

LANMAR + OLSR: A Scalable, Group Oriented Extension of OLSR

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Abstract

Group mobility has become more evidently a phenomenon that will occur to MANET applications. This paper presents an extension to one of the current MANET WG standards, namely, OLSR for such scenarios. The extension LANMAR+OLSR seeks to provide OLSR the functionality of Landmark Routing, a scalable routing protocol designed for large-scale MANETs exhibiting group mobility. This paper describes the implementation for the integration, which is expected to explore advantages from both protocols. Testbed verification of the implementation is reported with future work to follow.

1 Introduction

The Optimized Link State Routing Protocol (OLSR) [5] is a link state routing protocol with optimizations for MANETs. The protocol uses multi-point relays (MPRs) to reduce the number of "superfluous" broadcast packet retransmissions and also to reduce the size of the LS update packets. In the foreseen applications of MANETs deployed for disaster recovery, modern battlefields, homeland security, etc., group motion behaviors have become more and more evidently a phenomenon to occur. In the attempt to enable OLSR to exploit the group motion feature to achieve additional functionality and scalability, we presented here our work of integrating OLSR with LANMAR.

The Landmark Ad-hoc Routing Protocol (LANMAR) [1,2], developed at UCLA Wireless Adaptive Mobility Lab[6], is designed for scalable routing in large-scale ad hoc networks that exhibit group mobility. Theoretical analysis and simulations have been conducted and the protocol design has been evaluated in a variety of simulated scenarios. For example, simulation results illustrated that for a scenario with 400 nodes, LANMAR (with FSR) achieved 88% packet delivery ratio while FSR itself only delivered 50% [2]. In particular, LANMAR with OLSR has shown great reduction in message propagated at 400 nodes and thus improvement in packet delivery ratio [2].

In all, it will be of great advantages to have the two protocols working together towards scalability of group oriented MANETs. In this paper, we present our implementation work on the new extension of OLSR, namely, LANMAR+OLSR. The rest of the paper is organized as follows. Section 2 gives an overview of LANMAR protocol. Section 3 describes the details of the implementation of LANMAR+OLSR. Testbed validation of the implementation is reported in Section 4. And we conclude the paper in Section 5.

2 LANMAR Overview

LANMAR is well suited to network scenarios where a set of nodes move as a "logical group". The logical groups are taken as different subnets in LANMAR routing. Each logical group dynamically elects a node as a landmark node which is used to keep track of the group. The protocol consists of two complementary and cooperating routing schemes: (a) a local, "myopic" proactive routing scheme that operates within a limited scope centered at each node and exchanges route information about nodes up to only a few hops; and (b) a "long haul" distance vector routing scheme (referred as LMDV) that propagates the elected landmark of each subnet and the path to it into the whole network. A packet to a destination outside its local scope will be routed towards the landmark node corresponding to the destination's group. Routing to all nodes within its local scope can use any of the proactive approaches such as FSR[3], OLSR[4], and RIP [5]. As a result,

each node keeps two routing tables: local routing table and landmark table which maintain direct routes to near-by destinations and routes to all the landmarks from all the subnets, respectively.

3 LANMAR+OLSR Implementation

The implementation of LANMAR+OLSR is realized as a daemon in user space to minimize changes to the kernel. The implementation tries to keep the OLSR and LANMAR distance vector part (LMDV) independent while still allows them to communicate the necessary information. For example, LMDV needs information about group members within the local scope for landmark election while this information is kept at OLSR's routing table. The design principle leads to our current implementation of LANMAR+OLSR. Its features are described below.

- The LANMAR+OLSR daemon is in a multithreaded style. It has 3 threads for (1) sending OLSR packets, where only routes to nodes within a scope up to N (configurable) hop distances are maintained; (2) for sending LMDV packets, where paths to all landmark nodes over the entire network are maintained; and (3) for receiving all the routing packets. Actual routing and forwarding are performed at kernel level to reduced the time and process overhead.
- LANMAR routing protocol uses a two-tier address scheme <SubnetID, HostID>, where the "SubnetID" represents the logical group membership. A landmark hierarchy matches perfectly to the IP subnet hierarchy. Thus in our implementation, when a landmark entry, that serves as a routing direction towards a subnet, needs to be written into the kernel table, only the subnet address of the landmark node and the next hop node are transferred, along with the corresponding net mask, creating an entry of a subnet in the kernel table.
- The kernel routing table */proc/net/route* also provides a connection among the routing components. The three threads read and write the kernel routing table separately when they need to update the routing entries for either local or landmark nodes (from corresponding thread and protocols). Particularly, the landmark election calculates election weight, i.e., the number of members in its local scope, directly based on knowledge learned from the kernel routing table, thus avoiding node information exchange between the two protocols. To avoid race condition on the kernel routing table, the coordination of the different threads uses a semaphore mechanism.
- The implementation of LANMAR requires subnets for different groups. In order to avoid blindly broadcasting to all the MANET nodes, we choose to use multicast for the LANMAR+OLSR. All the routing packets are then addressed to the same multicast group. Original OLSR implementation was then modified for this purpose, instead of only broadcasting "HELLO Packets" to a node's own subnet for neighbor discovery. That way, as long as a node has correctly joined the predetermined multicast group, it will receive OLSR information regardless of what subnet its IP address is in.
- Two ports are used for the two routing components respectively, naming, OLSR and LMDV. Each of them sends or receives their own control packets from its designated port. The implemented LANMAR+OLSR thus executes as if running OLSR executable first and then running LANMAR executable next. However, this approach has enabled us to do minimal modification and to have the two protocols running independently in one daemon.

