Analysis on Routing Algorithms in Various Traffic Scenarios (VANET)

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Introduction

Objective

- Investigate the performance of various routing algorithms in different scenarios
- Assess the suitability of algorithms for specific environment types

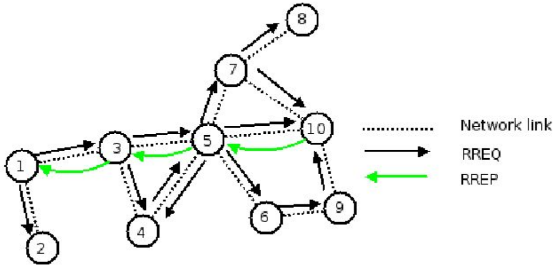
Scenarios for Evaluation

- Campus low pedestrian traffic
- Campus high pedestrian traffic
- Countryside low vehicular traffic
- Urban high vehicular traffic

https://stl.tech/blog/naas-now-later-how-network-as-a-service-benefits-your-business/

AODV (Ad-hoc On-demand Distance Vector)

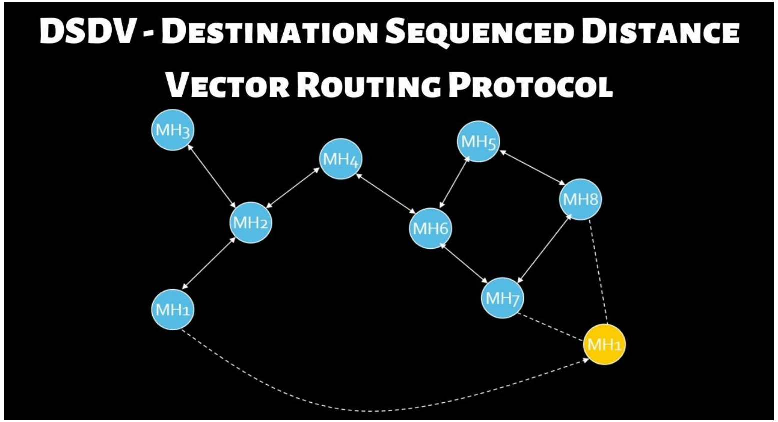
- Reactive routing protocol.
- Routes are established on-demand when needed.
- Nodes maintain routes to destinations through route discovery and route maintenance processes.
- Utilizes sequence numbers to ensure the freshness of rc information and prevent routing loops.
- Well-suited for ad-hoc networks with mobile nodes and unpredictable network topology changes.



https://www.researchgate.net/figure/AODV-routing-protocol-showing-the-route-discovery-process_fig2_220134116

DSDV (Destination-Sequenced Distance Vector)

- Proactive routing protocol.
- Each node maintains a routing table containing the next hop for each destination along with a sequence number.



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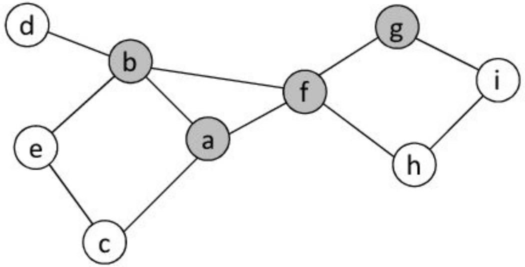
- Periodic updates are sent to neighboring nodes to advertise changes in routes.
- Uses sequence numbers to ensure the freshness of routing information and avoid routing loops.
- Suitable for relatively stable networks where periodic updates are feasible and overhead is acceptable.

OLSR (Optimized Link State Routing)

- Proactive routing protocol
- Nodes maintain topology information through periodic exchange of link state information.
- Each node calculates shortest paths to all destinations using the information collected.
- Utilizes multipoint relays (MPRs) to reduce overhead by selectively flooding control messages.
- Suitable for highly dynamic networks with frequent topology changes.



MPRs	Selector Set
a	b, c, f
b	a, e, f, d
f	a, b, h, g
g	f, i

https://www.researchgate.net/figure/AODV-routing-protocol-showing-the-route-discovery-process_fig2_220134116

Predictions

- OLSR: Efficient in stable, low-traffic environments; faces challenges in high-traffic scenarios; proactive nature suits predictable and low-traffic settings.
- AODV: Adapts well to dynamic changes, particularly in high-traffic scenarios; maintains efficiency across varying traffic levels; provides responsive on-demand route establishment.
- DSDV: Adequate in stable, low-traffic conditions; struggles in high-traffic scenarios due to periodic updates; performs decently in low-traffic scenarios but may encounter routing challenges over time.

