



UNIVERSITA' DEGLI STUDI DI PARMA
Dipartimento di Ingegneria dell'Informazione

Multicast Routing Protocols

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Multicast Routing Protocols

Current IP Multicast Routing Protocols

- DVMRP — Distance-Vector Multicast Routing Protocol
 - **broadcast-and-prune,**
unidirectional per-source trees,
builds own routing table
- MOSPF — Multicast Extensions to Open Shortest-Path First Protocol
 - **broadcast membership,**
unidirectional per-source trees,
uses unicast routing table

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Multicast Routing Protocols

Current IP Multicast Routing Protocols (cont.)

- PIM-DM — Protocol-Independent Multicast, Dense-Mode
 - **broadcast-and-prune,**
unidirectional per-source trees,
uses unicast routing table
- PIM-SM — Protocol-Independent Multicast, Sparse-Mode
 - **uses meeting places (“rendezvous points”),**
unidirectional per-source or shared trees,
uses unicast routing table
- CBT — Core-Based Trees
 - **uses meeting places (“cores”),**
omnidirectional shared trees,
uses unicast routing table

Multicast Routing Protocols: DVMRP

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Distance-Vector Multicast Routing Protocol

- Dense mode protocol - Broadcast and prune
 - Source trees created on demand based on RPF rule
- Uses own copy of the routing table with a protocol similar to RIP
 - e.g., use of poison reverse
 - Tunnels to overcome incongruent topologies
- Used with Mbone
- Many implementations
 - mrouterd, Bay, ...
 - Cisco

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Distance-Vector Multicast Routing Protocol

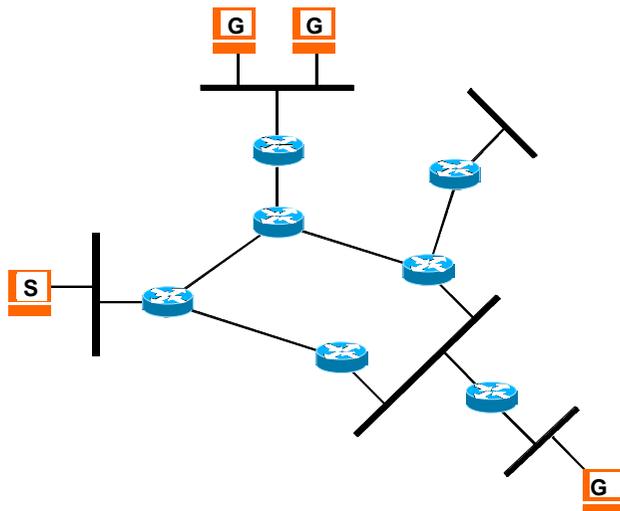
- DVMRP consists of two major components:
 - 1) a conventional distance-vector routing protocol (like RIP) which builds, in each router, a routing table like this:

subnet	shortest dist	via interface
a	1	i1
b	5	i1
c	3	i2
...

- 2) a protocol for determining how to forward multicast packets, based on the routing table and routing messages of (1)

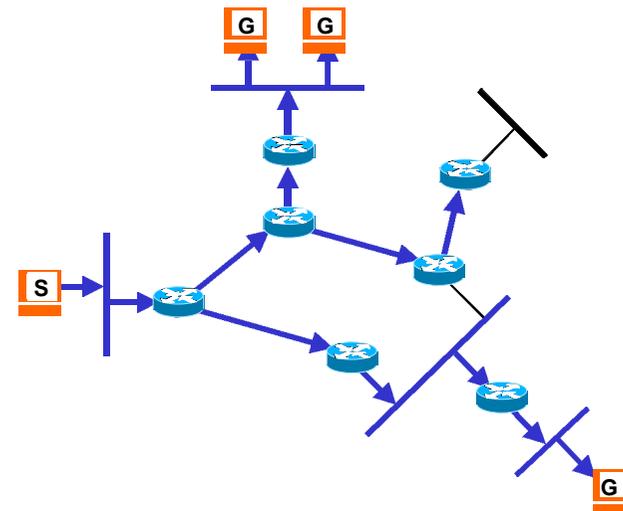
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Example Topology



