

## BANGLADESH UNIVERSITY OF ENGINEERING & TECHNOLOGY

NETWORK SIMULATOR - 2

COURSE NUMBER: CSE 322

LAB GROUP: A2

SUBMITTED BY:

**SHAMIUL HASAN (1505038)**

**SOUMIT SAHA (1505047)**

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

LEVEL – 3, TERM – 2

BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY

### **Topologies Under Simulation:**

1. Wired
2. Wireless 802.11 (Static)

### **Parameters Under Variation:**

1. Number of nodes
2. Number of flows
3. Number of packets per second
4. Coverage area for static wireless node

### **Modifications Made In The Simulator:**

1. Changes in the AODV Protocol. In 'aodv.cc' file, we changed the void AODV::recvRequest(Packet \*p) function. In this function, we changed the general AODV algorithm and used RAODV (Randomized AODV). We are randomly selecting an estimated drop factor and if the drop factor is less than actual drop factor, we are dropping it. We found this on a paper [linked](#) here.
2. Changes in RTT calculation. In 'tcp.cc' file we created a function named 'void TcpAgent::rtt\_update\_modified(double tao)'. The default rtt calculation algorithm takes exponential average of sample rtts to calculate new rtt. We are taking last 10 rtt samples and taking their average as new rtt sample.
3. We made changes in TCP Congestion Control. In 'tcp.cc' file, we added another case in 'void TcpAgent::opencwnd()' function and wrote our new TCP Congestion Control algorithm from intuition.
4. In 'ns-allinone-2.35/ns-2.35/mobile->omni-antenna.cc' file, we changed the variable gr to 5\*gt.

### **Results with Graphs:**

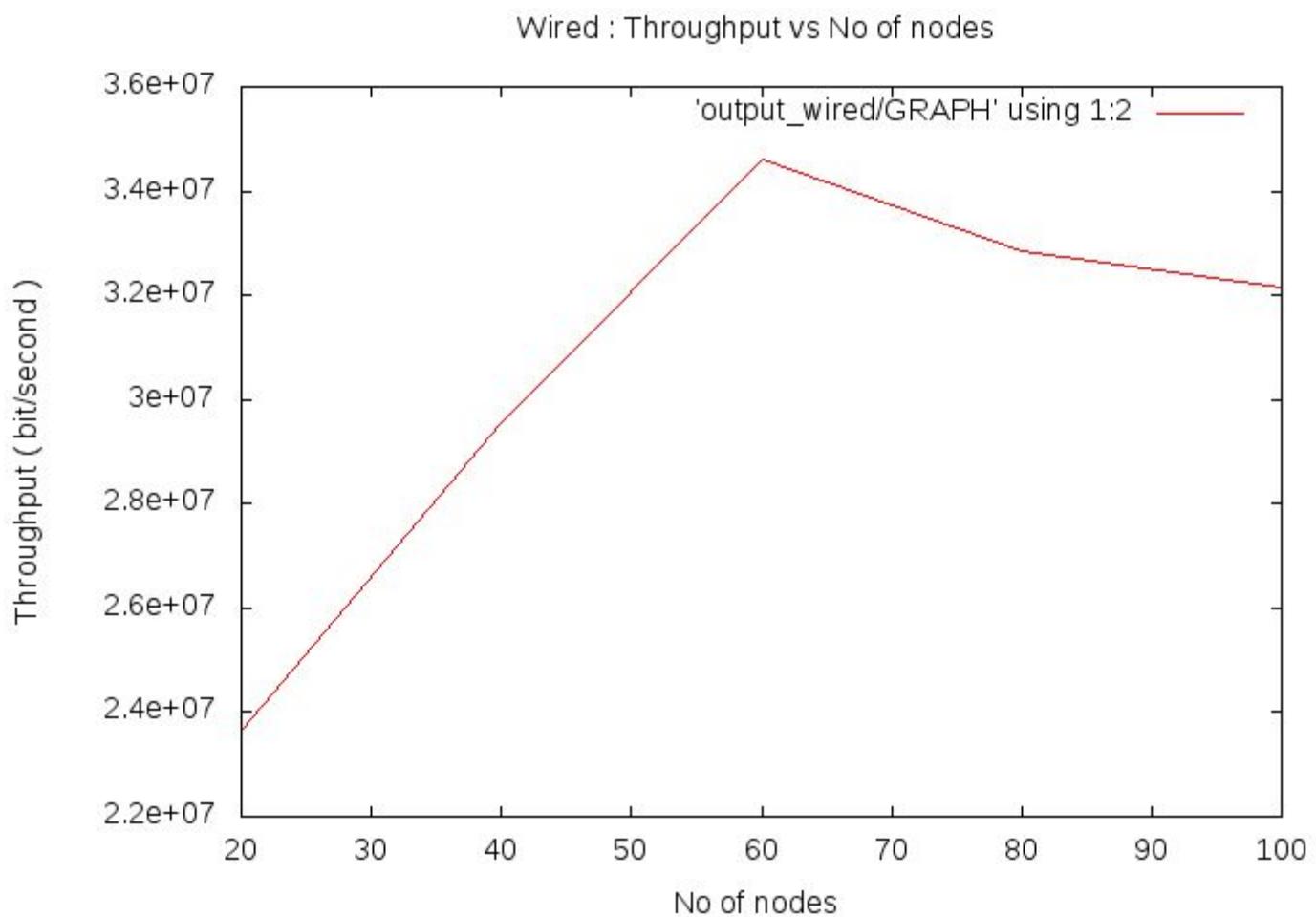
For each parameter under variation, 5 (five) sets of data were generated.

### **The metrics that were observed are listed below:**

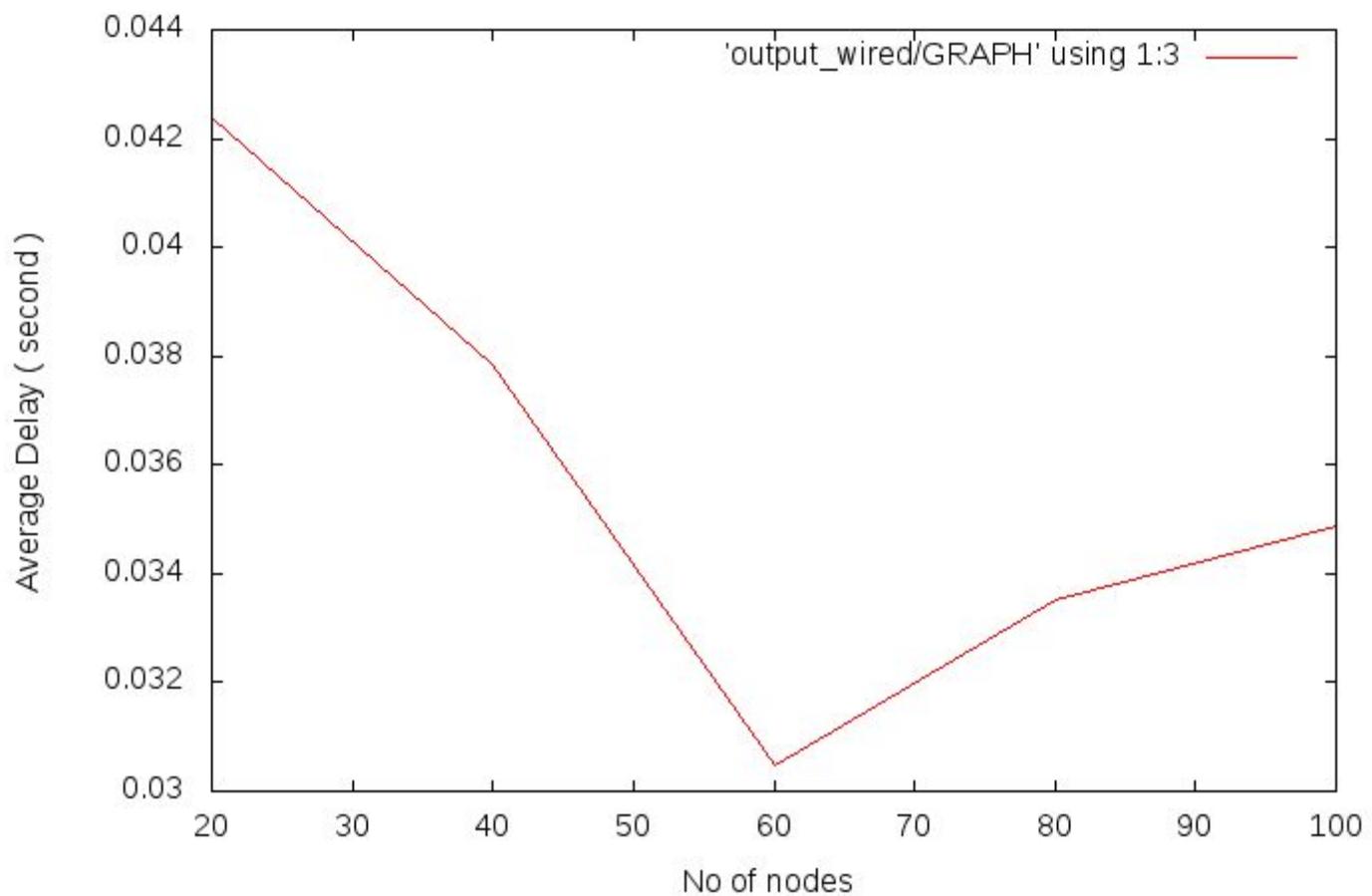
1. Network throughput
2. End-to-end delay
3. Packet delivery ratio (total # of packets delivered to end destination / total # of packets sent)
4. Packet drop ratio (total # of packets dropped / total # of packets sent)
5. Total energy consumption
6. Energy consumption per byte of data

The graphs were generated using the gnu gnuplot tool.

