Evaluating the performance of Mesh network protocols for disaster scenarios

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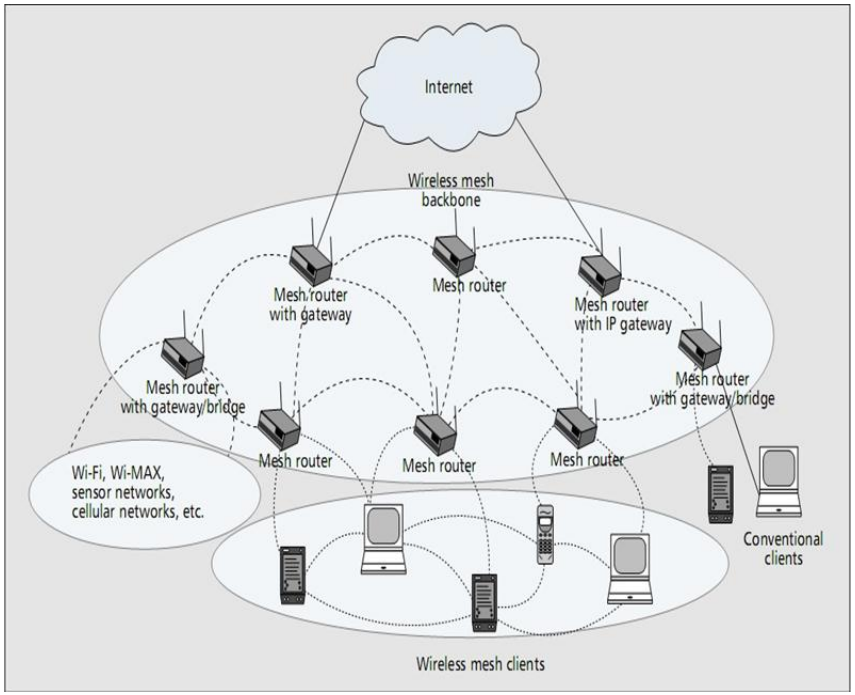
Introduction

Wireless Mesh Networks

- A group of self-organized and self-configured mesh clients and routers interconnected via wireless links.
- Application - Emergency and disaster networking.



Introduction (2)

- Project Aim
  - Evaluate the routing protocols:

    AODV (ad hoc on demand vector),

    DSR (demand source routing),

    OLSR (optimized link-state routing), when using **UDP (user datagram protocol)**.
  - Test which is the best routing protocol for these applications under the performance metrics **throughput, delay,** and **network load**.
- Performance Metrics
  - **Throughput –** tests the total amount of data that reaches the receiver (from the source) compared to the time taken by the receiver to receive the last packet.
  - **Delay** - tests the time taken by packets to pass through the network.
  - **Network Load** - test the amount of data traffic carried by the network.
- Simulation Tool
  - **OPNET** (optimized network evaluation tool)

User requirements & analysis

- Gathered data from
  - Users - Campus protection Service (CPS).
  - Documentation.
- Users want:
  - To communicate through voice and video.

User requirement	Application required	Transport protocol used
Voice	Voice over IP	User datagram protocol (UDP)
Video	Video conferencing	User datagram protocol (UDP)

Prototype

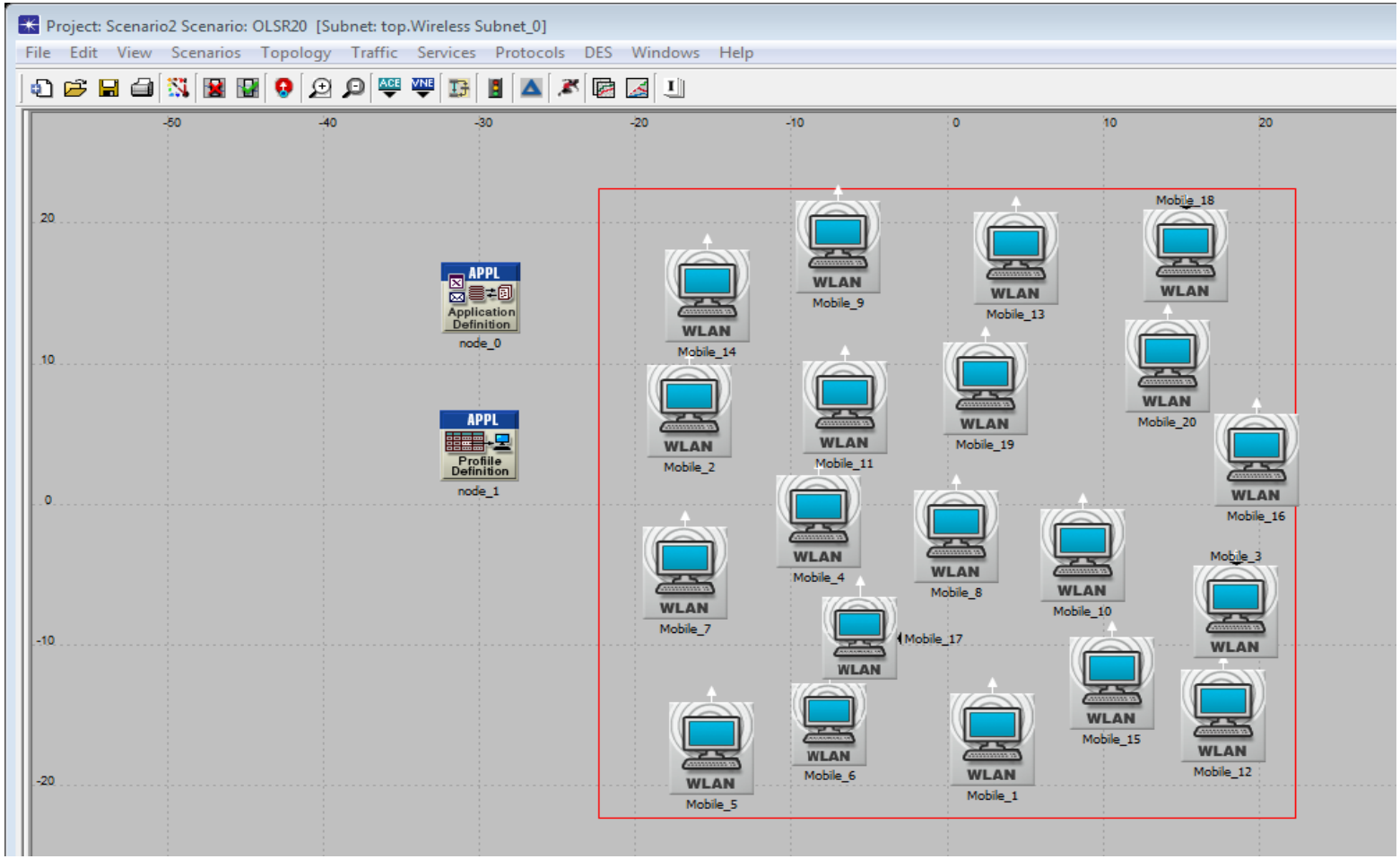
- Pilot Study
  - A small scale preliminary study conducted before a large-scale quantitative project is implemented.
  - Checks the feasibility.
  - Improves the design of the whole project.
  - Acquaint with OPNET software.

