OrderOne Networks
GTNetS OSPFv3-MANET Comparison

Summary

This paper compares the OrderOne Networks routing protocol against the version of OSPFv3 with MANET extensions (referred to as OSPF) currently being evaluated by the IETF.

The OrderOne Networks protocol substantially outperforms OSPF in both packet delivery ratio and control bandwidth usage.

In many cases the OrderOne Networks protocol delivered 20% - 50% more packets while generally consuming 2x - 5x less control bandwidth than the best OSPF variant.

The OrderOne Networks protocol needed less than 0.46Kbps of control bandwidth to have a similar or slightly better performance than OSPF across all test scenarios. This was generally 8x - 20x less bandwidth than was required by the best OSPF variant.

Regardless of the scenario, the control bandwidth for the OrderOne Networks protocol was limited to either 1.9Kbps or 0.46Kbps. By comparison, OSPF experienced considerable control bandwidth growth as the scenarios became more complex.

Finally, the best OSPF variant considerably reduces the topology of the network. The OrderOne Networks protocol does not need to artificially reduce the topology of the network. This allows a more robust network that is able to respond to disruption more easily.

Test Details

The OrderOne Networks protocol was integrated into the Boeing GTNetS Milcom 2006 snapshot (http://hipserver.mct.phantomworks.org/ietf/ospf/). Every effort was made to make this comparison as direct as possible.

The network and node parameters were selected to be similar to those network scenarios analyzed by the IETF:

Description	Value
Grid Length	500 m^2
Radio Range	R=40,80,..,240
Nodes	N=20,30,40,50,60
Velocity	Uniform (0,30 m/s)
Pause Time	0

There were three different OSPF variants tested: MDR.full.full, MDR.uni.minhop and OR.full.full. Both the .full.full variants experienced extremely high bandwidth growth and were only tested to 30 nodes. The OSPF configuration parameters were the default provided in 'BaseLine/comp_mdr_or-sp.pl'. They were:

Description	Value
Hello Interval	2 secs
Dead Interval	6 secs
Rxmt Interval	7 secs
MinLS Interval	5 secs
MinLS Arrival	1 sec
PushBack Interval	3.5 secs
Ack Interval	0.5 secs
Backup Wait Interval	0.5 secs
Two Hop Refresh	3 secs
Adj Connectivity	1
LSA Fullness	1

The OrderOne Networks protocol was implemented as a pure layer 3 protocol. The OrderOne Networks protocol was designed to use a fixed control packet rate with each control packet not to exceed a specified size.

The parameters for the higher bandwidth configuration:

Description	Value
Packet Interval	0.5 secs
Max Packet Size	100 bytes
Keep Alive Count	3

The higher bandwidth configuration is guaranteed never

to exceed 1.92 Kbps of control bandwidth (this includes the 20 bytes of IP header attached to each packet).

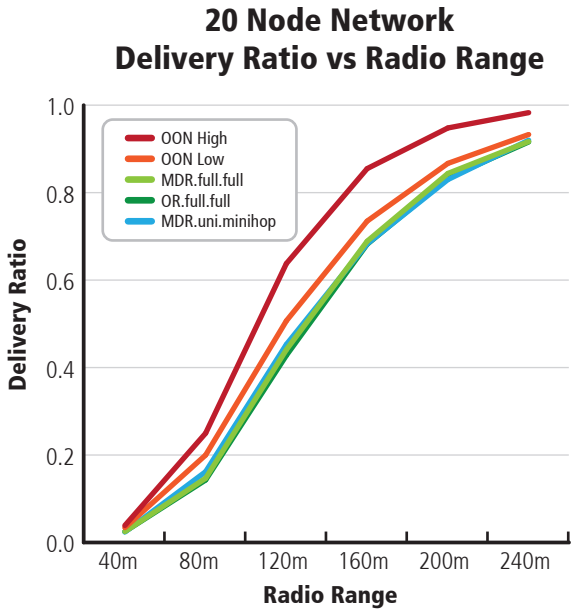
The low bandwidth parameters were selected so that the packet delivery ratio of the OrderOne Networks protocol was either similar or exceeded the best performing variant of the OSPF protocol:

