Networking Technologies and Applications

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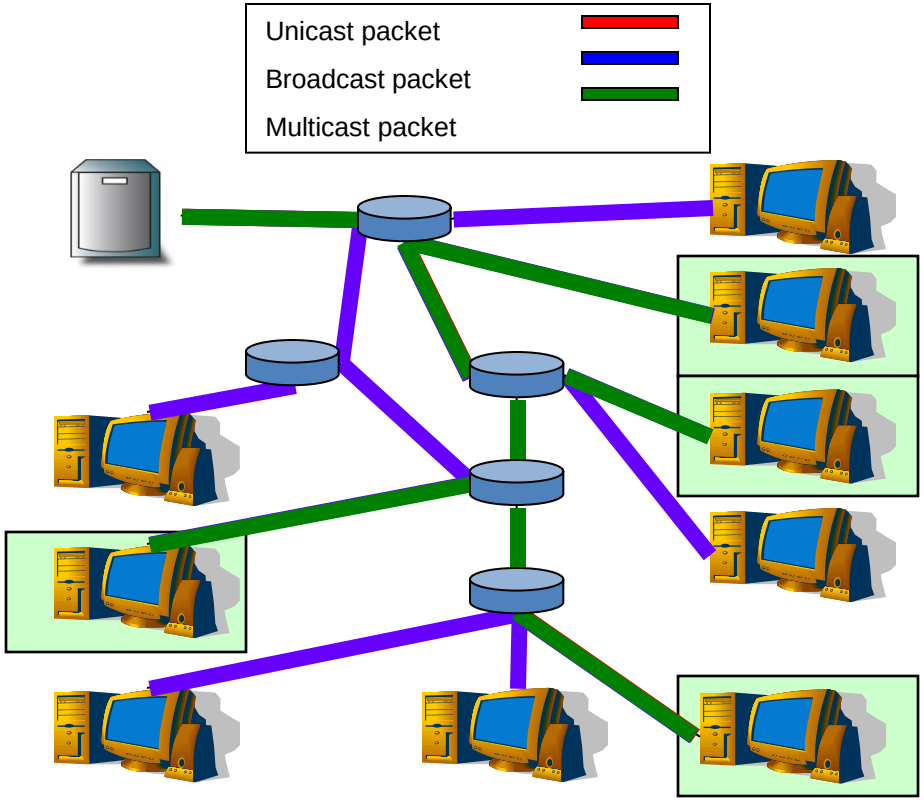
Group communication

- Goal: instead of a single destination node, communicate with a group of nodes
  - „natural” extension of the point-to-point communication (unicast)

- **Multicast**

What is multicast?

- **Unicast**
  - Point – to - point
  - Destination address: the address of one specific receiver
- **Broadcast**
  - Point – to – everyone
  - Destination address: address of the (sub)network
- **Multicast**
  - (Multi)point – to – multipoint
  - Destination address: group address



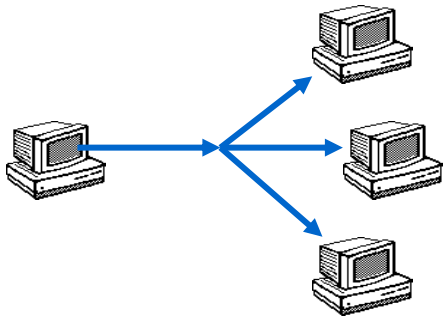
Group communication

- Packets have to be sent to all members of a group, not just a single destination
  - Group membership can be dynamic

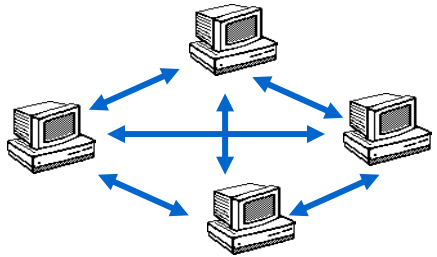
- Basic principle: once a group is created…
  - Interested receivers join the group
  - The network maintains the group and handles data delivery