Approach

- OSMWebwizard generates scenario
- Convert into ns2mobility.tcl files
- Filter the simulation to preserve only the period of interest
- Utilizes NS-2 mobility trace files to dictate node movement
- Sets up packet sending and receiving functionalities on nodes
- Store all packet flow information into .flowmon files
- Parse .flowmon files to extract useful information
- Evaluate performance with 3 metrics:

  Packet Loss Ratio, Delay, Number of Hops

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SUMO Simulation

Simulation Flow

- Initialization of node properties and wireless channel characteristics.
- Application of mobility model from an external NS-2 trace file.
- Dynamic assignment of IP addresses based on the number of nodes.
- Configuration of end-to-end communication between nodes using the specified routing protocol.
- Collection and output of simulation results through logs and FlowMonitor reports.
- Utilize ns3 built-in parsing script for .flowmon file and our own customized scripts to extract useful information and make data plots.

Wi-Fi PHY Layer/Channel Setup

```
WifiHelper wifi;
wifi.SetStandard(WIFI_STANDARD_80211b);

YansWifiPhyHelper wifiPhy;

YansWifiChannelHelper wifiChannel;
wifiChannel.SetPropagationDelay("ns3::ConstantSpeedPropagationDelayModel");
wifiChannel.AddPropagationLoss("ns3::FriisPropagationLossModel");
wifiPhy.SetChannel(wifiChannel.Create());

WifiMacHelper wifiMac;
wifiMac.SetType("ns3::AdhocWifiMac");
NetDeviceContainer adhocDevices = wifi.Install(wifiPhy, wifiMac, adhocNodes);

//Using the bulit-in ns-2 mobility helper
Ns2MobilityHelper sumo_trace (FileNamePrefix + location +".tcl");
sumo_trace.Install(); //install ns-2 mobility in all nodes
```

IP Address Dynamic Allocation

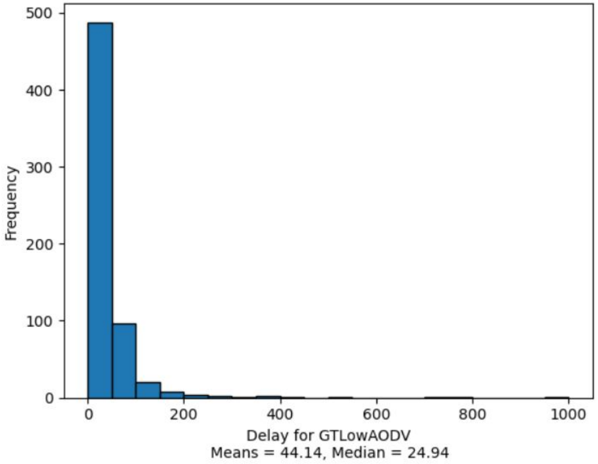
```
Ipv4AddressHelper address;
if (nnodes <= 254) // up to 254 usable IP addresses
{
    address.SetBase("10.1.1.0", "255.255.255.0");
}
else if (nnodes <= 510) // 255 to 510 usable IP addresses
{
    address.SetBase("10.1.0.0", "255.255.254.0");
}
else if (nnodes <= 1022) // 511 to 1022 usable IP addresses
{
    address.SetBase("10.1.0.0", "255.255.252.0");
}
else if (nnodes <= 2046) // 1023 to 2046 usable IP addresses
{
    address.SetBase("10.1.0.0", "255.255.248.0");
}
```

Packet Sending/Receiving Mechanism

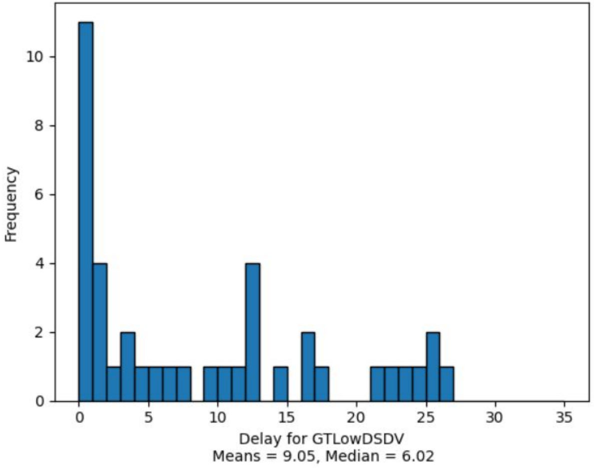
```
// Set up applications to send packets from each node to the previous node, starting from node 2
for (uint32_t i = 1; i < nnodes; ++i) {
    uint32_t senderIndex = i;
    uint32_t receiverIndex = i - 1;

    Ptr<Socket> sink = SetupPacketReceive(adhocInterfaces.GetAddress(receiverIndex), adhocNodes.Get(receiverIndex));
    Ptr<UniformRandomVariable> var = CreateObject<UniformRandomVariable>();

    OnOffHelper onoff("ns3::UdpSocketFactory", Address(InetSocketAddress(adhocInterfaces.GetAddress(receiverIndex), port)));
    onoff.SetAttribute("OnTime", StringValue("ns3::ConstantRandomVariable[Constant=1.0]"));
    onoff.SetAttribute("OffTime", StringValue("ns3::ConstantRandomVariable[Constant=0.0]"));
    ApplicationContainer temp = onoff.Install(adhocNodes.Get(senderIndex));
    temp.Start(Seconds(var->GetValue(sim_time *4.0 / 5,sim_time *4.0 /5 + 3.0)));
    temp.Stop(Seconds(sim_time));
}
```

