# Multicast Protocols

IGMP - IP Group Membership Protocol

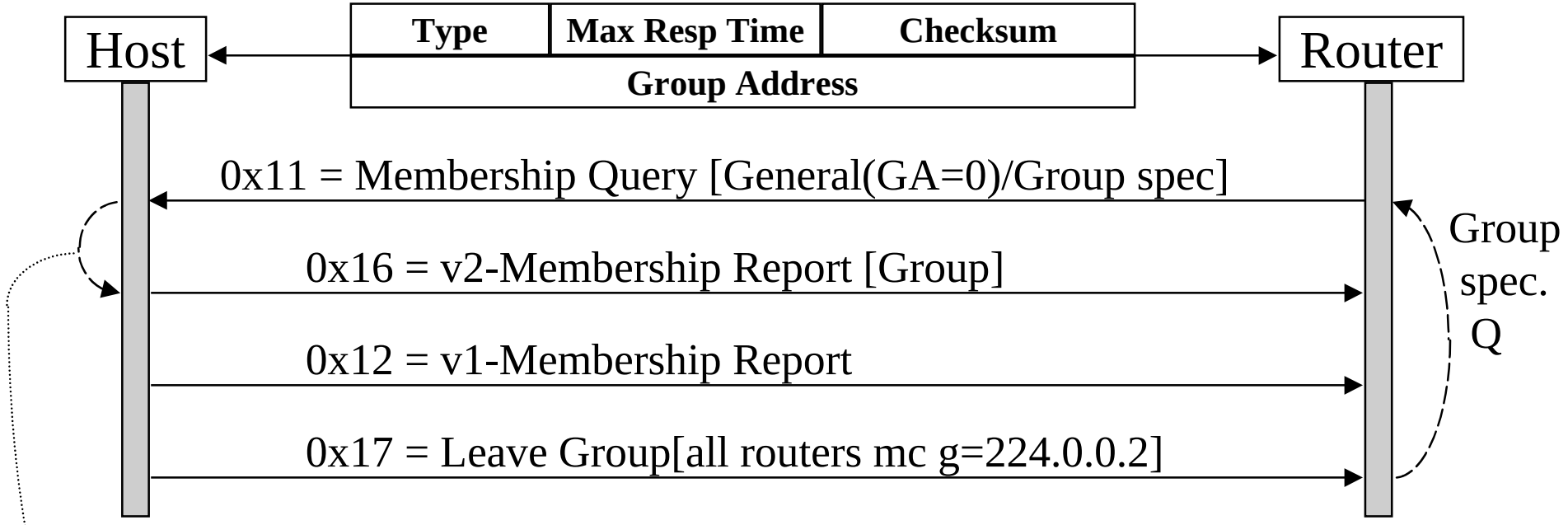
DVMRP - DV Multicast Routing Protocol

MOSPF - Multicast OSPF

(see notes pages for some slides!)

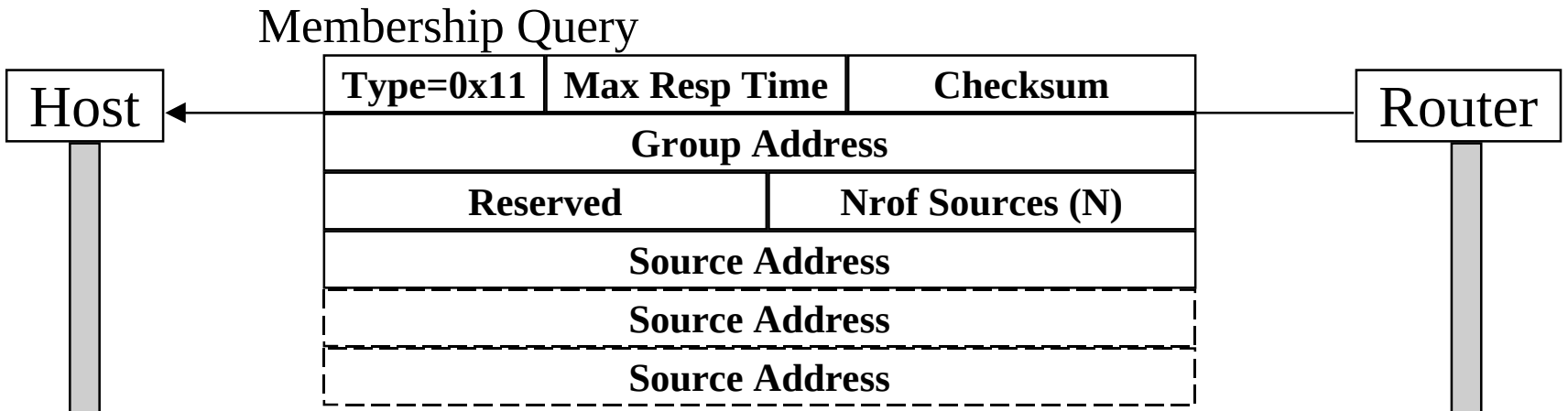
# IGMPv2 - Internet Group Management Protocol implements Group Membership

All syst MC group 224.0.0.1




- IGMP runs directly on IP as protocol nr 2.
- TTL == 1 in all IGMP msges
- Host will wait random[0...Max Resp Time] prior to response and will supress its response if it sees another response to the same group

# IGMPv3 adds selective reception from sources within a Group




Variants:

- General query: GA=0 and Nrof sources=0.
- Group specific query: GA=/=0, Nrof sources=0
- Group and source specific Query

0x22 = V3 Membership Report

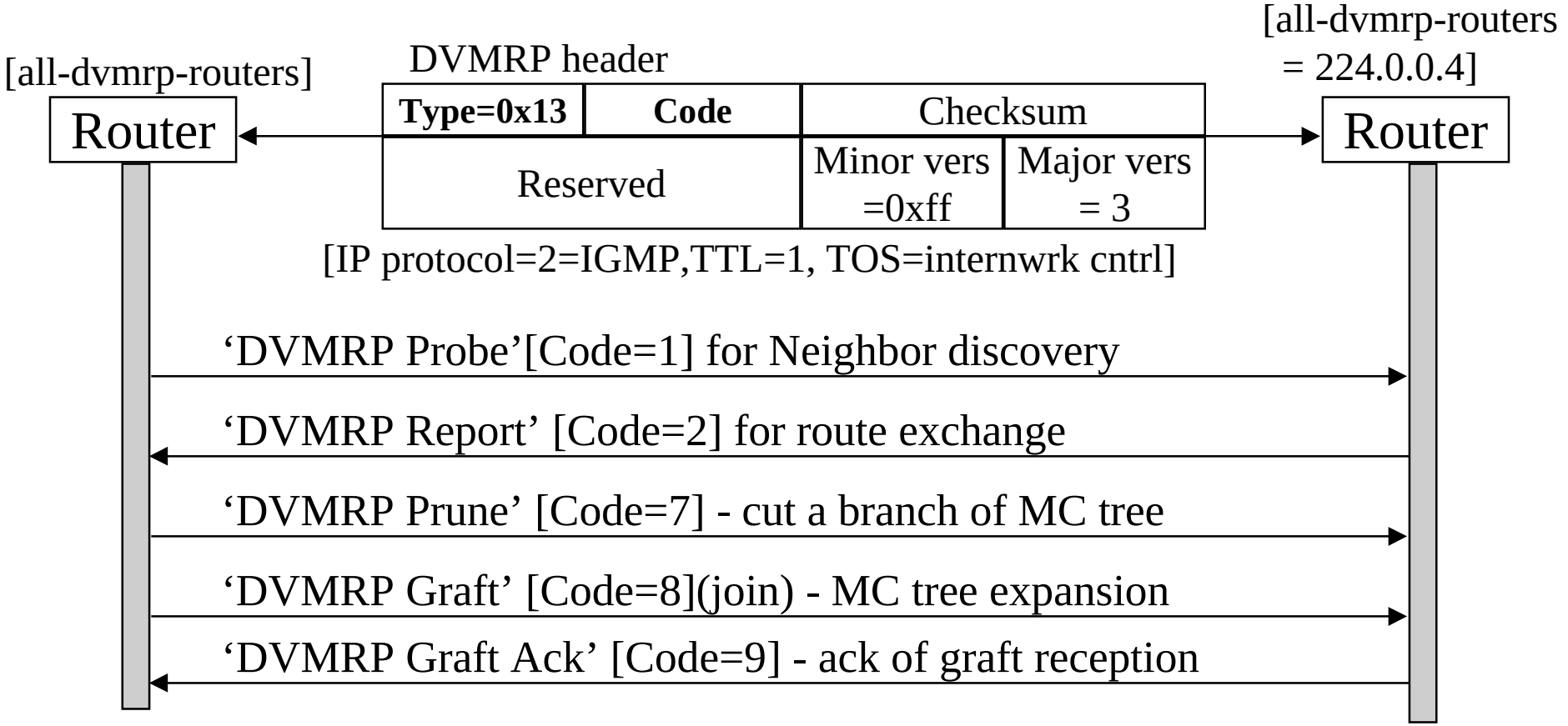
Can exclude listed sources within a Group or
include only listed sources within a Group