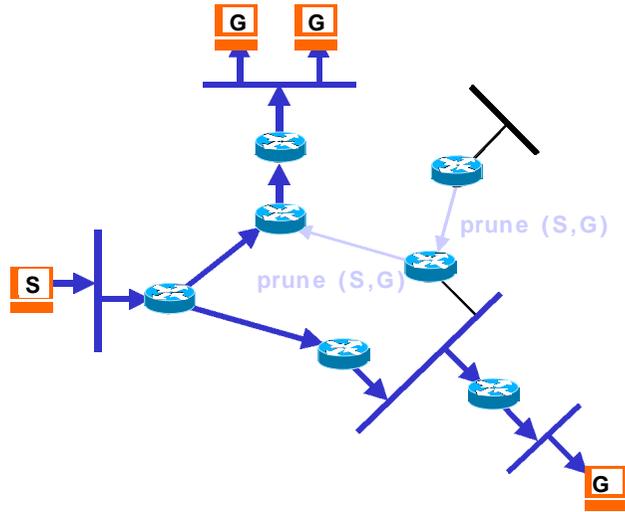
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Phase 1: Truncated Broadcast

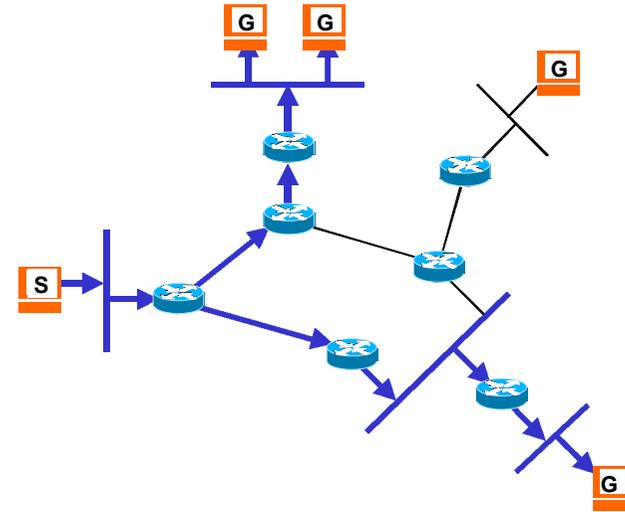


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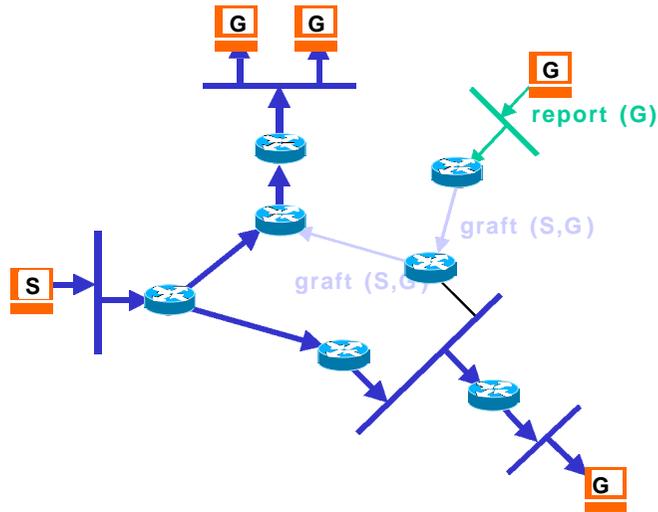
Phase 2: Pruning



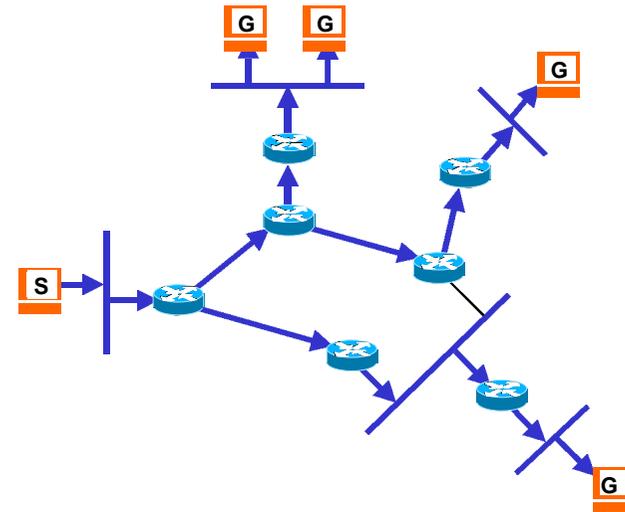
Steady State



Grafting on New Receivers



Steady State after Grafting



Multicast Routing Protocols: PIM

Protocol Independent Multicast (PIM)