Scenario	Parameters						
	No. of nodes	**Routing protocols**	**Transport protocol**	**Performance metrics**	**Simulation radius**	**Mobility rate**	**Simulation time**
Pilot	4	AODV, DSR, OLSR	UDP	Throughput, delay, network load	100m x 100m	5 meters/sec	10 min

Simulation testing

Exp	Parameters							
	No. of nodes	Routing protocols	Transport protocol	Testing parameters	Radius	Mobility rate	Simulation time	Application
1	4	AODV, DSR, OLSR	UDP	Throughput, delay, network load	500m x 500m	5 meters/sec	10 min	Voice
2	7	AODV, DSR, OLSR	UDP	Throughput, delay, network load	500m x 500m	5 meters/sec	10 min	Voice
3	10	AODV, DSR, OLSR	UDP	Throughput, delay, network load	1000m x 1000m	5 meters/sec	10 min	Voice
4	20	AODV, DSR, OLSR	UDP	Throughput, delay, network load	2000m x 2000m	5 meters/sec	10 min	Voice
5	40	AODV, DSR, OLSR	UDP	Throughput, delay, network load	2000m x 2000m	5 meters/sec	10 min	Voice

Simulation in OPNET



Test results analysis

- Global – from the whole network.
- Individual experiments.
- Testing parameters
  - throughput -> high means a good outcome, whereas for,
  - delay and
  - network load -> low means a good outcome.