# Experimental routing protocols have been developed for MBone - an overlay MC Internet

| Shared tree | Source based trees | |
|---|---|---|
| | Bcast and Prune | Domainwide reports |
| PIM Sparse*<br>Core Based tree* | DVMRP<br>PIM Dense* | MOSPF |

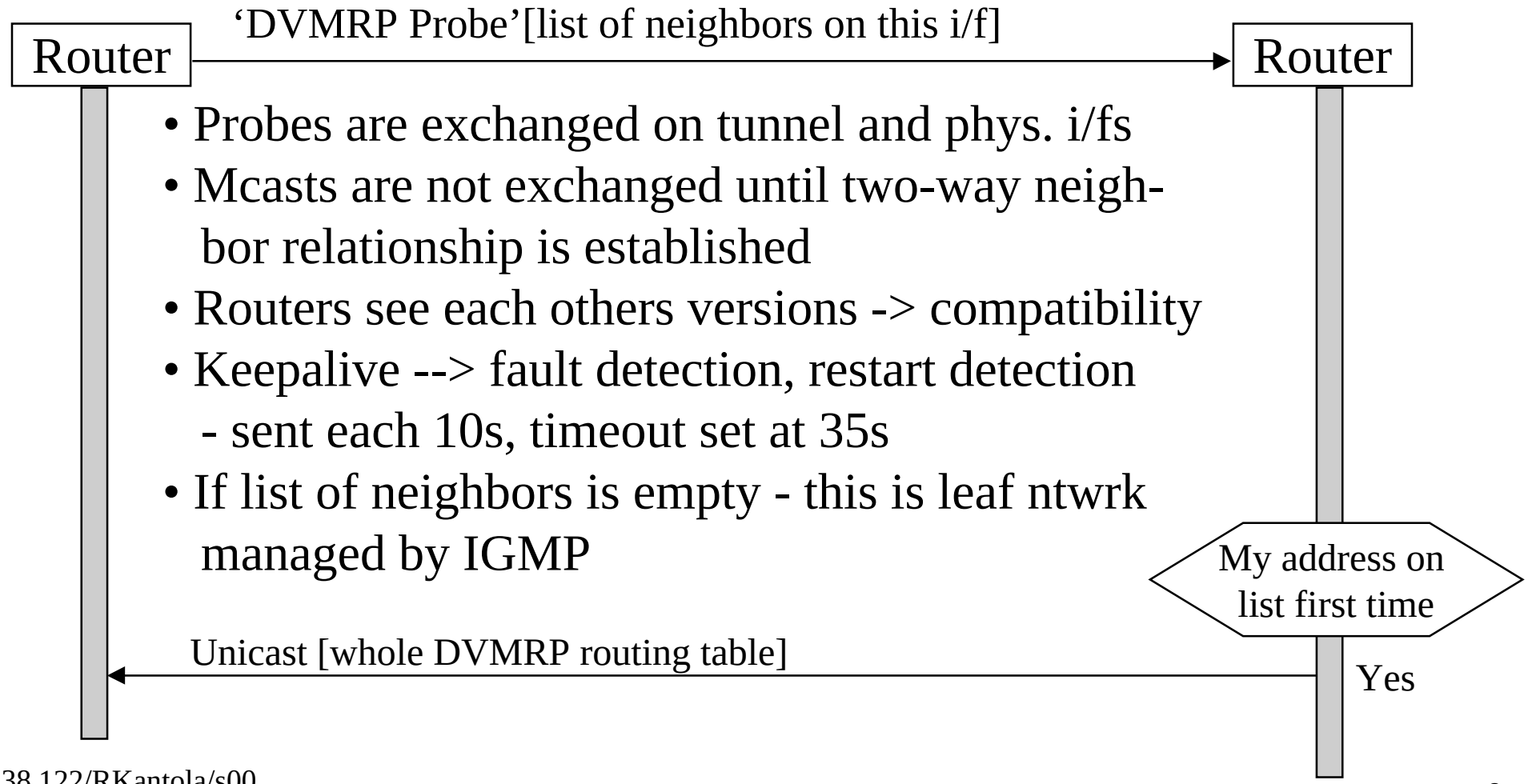
* Relies on Unicast routing protocol to locate MC-sources
Those that don’t, can route MC on routes separate from unicast routes.

# Distance Vector Multicast Routing Protocol (DVMRP) is used for MC routing in the MBone

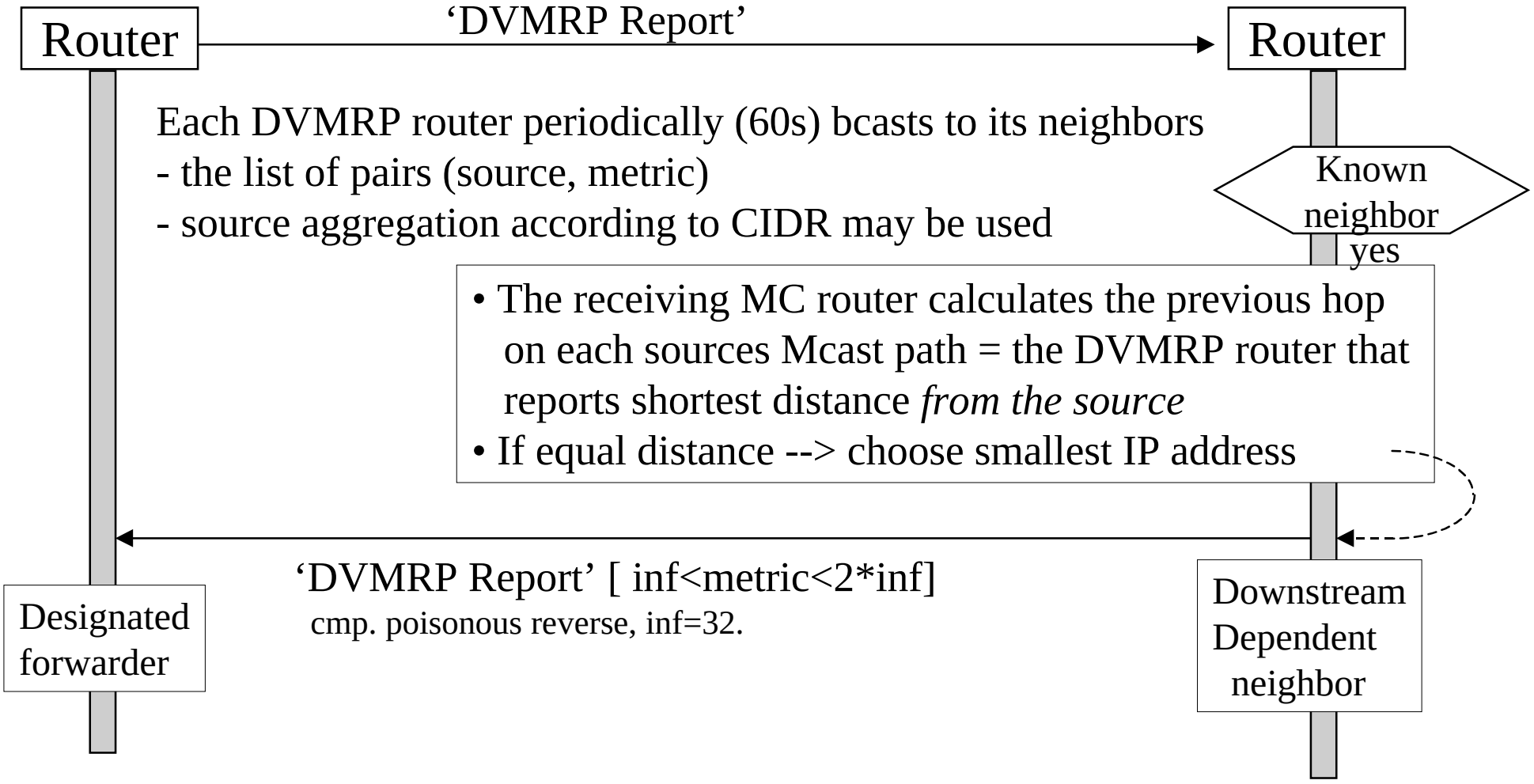



DVMRP is similar to RIP except that sources are like destinations in RIP

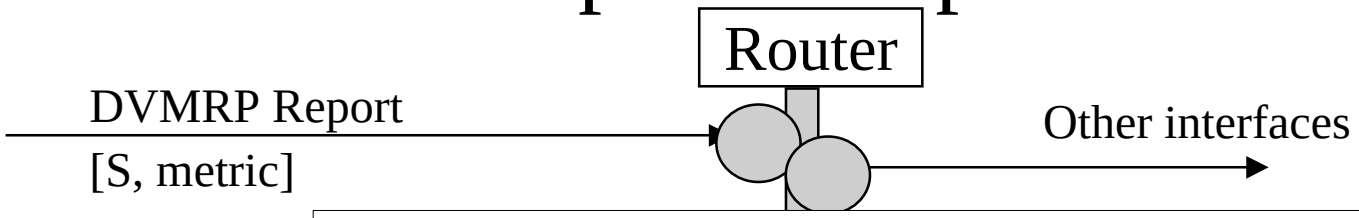
# Probes are used for neighbor discovery