4 Experiments

Experiments of LANMAR+OLSR are current at the testing stage, larger scale experiments are expected to come in the future. The reported experiment scenario consists of four laptops positioned in a straight line as shown in Figure 1 to achieve a multi-hop scenario. Among them, ONR1 and ONR3 are on the same subnet while ONR9 and ONR11 are using a different subnet. The lines represent a node's ability to communicate with neighbor nodes. In this situation, a packet transmitted from an end node (e.g., ONR3) to the node at the other end (e.g., ONR11) will have to travel through the two intermediate nodes. The IP addresses used are listed below. The laptops are equipped with WaveLan 802.11b wireless cards running the 2.4 version of the Linux kernel.

ONR3 (131.179.33.3)
 ONR1 (131.179.33.1)
 ONR9 (131.179.32.9)
 ONR11 (131.179.32.11)

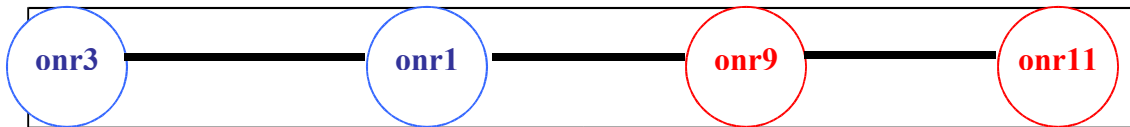


Figure 1 Testbed layout

We've tested this scenario with variations in which all the laptops were in the same subnet, and also in which the four laptops will share among 3 different subnets. We also tested the later scenario with the laptops in motion. The experimenters, holding the laptops and walking around Boelter Hall, stood still about 5-10 seconds to wait for the link to stabilize before taking the results. Then they switched positions or walked elsewhere for another testing. We were able to observe changes of neighboring nodes and the changes of landmark nodes through dumped LMDV tables and changed routing tables. By constantly checking the routing table of each laptop and using "ping" to see if we are out of range, we were able to tell if routes for all the nodes are correct. An example of routing tables corresponding to the Figure 1 layout is reported below.

Onr3 routing table (131.179.33.3)

Destination	Gateway	Netmask	Metric / Hop count
Onr1	Onr1	255.255.255.255	1
Onr9	Onr1	255.255.255.254	2
Onr11	Onr1	255.255.255.253	3
131.179.33.0	Onr1	255.255.255.0	1
131.179.32.0	Onr9	255.255.255.0	2
127.0.0.0	*	255.0.0.0	0
Default	Onr3	0.0.0.0	1

Onr1 routing table (131.179.33.1)

Destination	Gateway	Netmask	Metric / Hop count
Onr3	Onr3	255.255.255.255	1
Onr9	Onr9	255.255.255.255	1
Onr11	Onr9	255.255.255.254	2
131.179.33.0	Onr1	255.255.255.0	1
131.179.32.0	Onr9	255.255.255.0	1
127.0.0.0	*	255.0.0.0	0
Default	Onr9	0.0.0.0	1

Onr9 routing table (131.179.32.9)

Destination	Gateway	Netmask	Metric / Hop count
Onr1	Onr1	255.255.255.255	1
Onr3	Onr1	255.255.255.254	2
Onr11	Onr11	255.255.255.255	1
131.179.33.0	Onr1	255.255.255.0	1
131.179.32.0	Onr9	255.255.255.0	0
127.0.0.0	*	255.0.0.0	0
Default	Onr3	0.0.0.0	1

Onr11 routing table (131.179.32.11)

Destination	Gateway	Netmask	Metric / Hop count
Onr1	Onr9	255.255.255.254	2
Onr3	Onr9	255.255.255.253	3
Onr9	Onr9	255.255.255.255	1
131.179.33.0	Onr1	255.255.255.0	2
131.179.32.0	Onr9	255.255.255.0	0
127.0.0.0	*	255.0.0.0	0
Default	Onr3	0.0.0.0	1

5 Conclusions and Future work

This paper describes the implementation for an extension to OLSR for group oriented MANET scenarios. Our approach is to integrate LANMAR routing with OLSR. LANMAR has shown great potentials for scalable routing in the targeted MANET scenarios. The integration enables us to explore advantages from both protocols and to extend the functionality of OLSR to work in the targeted scenarios. Testbed verification of the implementation is reported. Larger scale testbed experiments are our immediate plan for future work, and validation of the experiments results with simulation results will also be conducted/

References

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