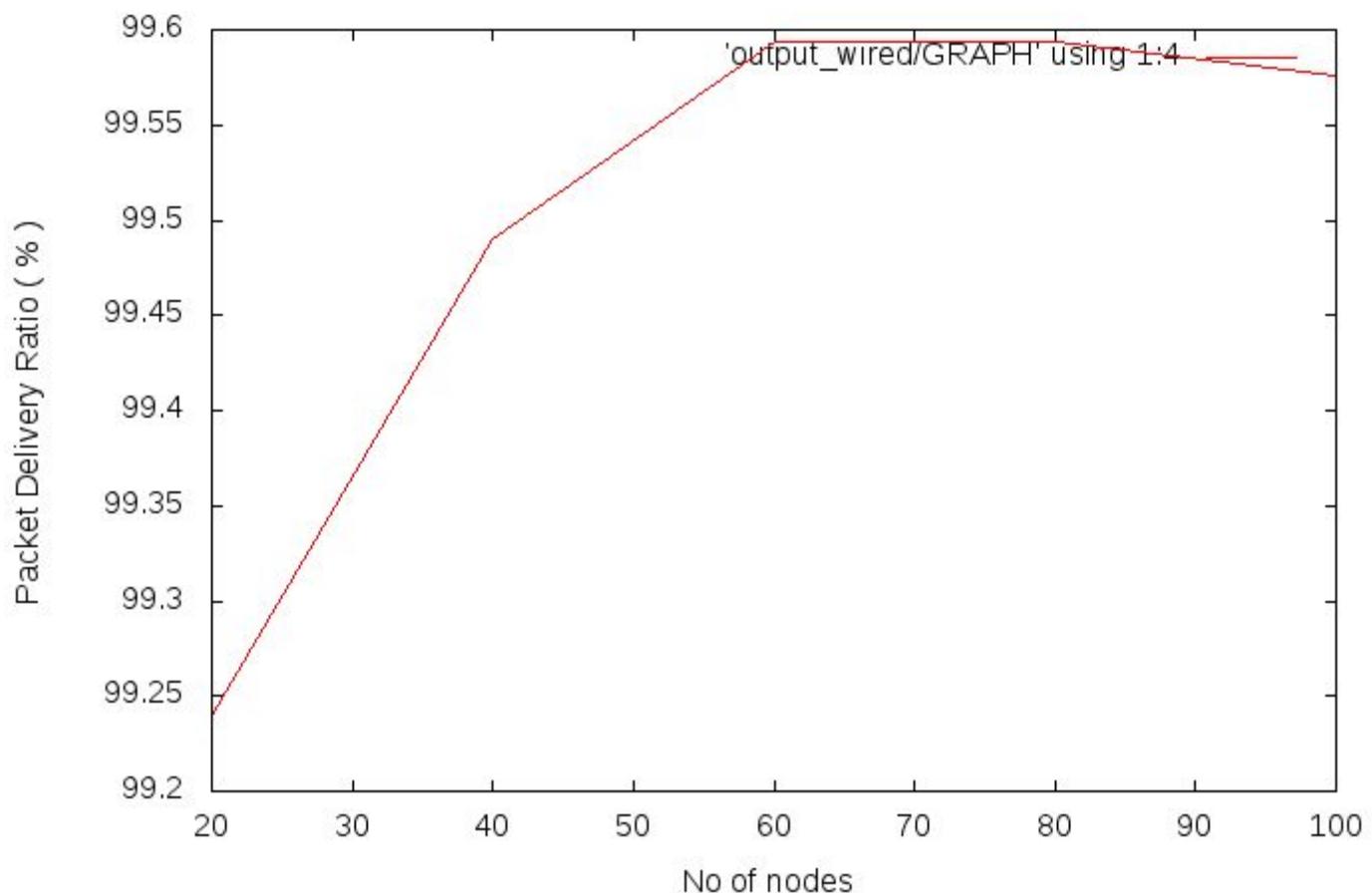
# **Wired (Before Modification)**

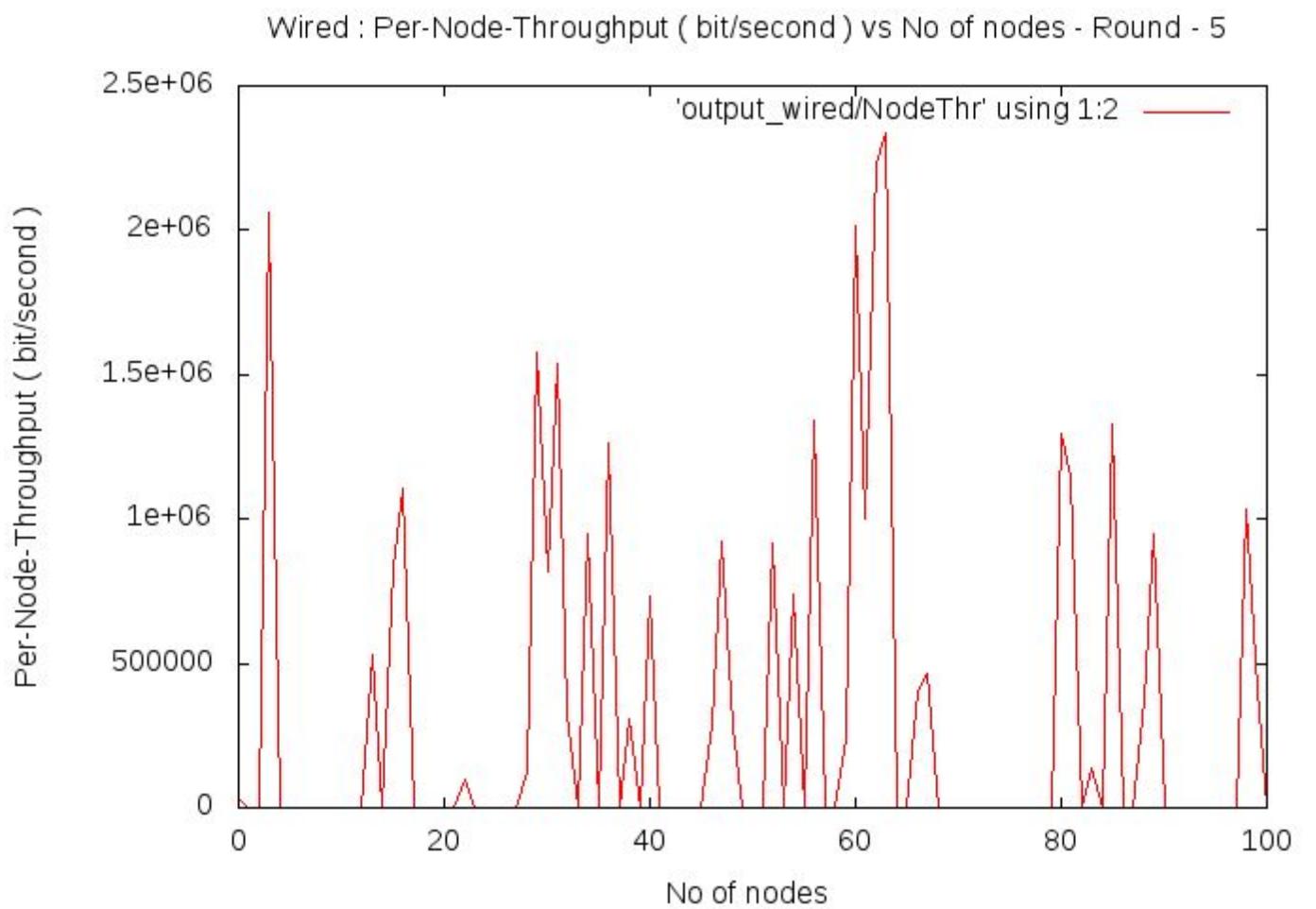


Wired : Average Delay vs No of nodes

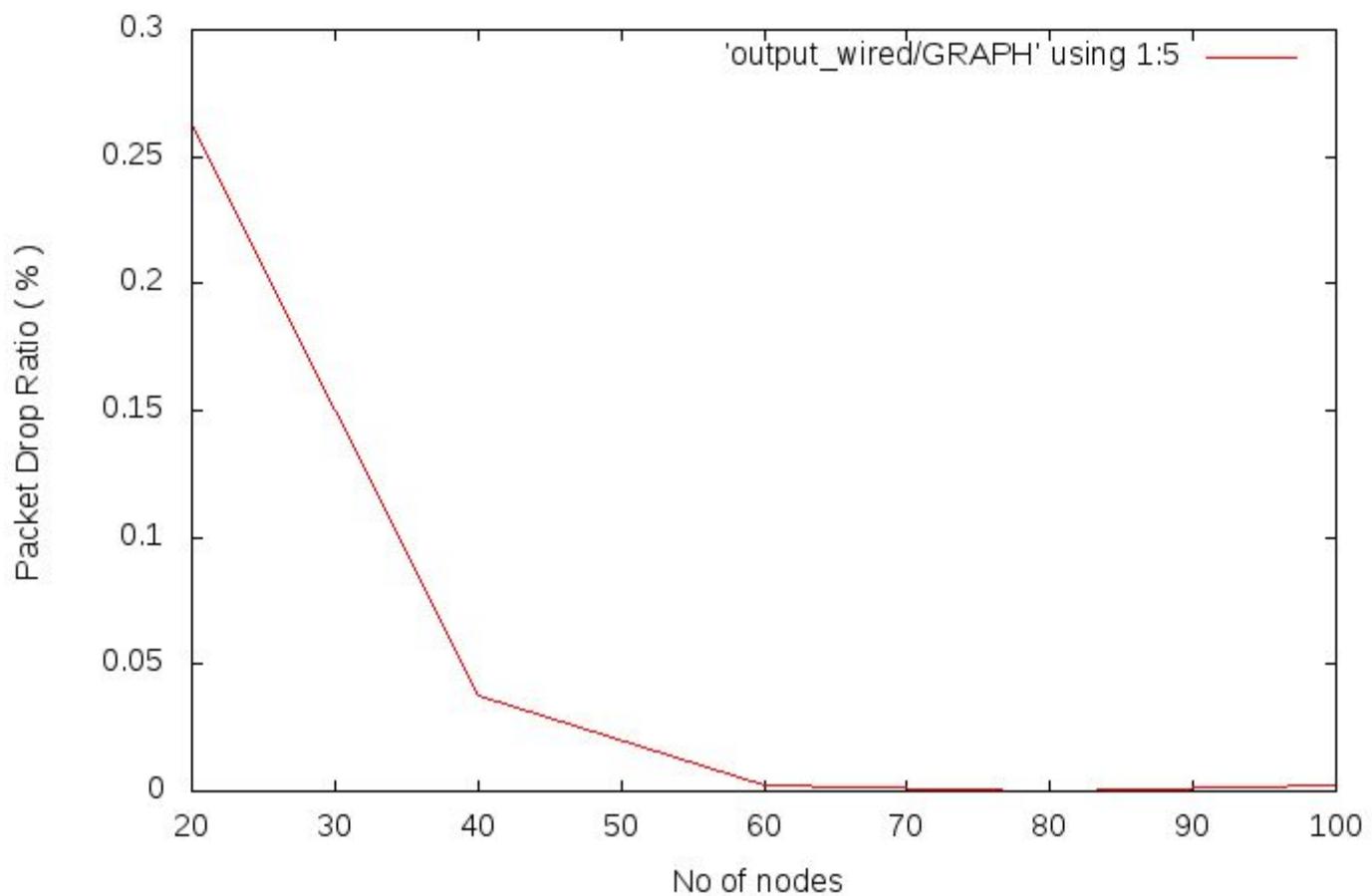


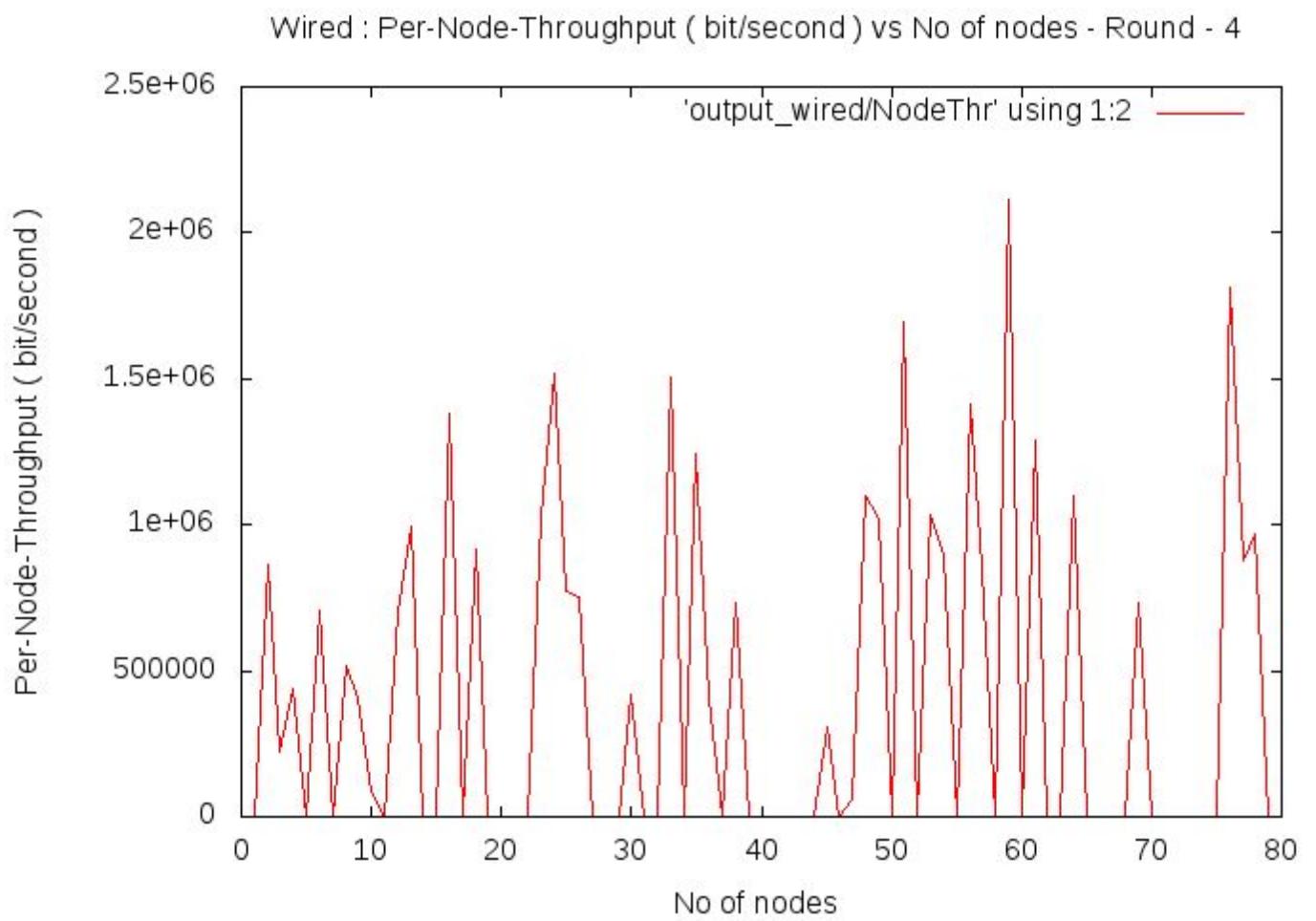
Wired : Packet Delivery Ratio vs No of nodes