# Route reports are used to build the source based trees



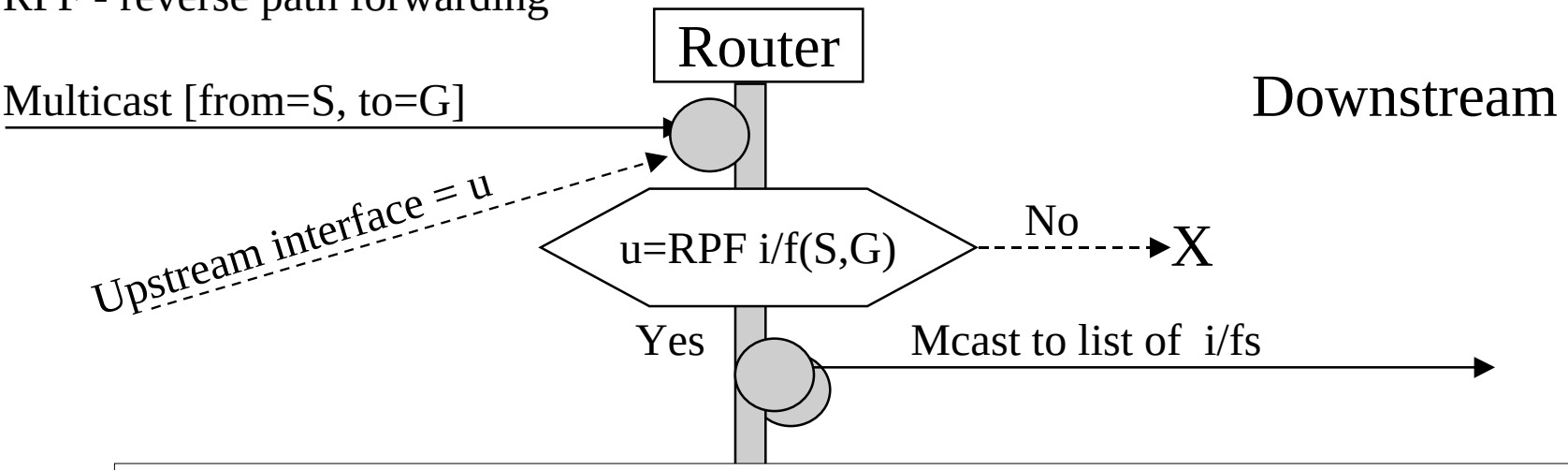
# Reports are processed:




```
Adjusted metric=metric+interface cost
If  Metric<inf & Adjust metric≥inf
    Set adjusted metric to inf
If Route is new and Adj metric<inf
   Add route to RT
   Delete prune state of more general route
Elseif Route exists
   If Received metric < inf
      Check if Designated forwarder status for (S,G) changes
      If Adjusted metric > existing metric
         From same neighbor: update metric, Sch flash update for route
      Elseif Adj.metric < existing metric
         Update metric for the route
         If sender was different, update RT, schedule flash updates
      Elseif Adj.metric = existing metric: refresh route ...
   Elseif Received metric =inf ...
   Elseif Inf < Received Metric < 2 * inf ...
```

