International Journal of Research (IJR)
e-ISSN: 2348-6848, p- ISSN: 2348-795X Volume 2, Issue 06, June 2015
Available at http://internationaljournalofresearch.org

A Survey Paper on Multi-Casting Routing Protocols

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Abstract:
In a multi-hop mobile ad-hoc network, mobile nodes cooperate to form a network without using any infrastructure such as access points and base stations. Instead, the mobile nodes forward packets for each other's allowing communication among nodes outside wireless transmission range. Examples of applications for ad-hoc networks range from military operation and emergency disaster relief to community networking and interaction among meeting attendees or students during a lecture. In this ad-hoc networking applications, security is necessary to guard the network from various types of attacks. In ad-hoc networks, adverse nodes can freely join the network, listen to and/or interfere with network traffic, and compromise network nodes leads to various network failures [1]. Since routing protocols are a fundamental tool of network-based computation, attacks on unsecured routing protocols can disrupt network performance and reliability. Multicasting is a more efficient method of supporting group communication, as it allows transmission and routing of packets to multiple destinations with fewer network resources. Multicasting can improve the efficiency of the wireless links, when sending multiple copies of messages, by exploiting the inherent broadcast property of the wireless medium when multiple mobile nodes are located within the transmission range of a node. Providing efficient multicasting over MANET faces many challenges, including dynamic group membership and constant update of delivery path due to node movement [2].

Keywords: Routing protocols; MANET; Multicasting; Centralized Mode; Dense Mode

1. INTRODUCTION

There are three ways to design multipoint networking applications: unicast, broadcast, and multicast.

Unicast
With a unicast design, applications can send one copy of each packet to each member of the multicast group. This technique is simple to implement, but it has significant scaling restrictions if the group is large. In addition, it requires extra bandwidth, because the same information has to be carried multiple times even on shared links.

Broadcast
In a broadcast design, applications can send one copy of each packet and address it to a broadcast address. This technique is even simpler than unicast for the application to implement. However, if this technique is used, the network must either stop broadcasts at the LAN boundary (a technique that is frequently used to prevent broadcast storms) or send the broadcast everywhere. Sending the broadcast everywhere is a significant usage of network resources if only a small group actually needed to see the packets.

Multicast
With a multicast design, applications can send one copy of each packet and address it to the group of computers that want to receive it. This technique addresses packets to a group of receivers rather than to a single receiver, and it depends on the network to forward the packets to only the networks that need to receive them.
IP addresses are organized into classes A, B, C, D, and E. Class A, B, and C addresses are the IP addresses used to identify hosts on a network, but what about class D and E addresses? Class E addresses are used for experimental purposes, while

the class D addresses range is used for multicast addresses.

2. MULTICAST ROUTING PROTOCOLS

Multicast routing protocols enable a collection of multicast routing devices to build (join) distribution trees when a host on a directly attached subnet, typically a LAN, wants to receive traffic from a certain multicast group, prune branches, locate sources and groups, and prevent routing loops.

There are several multicast routing protocols:

Distance Vector Multicast Routing Protocol (DVMRP)

The first of the multicast routing protocols and hampered by a number of limitations that make this method unattractive for large-scale Internet use. DVMRP [8] is a dense-mode-only protocol, and uses the flood-and-prune or implicit join method to deliver traffic everywhere and then determine where the uninterested receivers are. DVMRP uses source-based distribution trees in the form (S, G), and builds its own multicast routing tables for RPF checks.

Multicast OSPF (MOSPF)

Extends OSPF for multicast use, but only for dense mode. However, MOSPF [11] has an explicit join message, so routing devices do not have to flood their entire domain with multicast traffic from every source. MOSPF uses source-based distribution trees in the form (S, G).

Bidirectional PIM mode

A variation of PIM. Bidirectional PIM builds bidirectional shared trees that are rooted at a rendezvous point (RP) address. Bidirectional traffic does not switch to shortest path trees as in PIM-SM and is therefore optimized for routing state size instead of path length. This means that the end-to-end latency might be longer compared to PIM sparse mode. Bidirectional PIM routes are always wildcard-source (*, G) routes. The protocol eliminates the need for (S, G) routes and data-triggered events. The bidirectional (*, G) group trees carry traffic both upstream from senders toward the RP, and downstream from the RP to receivers. As a consequence, the strict reverse path forwarding (RPF)-based rules found in other PIM modes do not apply to bidirectional PIM. Instead, bidirectional PIM (*, G) routes forward traffic from all sources and the RP. Bidirectional PIM routing devices must have the ability to accept traffic on many potential incoming interfaces. Bidirectional PIM scales well because it needs no source-specific (S,G) state. Bidirectional PIM is recommended in deployments with many dispersed sources and many dispersed receivers.