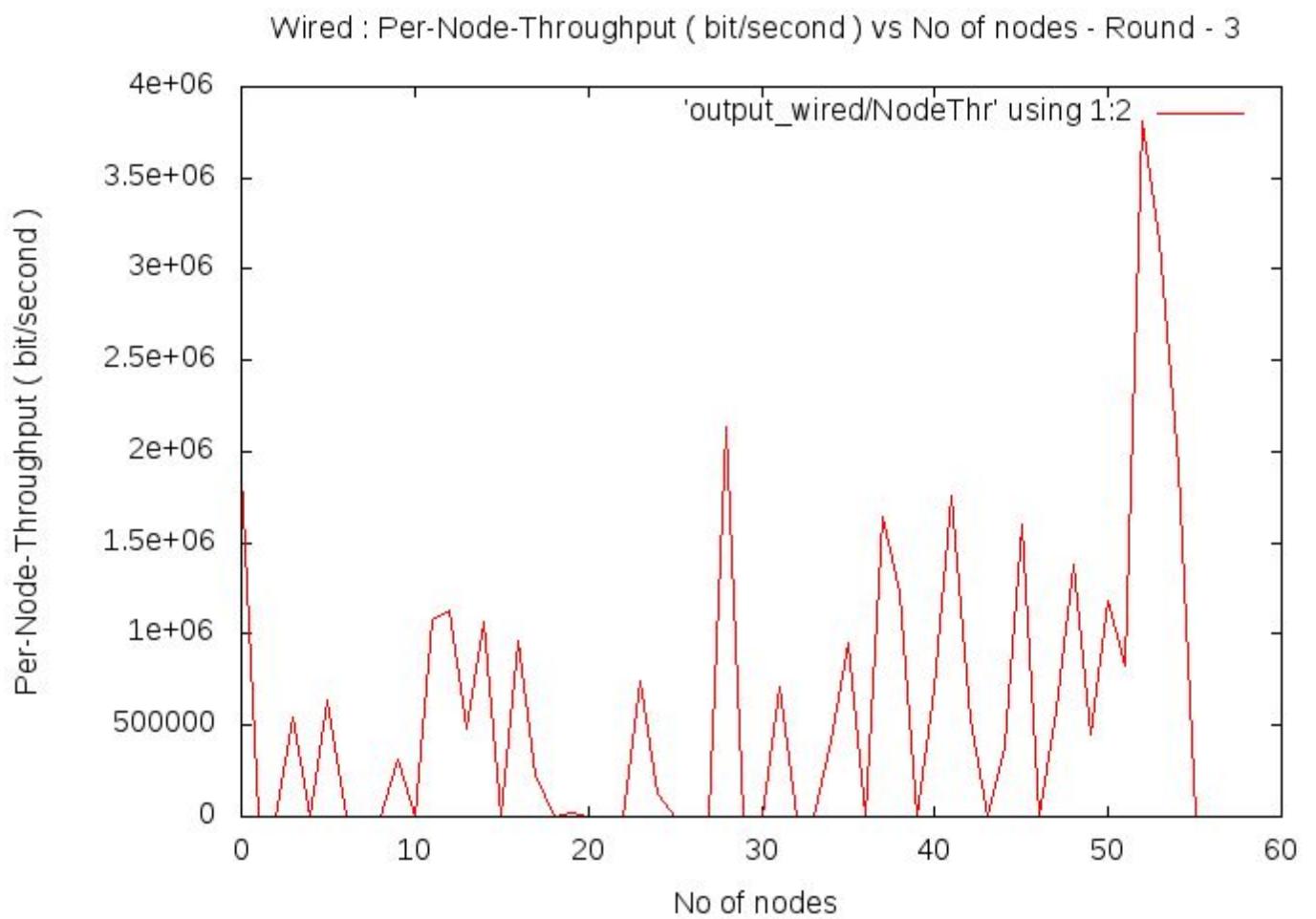


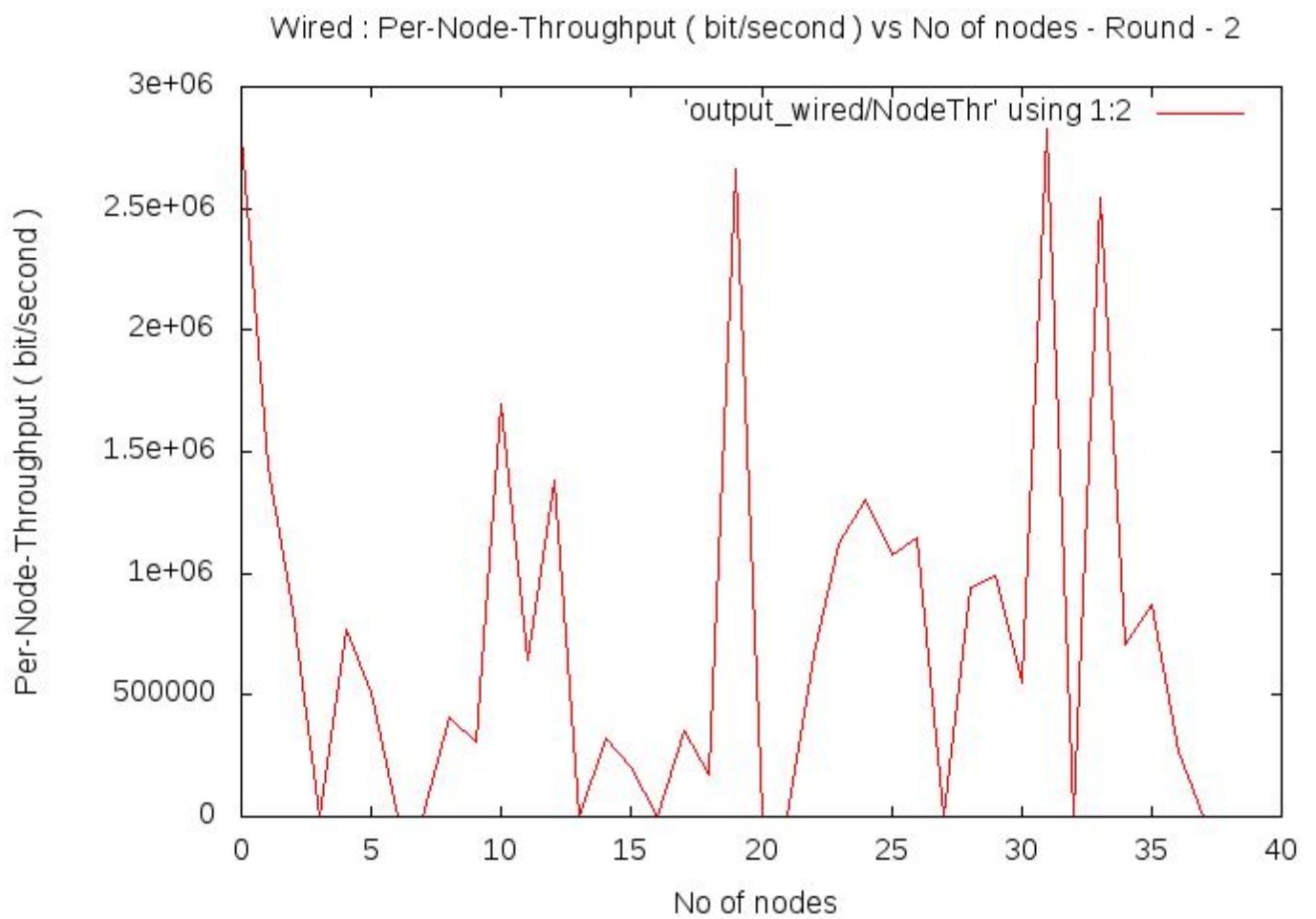


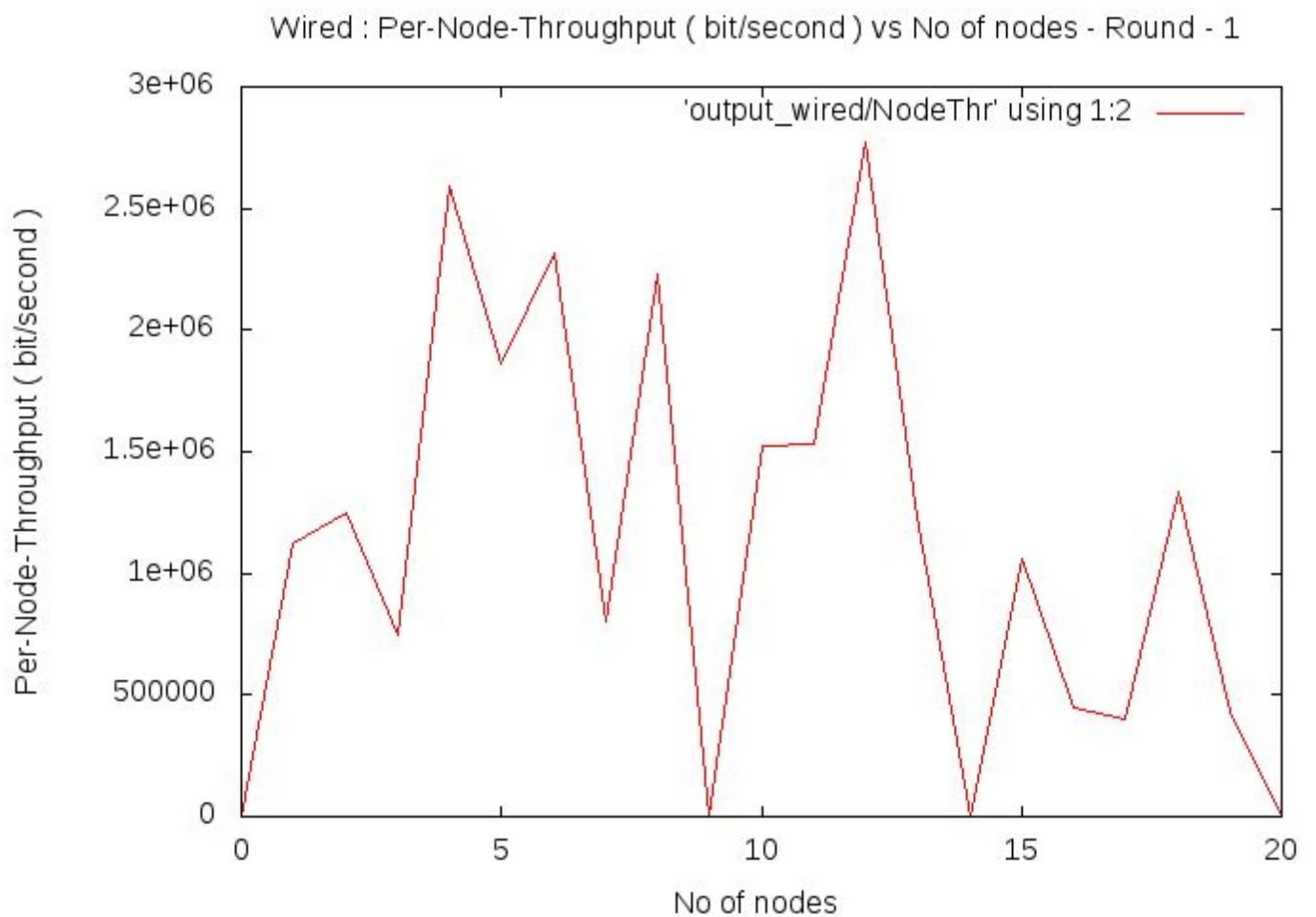
Wired : Packet Drop Ratio vs No of nodes