Results (GT Low Pedestrian Traffic)

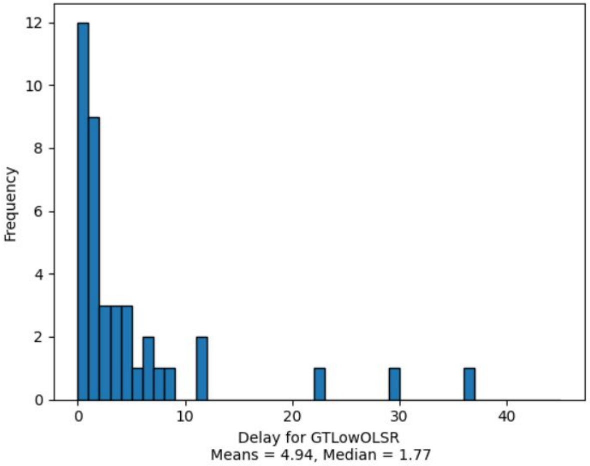
AODV



DSDV



OLSR



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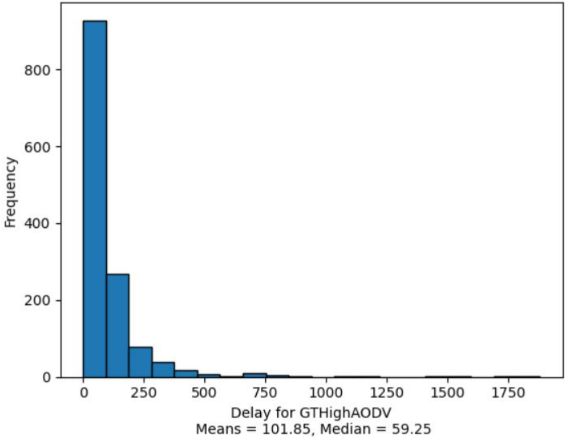
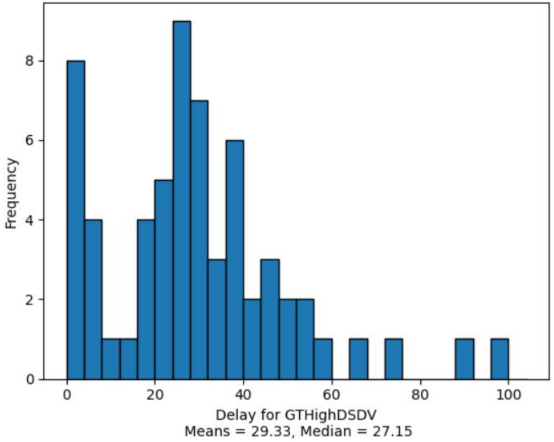
Results (GT High Pedestrian Traffic)