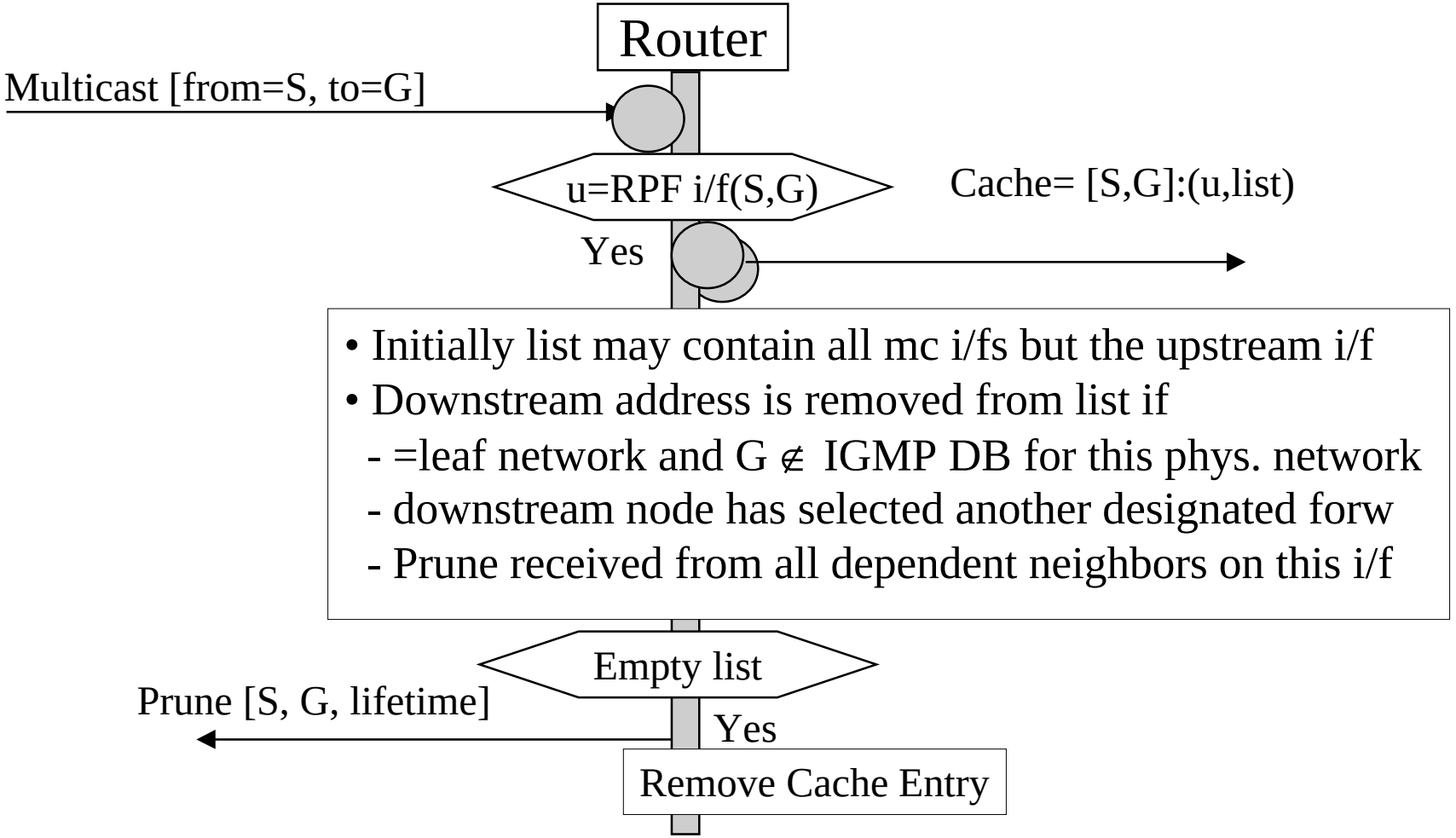
# Multicast algorithm

RPF - reverse path forwarding

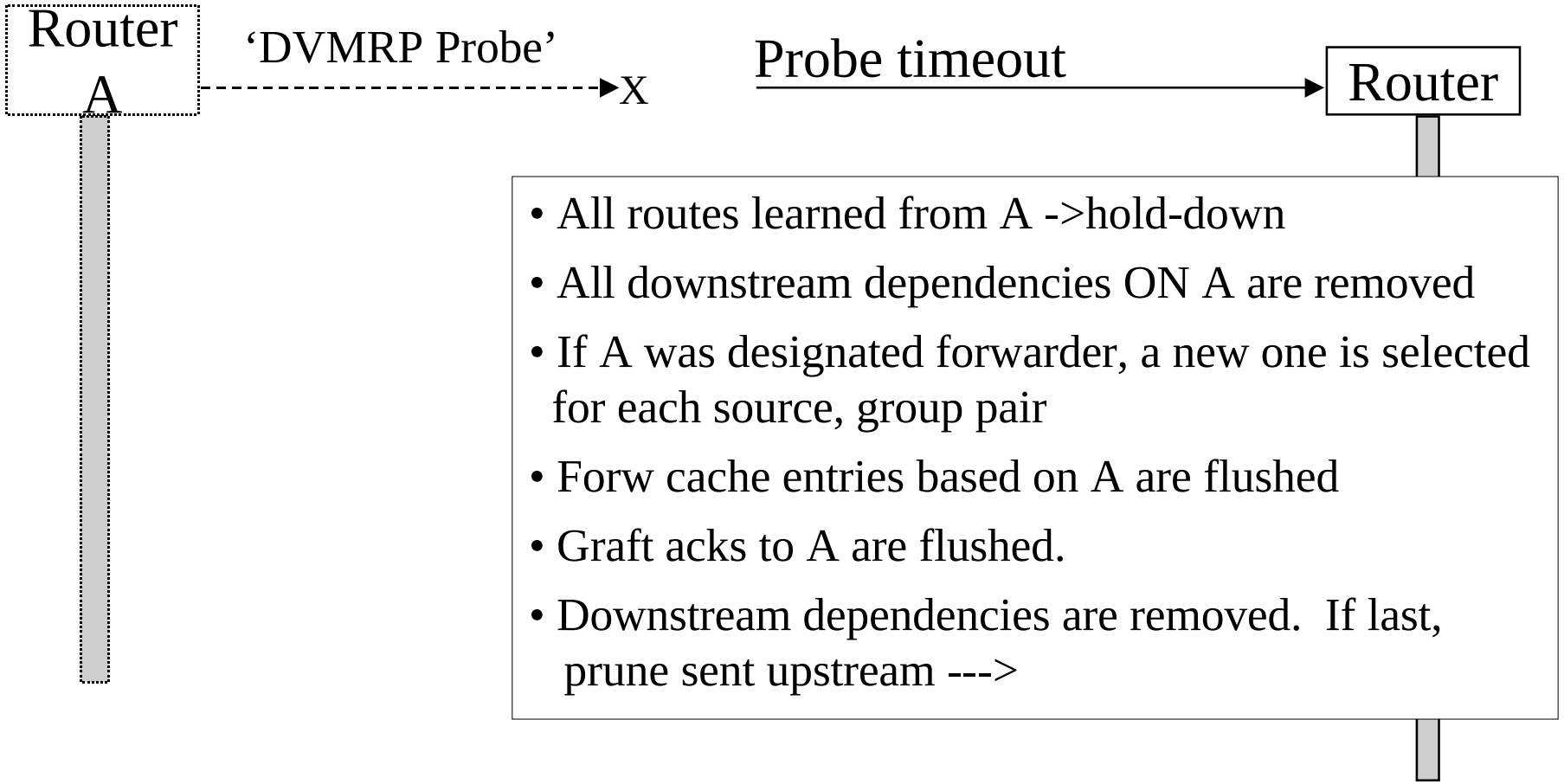



- At first mcast from RPF i/f a Forwarding Cache Entry [S,G]:(u,list...) is created using the DVMRP routing table
- List contains all downstream routers that have reported dependency on S
- Router is designated forwarder for downstream nodes