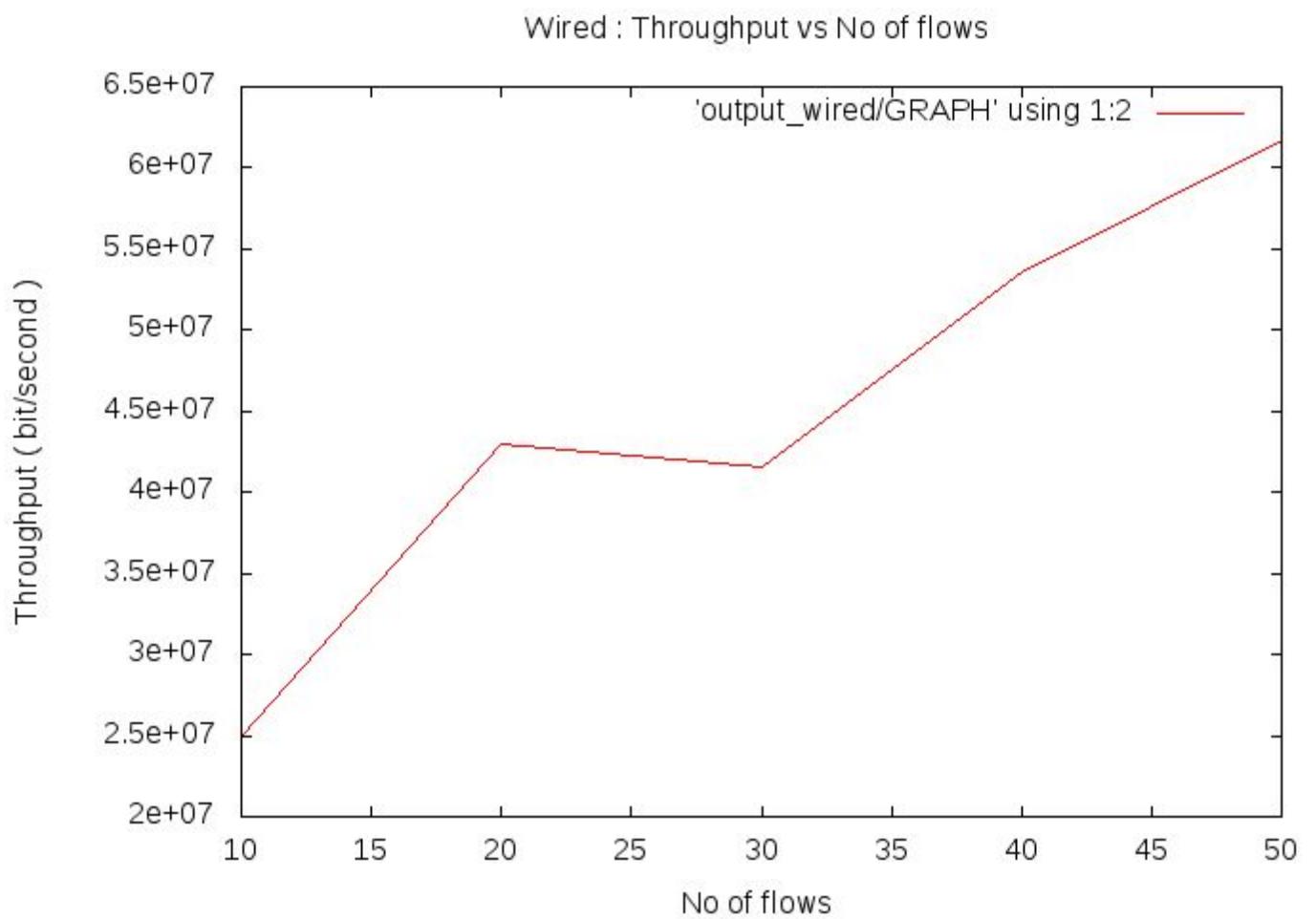




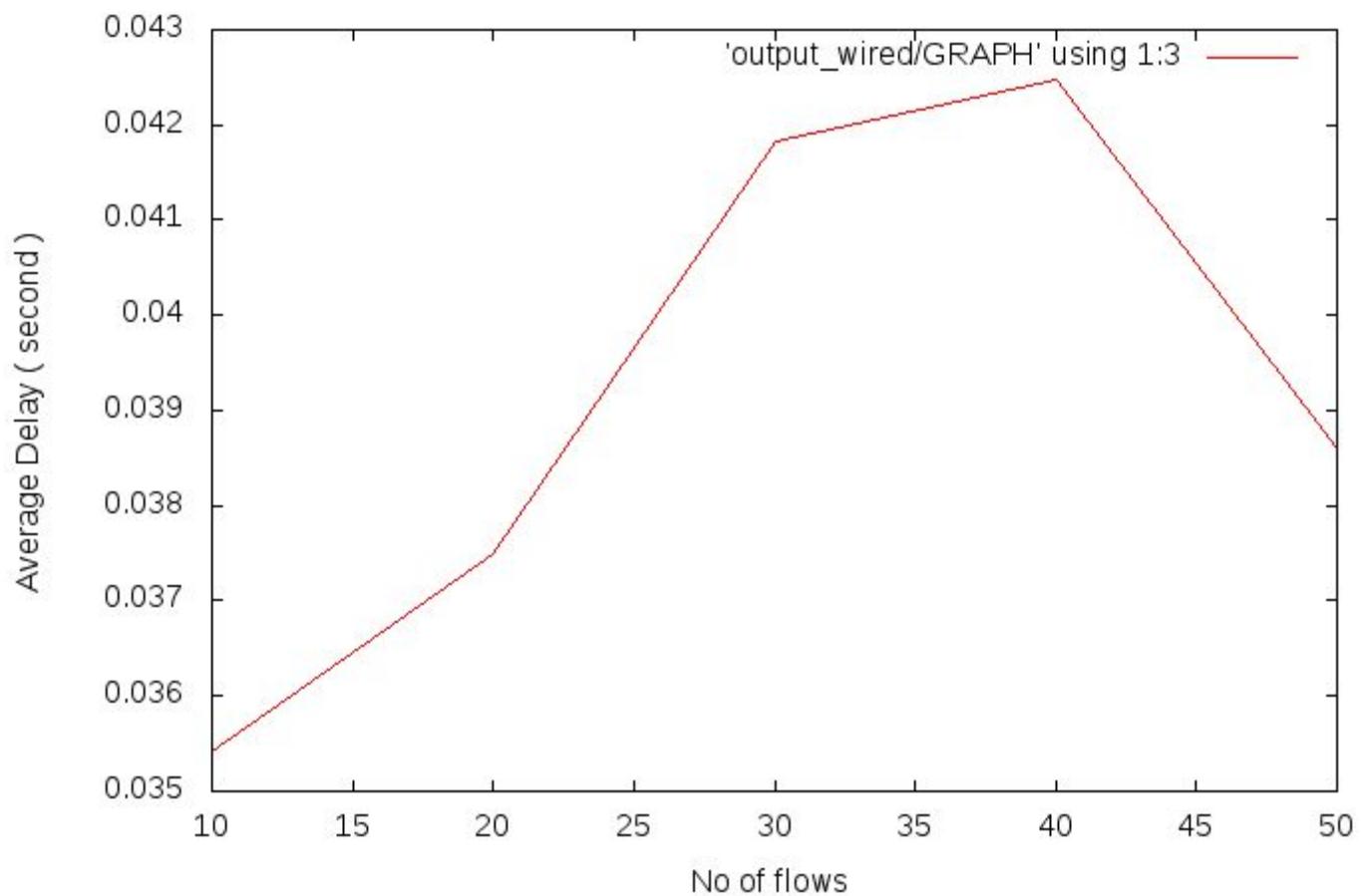




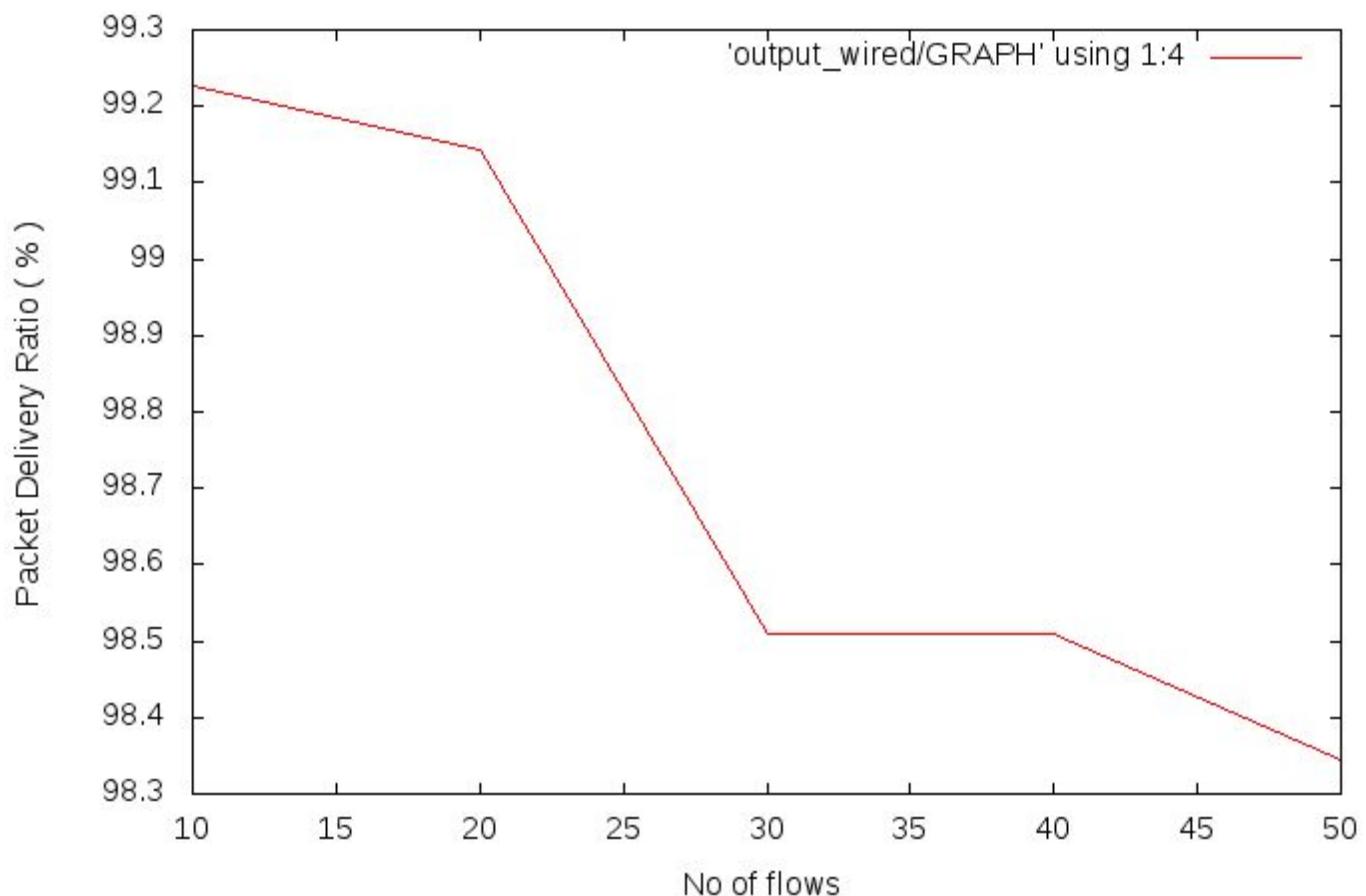




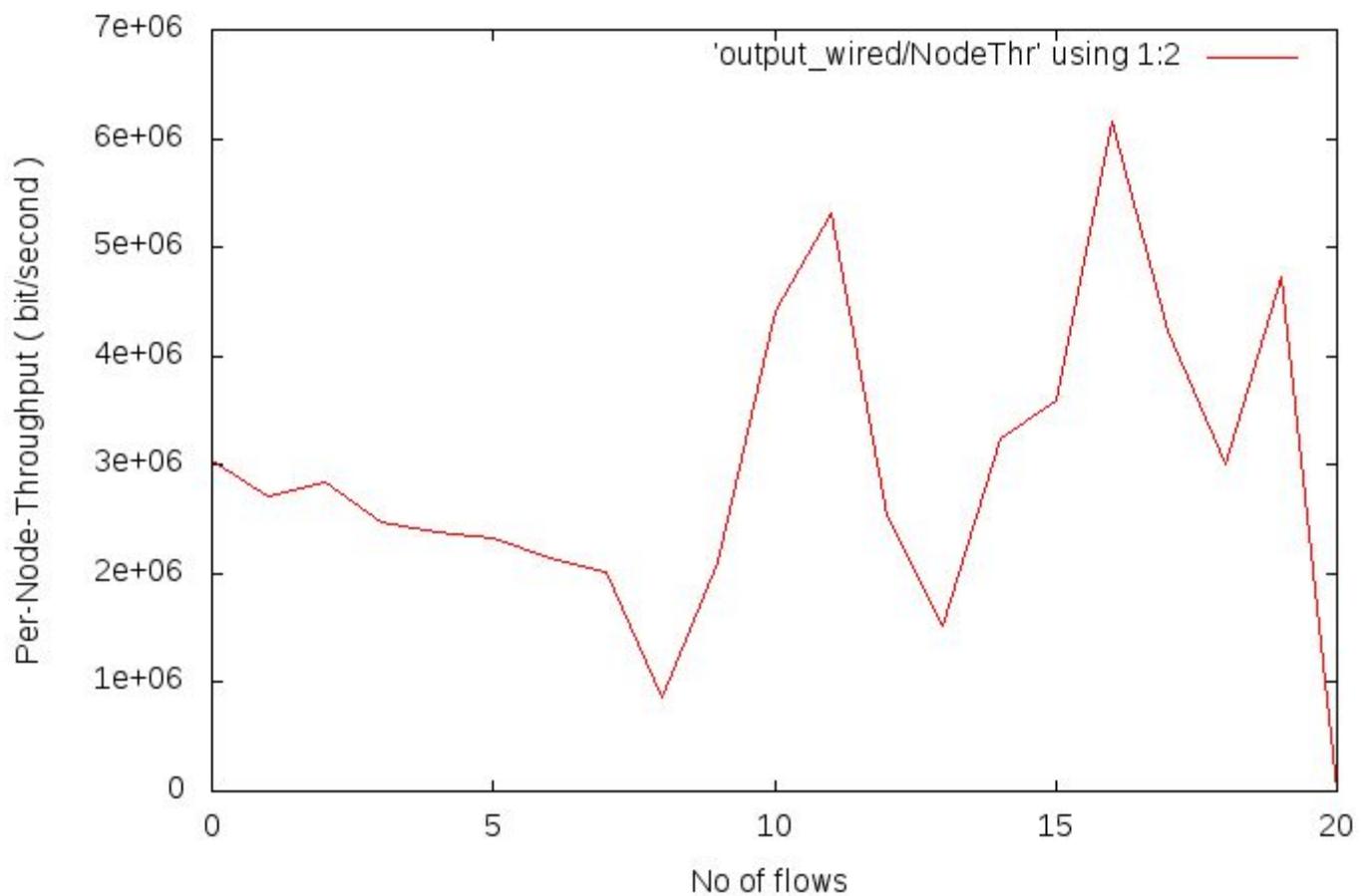
Wired : Average Delay vs No of flows