- “Protocol Independent”
 - **does not perform its own routing information exchange**
 - **uses unicast routing table made by any of the existing unicast routing protocols**
- PIM-DM (Dense Mode) - similar to DVMRP, but:
 - **without the routing information exchange part**
 - **differs in some minor details**
- PIM-SM (Sparse Mode), or just PIM - instead of directly building per-source, shortest-path trees:
 - **initially builds a single (unidirectional) tree per group , shared by all senders to that group**
 - **once data is flowing, the shared tree can be converted to a per-source, shortest-path tree if needed**

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Dense Mode PIM

- Broadcast and prune “ideal” for dense groups
- Source trees created on demand based on RPF rule
- If the source goes inactive, the tree is torn down
- Fewer implementations than DVMRP
- Draft: draft-ietf-pim-dm-new-v2-05.txt

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Sparse Mode PIM

- Explicit join model
 - **Receivers join to the Rendezvous Point (RP)**
 - **Senders register with the RP**
 - **Data flows down the shared tree and goes only to places that need the data from the sources**
 - **Last hop routers can join source tree by sending joins to the source**
- RPF check for the shared tree uses the RP
- RPF check for the source tree uses the source

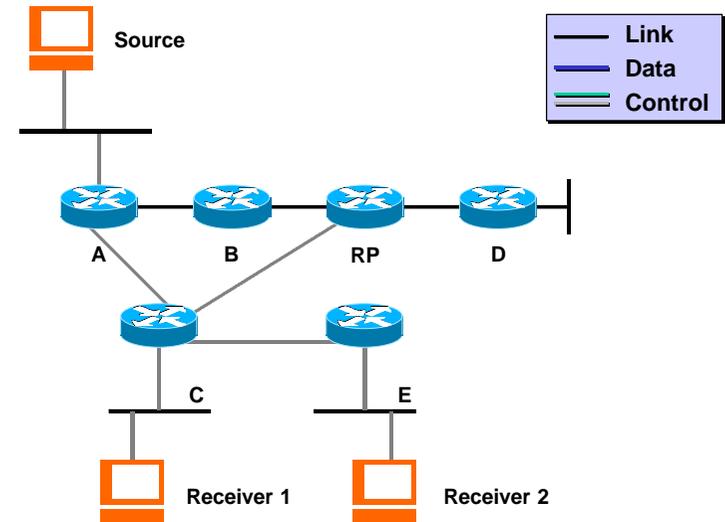
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Sparse Mode PIM

- Only one RP is chosen for a particular group
- RP statically configured or dynamically learned (Auto-RP, PIM v2 candidate RP advertisements)
- Data forwarded based on the source state (S, G) if it exists, otherwise use the shared state (*, G)
- Draft: draft-ietf-pim-sm-v2-new-10.txt

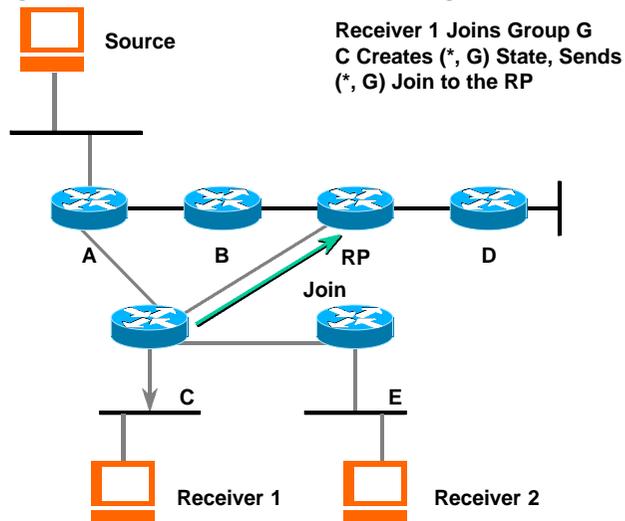
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Sparse Mode PIM Example