Multicast applications

- Many applications are not point-to-point
  - Point-multipoint
    - Remote learning
    - Cache update
    - Video on demand



  - Multipoint-to-multipoint
    - Videoconferences, Audio conferences, Chat,
    - Distributed networking games
    - Cooperative applications



Requirements

- No one size fits all solution

- Requirements are different
  - Depending on the application needs
  - Depending on group size
  - Depending on network services / support
  - Depending on member heterogeneity

Participation rules

- Membership control
  - Open group: anybody can join
  - Closed group: limited membership

- Source control
  - Anybody can send a packet to the group
  - Only a group member can be a source
  - Just a selected source can send data

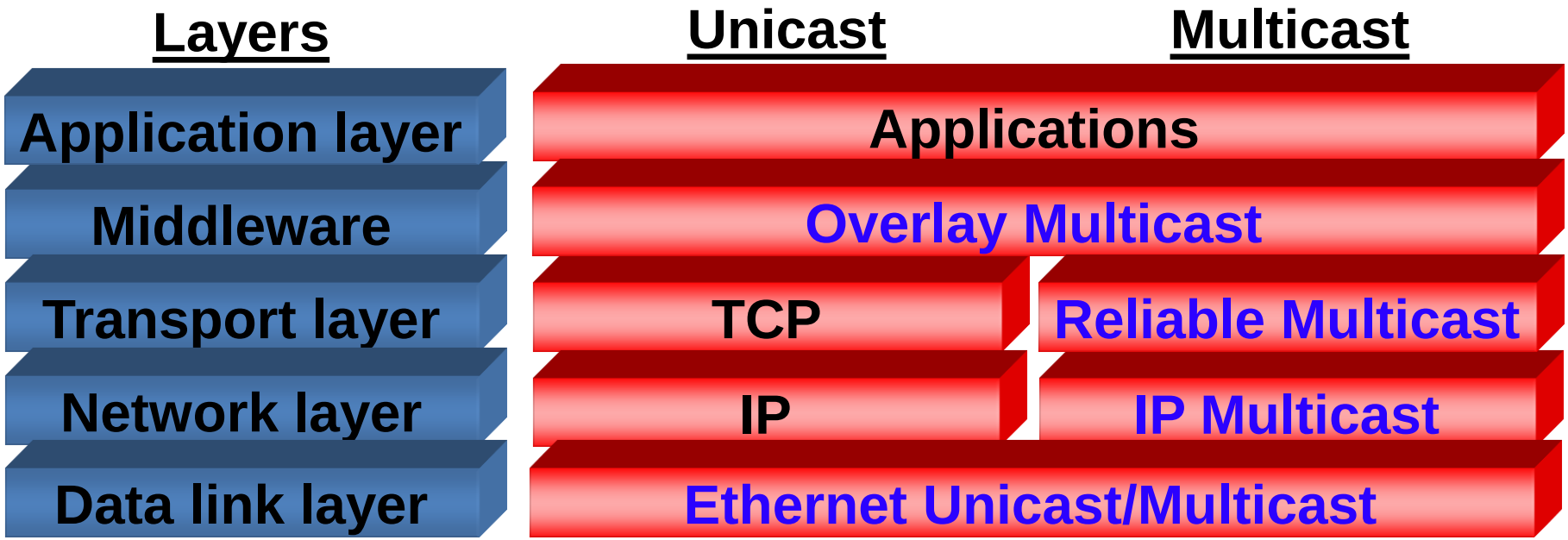
Reliability requirements

- Point-to-point communication
  - Reliable or best-effort (no guarantees)
  - The destination checks the packet: OK, or not
- Point-to-multipoint communication
  - Each receiver perceives the service differently
- Different reliability levels
  - 0-reliability: no receiver is guaranteed reliable transmission
  - 1-reliability: at least 1 receiver will reliably receive the packets
  - k-reliability: at least k receivers will reliably receive the packets
  - Total reliabiliy: all receivers will reliably receive the packets

