Internet Overlay Networks

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Overlay Networks
Overlay networks: A logical network laid on top of the Internet
- nodes are Internet end hosts
- links are virtual Internet paths

Multicast
- Multicast: act of sending data to multiple receivers.

Practical problems of network-layer multicast:
- requires routers to maintain per-group state; complicates the router design and implementation;
- slow to be widely adopted.

Network-layer vs. Overlay Multicast
- Network-layer multicast
  - performance issues for overlay multicast
    - Limit the bandwidth consumption of individual physical links
    - Minimize the source-to-end latency

Overlay multicast
Overlay Multicast: One Approach

Two steps:
- Forming an overlay mesh network with good links, don’t worry about loops at this step
  - too dense a mesh results in too much overhead in the second step, more probable to have high link stress
  - too sparse a mesh restricts what the second step can do
- For each multicast source, generating a shortest path tree or “reverse-path forwarding” on top of the overlay mesh

Revisit the Concept of Overlay Networks

Overlay networks: A logical network laid on top of the Internet.

Key advantages over networks with physical links:
- can be formed spontaneously
- can be easily maintained and changed

Key disadvantage compared with networks with physical links:
- performance

Overlay networks = peer-to-peer networks?

Applications to Overlay Networks

- multicast: network conferencing
- peer-to-peer file sharing
- multi-player interactive games
- software/news/files distribution
- ...

Multiplayer Interactive Games over Wide-area Networks

Some basics:
- A virtual 2/3-dimensional gaming space with many objects
- Player-initiated actions: moving your objects, attacking some other objects, etc.

Main challenges:
- Scalability: supporting many players
- Interactive: real-time constraint in synchronizing the actions and their impact on the gaming space
- Wide-area network: limited network resources
A straightforward way to do it

- a server and multiple client (each for a player)
- all player-initiated actions get to the server and its impact is propagated to all players (with bounded delay)
- actions can be aggregated when too many come too quickly

any other ideas about how it works?

Scalability

- What are the potential problems when the number of players scales up?
- Network bandwidth connecting the server is the main problem
- How to solve this?
  - multicast
  - distribute the server

Scalability (cont.)

- Additional problems:
  - load imbalance
  - handoff between partitions is tricky

Distribute the Server

- How do we keep track of which part belongs to which server?

Distribute the Server (cont.)

- Chord
- Content-addressable network
Files/News/Software Distribution on Demand

- Content distribution:
  - Popular web sites like Yahoo;
  - Breaking news from CNN;
  - Microsoft is distributing a new version of Windows online.

- All downloading from a central content site creates performance problems:
  - Limited bandwidth at the central site;
  - Many users are far away from the central site.

Means of Content Distribution

- By content providers, e.g., www.yahoo.com
  - replicated, distributed Internet sites

- By content consumers (or clients), e.g., UR
  - reduce bandwidth consumption of an organization through caching - Web caching

- By a third-party
  - content distribution network

Replicated Internet Sites

- Content providers build a set of distributed sites on the Internet.
- DNS answers the IP address of the site close to the client

Determining Nearby Content Server

- We create a "map", indicating distances between ISPs and content servers
- When a DNS query arrives at authoritative DNS server:
  - server determines ISP from which query originates
  - uses "map" to determine a nearby content server
- How to build the map?
  - pings from content servers to all possible ISPs