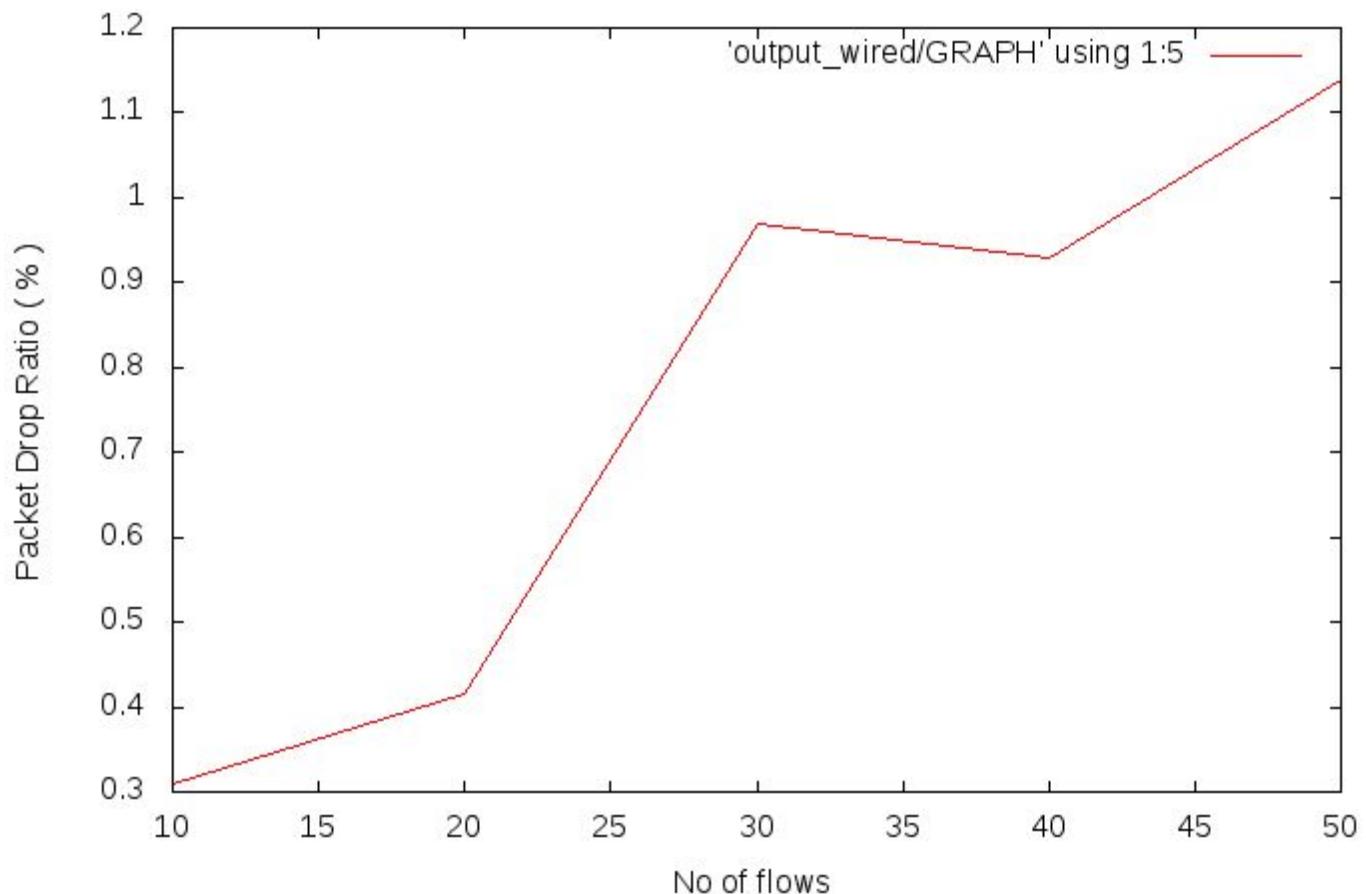
Wired : Packet Delivery Ratio vs No of flows

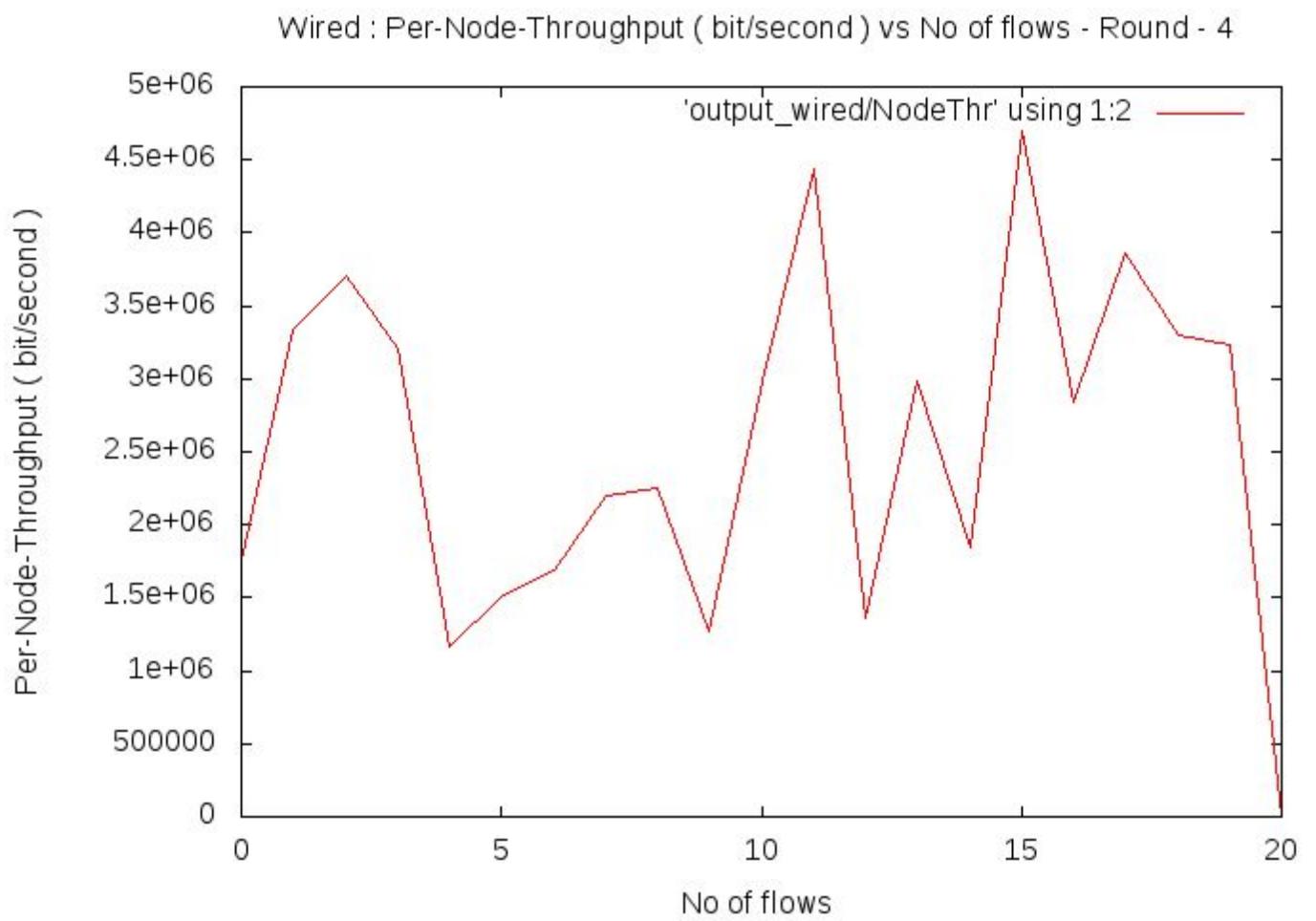


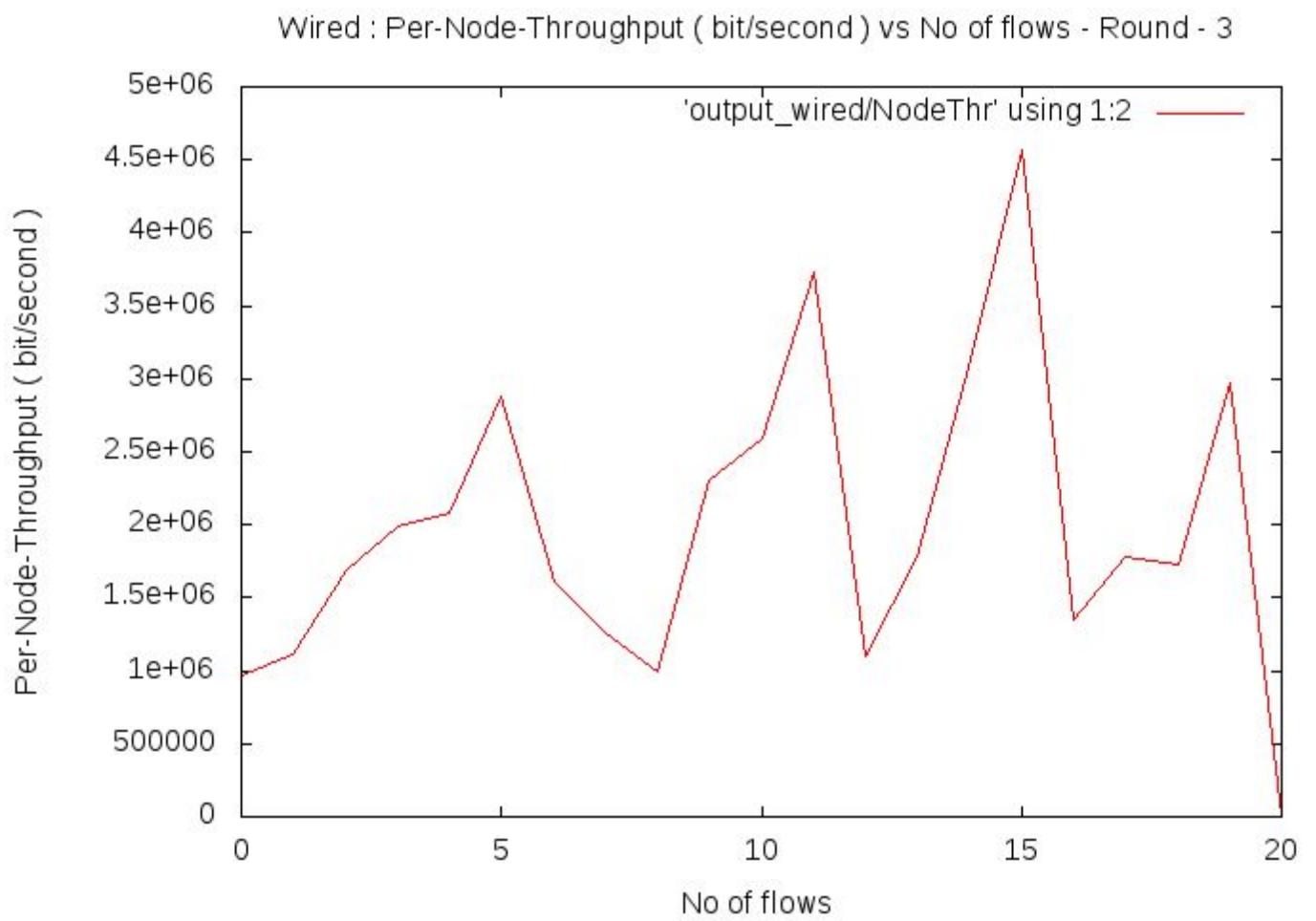
Wired : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 5