Multicast at different layers

- The multicast service can be implemented in different layers
  - Data link layer
    - E.g. Ethernet multicast
  - Network layer
    - E.g. IP multicast, Xcast
  - Application layer
    - E.g. Narada, TBCP
- Which solution is the best?
  - It depends, no general solution

Multicast at different layers



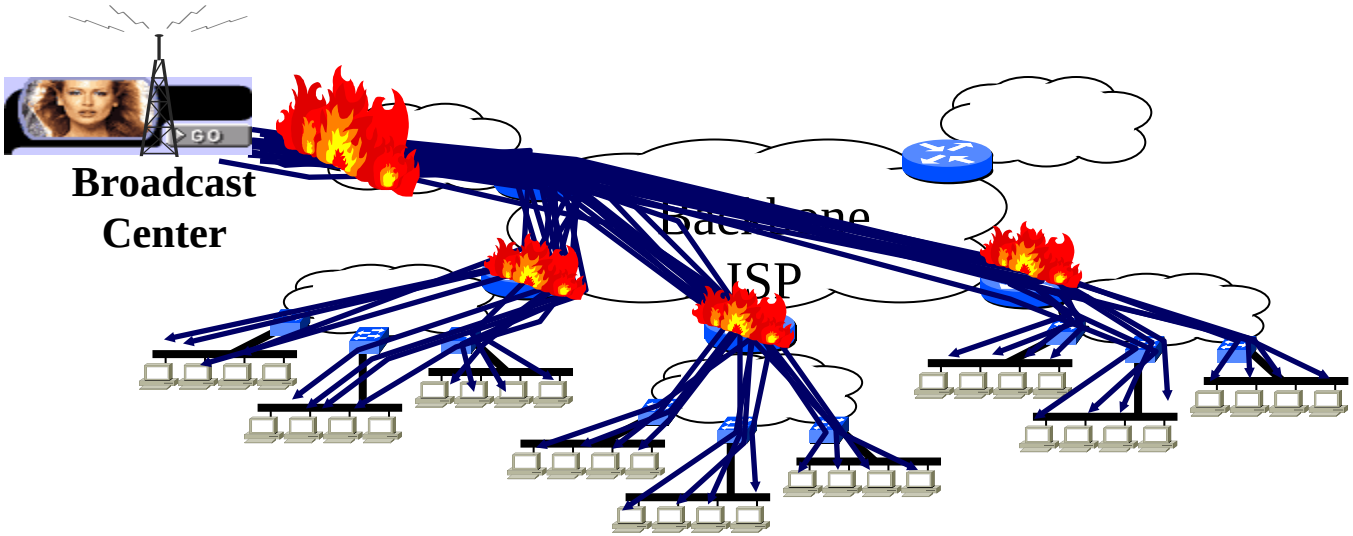
Ethernet Multicast

- Some Ethernet MAC addresses reserved for multicast
- If we want to join a G group
  - Our network interface card (NIC) normally listens only to packets sent to our unicast adress, or the network broadcast address
  - To join, it should listen also the the group address G
  - Hardware solution, efficient
- Communication in group G
  - The sender floods all the LAN segments
    - Like in case of broadcast
  - The cards that do not listen to group address G just drop the packets

