

# 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

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## Multicast

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

Remember the protocols?

Practical problems of network-layer multicast:

- complicates the router design and implementation; requires routers to maintain per-group state;
- slow to be widely adopted.

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## Network-layer vs. Overlay Multicast

Network-layer multicast

Overlay multicast

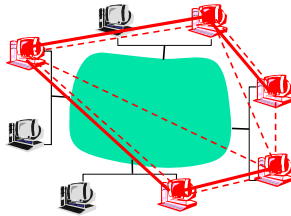
- Any better than multiple unicasts?
- performance issues for overlay multicast
  - Limit the bandwidth consumption of individual physical links
  - Minimize the source-to-end latency

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## Overlay Multicast: One Approach

### Two steps:

- Forming an overlay mesh network, 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



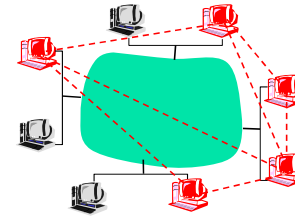
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## Overlay Mesh Network

- Node join
  - Add links to some randomly chosen existing members
- Node departure
  - Break links to departing node
  - Make up with additional random links
- Can we have network partition?
- Random links or good links?



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## 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

Internet overlay networks = peer-to-peer networks?

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## Applications to Overlay Networks

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

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## 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

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## 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

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## Scalability

- What are the potential problems when the number of players scales up?
  - Computation at the server
  - Network bandwidth connecting the server
- Solutions:
  - multicast
  - distribute the server

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## Distribute the Server

How do we know which server is in charge of a given area?

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