- If Designated forwarder becomes unreachable, Router assumes role of designated until it hears from a better candidate

# List of dependent neighbors is used to minimise the MC tree



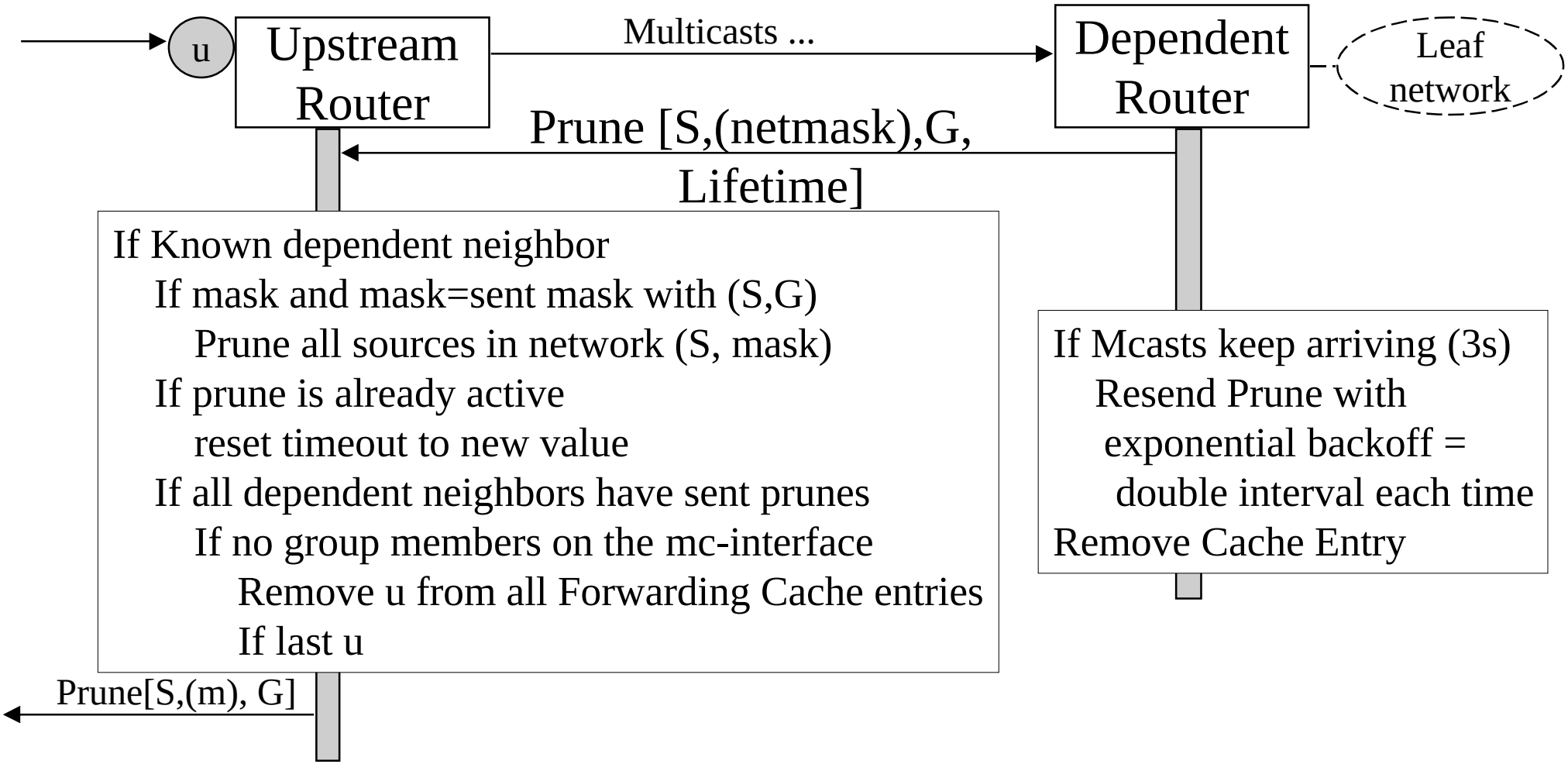
# On Probe timeout Caches are flushed



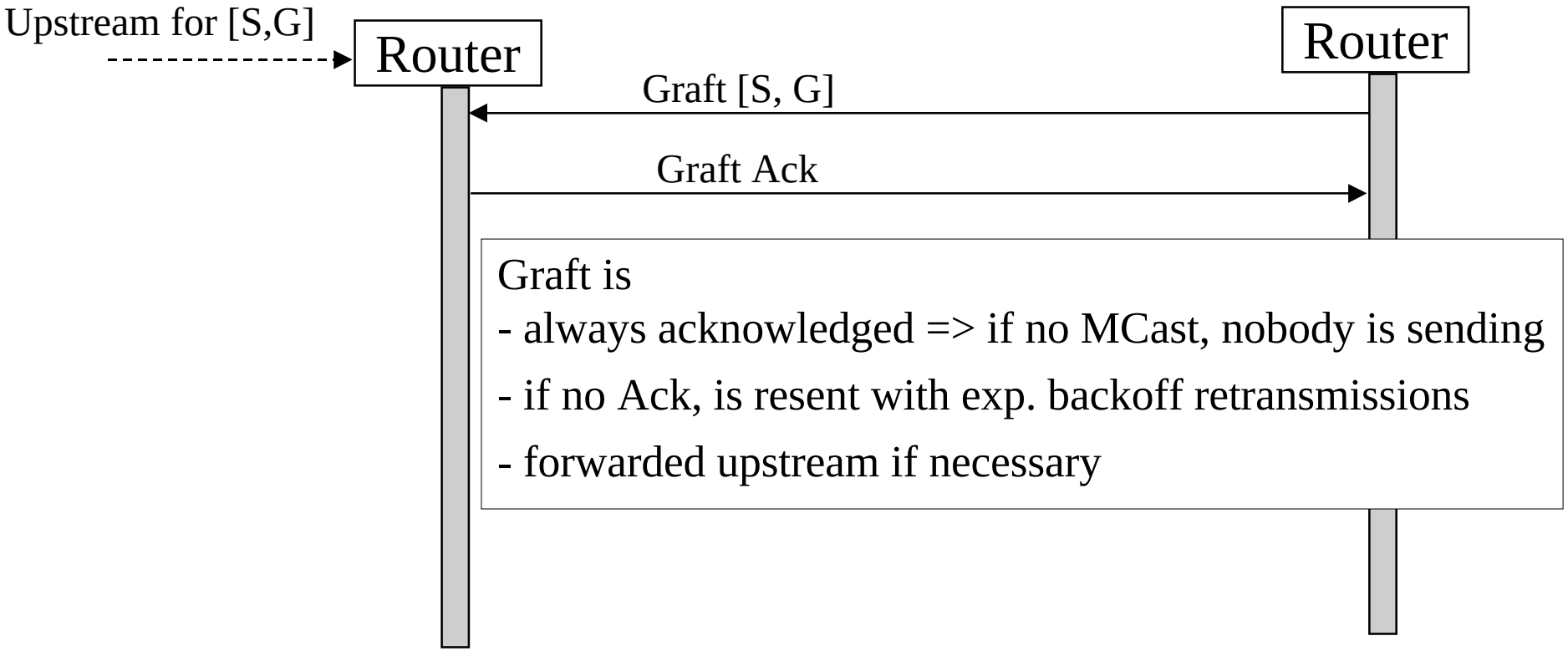
# Route hold-down is a state prior to deleting the route

