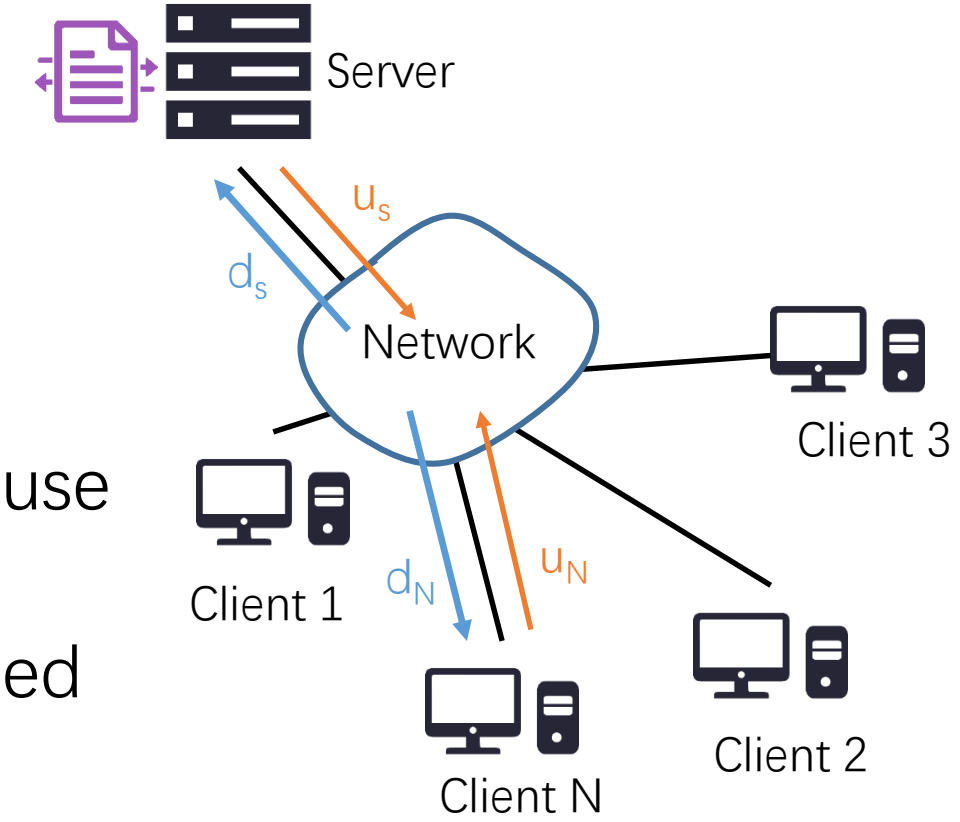
The C/S Model

for file distribution application

- File Transfer/FTP, Web/HTTP, Email/SMTP and DNS applications all use Client to Server model (C/S model).
- What happens if N clients or peers need to download a file (size of F) from S?
  - Note that in C/S model, clients cannot communicate with each other!!
  - S sends N copy of the file, and each client download a copy.
- The Distribution time is the time it takes to get a copy of the file to all N peers.



Downlink and Uplink links of end systems is considered as the bottlenecks, while the network core capacity is good enough, in our model!

Quantifying the Distribution Time (D_{cs})

C/S: poor scalability, DT is linear to N

- NF/u_s: S needs to send N copies to the network;
- F/d_i: each peer need to download a copy from the network;
- $d_{min} = Min\{d_1, d_2, \cdots, d_N\}$, so DT cannot be less than F/d_{min}
- $D_{cs} >= Max\{NF/u_s, F/d_{min}\}$
- When N → very large, what about DT?
  - $D_{cs} = NF/u_s = F/u_s * N$ (if $F/u=1$, $u_s=10u$), then $D_{cs}=0.1 * N$
  - D_{cs} is linear to N (poor scalability)

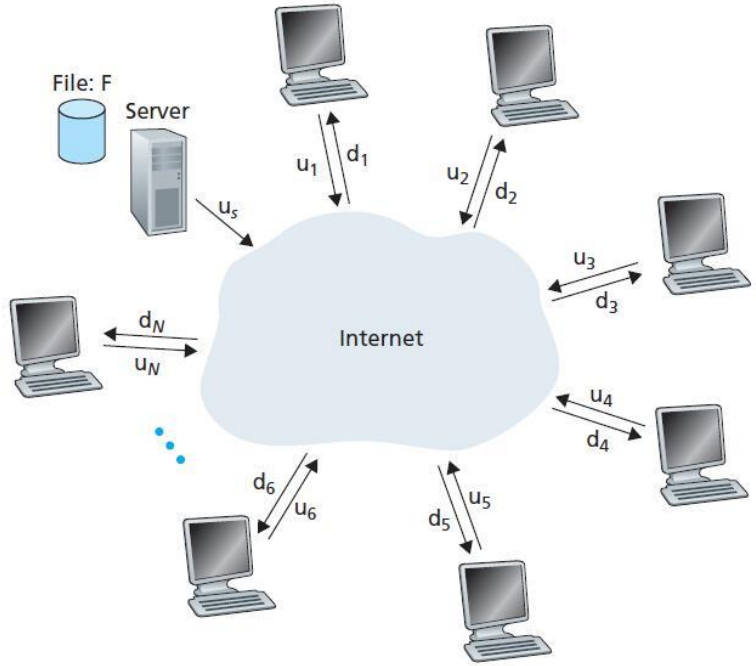
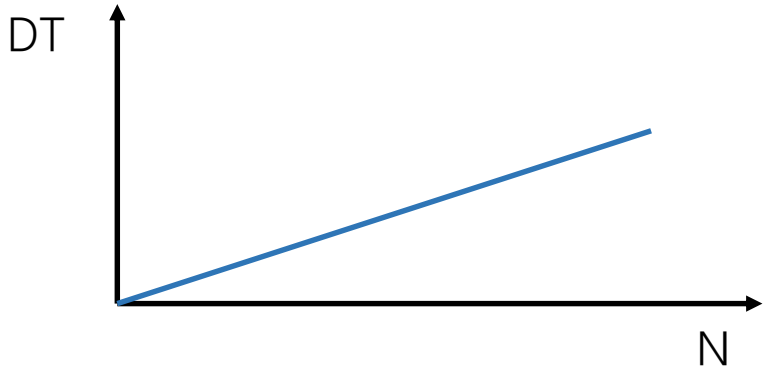