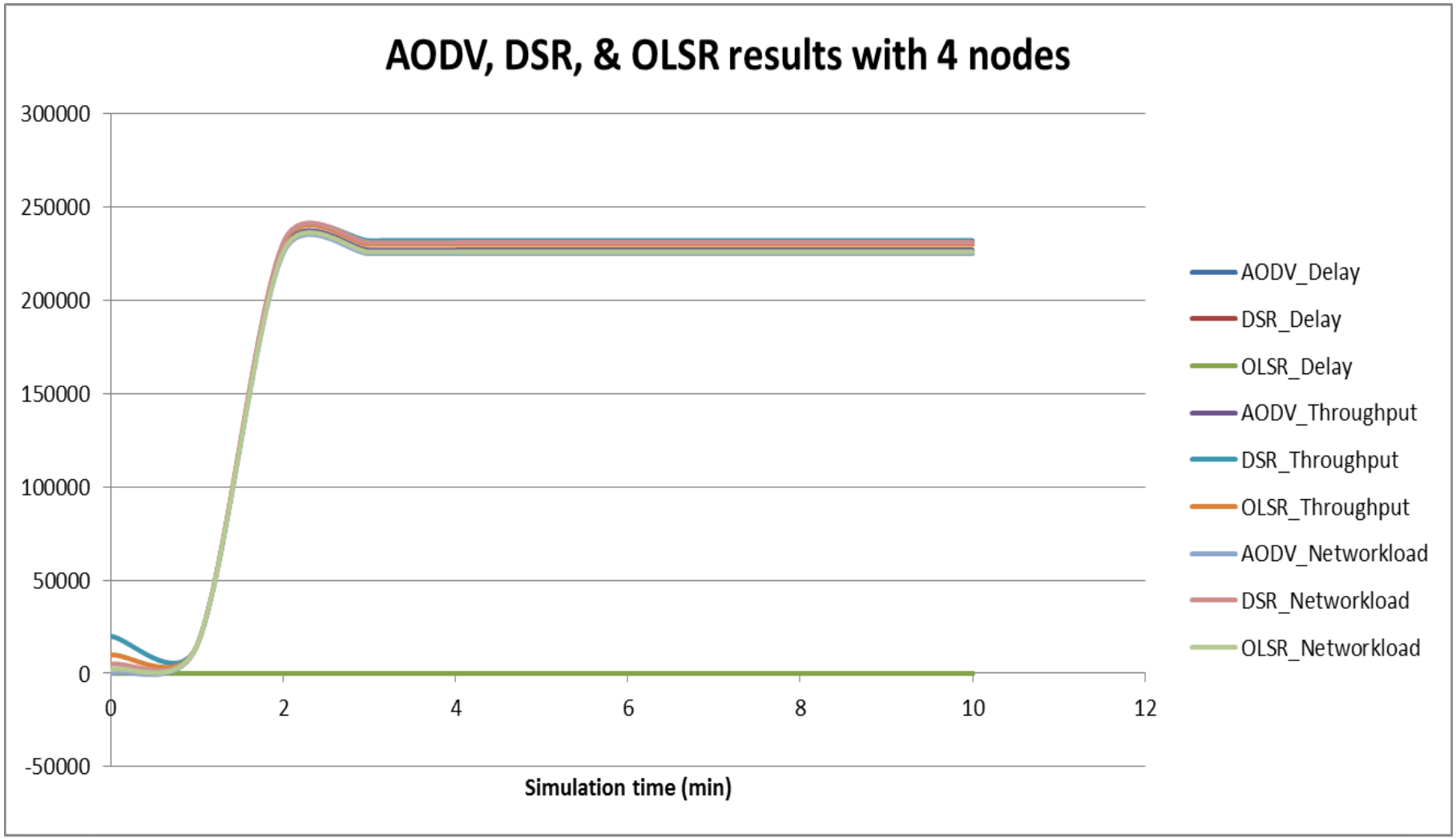
Comparative analysis

- First – look at average values for each protocol
- Second - look at performance of all three protocols for each experiment.
  - To get an idea of how scalability affects the protocols performance.
- Third – look at performance of all experiments under each testing parameter.
  - To get an idea of the performance of each protocol under that specific metric.

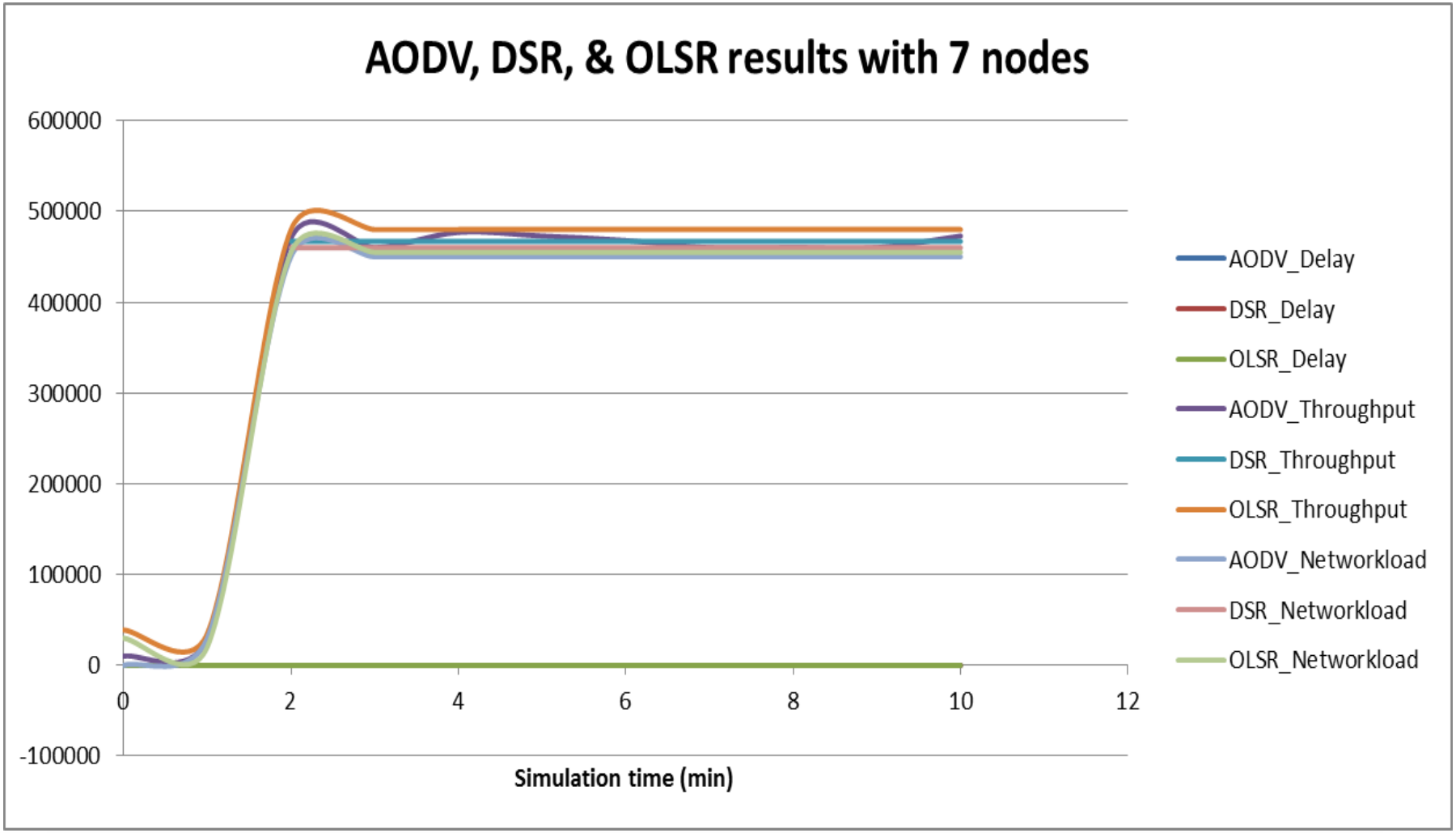
Results

Nodes	Parameters	AODV	DSR	OLSR
4	Throughput (bit/sec)	227,456	231,509.33	231,392
	Delay (sec)	0.0004436	0.0002972	0.0003597
	Network load (bit/sec)	225,056	230,677.33	225,056
7	Throughput (bit/sec)	461,248	464,426.66	480,384
	Delay (sec)	0.0007877	0.0003839	0.0007509
	Network load (bit/sec)	450,112	464,661.33	450,208
10	Throughput (bit/sec)	603,584	586,986.66	643,520
	Delay (sec)	0.0015	0.000975	0.0008170
	Network load (bit/sec)	562,688	587,221.33	569,280
20	Throughput (bit/sec)	2,881,698.66	876,216	1,206,578.66
	Delay (sec)	2.369853	5.765952	2.087846
	Network load (bit/sec)	849,645.66	892,045.33	763,914.66
40	Throughput (bit/sec)	12,661,229.33	1,072,970.66	4,153,493.33
	Delay (sec)	4.78048	12.351543	3.211828
	Network load (bit/sec)	1,156,144	819,378.66	943,986.66