- Routes expire on Report timeout or when an infinite metric is received
- An alternate route (that in RIP caused temporary loops) may exist
- Routers continue to advertise the Route with inf metric for 2 report intervals - this is the hold-down period
- All Forw Cache entries for the Route are flushed
- During hold-down, the route may be taken back, if (<inf and = SAME) metric is received from SAME router

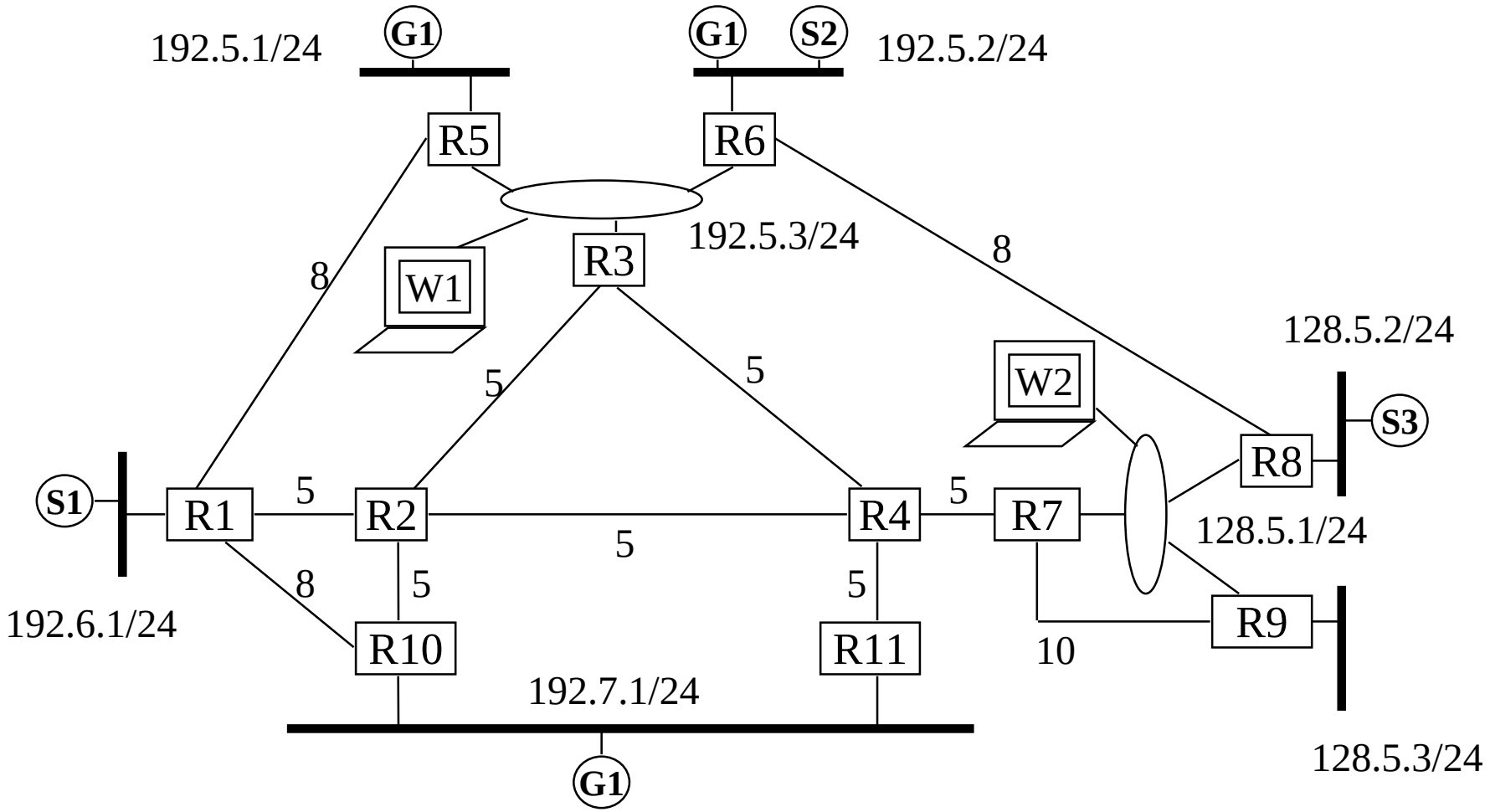
# Prunes minimise the Mcast tree



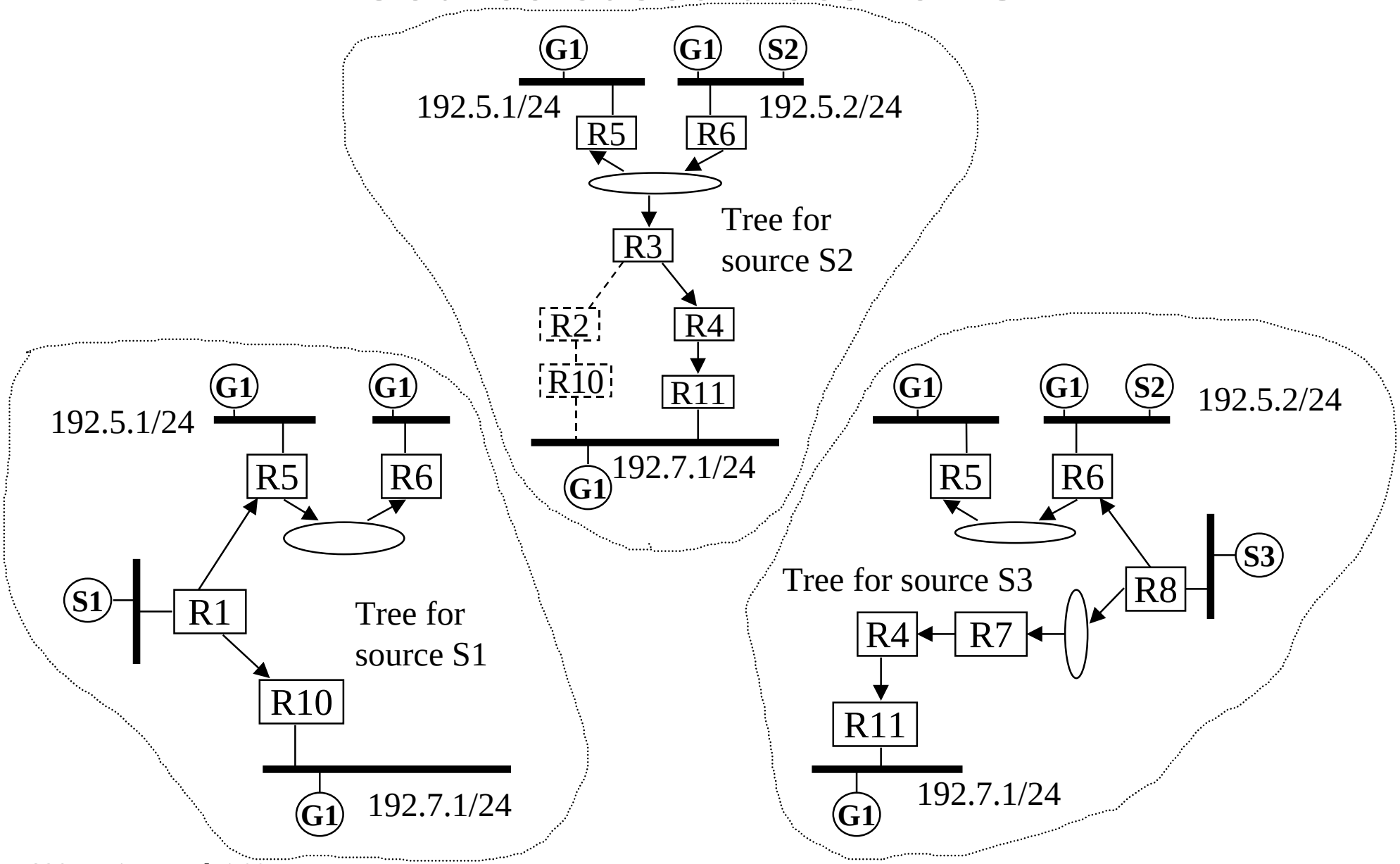
# Grafts are used to grow the tree when a new member joins the Group