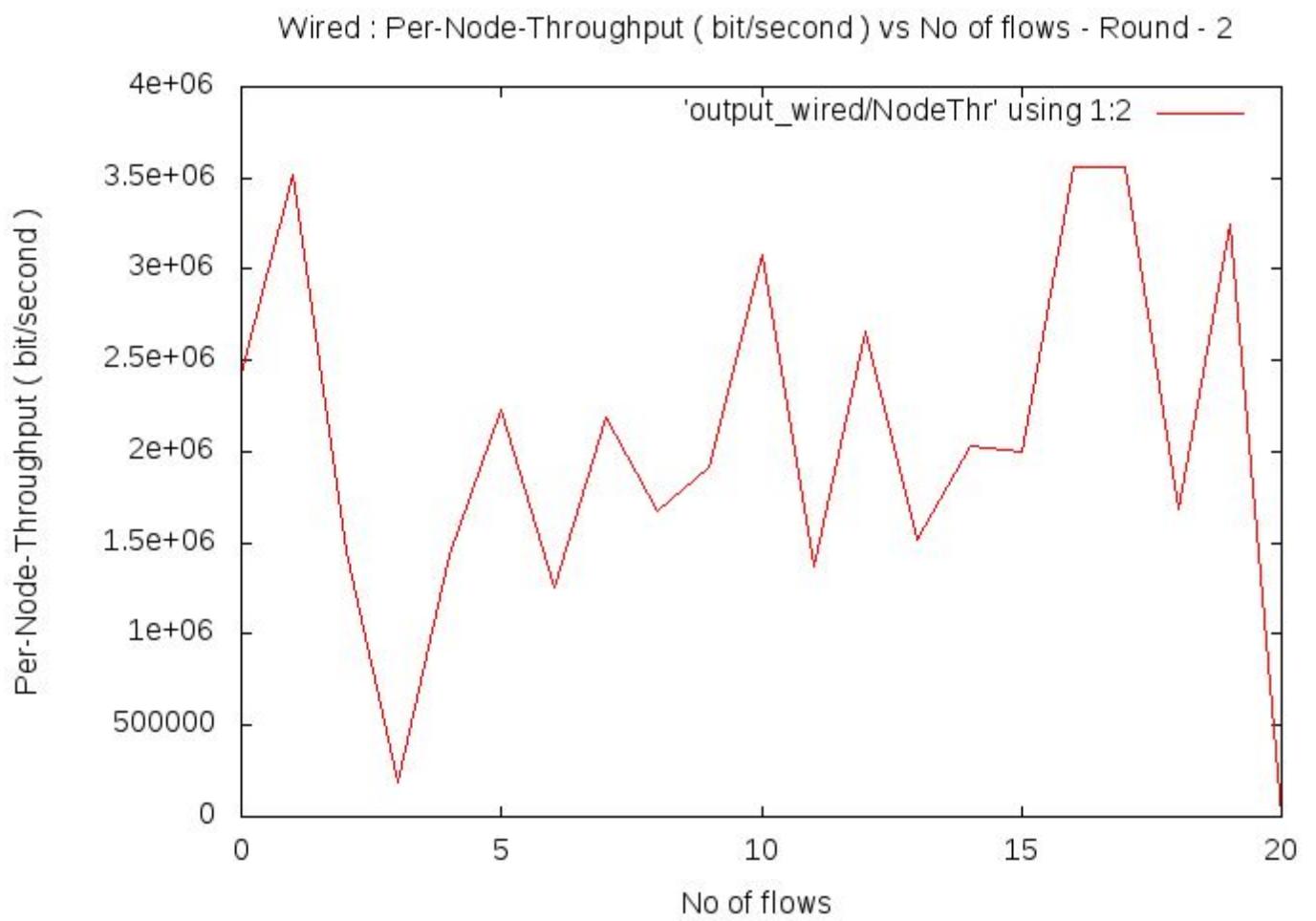


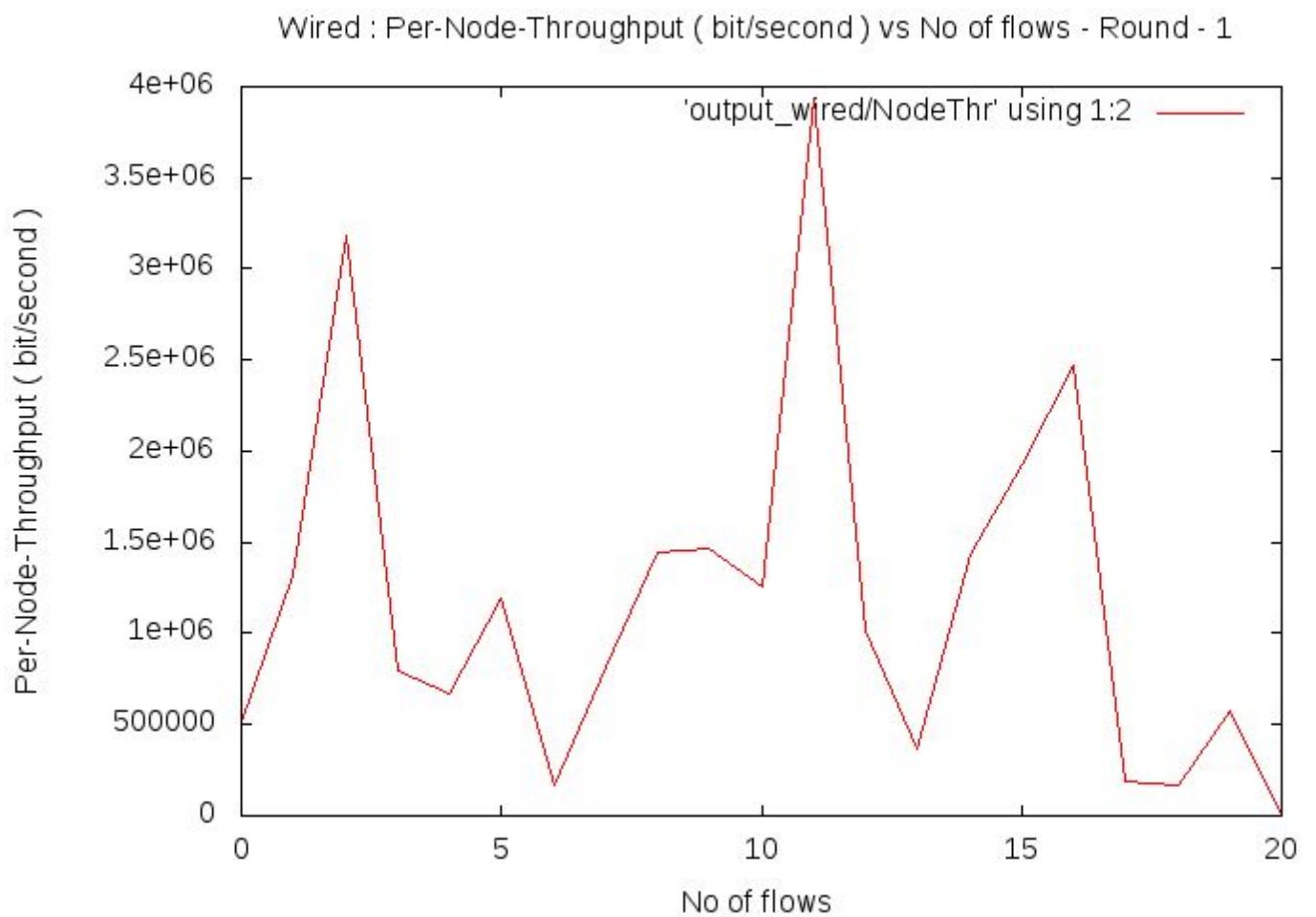
Wired : Packet Drop Ratio vs No of flows