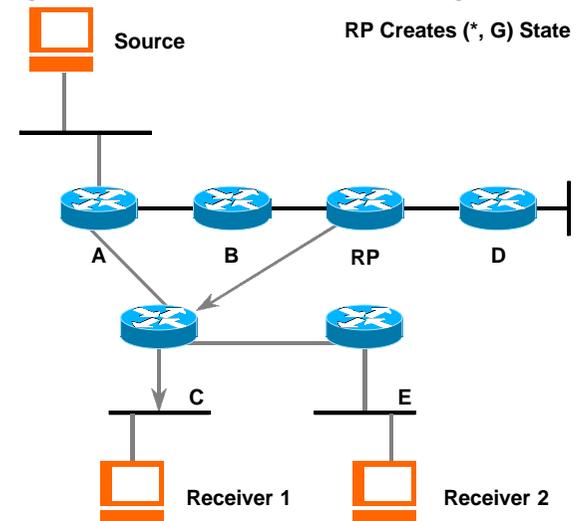
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Sparse Mode PIM Example



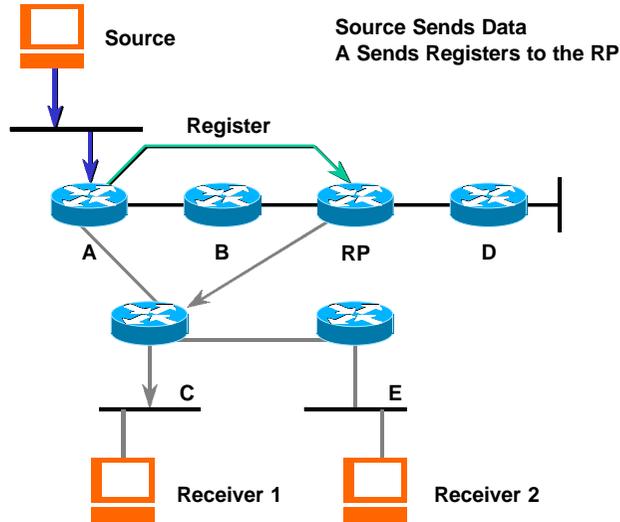
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Sparse Mode PIM Example