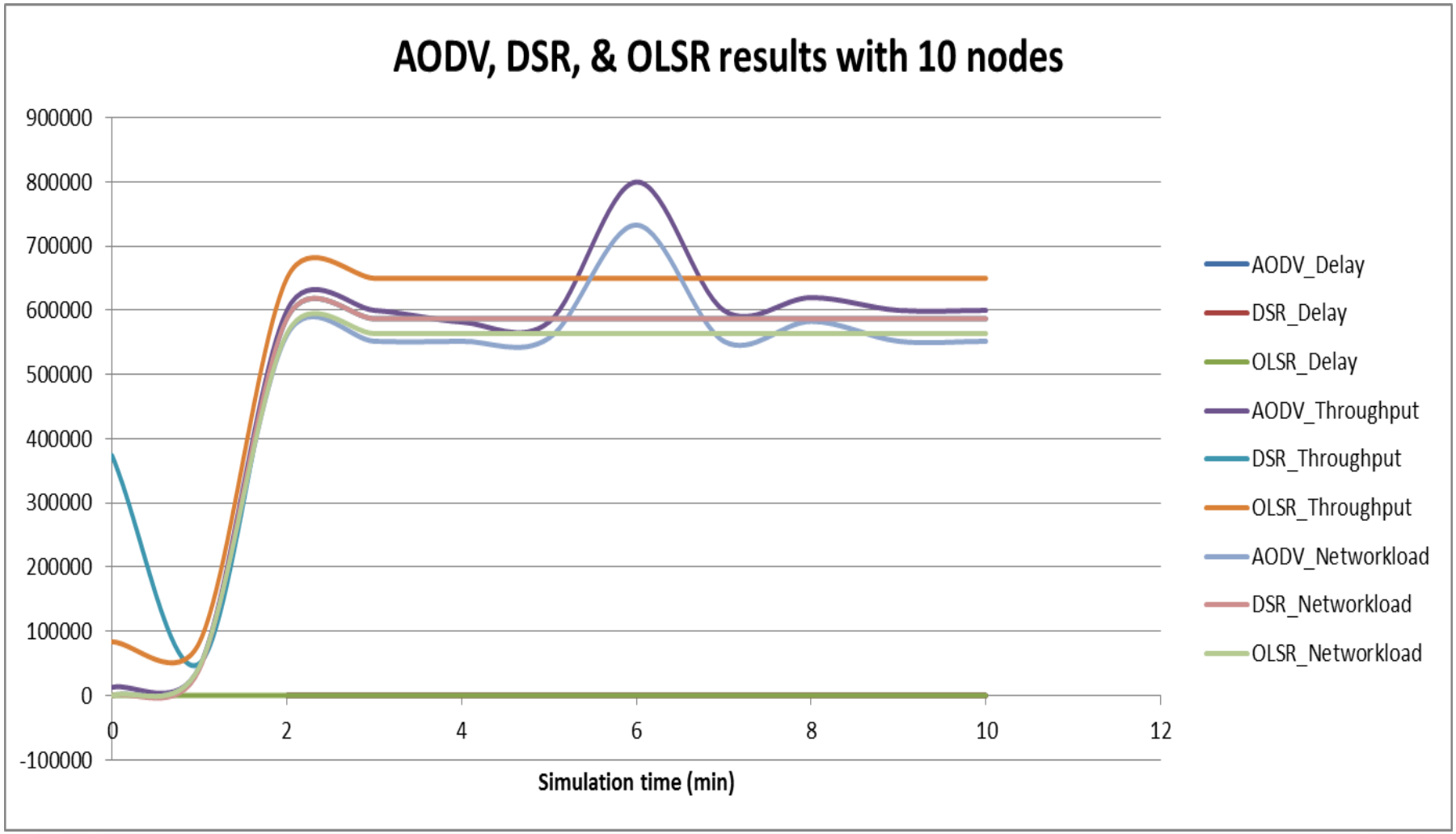
Results (2)


AODV, DSR, & OLSR results with 4 nodes
300000
250000
200000
150000
100000
50000
0
-50000
0
2
4
6
8
10
12
Simulation time (min)
AODV_Delay
DSR_Delay
OLSR_Delay
AODV_Throughput
DSR_Throughput
OLSR_Throughput
AODV_Networkload
DSR_Networkload
OLSR_Networkload

