features. Ironically, in the early 2000's, ten years after the protocols were designed, several things changed to give IS-IS a second chance. Digital Equipment Corporation had dissolved, and IS-IS was no longer considered valuable proprietary property. A newer version of IS-IS was defined to integrate it with IP and the Internet. Because OSPF was built for IPv4, a completely new version had to be developed to handle larger IPv6 addresses. The largest ISPs have grown to a size where the extra overhead in OSPF makes IS-IS more attractive. As a result, IS-IS has started to make a comeback.

26.16 Multicast Routing

26.16.1 IP Multicast Semantics

So far, we have discussed unicast routing. That is, we have considered routing protocols that propagate information about destinations that each has a static address and a location that does not change. One of the design goals for unicast route propagation is *stability* — continual changes in routes are undesirable because they lead to higher jitter and datagrams arriving out of order. Thus, once a unicast routing protocol finds a shortest path, it usually retains the route until a failure makes the path unusable.

Propagating *multicast routing* information differs dramatically from unicast route propagation. The difference arises because Internet multicast allows dynamic group membership and anonymous senders. Dynamic group membership means that an application can choose to participate in a group at any time and remain a participant for an arbitrary duration. That is, the IP multicast abstraction allows an application running on an arbitrary computer to:

- Join a multicast group at any time and begin receiving a copy of all packets sent to the group. To join a group, a host informs a nearby router. If multiple applications on the same host decide to join a group, the host receives one copy of each datagram sent to the group and makes a local copy for each application.
- Leave a multicast group at any time. A host periodically sends group membership messages to the local router. Once the last application on the host leaves the group, the host informs the local router that it is no longer participating in the group.

An IP multicast group is anonymous in two ways. First, neither a sender nor a receiver knows (nor can they find out) the identity or the number of group members. Second, routers and hosts do not know which applications will send a datagram to a group, because an arbitrary application can send a datagram to any multicast group at any time. That is, membership in a multicast group only defines a set of receivers — a sender does not need to join a multicast group before sending a message to the group.