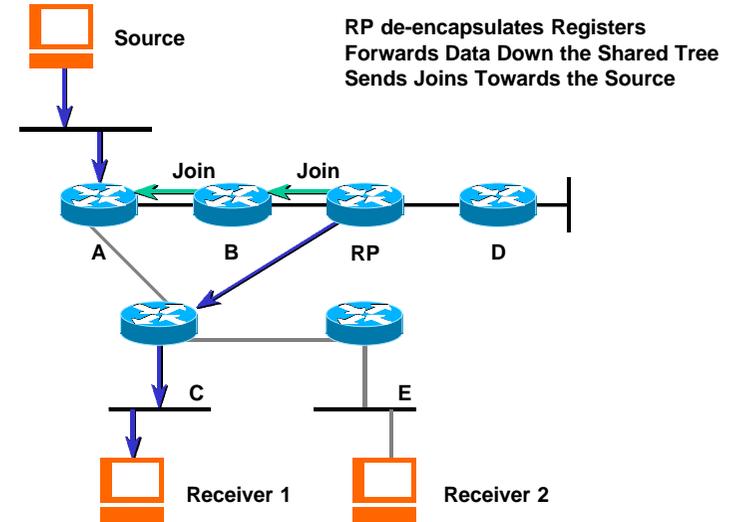


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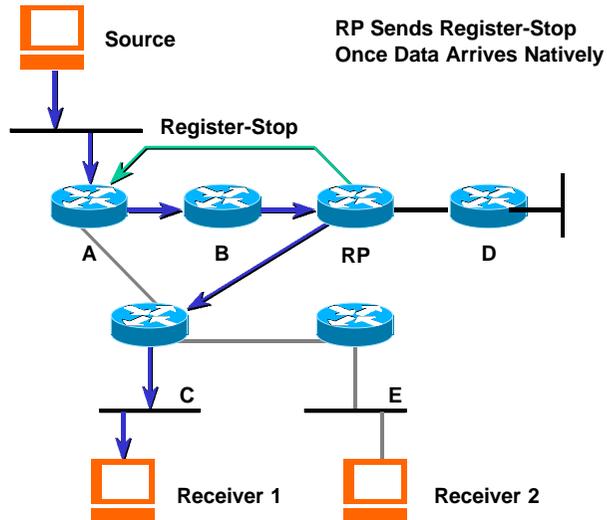
Sparse Mode PIM Example