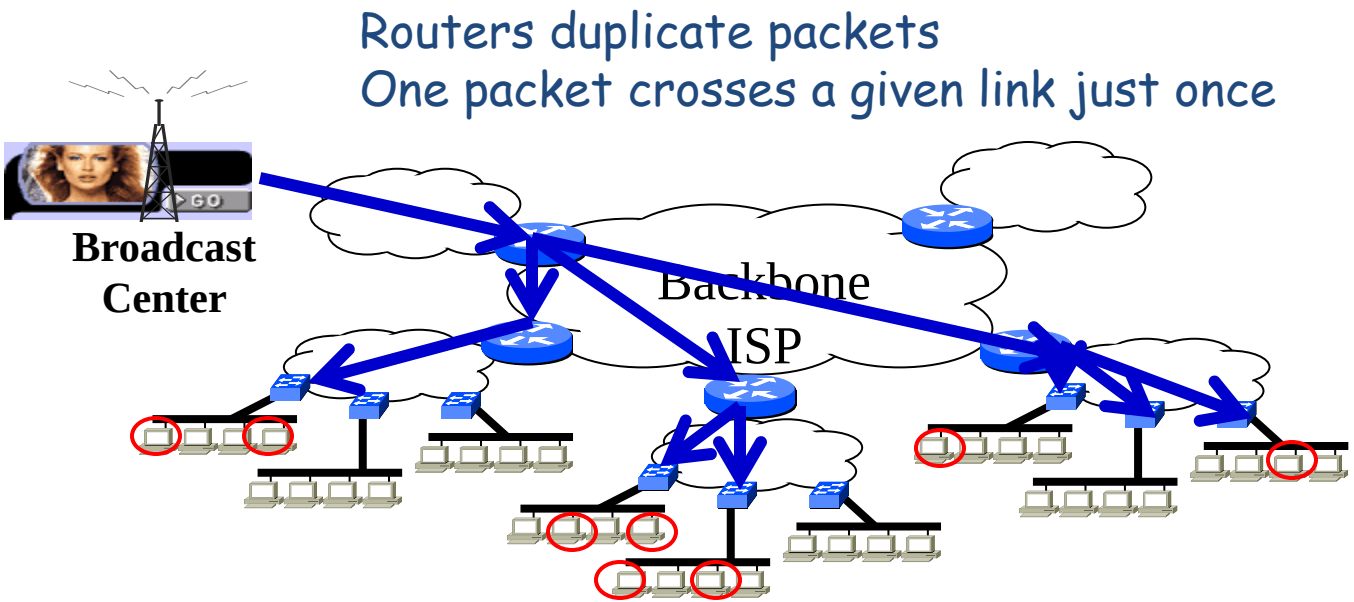
Network layer multicast

- The goal is the optimisation of networ layer resources
  - One packet crosses just once a given link
- Routers build and maintain a multicast tree
  - Traffic forwarding along the tree
  - Routers duplicate packets where needed
    - Branching points on the tree

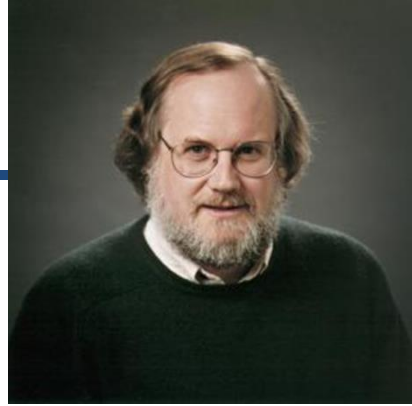
Group level unicast is not scalable



Let’s build trees instead



IP Multicast



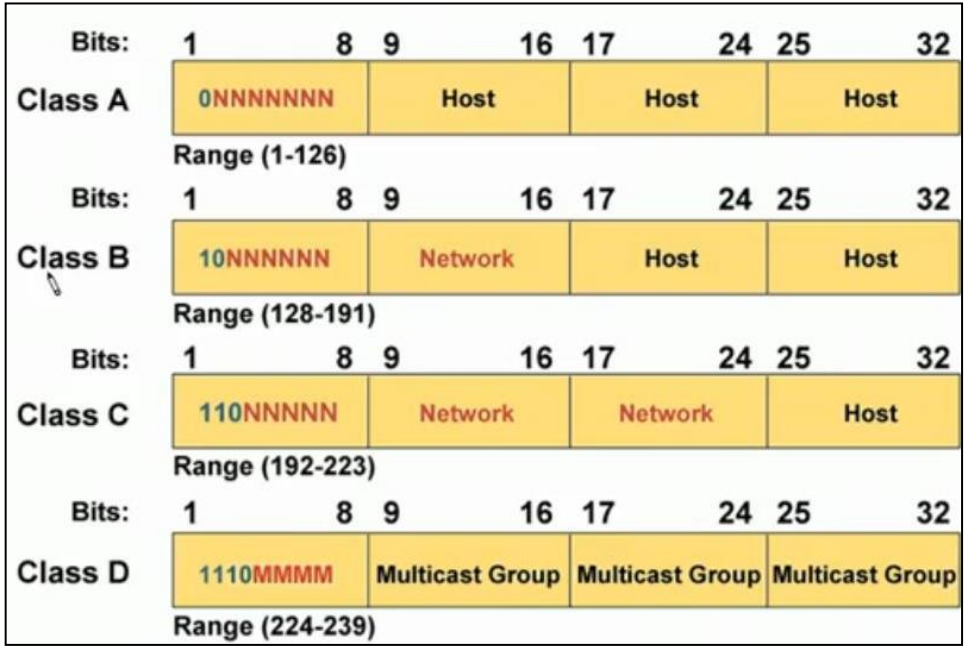
- Steve Deering PhD dissertation (1990)
  - **Any Source Multicast (ASM)**

