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Comparison Analysis of Secure Multicasting Routing Protocols in Mobile Adhoc Networks

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ABSTRACT

Mobile Ad-Hoc Network (MANET) is a dynamic, multi-hop and autonomous network composed of light wireless mobile nodes. Multicast has great importance in MANET due to their inherent broadcast capability. However, due to the dynamic topology of MANETs to build optimal multicast trees and maintaining group membership a lot many control messages required. These overhead consume the mobile node resources like power and network resources like wireless links bandwidth that creates hurdle in implementing energy assurance and reduced overhead multicast protocol for Mobile Ad hoc Networks (MANET).This multicasting technique is intended to give energy and bandwidth efficiency with secure content delivery. The review paper concentrates on describing such an efficient and secure multicasting routing protocols in mobile adhoc networks. On the basis of comparison of multicasting protocols, Protocol for Unified Multicasting through Announcement (PUMA) has been showing strength compare to other protocols. PUMA does not rely on any unicast routing approach. It shows data at a higher efficiency, while also provides a tight bound for control overhead in a wide range of network scenarios. But the security aspect is not taken care in the said protocol.

Keywords:— *Ad hoc Network, Multicasting, Security, Key Management*

I. INTRODUCTION

A multicast routing protocol is one type of service provider that functions as a client within the framework of the router architecture. The routing architecture is designed to be extended by such router client modules. A multicast routing protocol manages group membership and controls the path that multicast data takes over the network. Examples of multicast routing protocols include: Protocol Independent Multicast (PIM), Multicast Open Shortest Path First (MOSPF), and Distance Vector Multicast Routing Protocol (DVMRP). The Internet Group Management Protocol (IGMP) is a special multicast routing protocol that acts as an intermediary between hosts and routers[1].

A. Distance Vector Multicast Routing Protocol (DVMRP):

DVMRP was the first multicast routing protocol developed for the Internet. DVMRP can operate in an environment where some, but not all routers in the network are capable of multicast forwarding and routing. This is achieved by having DVMRP run a separate unicast routing algorithm, similar to RIP, to determine the shortest-paths between all multicast-capable routers. DVMRP uses flood-andprune to set up source-based trees. DVMRP messages are encapsulated in IGMP messages, where the type field is set to 3.

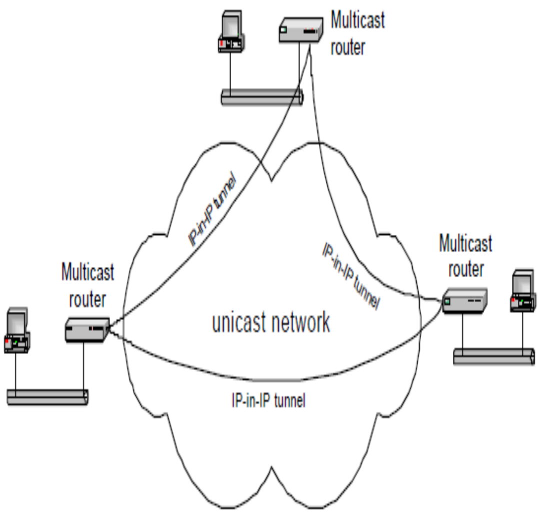

Figure 1: IP Multicast Routing

DVMRP played an important role in the early deployment of IP multicast. IP multicast deployment in the Internet began in the early 1990s with the creation of the Multicast Backbone (MBONE). The multicast routing algorithm in the MBONE is DVMRP. The MBONE solved the problem of wide-area IP multicast routing on the Internet where only few routers were capable of IP multicast routing, by setting up a virtual network of multicast routers that are connected by unicast path. These multicast routers exchanged multicast IP datagram that were encapsulated in IP unicast datagrams, using the IP-in-IP option in the IP header, as shown in figure 1.1. As a result of the encapsulation, the MBONE is a virtual network, where each link between two multicast routers consists of a complete unicast path[2]. As more and more routers provide native support for IP multicast, meaning that they are capable of forwarding IP multicast traffic and running a multicast routing protocol, the need for a virtual multicast network has all but disappeared.

B. Multicast Open Shortest Path First (MOSPF):

MOSPF consists of multicast extensions to the unicast routing protocol OSPF, and requires that OSPF is used for unicast routing. In MOSPF, multicast routers broadcast link state advertisements (LSAs) to all other multicast routers. Then, as in unicast OSPF, each multicast router calculates routes independently. MOSPF computes shortest-path trees for each sender in the multicast group. A router computes a shortest-path tree for a source only if there is traffic from that sender.