PIM dense mode

In this mode of PIM [12], the assumption is that almost all possible subnets have at least one receiver wanting to receive the multicast traffic from a source, so the network is *flooded* with traffic on all possible branches, then pruned back when branches do not express an interest in receiving the packets, explicitly (by message) or implicitly (time-out silence). This is the *dense mode* of multicast operation. LANs are appropriate networks for dense-mode operation. Some multicast routing protocols, especially older ones, support only dense-mode operation, which makes them inappropriate for use on the Internet. In contrast to DVMRP and MOSPF [8, 11], PIM dense mode allows a routing device to use any unicast routing protocol and performs RPF checks using the unicast routing table. PIM dense mode has an implicit join message, so routing devices use the flood-and-prune method to deliver traffic everywhere and then determine where the uninterested receivers are. PIM dense mode uses source-based distribution trees in the form (S, G), as do all dense-mode protocols. PIM also supports sparse-dense mode, with mixed sparse and dense groups, but there is no special notation for that operational mode. If *sparse-dense mode* is supported, the multicast routing protocol allows some multicast groups to be sparse and other groups to be dense.

PIM sparse mode

In this mode of PIM, the assumption is that very few of the possible receivers want packets from each source, so the network establishes and sends packets only on branches that have at least one leaf indicating (by message) an interest in the traffic. This multicast protocol allows a routing device to use any unicast routing protocol and performs reverse-path forwarding (RPF) checks using the unicast routing table. PIM sparse mode has an *explicit* join message, so routing devices determine where the interested receivers are and send join messages upstream to their neighbors, building trees from receivers to the rendezvous point (RP). PIM sparse mode uses an RP routing device as the initial source of multicast group traffic and therefore builds distribution trees in the form (*,G), as do all sparse-mode protocols. PIM sparse mode [13] migrates to an (S,G) source-based tree if that path is shorter than through the RP for a particular multicast group's traffic. WANs are appropriate networks for sparse-mode operation, and indeed a common multicast guideline is not to run dense mode on a WAN under any circumstances.

Core Based Trees (CBT)

Shares all of the characteristics of PIM sparse mode (sparse mode, explicit join, and shared (*, G) trees), but is said to be more efficient at finding sources than PIM sparse mode. CBT [3] is rarely encountered outside academic discussions. There are no large-scale deployments of CBT, commercial or otherwise.

PIM source-specific multicast (SSM)

Enhancement to PIM sparse mode that allows a client to receive multicast traffic directly from the source, without the help of an RP. Used with IGMPv3 to create a shortest-path tree between receiver and source.

IGMPv1

The original protocol defined in RFC 1112, *Host Extensions for IP Multicasting*. IGMPv1 sends an explicit join message to the routing device, but uses a timeout to determine when hosts leave a group. Three versions of the Internet Group Management Protocol (IGMP) run between receiver hosts and routing devices.

IGMPv2

Defined in RFC 2236, *Internet Group Management Protocol, Version 2*. Among other features, IGMPv2 adds an explicit leave message to the join message.

IGMPv3

Defined in RFC 3376, *Internet Group Management Protocol, and Version 3.* Among other features, IGMPv3 optimizes support for a single source of content for a multicast group, or source-specific multicast (SSM). Used with PIM SSM to create a shortest-path tree between receiver and source.

Bootstrap Router (BSR) and Auto-Rendezvous Point (RP)

Allow sparse-mode routing protocols to find RPs within the routing domain (autonomous system, or AS). RP addresses can also be statically configured.

Multicast Source Discovery Protocol (MSDP)

Allows groups located in one multicast routing domain to find RPs in other routing domains. MSDP is not used on an RP if all receivers and sources are located in the same routing domain. Typically runs on the same routing device as PIM sparse mode RP. Not appropriate if all receivers and sources are located in the same routing domain.

Session Announcement Protocol (SAP) and Session Description Protocol (SDP)

Display multicast session names and correlate the names with multicast traffic. SDP [15, 16] is a session directory protocol that advertises multimedia conference sessions and communicates setup information to participants who want to join the session. A client commonly uses SDP to announce a conference session by periodically multicasting an announcement packet to a well-known multicast address and port using SAP.

Pragmatic General Multicast (PGM)

Special protocol layer for multicast traffic that can be used between the IP layer and the multicast application to add reliability to multicast traffic. PGM [10, 11] allows a receiver to detect missing information in all cases and request replacement information if the receiver application requires it.

3. MULTICAST VS UNICAST

The Junos® operating system (Junos OS) routing protocol process supports a wide variety of routing protocols. These routing protocols carry network information among routing devices not only for *unicast* traffic streams sent between one pair of clients and servers, but also for *multicast* traffic [6, 7] streams containing video, audio, or both, between a single server source and many client receivers. The routing protocols used for multicast differ in many key ways from unicast routing protocols.

Information is delivered over a network by three basic methods: unicast, broadcast, and multicast.

With unicast traffic [4], many streams of IP packets that travel across networks flow from a single source, such as a website server, to a single destination such as a client PC. Unicast traffic is still the most common form of information transfer on networks.

Broadcast traffic flows from a single source to all possible destinations reachable on the network, which is usually a LAN. Broadcasting is the easiest way to make sure traffic reaches its destinations.

Television networks use broadcasting to distribute video and audio. Even if the television network is a cable television (CATV) [16] system, the source signal reaches all possible destinations, which is the main reason that some channels' content is scrambled. Broadcasting is not feasible on the Internet because of the enormous amount of unnecessary information that would constantly arrive at each end user's device, the complexities and impact of scrambling, and related privacy issues.