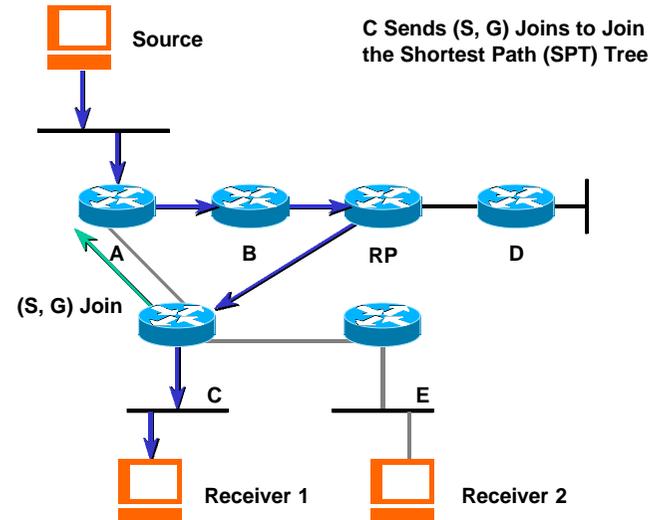
Sparse Mode PIM Example



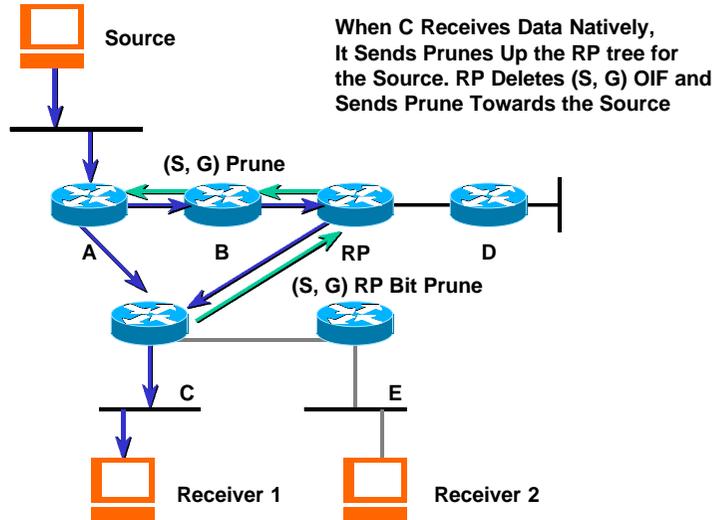
Sparse Mode PIM Example



Sparse Mode PIM Example

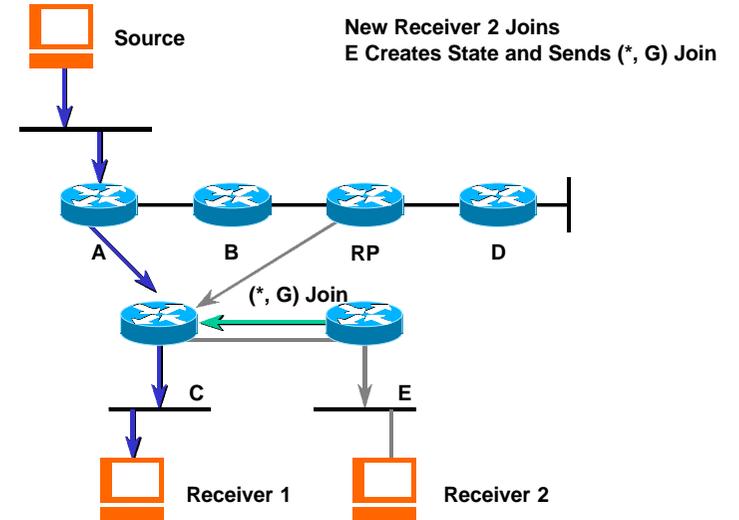


Sparse Mode PIM Example



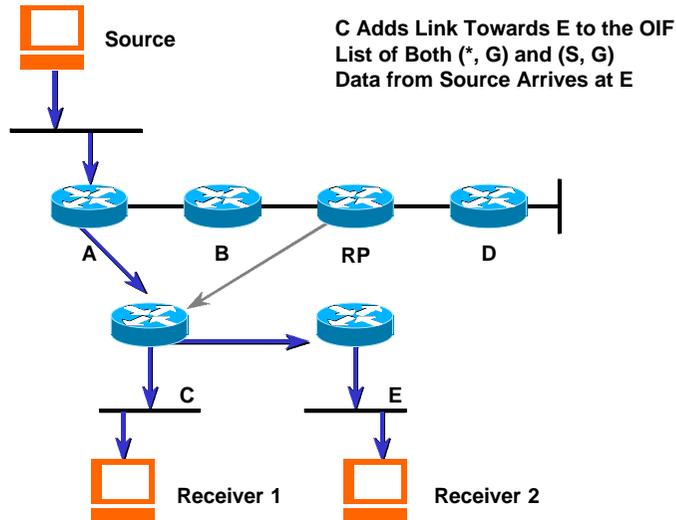
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Sparse Mode PIM Example



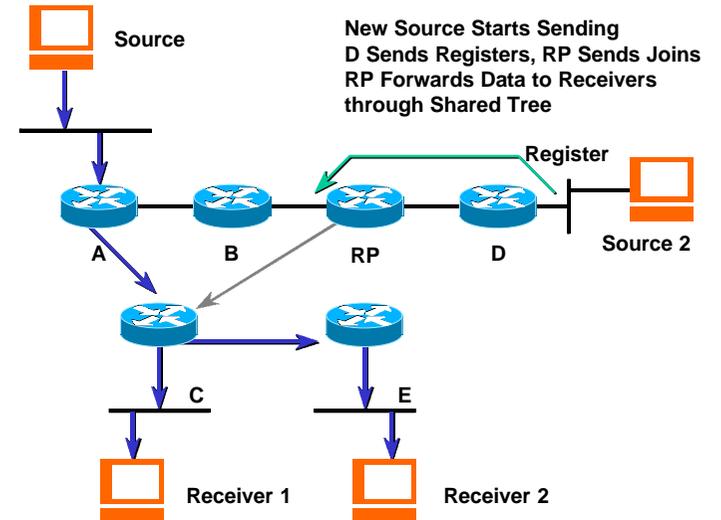
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Sparse Mode PIM Example



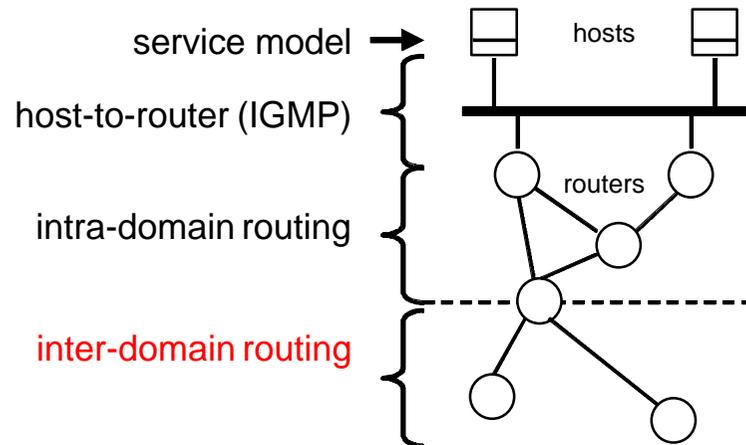
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Sparse Mode PIM Example



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Components of IP Multicast



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Need for "Inter-Domain" Multicast

- the MBone is one big, flat network
 - **why is this bad?**
- experience shows big, flat networks do not scale
 - **every router knows the existence of every single other router/subnet in the topology (lots of state)**
 - **infrequent problems become frequent when the size of the network grows large (instability)**
- scalability/instability are not the only problems
 - **ISPs consider multicast protocols to be flawed**

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What Exactly is Needed?