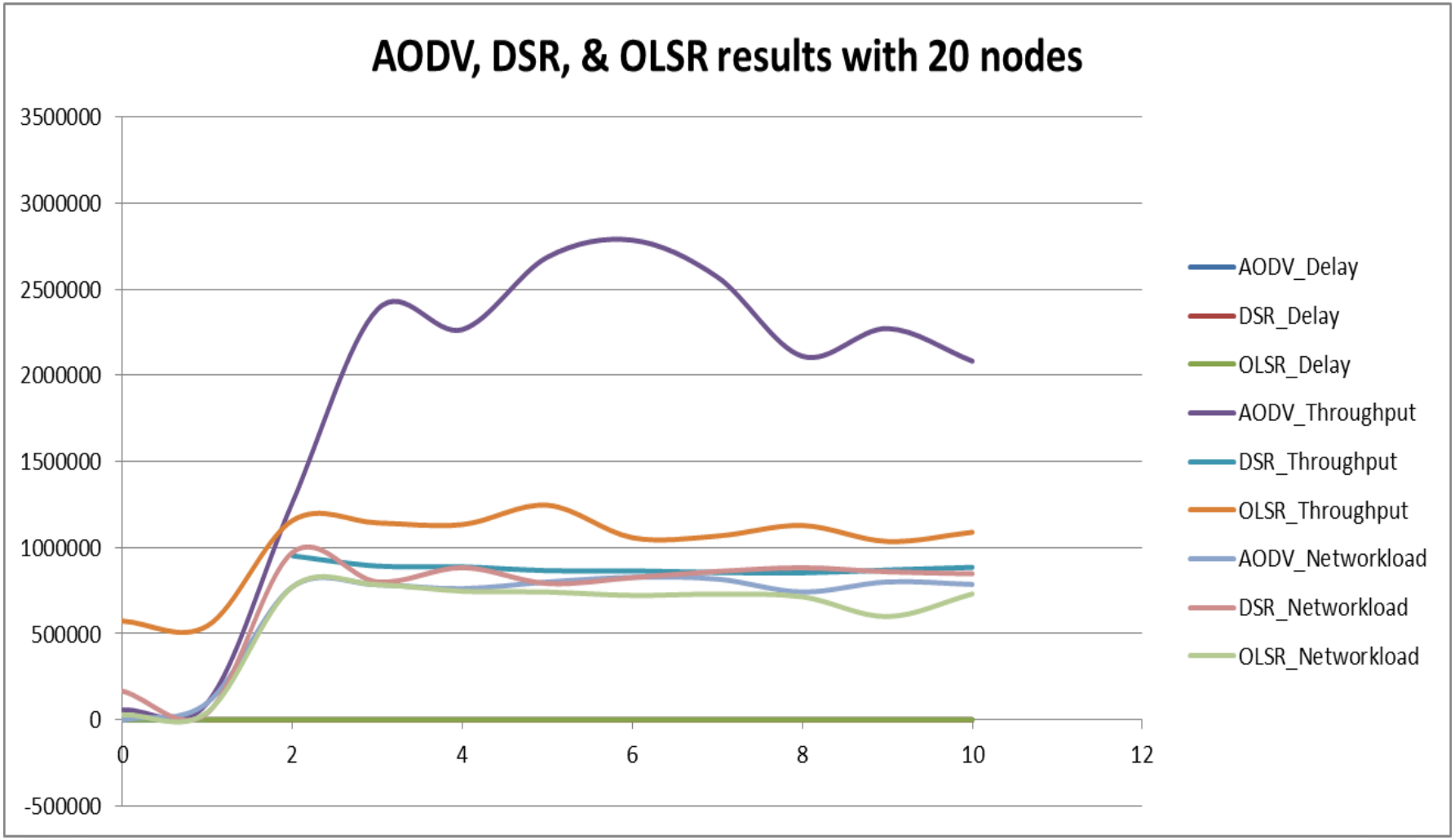
Results (3)


AODV, DSR, & OLSR results with 7 nodes
600000
500000
400000
300000
200000
100000
0
-100000
0
2
4
6
8
10
12
Simulation time (min)
AODV_Delay
DSR_Delay
OLSR_Delay
AODV_Throughput
DSR_Throughput
OLSR_Throughput
AODV_Networkload
DSR_Networkload
OLSR_Networkload

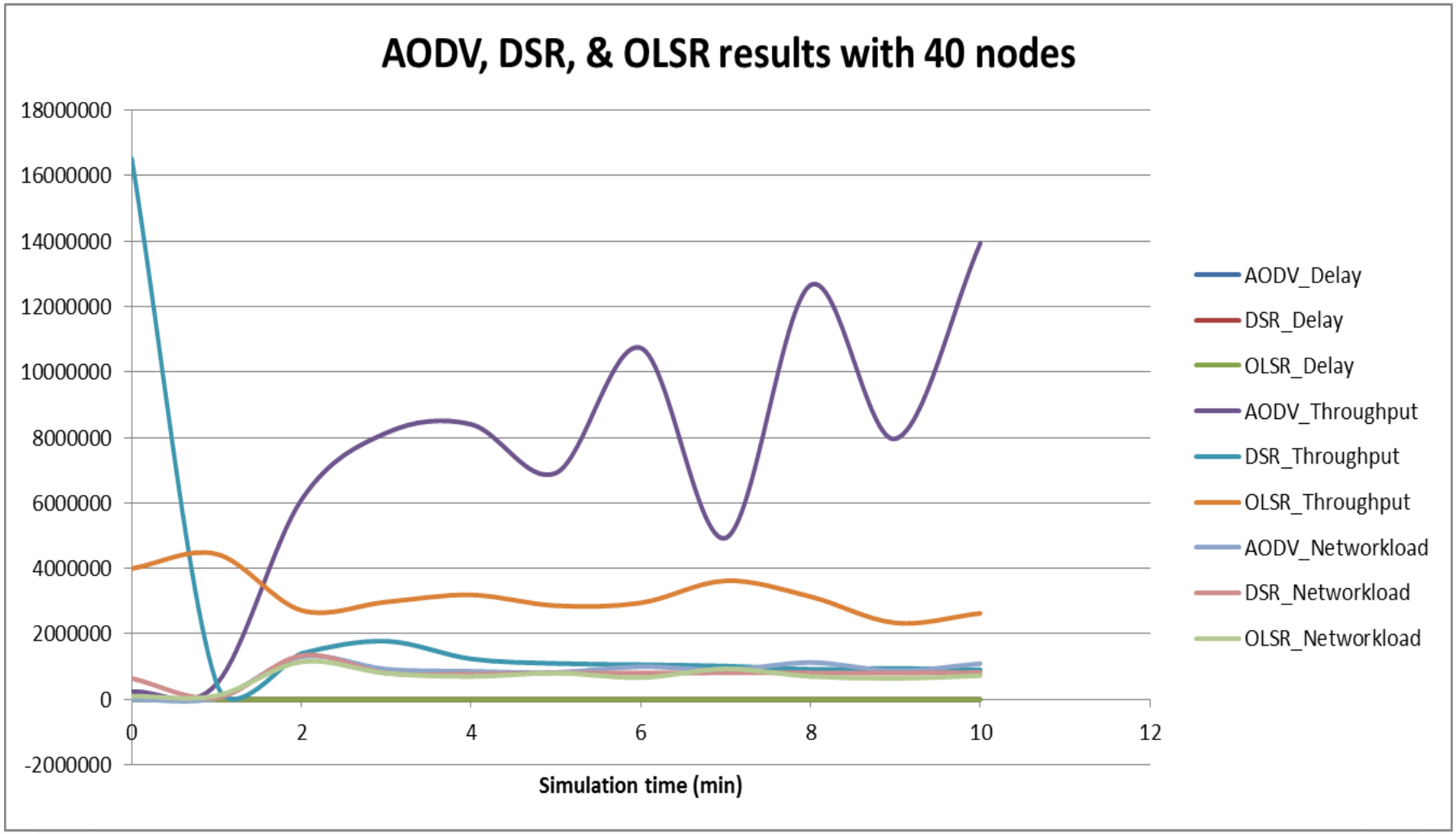
Results (4)