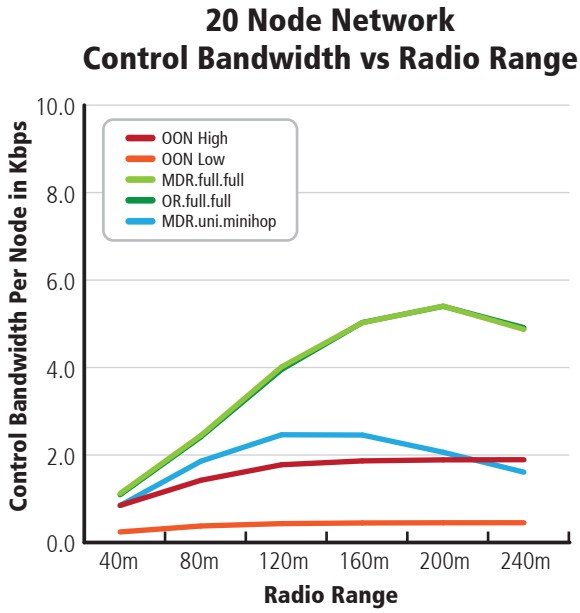
Description	Value
Packet Interval	1.9 secs
Max Packet Size	90 bytes
Keep Alive Count	3

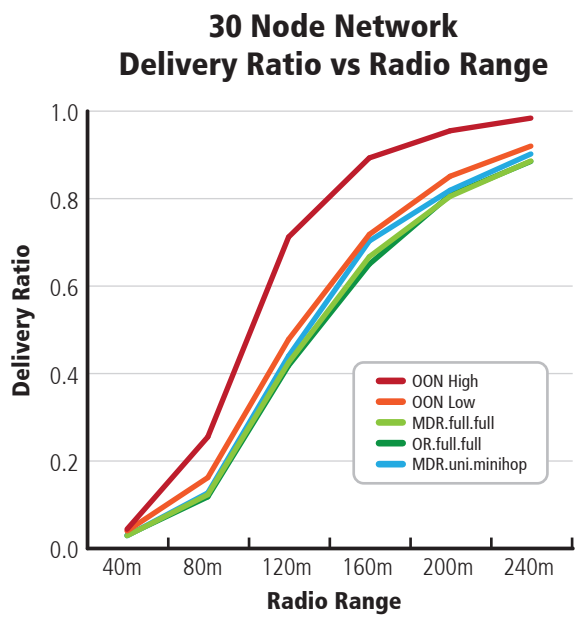
The low bandwidth configuration guarantees that the OrderOne Networks protocol will not exceed 0.463Kbps of control bandwidth per node.

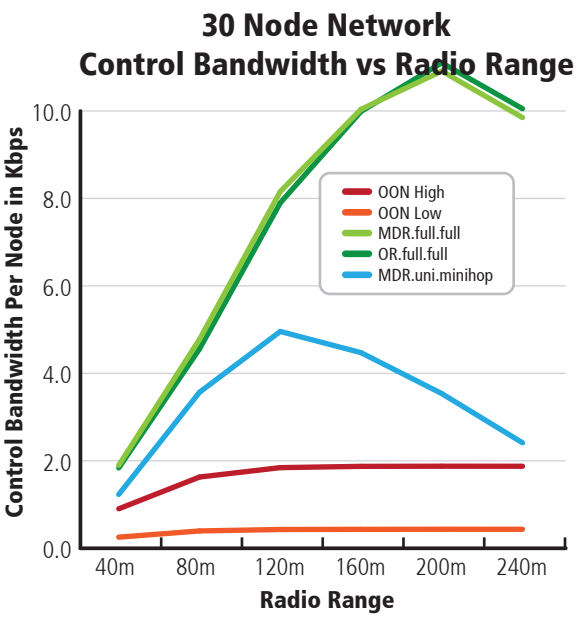
The control bandwidth for the OrderOne Networks protocol never exceeded these specified levels. The control bandwidth required by OSPF jumps considerably as the scenario complexity increases.

The following charts illustrate the delivery ratio and control bandwidth overhead. Control bandwidth reflects the average control bandwidth per node.