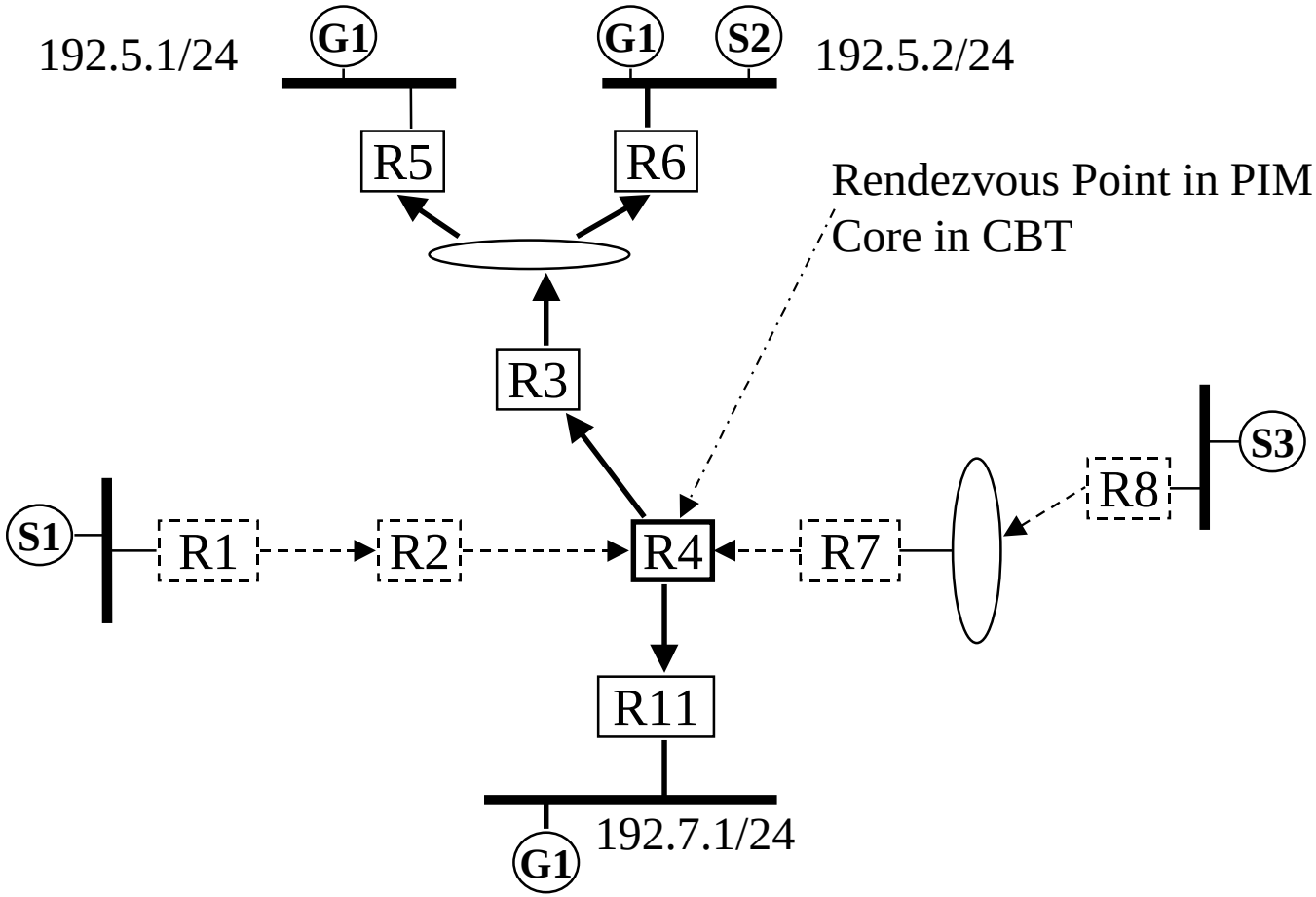
# Multicast routing example



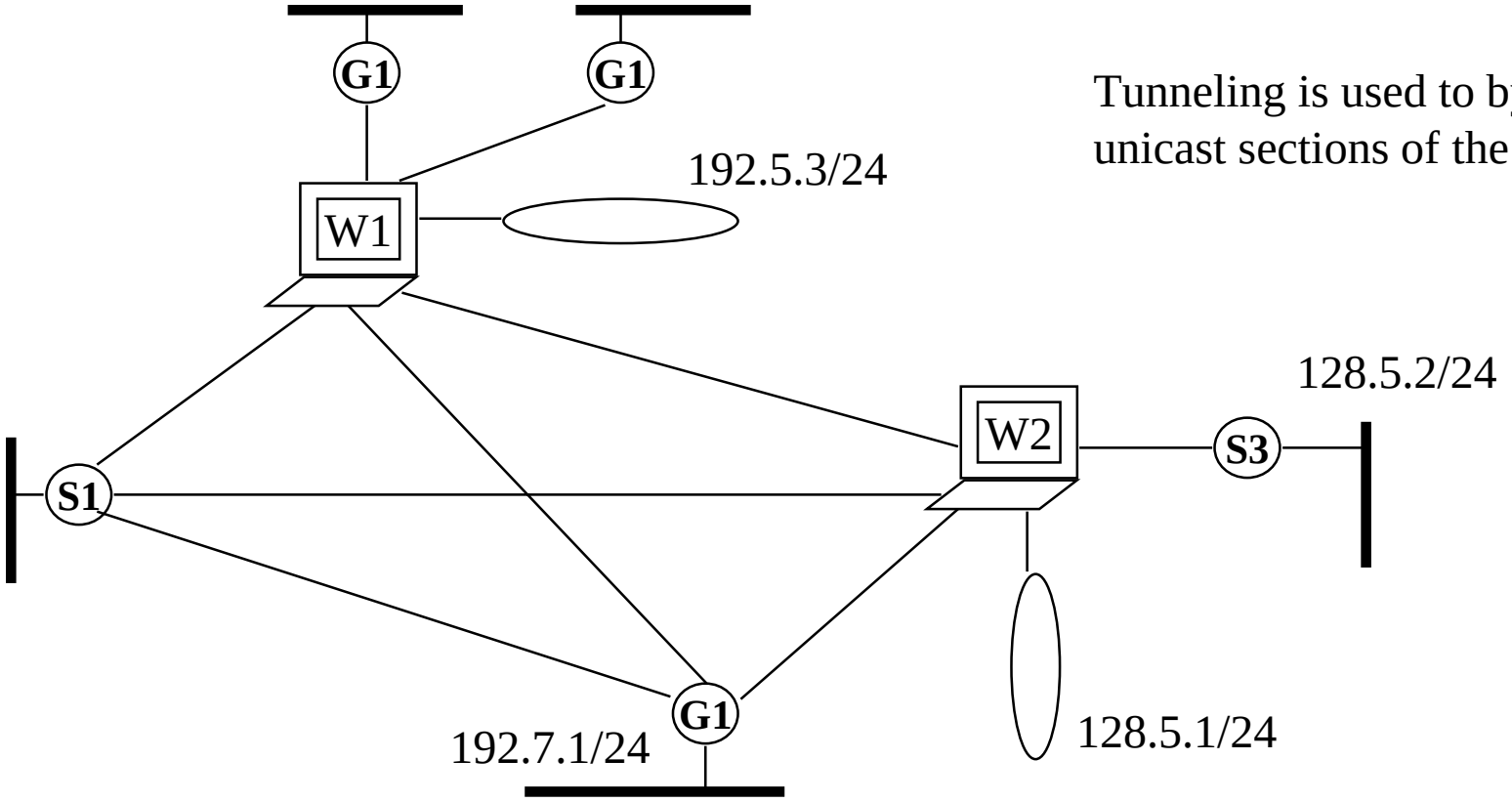
# Source based trees for G1



# Shared Multicast tree for G1



# Mbone overlay is based on WSs running DVMRP




Tunneling is used to bypass unicast sections of the Internet

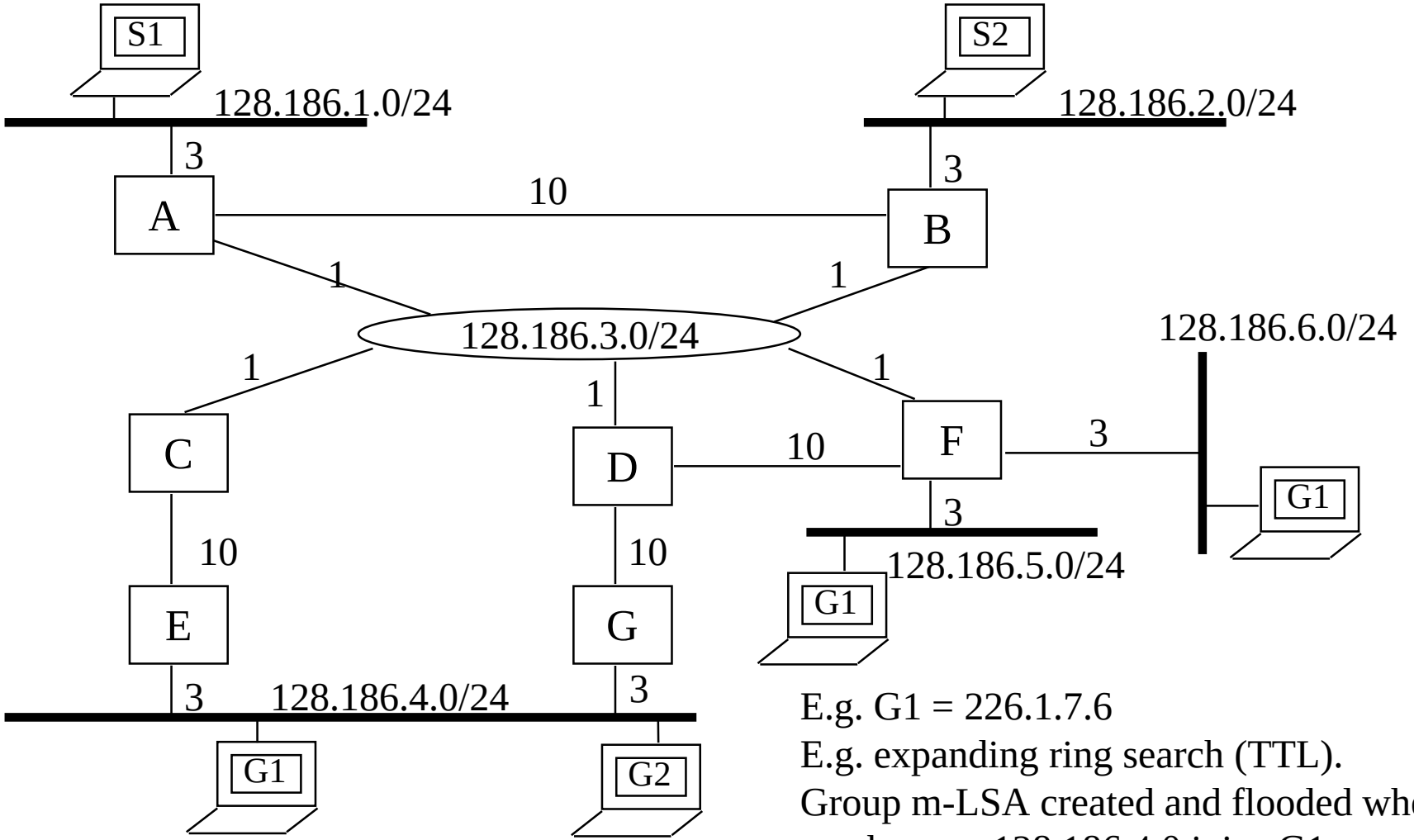
# MOSPF (Multicast Extensions to OSPF)

- is an extension of OSPF, allowing Multicast to be introduced into an existing OSPF unicast routing domain
- unlike DVMRP, MOSPF is not susceptible to the normal convergence problems of Distance Vector algorithms.
- limits the extent of multicast traffic to group members, something e.g. DVRMP cannot always do. Restricting the extent of multicast datagrams is desirable for high-bandwidth multicast applications or limited-bandwidth network links (or both).

# MOSPF can be deployed gracefully

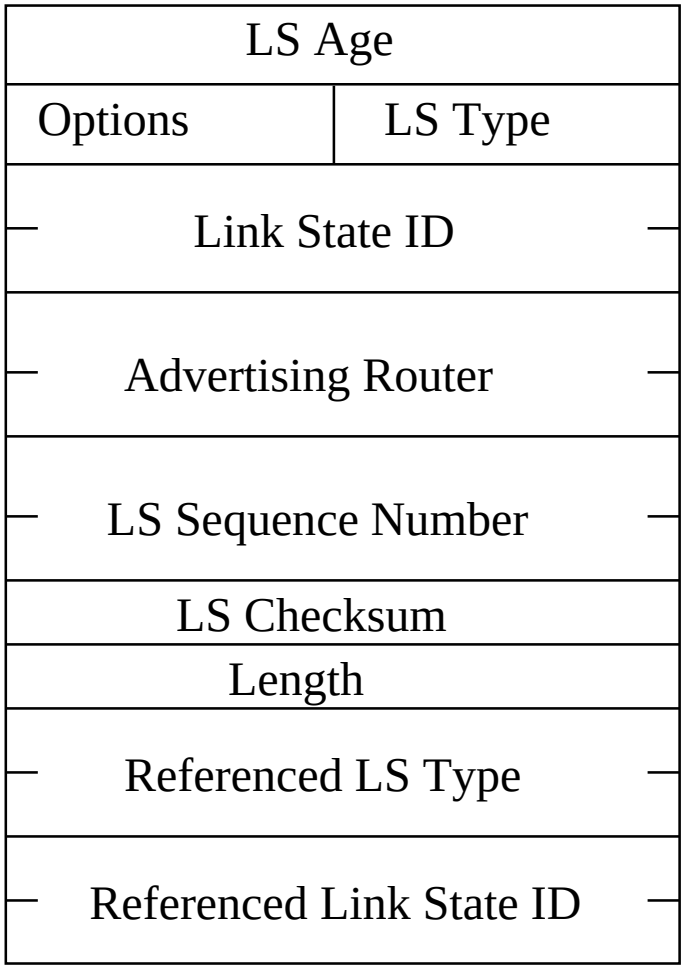
- Introduces multicast routing by adding a new type of LSA to the OSPF link-state database and by adding calculations for the paths of multicast datagrams.
- The introduction of MOSPF to an OSPF routing can be gradual - MOSPF will automatically route IP multicast datagrams around those routers incapable of multicast routing, whereas unicast routing continues to function normally.
- MOSPF can be, and is in isolated places, deployed in the MBONE. A MOSPF domain can be attached to the edge of the MBONE, or can be used as a transit routing domain within the MBONE's DVMRP routing system.

# An MOSPF Routing Domain




E.g. G1 = 226.1.7.6
E.g. expanding ring search (TTL).
Group m-LSA created and flooded when e.g. host on 128.186.4.0 joins G1.

# Group-membership-LSA is created and flooded when an IP user joins an MC-group using IGMP




0

E-bit. LS Type 6 (group-membership-LSA)

226.1.7.6 (group G1)

128.186.4.1 (router E)