AODV, DSR, & OLSR results with 10 nodes
900000
800000
700000
600000
500000
400000
300000
200000
100000
0
-100000
0
2
4
6
8
10
12
Simulation time (min)
AODV_Delay
DSR_Delay
OLSR_Delay
AODV_Throughput
DSR_Throughput
OLSR_Throughput
AODV_Networkload
DSR_Networkload
OLSR_Networkload

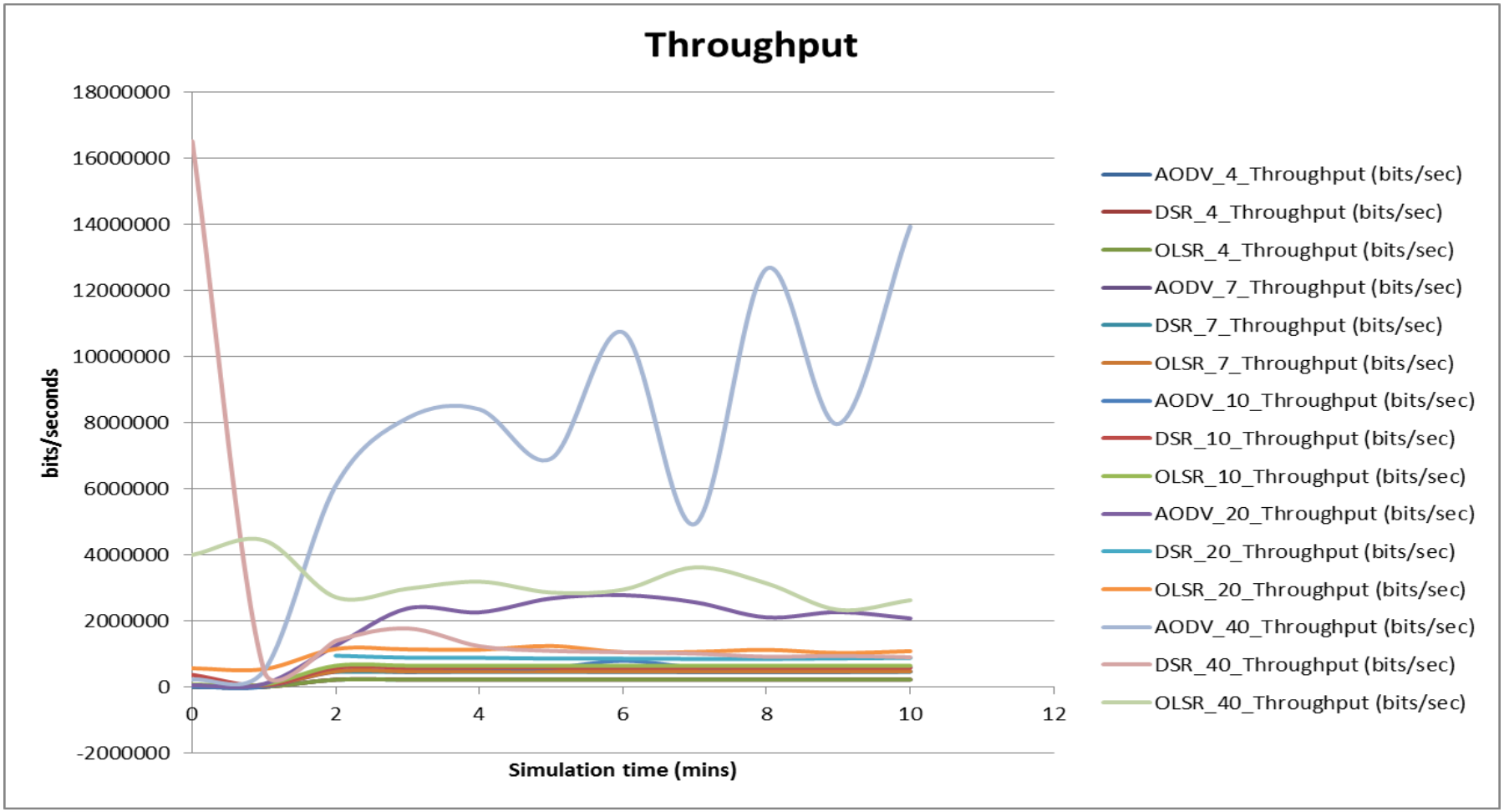
Results (5)


AODV, DSR, & OLSR results with 20 nodes
3500000
3000000
2500000
2000000
1500000
1000000
500000
0
-500000
0
2
4
6
8
10
12
AODV_Delay
DSR_Delay
OLSR_Delay
AODV_Throughput
DSR_Throughput
OLSR_Throughput
AODV_Networkload
DSR_Networkload
OLSR_Networkload

