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Analysis of OLSR Mesh Networks and Autonomous Deployment of Mesh Network Nodes

I. Introduction

With the growth of mobile devices, wireless communication became critical in computer networking. Interference between mobile devices and lost connections are among the common difficulties that arise with the creation and maintenance of wireless mesh networks [1]. Ad-hoc networks require strategies to maintain a minimum quality of service (QoS) for connected and mobile devices on these networks [2]. Considerations for optimizing decentralized networks are based on power consumption and throughput or delay between various devices on the network [3, 4]. Protocols and routing algorithms become extremely important in determining the best strategies to maintain QoS [2, 5]. I seek to design a deployment strategy for mobile devices operating as part of a mobile wireless mesh network based on QoS constraints.

The goal is to develop a deployment strategy for OLSR mesh network nodes using mobile ground robots. The robots will be tasked with maintaining QoS over a given coverage area, designated by a map input to the mission control center.

Optimized Link State Routing (OLSR) is a protocol for mesh networks that automatically updates the network topology and disseminates information to all nodes running OLSR. OLSR is an optimal protocol choice for mobile ad-hoc networks because of the adaptability of OLSR. As a proactive link-state routing protocol, OLSR has the potential for quickly and effectively updating network information when the corresponding nodes are mobile.

II. Methodology

Static Experiment

I analyzed the OLSR protocol using Raspberry Pi 2 Model B computers attached to Pioneer 3-DX robots along a path through the University Engineering Building. Analysis of OLSR was undertaken through the development of a testbed with 5 OLSR nodes. Each node was a Raspberry Pi 2 Model B powered by a 12-volt battery with a 5-volt converter. The Pioneer robots were controlled using a Logitech F710 gamepad.

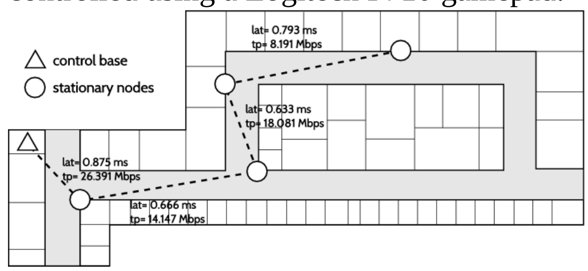

Figure 1. Static mesh network node locations with average latency and average throughput between links.

A linear static network (Fig. 1) was determined by placing nodes in various locations on the second floor of the building and measuring the network QoS parameters jitter, latency, throughput, and packet delivery ratio (PDR). The experiment ran for 10 minutes, and average values for the network qualities were determined.

Mobile Experiment

Following the static network setup, a network with 4 nodes (including the control center) was created, with a 5th node placed on a Pioneer 3-DX robot. The placement of 4 static nodes was determined by testing throughput and latency to the experiment control base.

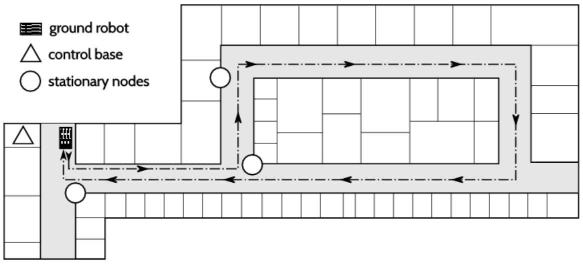

Figure 2. Robot path during mobile experiment. The mobile node is shown as the ground robot.

The 5th node traversed a path (Fig. 2) past the static nodes, guided by the joystick controller. Four separate experiments were run for the mobile experiment to determine throughput, retransmissions, jitter, and PDR as the robot moved along the path of the mobile node.

III. Results

The static network analysis demonstrated that OLSR automatically redesigns the network topology based on link quality. OLSR routes information on the network adaptively using the best link quality among its neighbor nodes.