0x80000001

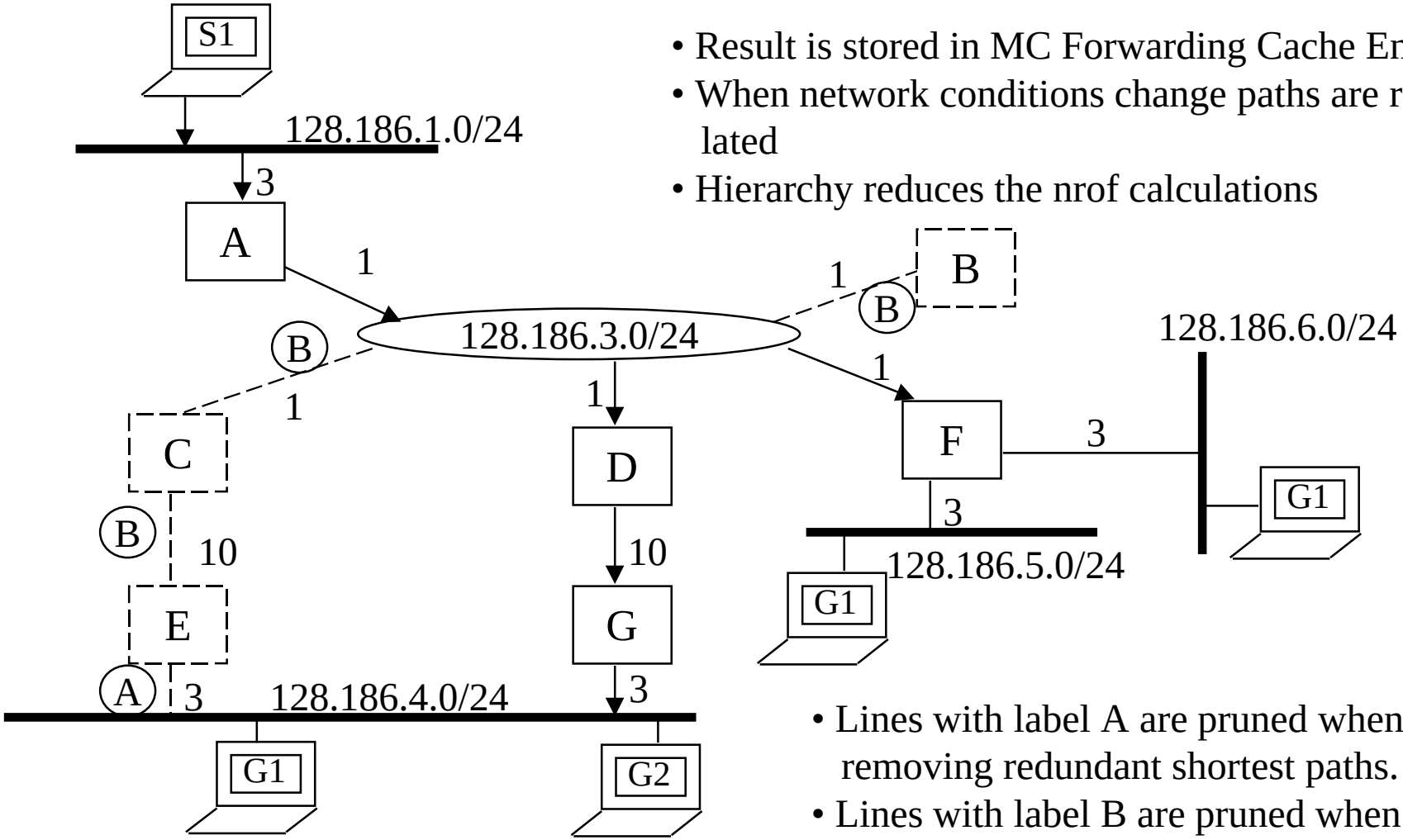
0x3da9

28 bytes

2 (network)

128.186.4.1 (128.186.4.0/24)

# MOSPF calculates Shortest-path trees on demand

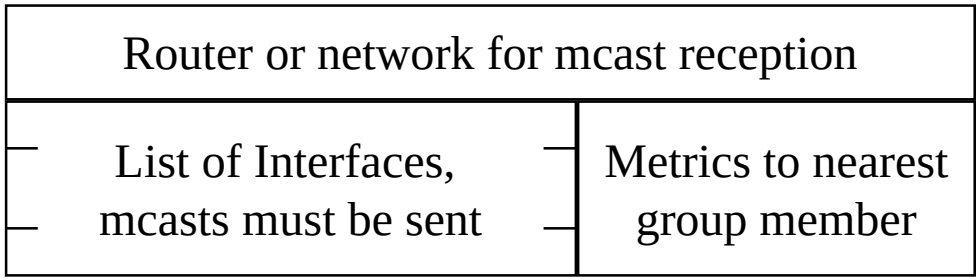



- Result is stored in MC Forwarding Cache Entry
- When network conditions change paths are recalculated
- Hierarchy reduces the nrof calculations

- Lines with label A are pruned when removing redundant shortest paths.
- Lines with label B are pruned when removing links that do not lead to G1

# Forwarding Cache Entry stores MC path routing info

Source network, Group -->




A Cache Entry may be deleted at any time -> will be recalculated on demand

Cache entries must be deleted, when changed LSAs are received
- Router-LSA, Network-LSA (on router or link failure or cost change) => delete all entries since can't tell which are affected

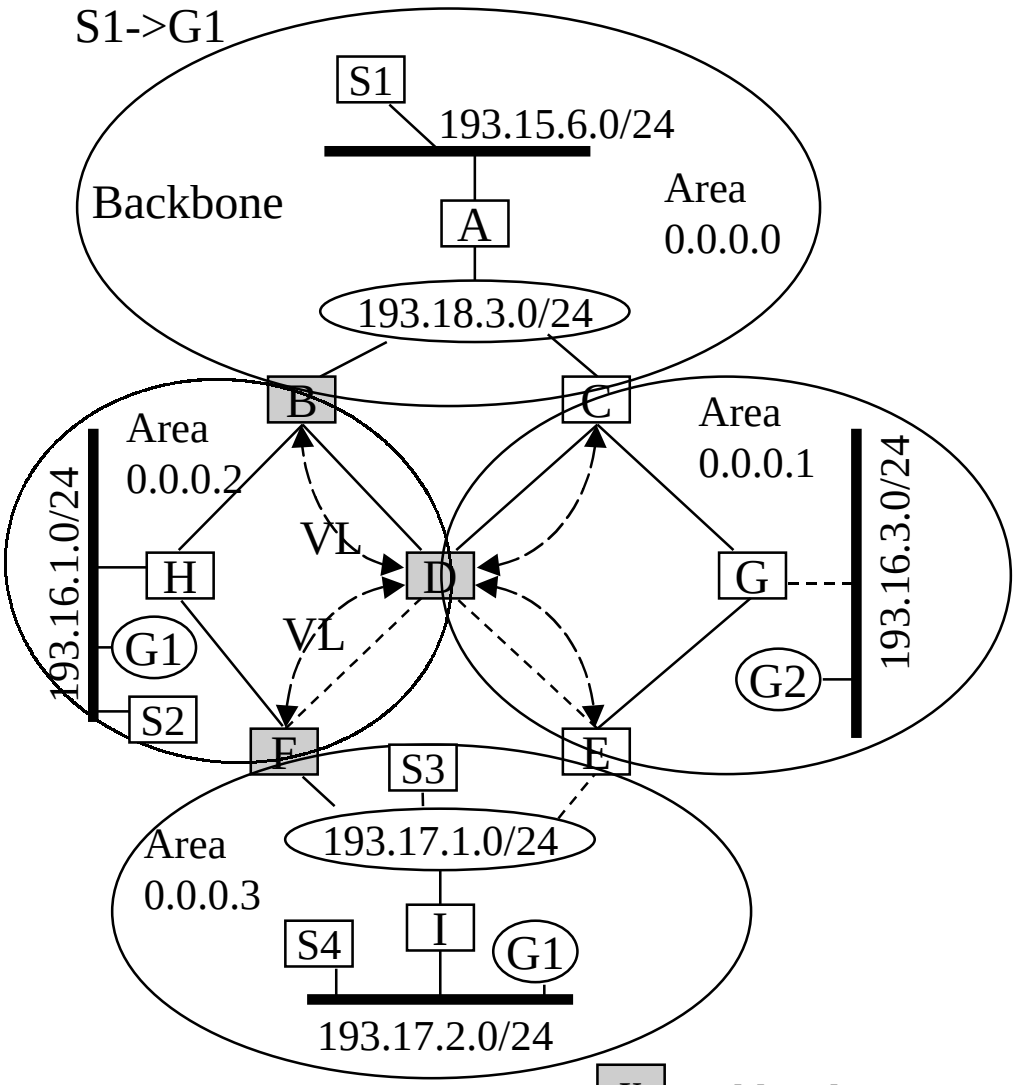
- Group-m-LSA: delete entries of that group

- Hierarchy => the farther away the change is the fewer cache entries are deleted

# On demand route calculations use Dijkstra's SPF-algorithm

- Calculation is rooted on the source not the router as for unicast
- For a new mcast, every router performs the same calculation
- Stub networks do not appear in MOSPF calculation (e.g router F )
- Tiebreaks for equal cost routes - previous hop router that has highest address is chosen (e.g. G over E)

# Two level hierarchy aggregates both sources and group addresses




- In aggregation some info is lost --> sometimes mcasts are sent needlessly: C->G:to G1
- Presense of sources is reported by summary-LSA with MC -bit set: F to H-> S3+S4 entry
- Area border router advertise Group-m-LSAs to bbone (B: G1, D,E,F:G1, C,D,E:G2) - no exact location
- Routers in non-bbone do not know location of group mmbrs

# Summary of Multicast Protocols for the Internet

| Shared tree | Source based trees | |
|---|---|---|
| | Bcast and Prune | Domainwide reports |
| PIM Sparse*<br>Core Based tree* | DVMRP<br>PIM Dense* | MOSPF |

* Rely on Unicast routing protocol to locate MC-sources.

- Those that don’t, can route MC on routes separate from unicast routes.
- For Shared tree protocols an additional step of finding the Core or Rendesvouz Point must be performed.
- Directories are useful on service management level.