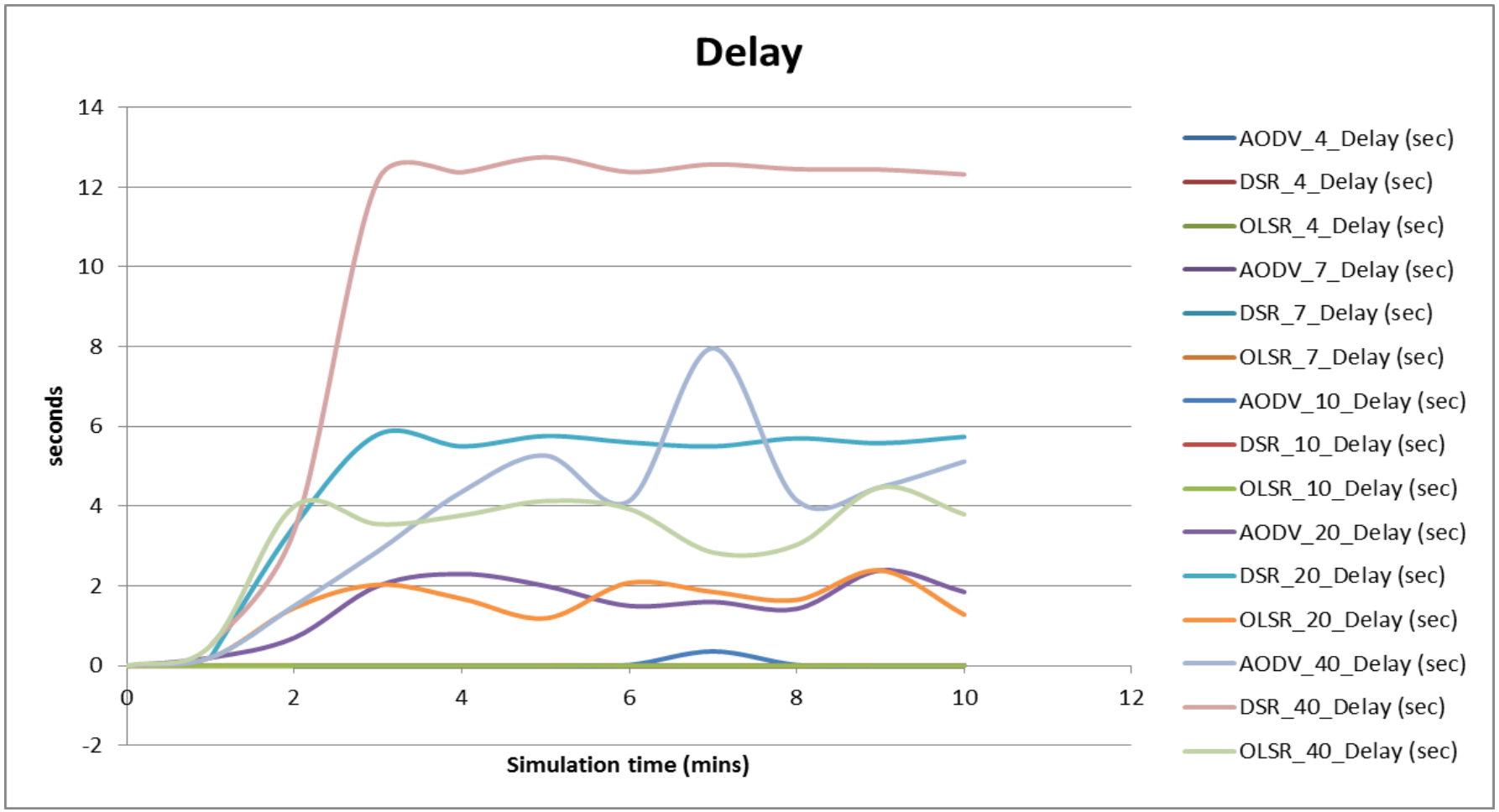
Results (6)


AODV, DSR, & OLSR results with 40 nodes
18000000
16000000
14000000
12000000
10000000
8000000
6000000
4000000
2000000
0
-2000000
0
2
4
6
8
10
12
Simulation time (min)
AODV_Delay
DSR_Delay
OLSR_Delay
AODV_Throughput
DSR_Throughput
OLSR_Throughput
AODV_Networkload
DSR_Networkload
OLSR_Networkload