C. Core Based Tree (CBT):

CBT was the first routing protocol for the Internet that took a core based tree approach. CBT builds a shared tree using reverse-path forwarding, without making assumptions on the unicast routing protocol used. The core of a group is either statically configured, or determined as the outcome of a selection process from a candidate set. Different multicast groups may use different core-bases trees. Distribution trees in CBT are bidirectional that is, routers are capable of forwarding multicast packets downstream away from the core as well as upstream towards the core.

D. Protocol Independent Multicast (PIM):

Protocol independent multicast consists of two multicast routing protocols: PIM Dense Mode (PIM-DM) and PIM Sparse Mode (PIM-SM). PIM-DM builds source-based trees using flood-and-prune, and is intended for large multicast groups where most networks have a group member. PIM-SM builds core-based trees as well as source-based trees with explicit joins. PIM-DM and PIM-SM, respectively, are in several aspects similar to DVMRP and CBT. Just like CBT, PIM can operate on top of any unicast routing protocol, hence the name protocol independent multicast[3]. A consequence of this is that PIM must assume that all routers in the network are multicast enabled. An important difference between the core-based trees of PIM and CBT is that the trees in PIM are unidirectional, that is, sources always forward packets to the core, and the core transmits packets downstream the core based tree.

II. Related Work

In the following subsections I am going to explain multicasting protocols in Ad- hoc network and then comparison between them.

A. ODMRP:

ODMRP is On-Demand and mesh based protocol that sends data packets from source to destination with creating mesh. One of the important metrics in QOS of forwarding packets is Packet Delivery Ratio (PDR). PDR may be affected by mobility, Group Size, Packet Size and action range. Since ODMRP use single route for forwarding packets, if this route fails the packet is lost and cause to PDR reduction in destination[4].

ODMRP is based on mesh (instead of tree) forwarding. It applies on demand (as opposed to periodic) multicast route construction and membership maintenance. Simulation results show that ODMRP is effective and efficient in dynamic environments and scales well to a large number of multicast members.

The advantages of ODMRP are:

- Low channel and storage overhead
- Usage of up-to-date and shortest routes
- Robustness to host mobility
- Maintenance and exploitation of multiple redundant paths
- Scalability to a large number of nodes

ODMRP applies on-demand routing techniques to avoid channel overhead and improve scalability. It uses the concept of forwarding group (a set of nodes responsible for forwarding multicast data on shortest paths between any member pairs) to build a forwarding mesh for each multicast group. It works on mesh network instead of tree structure network.

B. MAODV:

MAODV (Multicast Ad hoc On-Demand Distance Vector) builds a group tree, shared by all sources and receivers for a group. It uses a hard state maintenance approach. The group tree enables it to localize group joins and connection of newly active sources to the multicast tree, as well as, repairs when the tree becomes disconnected. The use of a shared tree and the localized connection and reconnection to the tree result in longer forwarding paths for data packets. Such paths have a higher likelihood of packet loss due to collisions, and higher end-to-end delay; they are also more likely to break which also leads to packet loss and a more frequent invocation of the route repair mechanisms within the protocol. MAODV requires the use of periodic neighbor detection packets for detection of broken links, and periodic group leader control packet floods for disseminating a multicast group’s sequence number. MAODV creates a shared tree between the multicast sources and receivers for a multicast group. The root of each group tree is a multicast source or receiver for the group that has been designated as a group leader. Each data packet is forwarded to all nodes on this list except the node from which it was received. The packet is forwarded as either a unicast to each such neighbor, or as a broadcast, when it needs to be forwarded on to multiple nodes[5]. The advantage of MAODV is that routes are established on demand and destination sequence numbers are used to find the latest route to the destination. MAODV's main disadvantage is that it suffers from high End-to-End Delay since packets must travel longer paths within the shared tree. Also because of the higher network load caused by the large number of control and data transmissions, congestion may increase.

C. CAMP:

Core Assisted Mesh Protocol (CAMP) [33] is a mesh-based multicast routing protocol which uses one or more core nodes to create and maintain multicast mesh. Inspired from the basic architecture used in IP multicast, CAMP uses predefined core nodes which are known to all the nodes in the wireless network. However, these core nodes can leave the group if no node is con-nected to them. It assumes the existence of underlying unicast routing protocol which provides routing information to the mesh nodes. CAMP imposes a restriction on underlying unicast routing protocol such that it must provide correct distance from the known destination in finite amount of time. In the process of mesh creation CAMP ensures that the shortest distance to reach any particular node is included in the multicast mesh. Mesh creation process in CAMP consists of request and reply messages just like ODMRP. Cores are used to limit the control traffic overhead required for receivers to become member of multicast group, however nodes can still join the group even if all the cores becomes unavailable. To ensure that shortest path between each source and receiver is included in the multicast mesh, every entry in the packet forwarding cache is verified periodically. If number of packets coming from a reverse path falls below a certain threshold, a push join or "heart beat" message is sent to all the sources for which this reverse path is being used, thus ensuring that shortest path is always included in the multicast mesh.