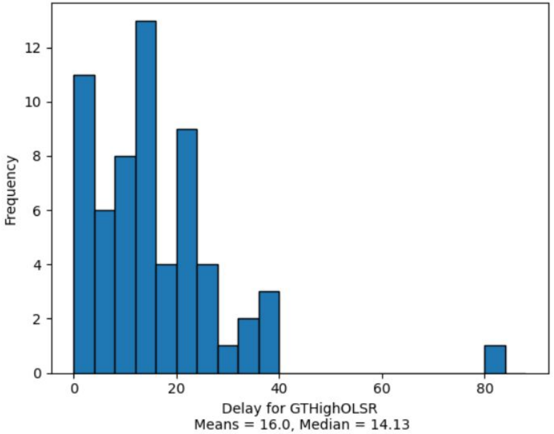
AODV



DSDV



OLSR



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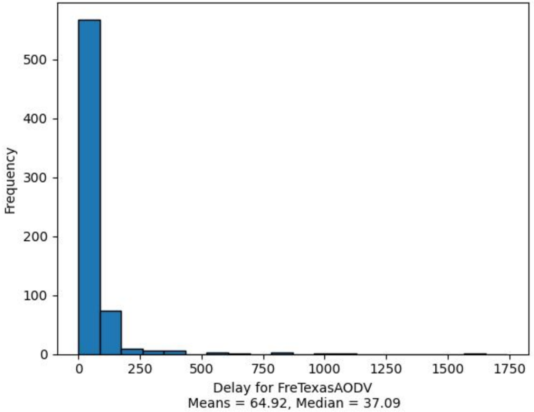
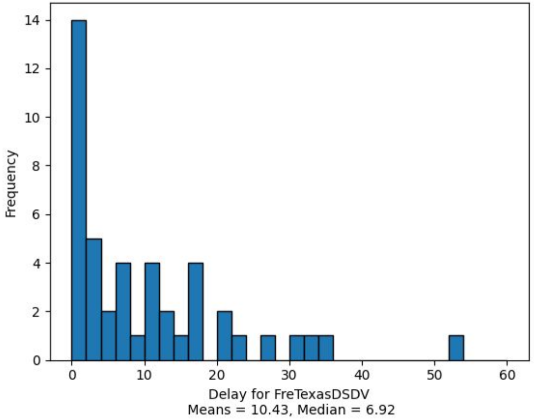
Results (Low Vehicular Traffic)

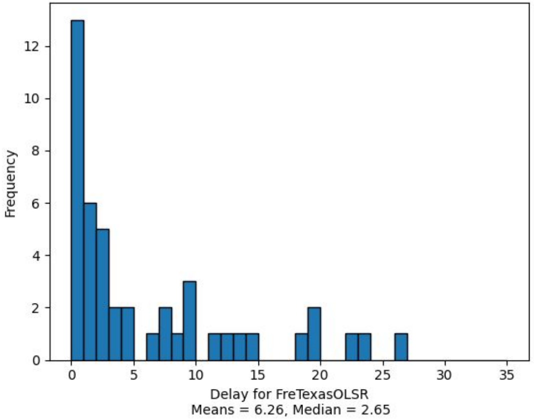
AODV



DSDV



OLSR



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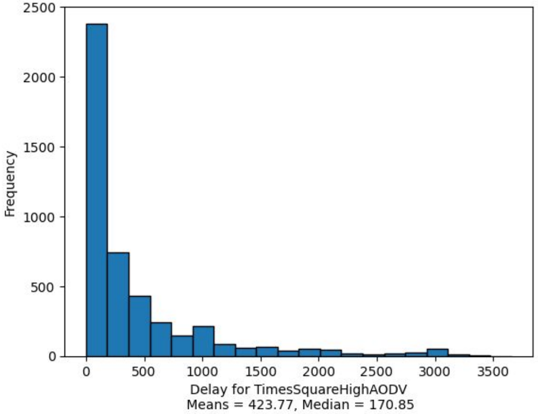
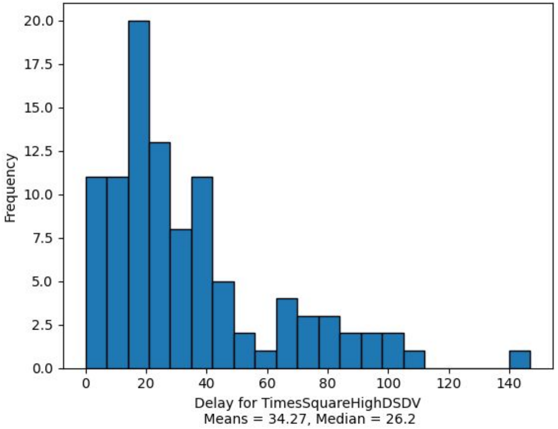
Results (High Vehicular Traffic)

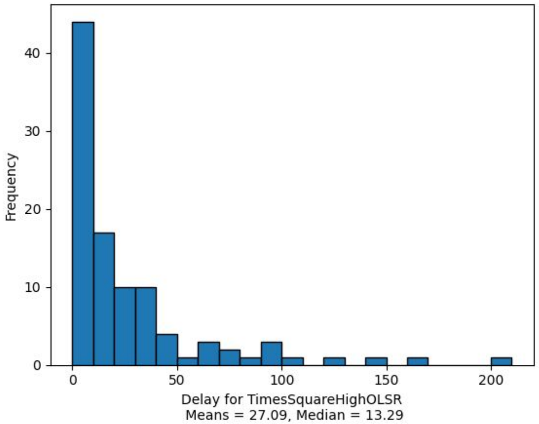
AODV



DSDV



OLSR



Conclusion

- Within the same traffic scenarios, OLSR has a better performance since it has a shorter delay compared to AODV and DSDV.
- However, other performance metrics need to be taken into account
- In terms of packet loss ratio and number of hops, the same result does not hold
- Further detailed analysis in the report.

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Future Work

- Other more sophisticated evaluation metrics such as energy consumption, fairness, scalability, etc
- Test on highway vehicles
- More complex sending/receiving mechanism
- DSR algorithm