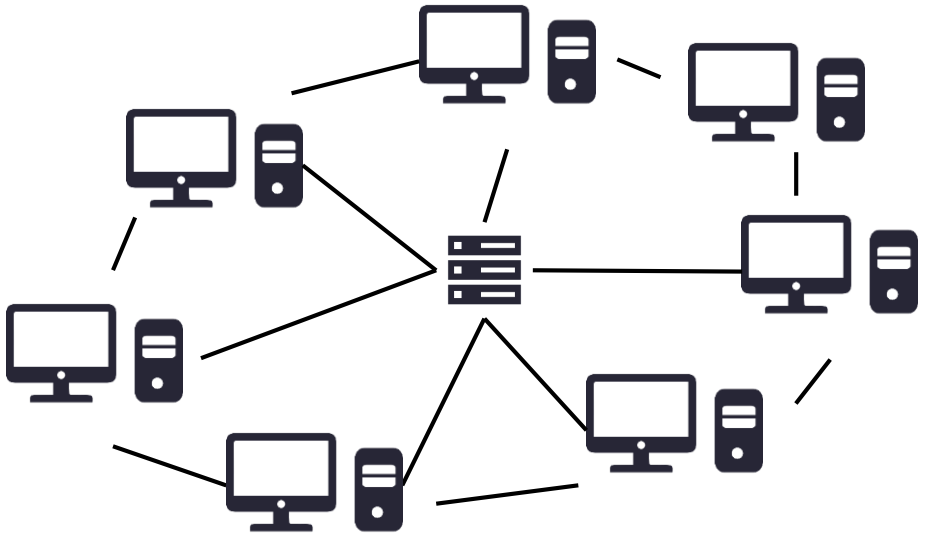
Figure 2.24 ♦ An illustrative file distribution problem



The Peer to Peer/P2P Model

for file distribution

- What happens if N clients or peers need to download a file (size of F) from S?
  - Note that in P2P model, clients can communicate with each other!!
  - S at least sends a copy of the file, and each client download a copy, can from S or other peers.
- What about the distribution time?



Quantifying the Distribution Time (D_{p2p})

P2P: self-scalability, D_{p2p} has a upper bound

- F/u_s: at least for S to send a copy of file to the network;
- F/d_{min}: at least for a peer to download a file from the network;
- NF/u_{total}: at least for delivery NF bits, using all uplinks (S and peers);
  - $u_{total} = u_s + u_1 + u_2 + \cdots + u_N$
- $D_{p2p}=Max\{F/u_s, F/d_{min}, \mathbf{NF/u_{total}}\}$
- $F/u = 1$, $u_s = 10u$, $u_i = u$, $d_{min} >> u$, then $NF/u_{total}=N/(10+N)*F/u = N/(10 + N) = 1 – (10/10+N)$
- NF/u_{total} has a upper bound

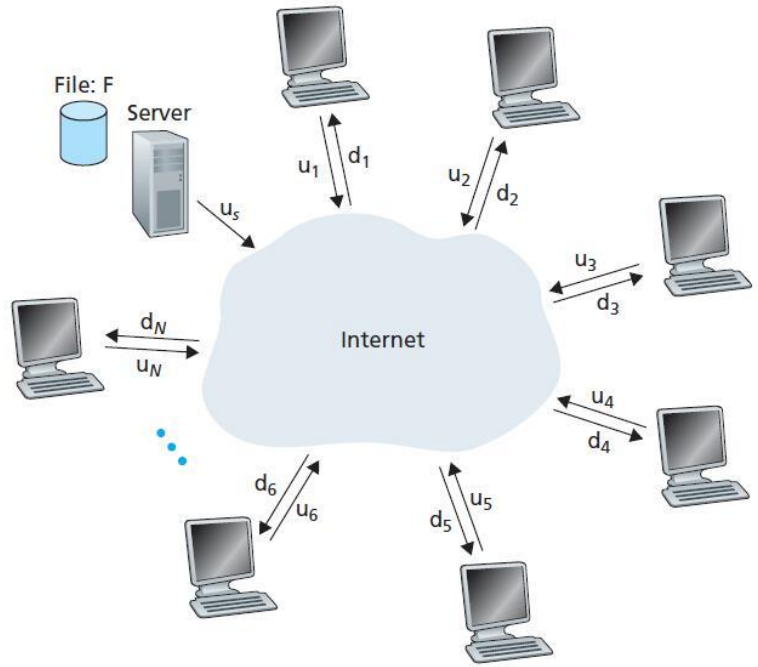


Figure 2.24 ♦ An illustrative file distribution problem

Quantifying the Distribution Time

- In C/S: $D_{cs} = 0.1 * N$
- In P2P: $D_{p2p} = 1 – (10/10+N)$

Self-scalability

Figure 2.25 ♦ Distribution time for P2P and client-server architectures

BitTorrent

- BitTorrent is a popular P2P protocol for file distribution!
  - Tracker
  - Torrent
    - neighboring peers
  - Chunks of a file (256 Kbytes)