- intra-domain routing protocols
- inter-domain route exchange protocol
- mechanism for connecting domains
 - **mechanism for routing between backbones**
 - **consideration for "politics" between domains**
- address allocation

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Intra-Domain Routing Protocols

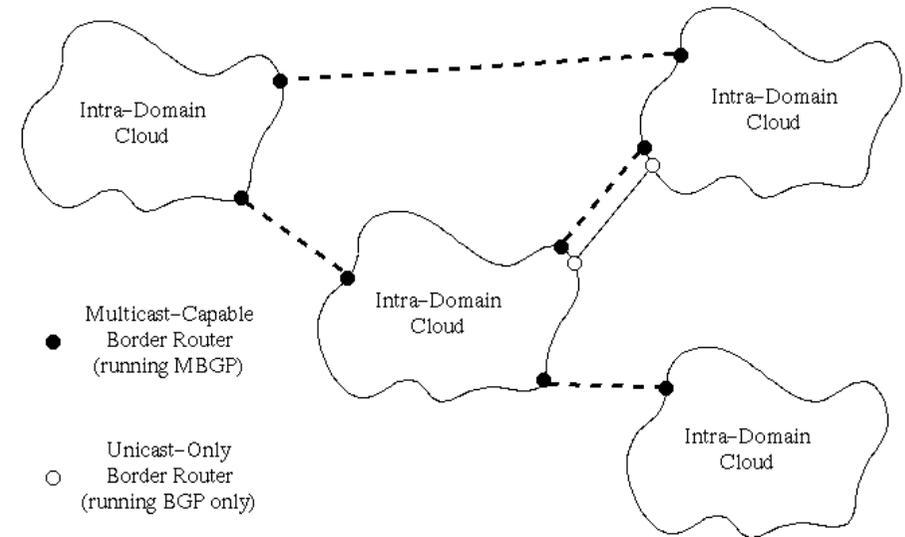
- Already exist
- Are either "broadcast-and-prune" or "explicit join"
 - **Explicit join protocols are by far the most scalable and the most efficient**
- "Best" protocol to-date seems to be PIM-SM
 - **best is good tradeoff between efficiency/complexity**
 - **best is most widely available**

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Inter-Domain Route Exchange

- Exchange multicast reachability between Autonomous Systems (AS)
 - **Just like unicast routes are exchanged with BGP**
 - **Protocol is "Multiprotocol extensions to BGP" (RFC 2283)**
 - Also known as "Multicast" BGP (MBGP)
 - Also known as BGP4+
- MBGP is available and deployed today.
 - **Multiple vendors: Juniper, Cisco, Nortel, 3Com, IBM**
- Allows different unicast/multicast topologies

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Issues

Deployment Obstacles— Non-Technical Issues

- How to bill for the service
 - **Is the service what runs on top of multicast?**
 - **Or is it the transport itself?**
 - **Do you bill based on sender or receiver, or both?**
- How to control access
 - **Should sources be rate-controlled (unlike unicast routing)**
 - **Should receivers be rate-controlled?**
- Multicast-related security holes
 - **Network-wide denial of service attacks**
 - **Eaves-dropping simpler since receivers are unknown**

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Deployment Obstacles— Technical Issues

- Source tree state will become a problem as IP multicast gains popularity
 - **When policy and access control per source are the rule rather than the exception**
- Group state will become a problem as IP multicast gains popularity
 - **10,000 three member groups across the Internet**
- Hopefully we can upper bound the state in routers based on their switching capacity
- ISPs don't want to depend on competitor's RP
 - **Do we connect shared trees together?**
 - **Do we have a single shared tree across domains?**
 - **Do we use source trees only for inter-domain groups?**

- Unicast and multicast topologies may not be congruent across domains
 - **Due to physical/topological constraints**
 - **Due to policy constraints**
- Need inter-domain routing protocol that distinguishes unicast versus multicast policy