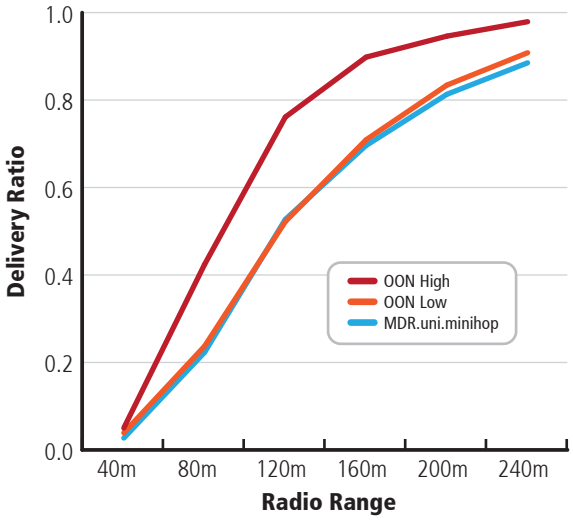




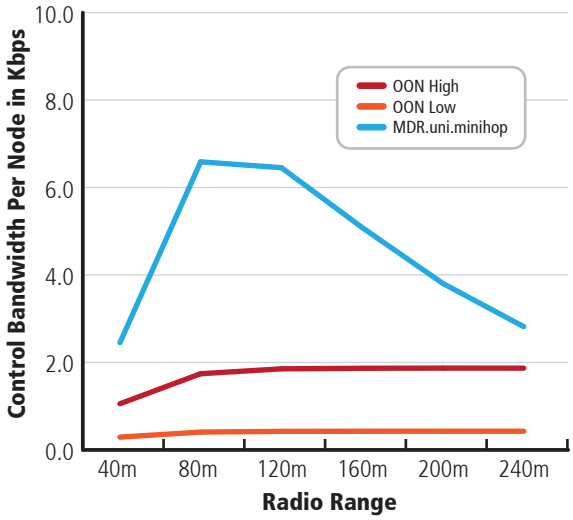




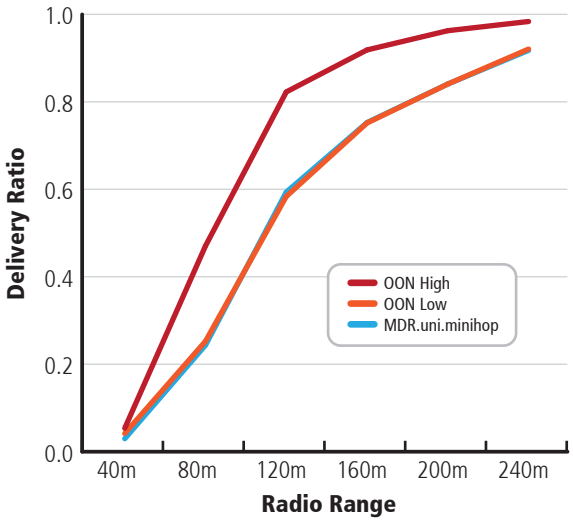
40 Node Network
Delivery Ratio vs Radio Range



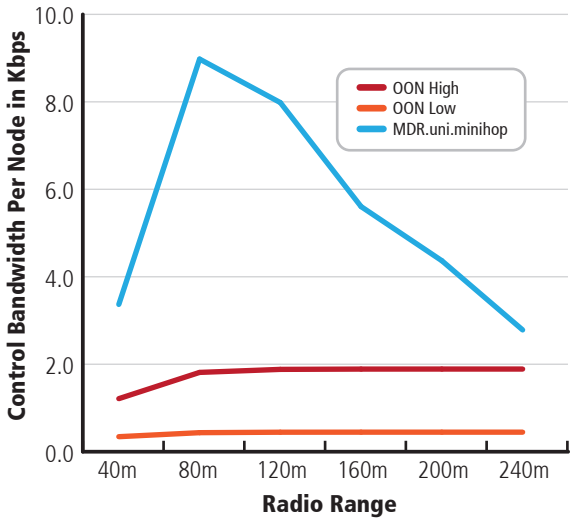
40 Node Network
Control Bandwidth vs Radio Range