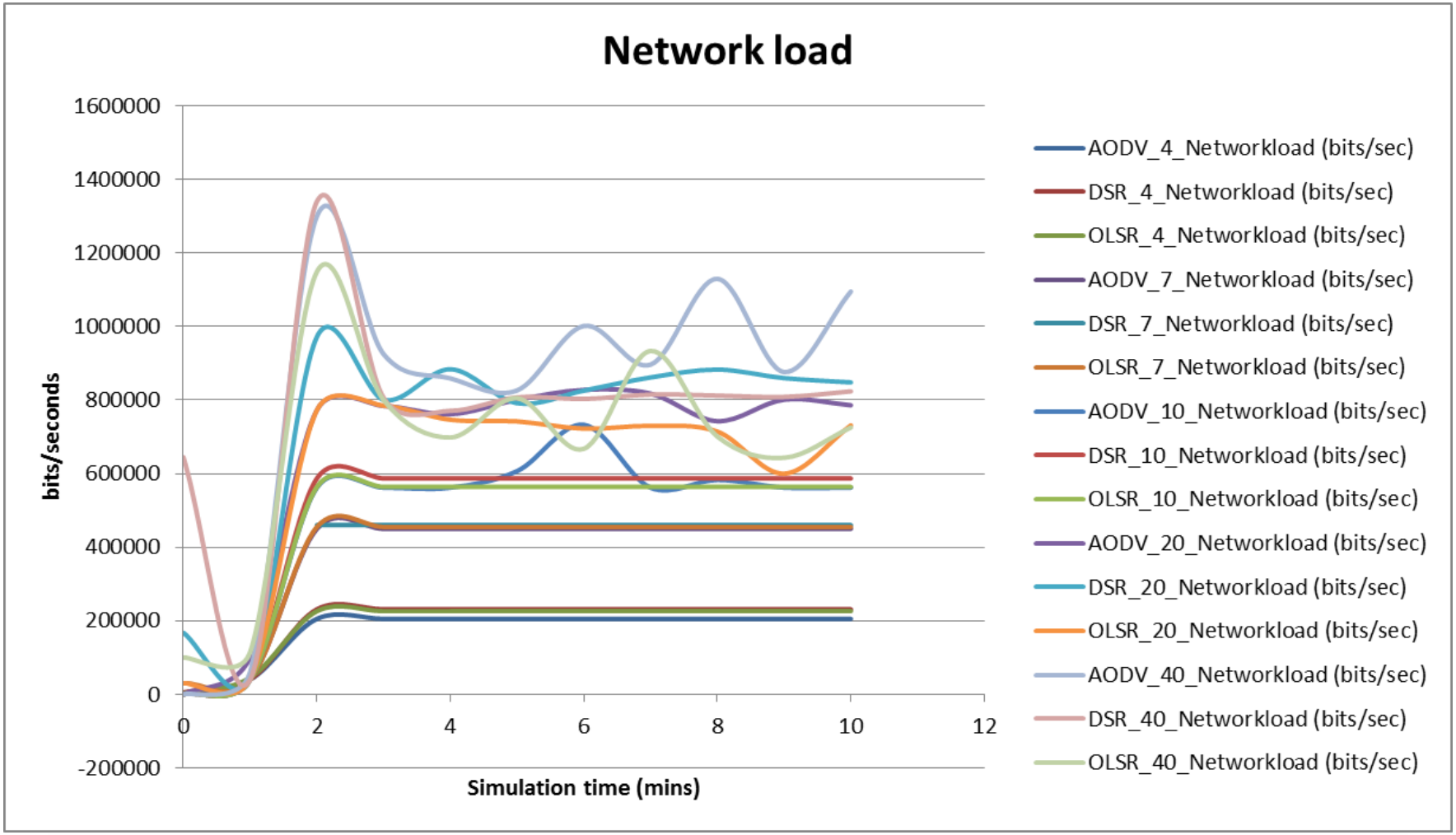
Results (7)


Throughput
18000000
16000000
14000000
12000000
10000000
8000000
6000000
4000000
2000000
0
-2000000
bits/seconds
0
2
4
6
8
10
12
Simulation time (mins)
AODV_4_Throughput (bits/sec)
DSR_4_Throughput (bits/sec)
OLSR_4_Throughput (bits/sec)
AODV_7_Throughput (bits/sec)
DSR_7_Throughput (bits/sec)
OLSR_7_Throughput (bits/sec)
AODV_10_Throughput (bits/sec)
DSR_10_Throughput (bits/sec)
OLSR_10_Throughput (bits/sec)
AODV_20_Throughput (bits/sec)
DSR_20_Throughput (bits/sec)
OLSR_20_Throughput (bits/sec)
AODV_40_Throughput (bits/sec)
DSR_40_Throughput (bits/sec)
OLSR_40_Throughput (bits/sec)

Results (8)


Delay
seconds
14
12
10
8
6
4
2
0
-2
0
2
4
6
8
10
12
Simulation time (mins)
AODV_4_Delay (sec)
DSR_4_Delay (sec)
OLSR_4_Delay (sec)
AODV_7_Delay (sec)
DSR_7_Delay (sec)
OLSR_7_Delay (sec)
AODV_10_Delay (sec)
DSR_10_Delay (sec)
OLSR_10_Delay (sec)
AODV_20_Delay (sec)
DSR_20_Delay (sec)
OLSR_20_Delay (sec)
AODV_40_Delay (sec)
DSR_40_Delay (sec)
OLSR_40_Delay (sec)

Results (9)


Network load
1600000
1400000
1200000
1000000
800000
600000
400000
200000
0
-200000
bits/seconds
0
2
4
6
8
10
12
Simulation time (mins)
AODV_4_Networkload (bits/sec)
DSR_4_Networkload (bits/sec)
OLSR_4_Networkload (bits/sec)
AODV_7_Networkload (bits/sec)
DSR_7_Networkload (bits/sec)
OLSR_7_Networkload (bits/sec)
AODV_10_Networkload (bits/sec)
DSR_10_Networkload (bits/sec)
OLSR_10_Networkload (bits/sec)
AODV_20_Networkload (bits/sec)
DSR_20_Networkload (bits/sec)
OLSR_20_Networkload (bits/sec)
AODV_40_Networkload (bits/sec)
DSR_40_Networkload (bits/sec)
OLSR_40_Networkload (bits/sec)

Project conclusion

- Overall experiment results AODV showed better performance in terms of throughput and network load and DSR performed better in terms of delay when using UDP.
- But for individual experiments, two routing protocols OLSR and AODV perform better than DSR when using UDP because they depend on the scalability of a network.
- DSR does give better results with a small network when using UDP.
- But this may not necessarily mean that OLSR and AODV will always perform better than DSR.
- Different routing protocols have different attributes, and depending on the on the type of network and traffic type these routing protocols will always perform differently.

Future work

- Test different traffic applications which are used in disaster events (e.g. video communication).
  - require using simulation tools that support this type of traffic application
    - e.g. OPNET and/or Network Simulation version 2 (NS2).
- It would be interesting to get data for a real-life event
  - e.g. apply the testing on a case study
  - to test if the findings of the simulation would correspond with real-life results.

Timeline

	Term 1 - Project analysis							Term 2 - Project design & development						
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
User requirements														
Requirements analysis design														
Documentation														
Overview of protocols														
Simulation environment analysis														
Pilot study														
Demo														
Documentation														

Timeline (2)

	Term 3 - Project implementation							Term 4 - Project testing & evaluation						
	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7	Week 1	Week 2	Week 3	Week 4	Week 5	Week 6	Week 7
Simulation methodology														
Implementation														
Documentation														
Results analysis														
Results conclusion														
Documentation writeup														

Reference

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