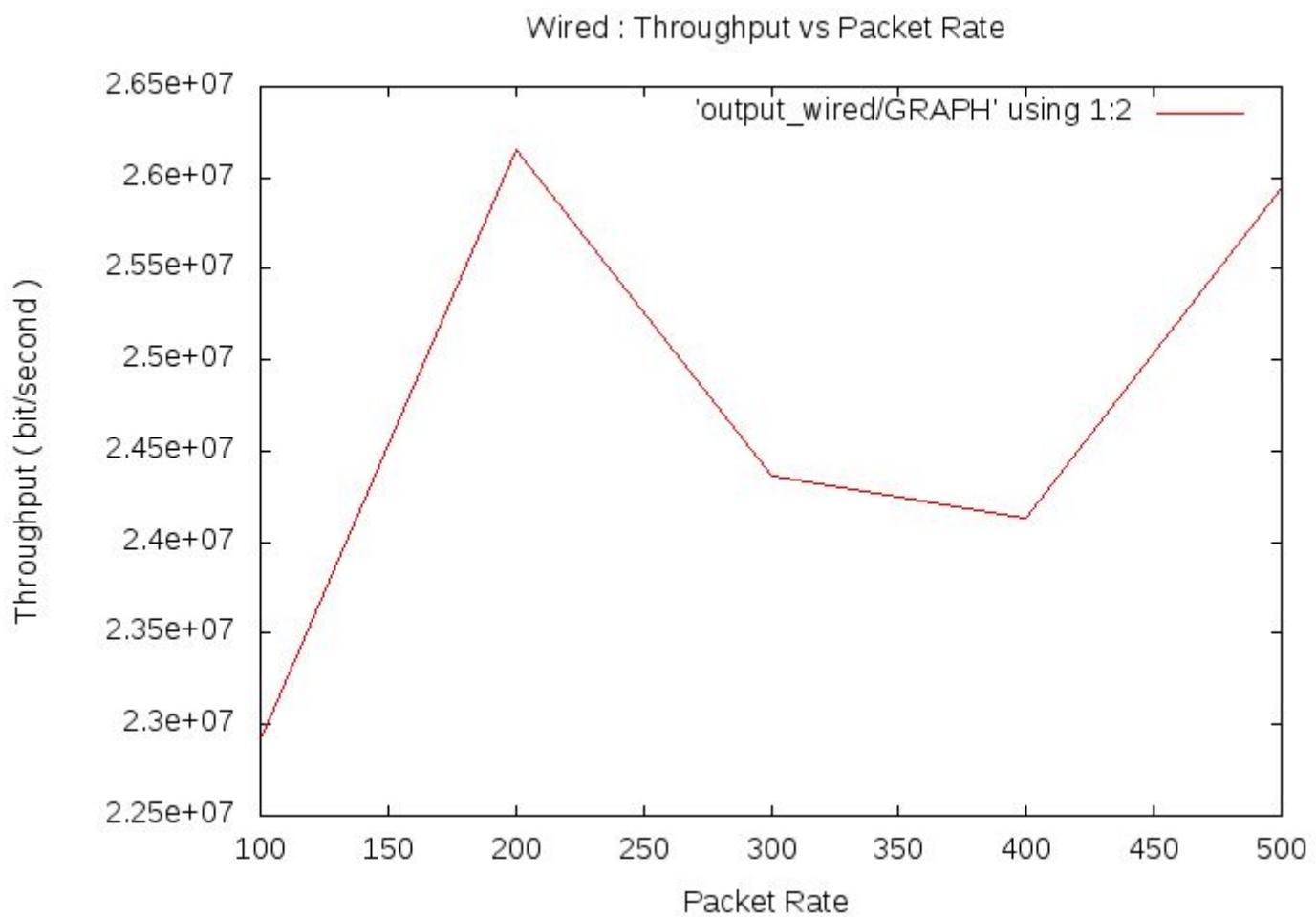


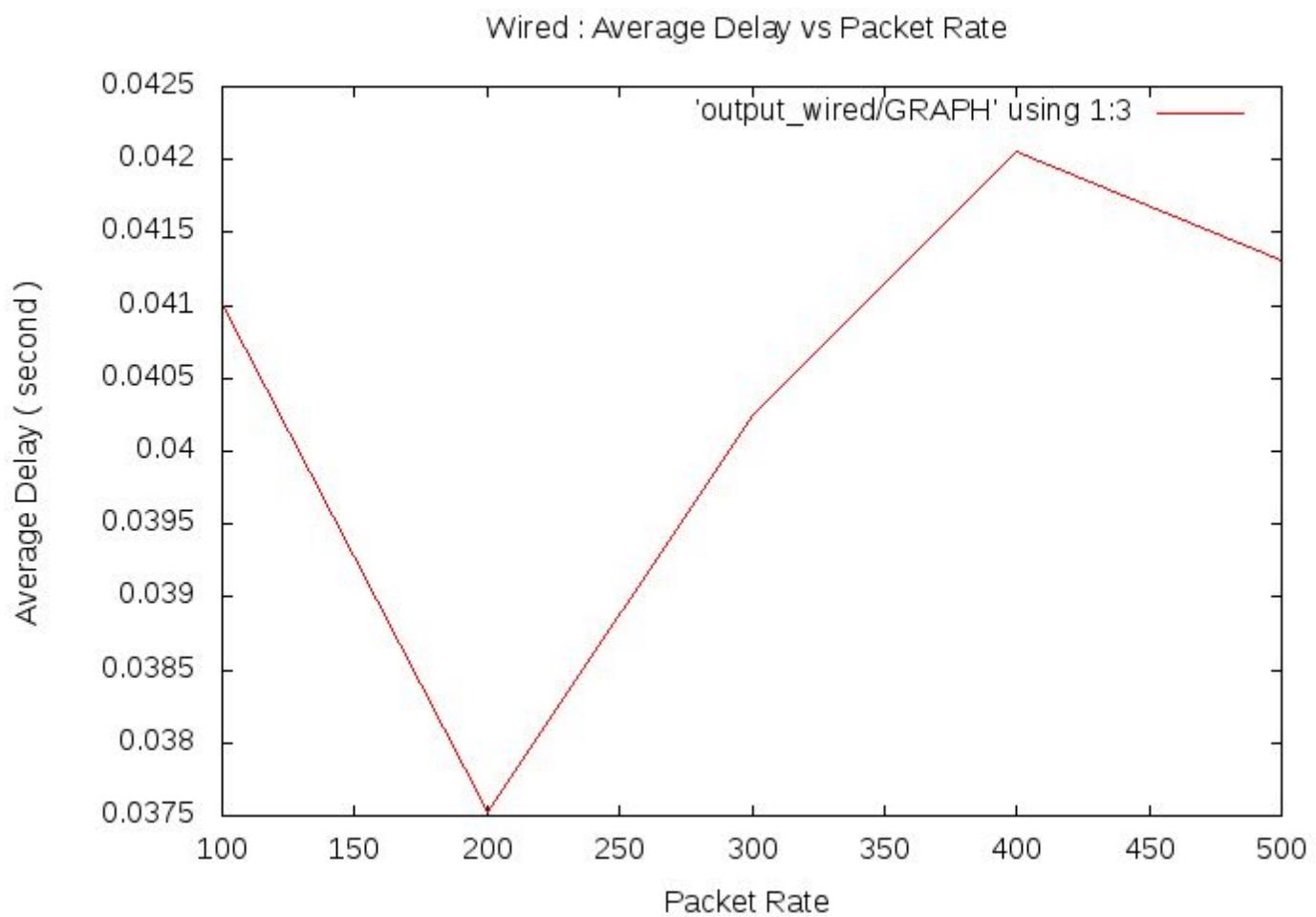


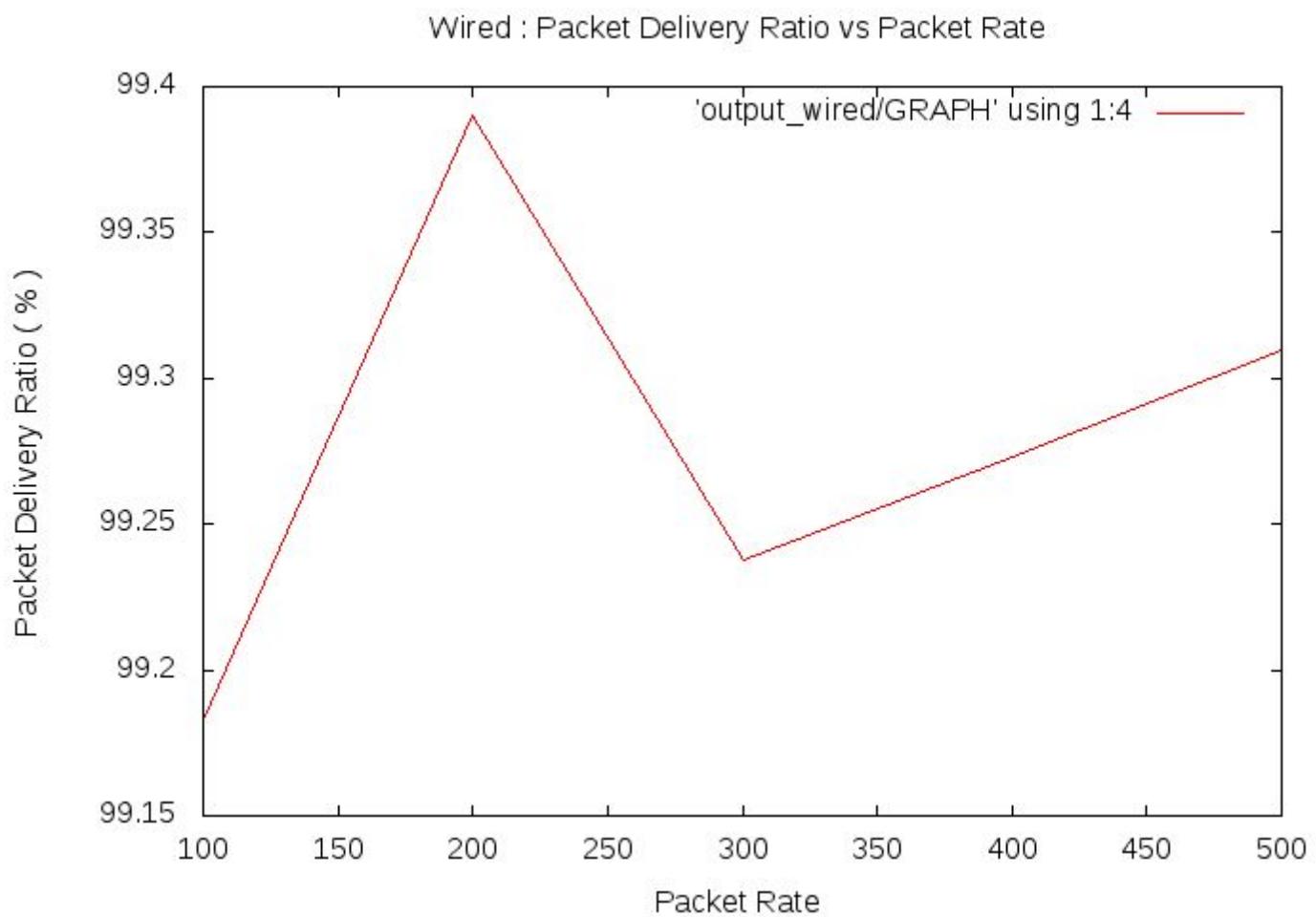


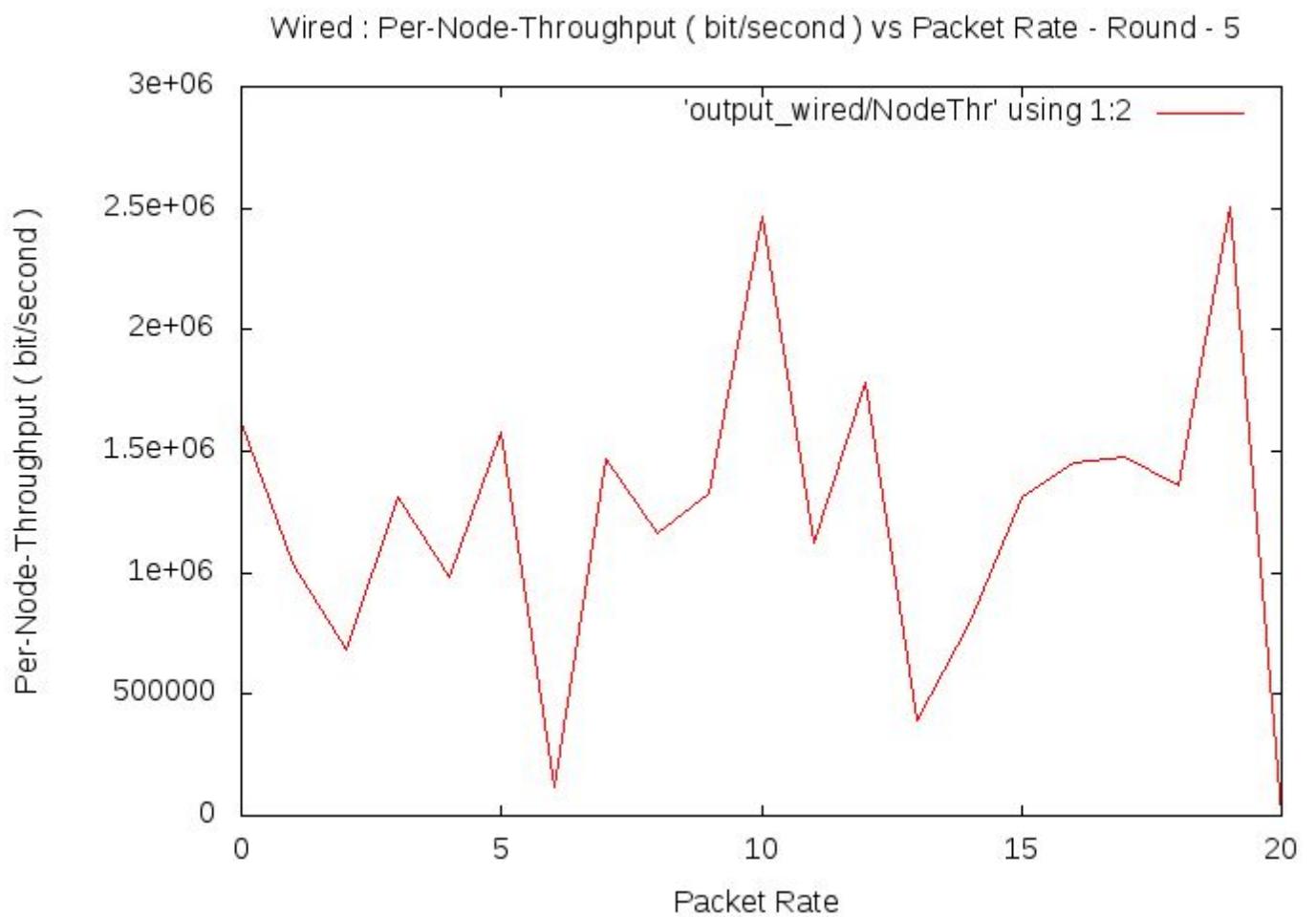




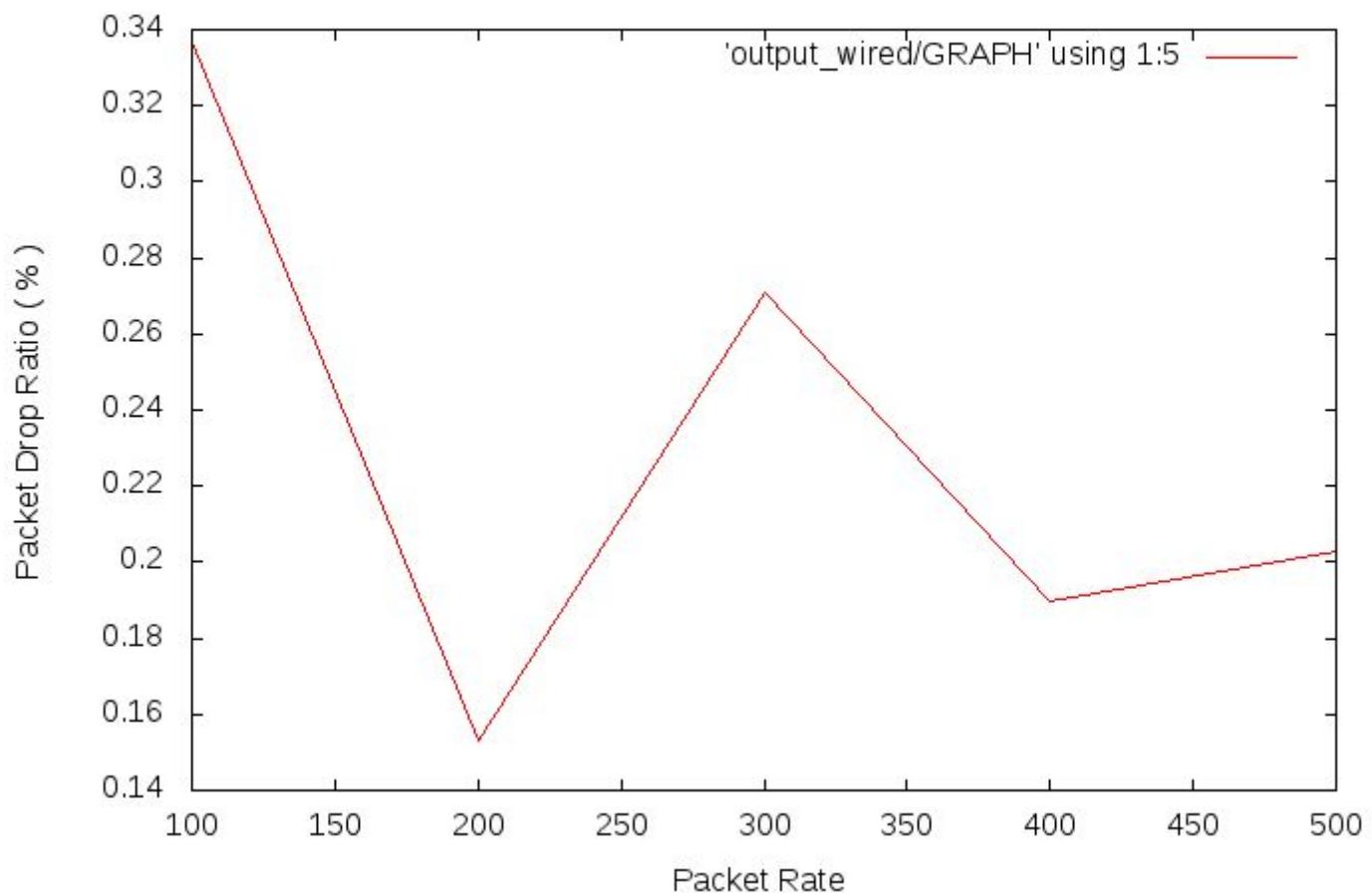