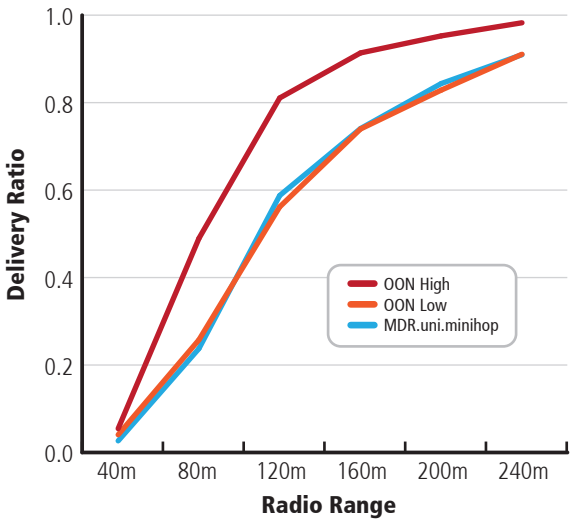
50 Node Network
Delivery Ratio vs Radio Range



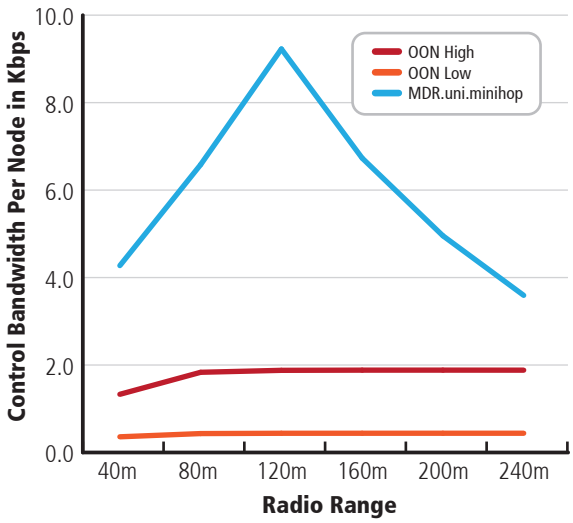
50 Node Network
Control Bandwidth vs Radio Range



60 Node Network
Delivery Ratio vs Radio Range



60 Node Network
Control Bandwidth vs Radio Range



Testing Remarks

Since the OSPF variants MDR.full.full and OS.full.full have a similar delivery ratio to MDR.uni.minhop, but their control bandwidth grows exponentially, they are not considered for the scenarios containing 40, 50 and 60 nodes.

OSPF crashed when running the 60 node scenario with a radio range of 80m. An extrapolated number was used to avoid a break in the chart.

The OrderOne Networks protocol simulation time was less than OSPF in virtually all scenarios. In many cases it was 3x faster executing than OSPF.

Latency

The OrderOne Networks protocol experienced 10% - 30% better packet delivery latency for most scenarios. The exception is for smaller networks with a shorter radio range where the latency was comparable or slightly higher. This was most likely due to the greater quantity of packets being delivered.

No Topology Control Needed

It is generally accepted that in order to scale to larger, denser networks topology control is necessary. The OrderOne Networks protocol is an exception to this rule.

The OrderOne Networks protocol does not need to limit the network topology in order to scale. Regardless of the amount of bandwidth allocated to the OrderOne Networks protocol, it will build and maintain links with all available neighbors.

By avoiding the need to limit the topology, network resiliency is increased and instant hand-offs are easily supported.

It also reduces the latency of delivered packets.

Implementation

The OrderOne Networks protocol implementation was based as closely as possible on the Boeing implementation of OSPFv3-MANET. This was done to ensure the results presented here are as directly comparable as possible.

There was no link layer feedback of any kind. The OrderOne Networks protocol was implemented only at layer 3.

If layer 2 feedback was used, it would allow instant fail-over by using the many alternative routes built by the OrderOne Networks protocol.

The OrderOne Network protocol was written in C, uses no floating point math, is endian independent, non-blocking and has no OS calls. It compiles to approximately 85K on an x86 Linux machine and may be easily integrated into most platforms and simulations.

More Information

The OrderOne Networks protocol is a proprietary routing protocol developed by OrderOne Networks.

A whitepaper describing the mechanisms may be requested by writing to whitepaper@OrderOneNetworks.com or calling 416 732-6117.

Credits

The author would like to thank Boeing for making this high quality version of OSPF available on their website and David Davies for his considerable efforts.