- Open group communication model
  - Anybody can join the group, no access control
  - One user can be member of several groups in the same time
  - Anybody can send to the group, even non members
  - Group membership is dynamic
  - Nobody knows the size of the group, or its members

IP Multicast

- S. Deering, "Host Extensions for IP Multicasting", RFC 1112, 1989.

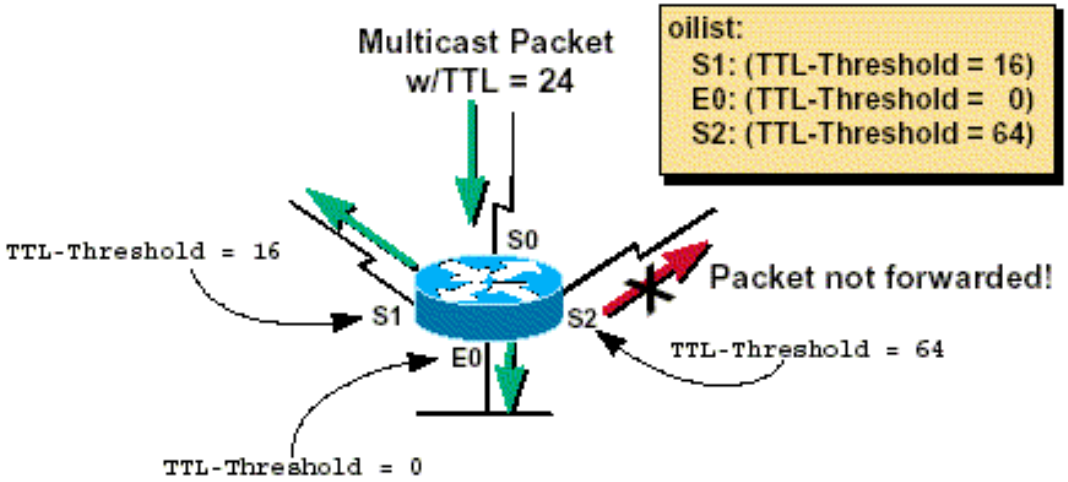
- The source sends its packets to a group address
- Anybody who joined the group is „reachable” through this address
  - Receives packets that are sent to this destination address
- A multicast group is identified by a **class D** IP address
  - **224.0.0.0 – 239.255.255.255**
  - 1110 + 28 bit group ID



Multicast Scoping

- The scope of an IP multicast group is limited:
  - TTL based scoping
  - Administrative scoping

- TTL based scoping
  - Node-local 0
  - Link-local 1
  - Site-local < 32
  - Region-local < 64
  - Continent-local < 128
  - Global Scope < 255



Multicast Scoping

- Administrative scoping
  - link-local scope 224.0.0.0 - 224.0.0.255
    - A router never forwards such a packet
  - global scope 224.0.1.0 - 238.255.255.255
    - Valid on the entire internet
  - administrative scope 239.0.0.0 - 239.255.255.255
    - Never forwarded outside the Intranet of a given organization