

M&Ms: CS Freshmen Experience

600.105

Networks

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Spring 2017 / Week 3

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Networks

Reading:

https://en.wikipedia.org/wiki/History_of_the_Internet

<https://en.wikipedia.org/wiki/Routing>

https://en.wikipedia.org/wiki/Distance-vector_routing_protocol

https://en.wikipedia.org/wiki/Link-state_routing_protocol

https://en.wikipedia.org/wiki/Internet_protocol_suite

https://en.wikipedia.org/wiki/Berkeley_sockets

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The Internet Revolution A Technical Perspective

A **single, multi-purpose, IP-based** network

- The art of design – a successful paradigm
 - Keep it simple in the middle
 - Best-effort packet switching, routing (intranet, Internet)
 - Smart at the edge
 - End-to-end reliability, naming
- Could therefore adapt and scale
 - Survived for 4 decades and counting
 - Sustained at least 7 orders of magnitude growth
- Standardized and a lot rides on it
 - **The basic services are not likely to change**

Routing

- Distance vector routing
- Link state routing
- Inter-network routing

Distance Vector Routing

- Each router knows the id of every other router in the network.
- Each router maintains a vector with an entry for every destination that contains:
 - The cost to reach the destination from this router.
 - The first link that is on that least-cost path.
- Each router periodically sends its vector to its direct neighbors.
- Upon receiving a vector, a router updates the local vector based on the direct link's cost and the received vector.

Link State Routing

- Each router knows the id of every other router in the network.
- Each router maintains a topology map of the whole network.
- Each router periodically floods its direct links state (with its direct connectivity information).
- Upon receiving a vector, a router updates the local topology map and re-calculates shortest paths.

Internet Routing

- Routing Information Protocol:
 - Distance vector protocol.
 - Hop count metric
 - Exchange is done every 30 seconds, fault detection every 180 seconds.
 - Cheap and easy to implement, unstable in the presence of faults.
- Open Shortest Path First:
 - Link state protocol.
 - Internal hierarchy for better scaling.
 - Optimization for broadcast LANs with routers on them. (A designated router represents the whole LAN) - Saves control messages and size.

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Internet Routing (cont)

- A hierarchical routing protocol that connects networks, each of which runs an internal routing protocol.
- OSPF or RIP are common internal protocols.
- BGP - Border Gateway Protocol -
 - A path vector protocol with additional **policy** information for each path. Path vector protocols have the complete path in each entry and not only the next direct member.
 - Generally used as the hierarchical routing protocol.

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Sockets: Simple API to Access It All

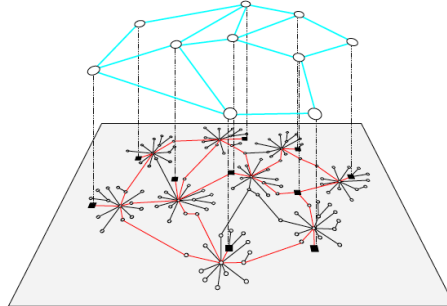
- Socket
- Bind
- Sendto
- Recvfrom

- Listen
- Connect
- Accept
- Send

New Applications Bring New Demands

- Communication patterns
 - From Point-to-point – to point-to-multipoint – to many-to-many
- High performance reliability
 - “Faster than real-time” file transfers
- Low latency interactivity
 - 150ms key stroke mirroring
 - 100ms for VoIP
 - 80-100ms for interactive games (65ms one way for remote surgery?)
- End-to-end dependability
 - From “Internet” dependability – to “phone service” dependability – to “TV service” dependability – to “remote surgery” dependability
- System resiliency
 - From E-mail fault tolerance – to financial transaction security – to critical infrastructure (SCADA) intrusion tolerance

The Overlay Paradigm



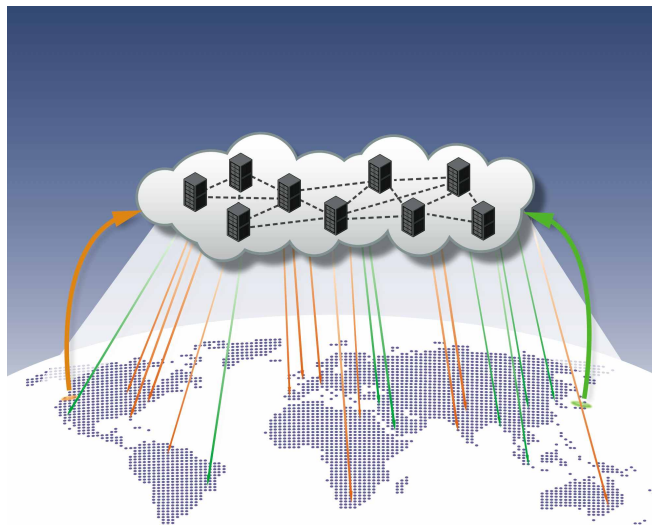
- Overlay paradigm:
 - In contrast to “keep it simple in the middle and smart at the edge”
 - Move intelligence and resources to the middle
 - Software-based overlay routers working on top of the internet
 - Overlay links translated to Internet paths
- Smaller overlay scale (# nodes) → smarter algorithms, better performance, and new services.

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The LiveTimeNet Cloud



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State-of-the-art: Combining Timeliness and Reliability over the Internet



200ms one-way latency requirement, 99.999% reliability guarantee
40ms one-way propagation delay across North America

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New Challenges: Combining Timeliness and Reliability



130ms **round-trip** latency requirement
80ms round-trip propagation delay across North America

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