D. AMRIS:

AMRIS (Ad hoc Multicast Routing protocol) establishes a shared tree for multicast data forwarding. AMRIS does not require a separate unicast routing protocol. Each node in the network is assigned a multicast session ID number. The ranking order of ID numbers is used to direct the flow of multicast data. The main difference between AMRIS and other multicast routing protocols is that each participant in the multicast session must have a session specific multicast session member id (msm-id). This msm-id provides each node with an indication of its "logical height" in the multicast delivery tree. The drawbacks of AMRIS are that each node must send a periodic beacon to signal their presence to neighboring nodes and that it is very sensitive to mobility and traffic load [6]. The primary reasons for its poor performance are the number of necessary retransmissions and the size of beacons, both of which create overhead and can cause increased congestion.

F. PUMA:

The Protocol for Unified Multicasting Through Announcements (PUMA) is a distributed, receiver initiated, mesh based multicast routing protocol. By default, the first receiver in a multicast group acts as the core (i.e., rendezvous point) for that particular group. PUMA uses a simple and very efficient control message, a multicast announcement, to maintain the mesh. Besides that, multiple meshes can be compiled into a single announcement bucket. PUMA does not require any unicast protocol, and all transmissions are broadcasts. Even though broadcast transmissions are unreliable, the mesh itself introduces some redundancy, and because

Table 1. Comparison of Multicasting Protocols

	ODMRP	**MAODV**	**CAMP**	**AMRIS**	**PUMA**
N/w topology	Mesh	Tree	Mesh	Tree	Mesh
Initialization approach by	Source	Source	Source & Receiver	Source	Receiver
Maintenance approach	Soft State	Hard State	Hard State	Soft State	Soft state
Dependency	No	Yes	Yes	No	No
Loop free	Yes	Yes	Yes	Yes	Yes
Flooding of control packet	Yes	Yes	No	No	No
Independent routing protocol	Yes	Yes	No	No	Yes
Periodic control message	Yes	Yes	No	Yes	Yes
Advantage	Packet delivery ratio is better due to route redundancy	Avoids sending duplicate packets to receivers Routes are on demand	Better Bandwidth allocation. Good scalability because due to no flooding	No loops. Link breaks are locally repaired. simplicity	High data delivery ratio. limited control overhead
Disadvantage	Create congestion due to high processing load	High end to end delay. High network load due to larger data & control transmission	Network convergence and control traffic growth in the presence of mobility	Waste of bandwidth. Slow rejoin scheme. increased average hop distance	No acknowledgement. no delivery validation

the mesh includes only group members and the nodes interconnecting them, broadcasts remain scoped within the mesh[7]. As a multicast announcement propagates throughout the mesh, nodes learn the shortest path to the core. This way, data packets can be quickly routed to the core. On its way toward the core, two things can happen to a data packet: (a) the packet goes all the way until it reaches the core, or (b) a mesh member is hit before reaching the core.

III. Comparison of Multicasting Protocols:

Multicast announcements are used to elect cores dynamically, determine the routes for sources outside a multicast group to unicast multicast data packets towards the group, join and leave the mesh of a group, and maintain the mesh of the group. PUMA protocol is advantageous due to its high packet delivery ratio and limited congestion. The comparison of multicasting protocols is shown in table 1. PUMA provides the lowest and a very tight bound for the control overhead compared to ODMRP and MAODV. In other words, the control overhead of PUMA is almost constant node when mobility, number of senders, multicast group size or traffic load is changed. It also provides the highest packet delivery ratio for all scenarios. The mesh constructed by PUMA provides redundancy to the region containing receivers, thus reducing unnecessary transmissions of multicast data packets[8].

IV. CONCLUSION

This paper presents a comparison of multicasting protocols designed for ad hoc network. The comparison will helps in choosing a PUMA protocol for multicast ad hoc network. PUMA incurs far less overhead as compare to tree based multicast protocols and has higher delivery ratios because tree based protocols have to maintain tree structure so they expend too many packets which leads to congestion. Secure communication is a major concern in multicast ad hoc networks, especially because multicasting protocols are applied in many emerging applications. One of the major problems in multicast ad hoc networks is how to manage the cryptographic keys that are needed. A proper key management scheme is thus a critical factor for success of multicast ad hoc network which is extension of this paper.

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