During the mobile robot experiment, connection between the mobile node and the 4th OLSR node was lost at the furthest point from the control base. The connection loss is noted in the 5 graphs over time (Fig. 3). As demonstrated by the hop count vs. time graph (Fig. 3e), connection loss is seen by 5 hops (5 hops is considered infinite under the experiment topology). The throughput (Fig. 3a) and delay (Fig. 3b) graphs show that network QoS significantly decreases as the hop count increases. The jitter (Fig. 3c) and delay (Fig. 3b) graphs show a smaller increase and decrease respectively as hop count increases. The 5 graphs display the connection loss (with low throughput and PDR, and high delay, jitter, and hop count) and a regained connection to the 3rd node with

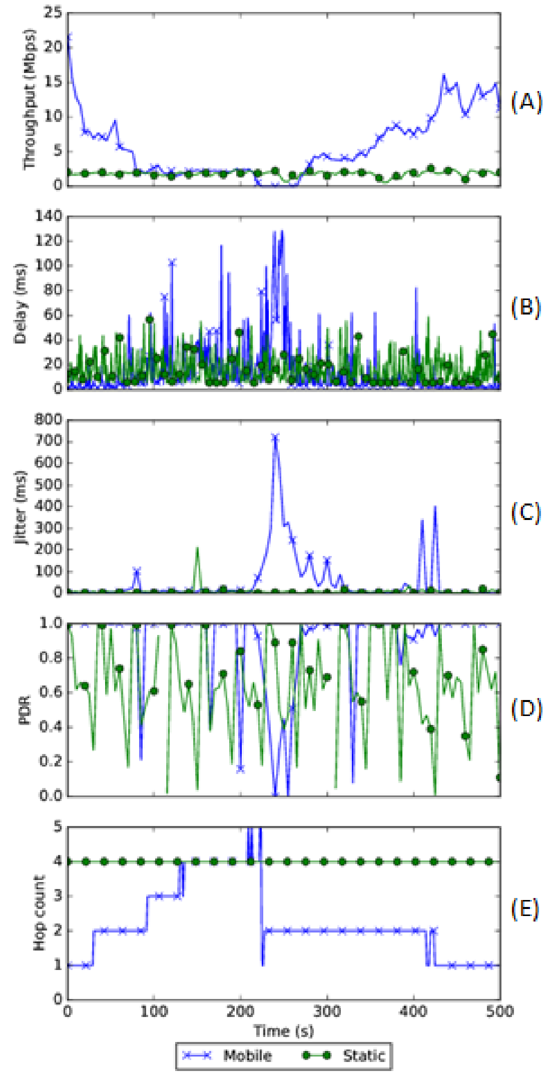

Figure 3. QoS parameters over time during the mobile experiment. The mobile node is disconnected from the network near the 210 second mark and the connection is regained near the 230 second mark.

an updated topology; however, the graphs oscillate due to the environment and other unknown variables.

IV. Conclusion/Future Work

The properties of OLSR in mesh network maintenance make OLSR an ideal candidate for testing and optimizing connections in a mobile network. Since OLSR automatically redesigns the network topology based on network parameters, a network's QoS can be maintained by monitoring and adapting to OLSR's link quality oscillations.

My future work will use OLSR and its link quality characteristic as a tool to optimize the deployment of OSLR nodes to support a requested wireless coverage area or to explore a geographic space while maintaining a network with sufficient QoS. I will use a static command center node and 4 mobile robots running OLSR to capture video as the nodes explore and maintain the network at the greatest distance from the command center. The robots will use sonar and a wall-following strategy to avoid obstacles. The challenges I currently face arise from stacking ROS, Linux, and the OLSR daemon (olsrd) for use on a single Pi. The software components have misaligned compatibility and require significant changes to settings to function properly.

The network will be maintained by moving closer to or farther away from the control center depending on the OLSR link quality metric. The program running the robots will autonomously move to optimize network QoS.

The network optimization algorithm, robotic deployment experiment, and proof of concept QoS will be packaged as a publication to be submitted to MobiCom '17 or MobiHoc '17.

V. Applications

Mobile mesh networks are useful for application in many fields, most notably in search-and-rescue operations, exploration, and connected network maintenance on highly mobile devices [6]. OLSR and the deployment strategy I design has specific applications in establishing a network without existing infrastructure or in maintaining QoS for mobile nodes. The maintenance of the network after deployment can serve as a dynamic solution to provide QoS for vehicular ad-hoc networks applications such as connected cars or drones while transmitting data.

VI. References

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