Multicast traffic lies between the extremes of unicast (one source, one destination) and broadcast (one source, all destinations). Multicast is a "one source, many destinations" method of traffic distribution, meaning only the destinations that explicitly indicate their need to receive the information from a particular source receive the traffic stream.

On an IP network [12], because destinations (clients) do not often communicate directly with sources (servers), the routing devices between source and destination must be able to determine the topology of the network from the unicast or multicast perspective to avoid routing traffic haphazardly. Multicast routing devices replicate packets received on one input interface and send the copies out on multiple output interfaces.

In IP multicast, the source and destination are almost always hosts and not routing devices. Multicast routing devices distribute the multicast traffic across the network from source to destinations. The multicast routing device must find multicast sources on the network, send out copies of packets on several interfaces, prevent routing loops, connect interested destinations with the proper source, and keep the flow of unwanted packets to a minimum. Standard multicast routing protocols provide most of these capabilities, but some router architectures cannot send multiple copies of packets and so do not support multicasting directly.

4. IP MULTICAST USES

Multicast allows an IP network [5, 6] to support more than just the unicast model of data delivery that prevailed in the early stages of the Internet. Multicast, originally defined as a host extension in RFC 1112 in 1989, provides an efficient method for delivering traffic flows that can be characterized as one-to-many or many-to-many.

Unicast traffic is not strictly limited to data applications. Telephone conversations, wireless or not, contain digital audio samples and might contain digital photographs or even video and still flow from a single source to a single destination. In the same way, multicast traffic is not strictly limited to multimedia applications. In some data applications, the flow of traffic is from a single source to many destinations that require the packets, as in a news or stock ticker service delivered to many PCs. For this reason, the term *receiver* is preferred to *listener* for multicast destinations, although both terms are common.

Network applications that can function with unicast but are better suited for multicast include collaborative groupware, teleconferencing, periodic or "push" data delivery (stock quotes, sports scores, magazines, newspapers, and advertisements), server or website replication, and distributed interactive simulation (DIS) such as war simulations or virtual reality. Any IP network concerned with reducing network resource overhead for one-to-many or many-to-many data or multimedia applications with multiple receivers benefits from multicast.

If unicast were employed by radio or news ticker services, each radio or PC would have to have a separate traffic session for each listener or viewer at a PC (this is actually the method for some Web-based services). The processing load and bandwidth consumed by the server would increase linearly as more people "tune in" to the server. This is extremely inefficient when dealing with the global scale of the Internet. Unicast places the burden of packet duplication on the server and consumes more and more backbone bandwidth as the number of users grows.

If broadcast were employed instead, the source could generate a single IP packet stream using a broadcast destination address. Although broadcast eliminates the server packet duplication issue, this is not a good solution for IP because IP broadcasts can be sent only to a single subnetwork, and IP routing [7] devices normally isolate IP subnetworks on separate interfaces. Even if an IP packet stream could be addressed to literally go everywhere, and there were no need to "tune" to any source at all, broadcast would be extremely inefficient because of the bandwidth strain and need for uninterested hosts to discard large numbers of packets. Broadcast places the burden of packet rejection on each host and consumes the maximum amount of backbone bandwidth.

For radio station or news ticker traffic, multicast provides the most efficient and effective outcome, with none of the drawbacks and all of the advantages of the other methods. A single source of multicast packets finds its way to every *interested* receiver. As with broadcast, the transmitting host generates only single stream of IP packets, so the load remains constant whether there is one receiver or one million. The network routing devices replicate the packets and deliver the packets to the proper receivers, but only the replication role is a new one for routing devices. The links leading to subnets consisting of entirely uninterested receivers carry no multicast traffic. Multicast minimizes the burden placed on sender, network, and receiver.

5. MULTICAST APPLICATIONS

Most people dealing with multicast, sooner or later decide to connect to the MBone, and then they usually need an mrouted. You'll also need it if you don't have a multicast-capable router and you want multicast traffic generated in one of your subnets to be "heard" on another. Mrouted does circumvents the problem of sending multicast traffic across unicast routers it encapsulates multicast datagrams into unicast ones (IP into IP) [10] but this is not the only feature it provides. Most important, it instructs the kernel on how to route (or not-to-route) multicast datagrams based on their source and destination. So, even having a multicast capable router, mrouted can be used to tell it *what* to do with the datagrams (note I said *what*, and not *how*; mrouted says "forward this to the network connected to that interface", but actual forwarding is performed by the kernel). This distinction between actual-forwarding and the algorithm that decides who and how to forward is very useful as it allows writing forwarding code only once and place it into the kernel [15, 16]. Forwarding algorithms and policies are then implemented in user space daemons, so it is very easy to change from one policy to another without the need of kernel recompilation.

Audio Conferencing

Video Conferencing

6. CONCLUSION

This paper shows that there are various routing protocols available for multicasting. Our main focus of study is centralized, dense and sparse mode of multicasting. In our future work we can implement these routing protocols and we can evaluate the performance of these routing protocols over delay, throughput and packet delivery ratio.

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