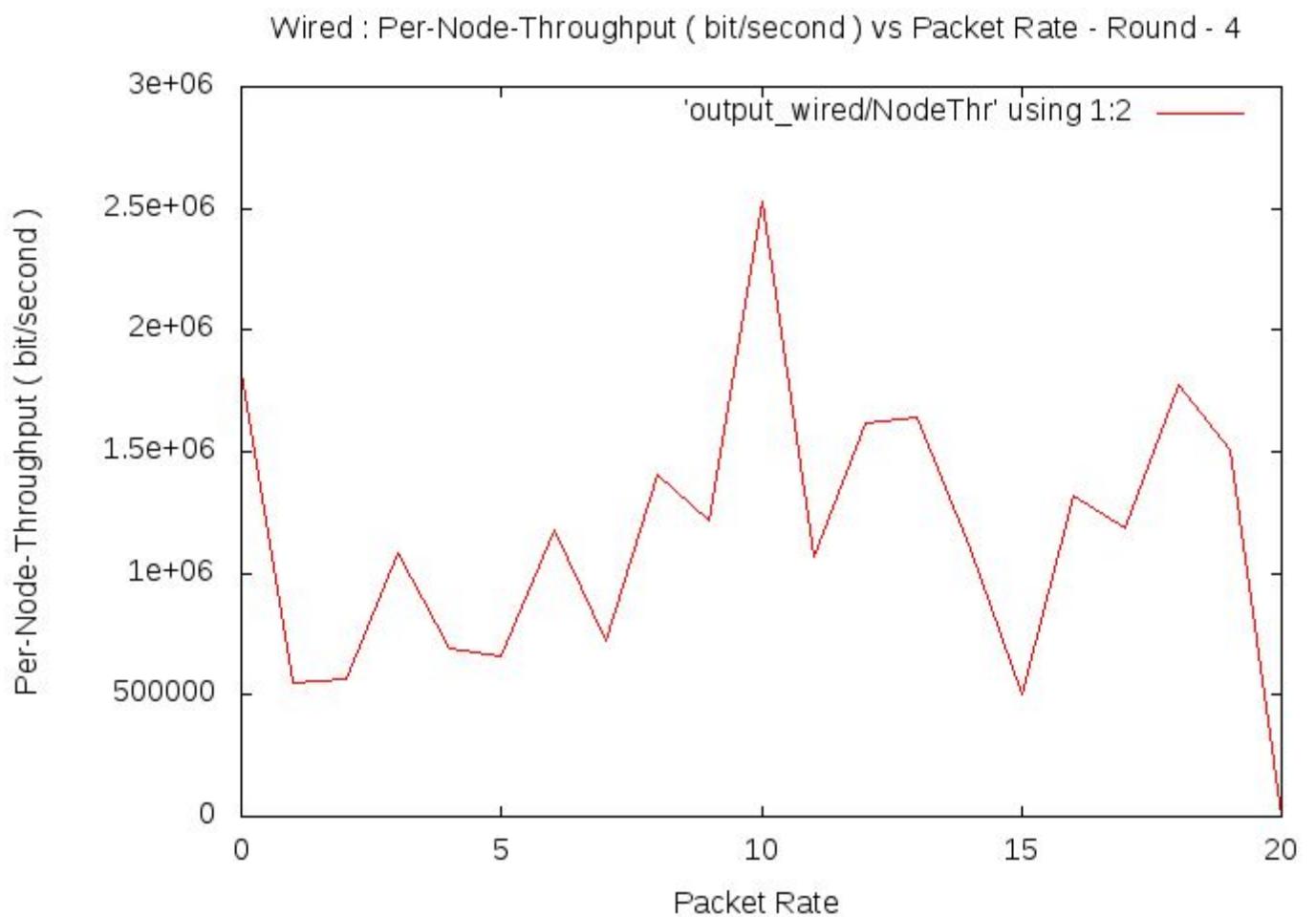


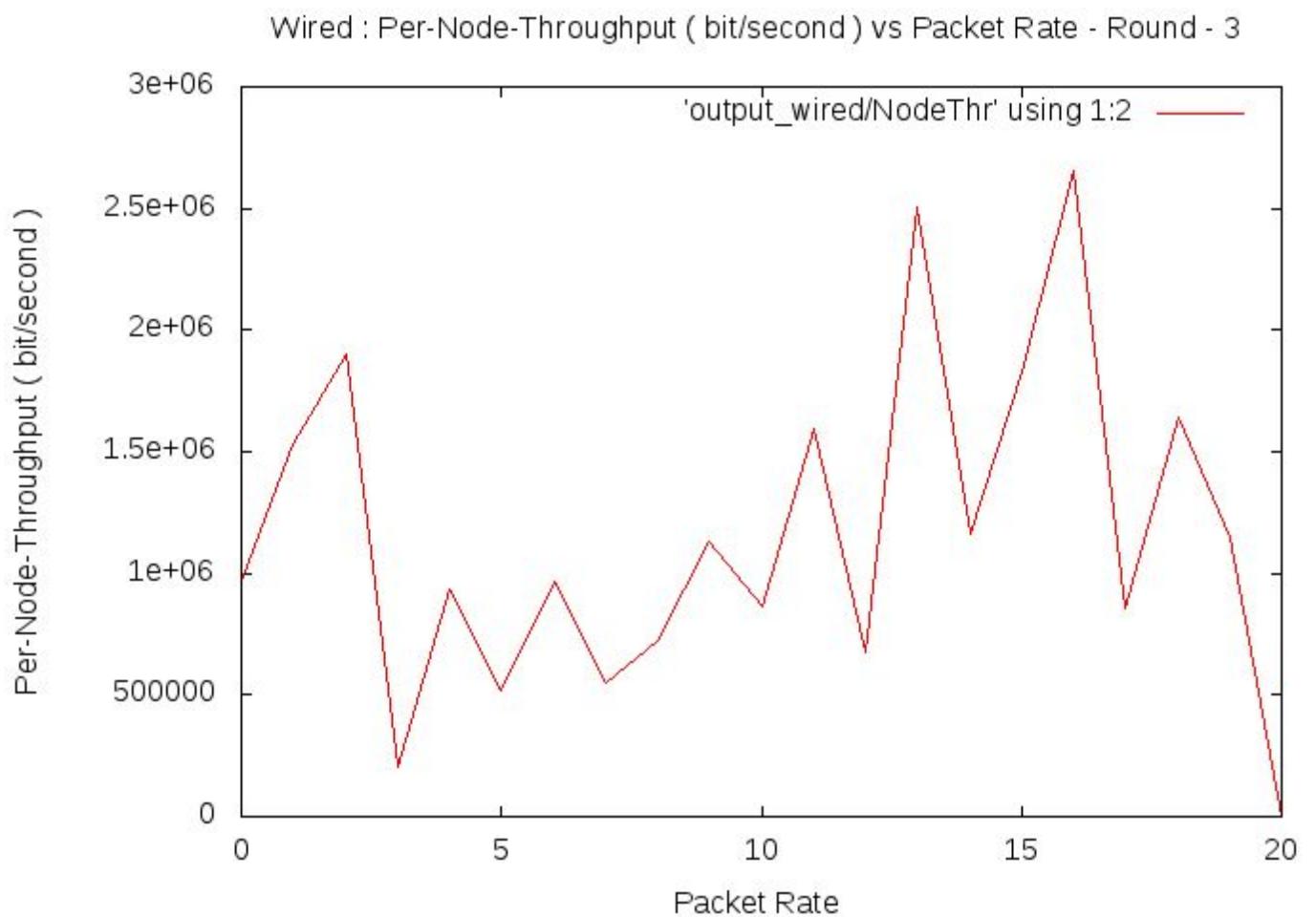


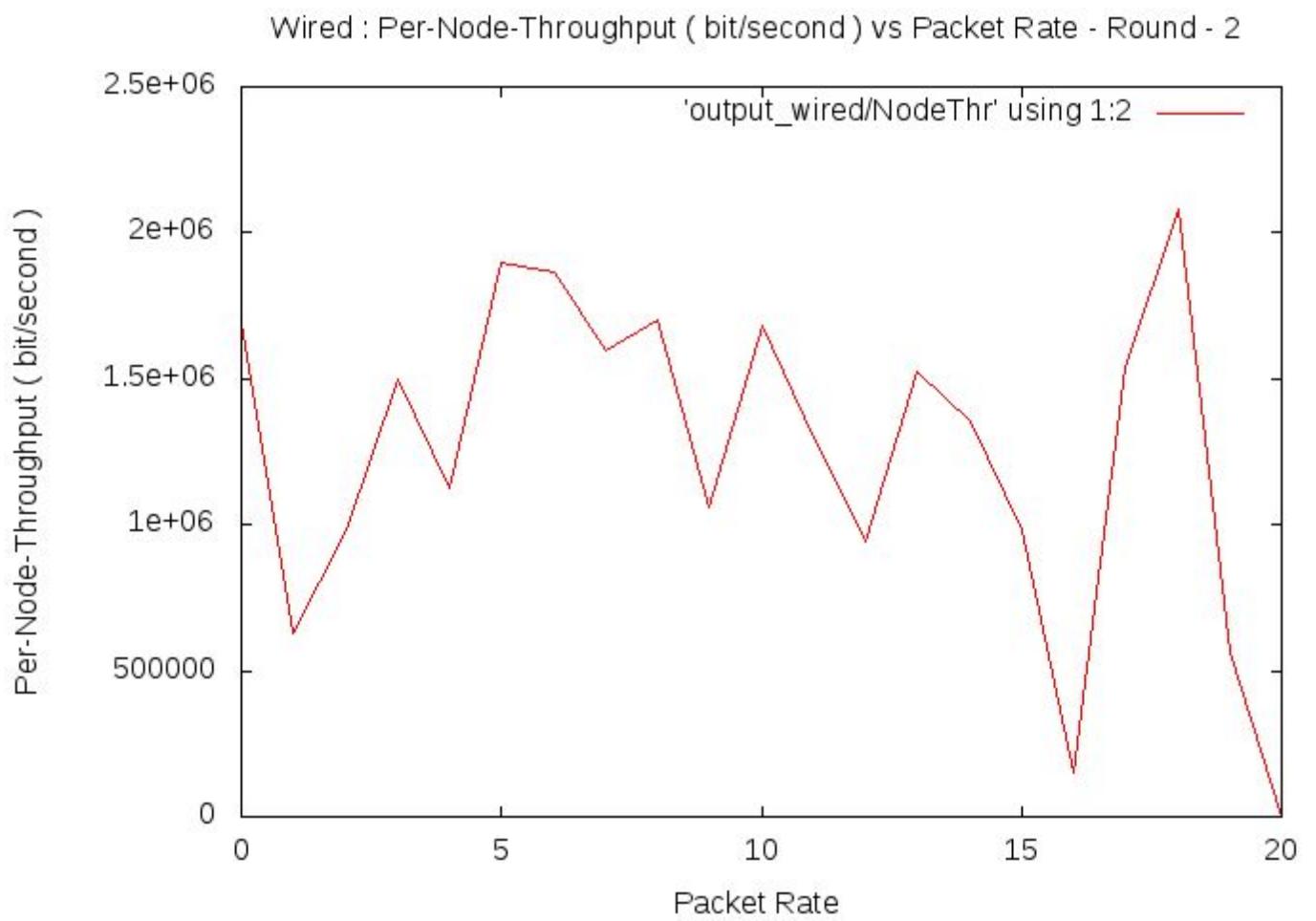


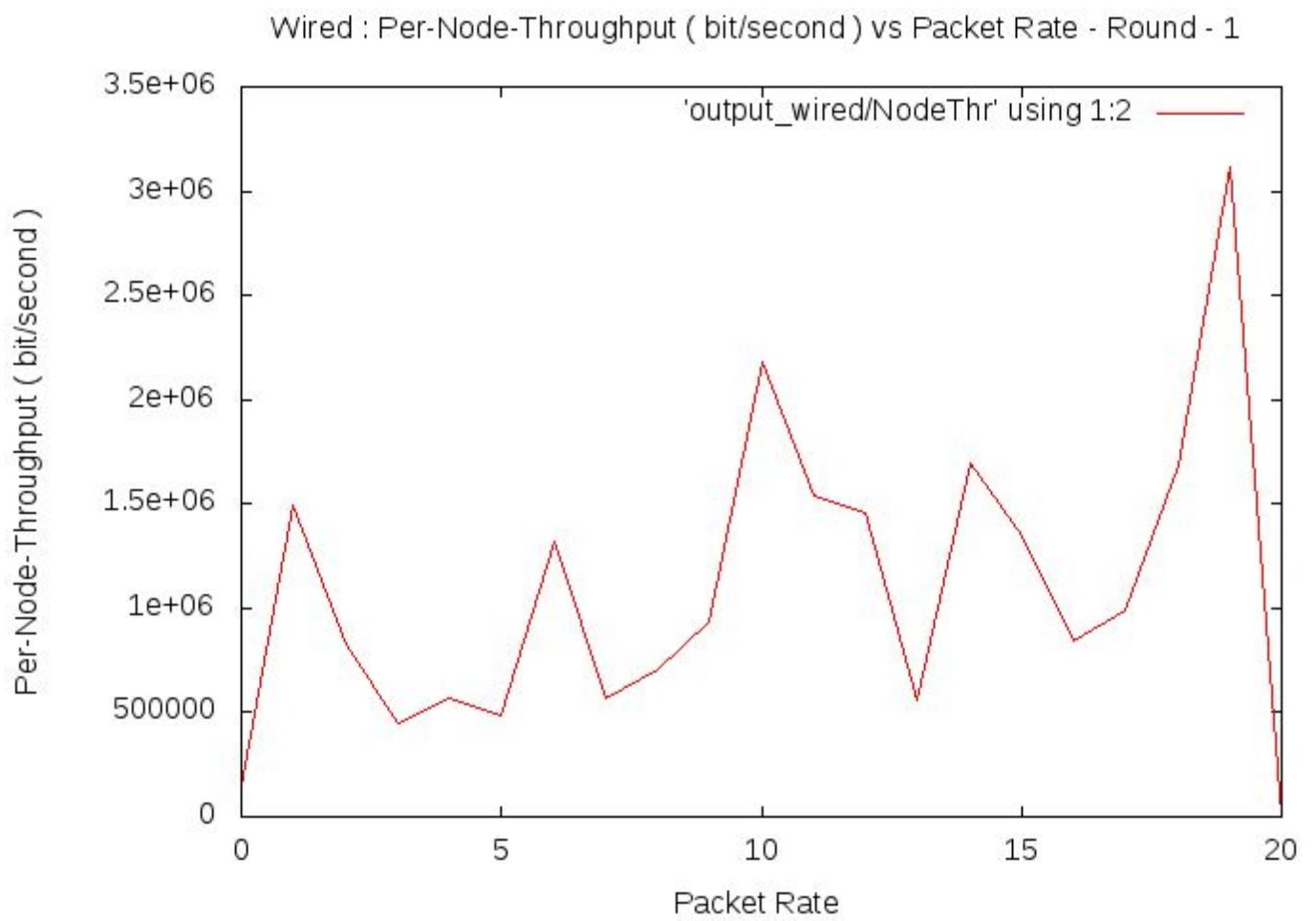
Wired : Packet Drop Ratio vs Packet Rate







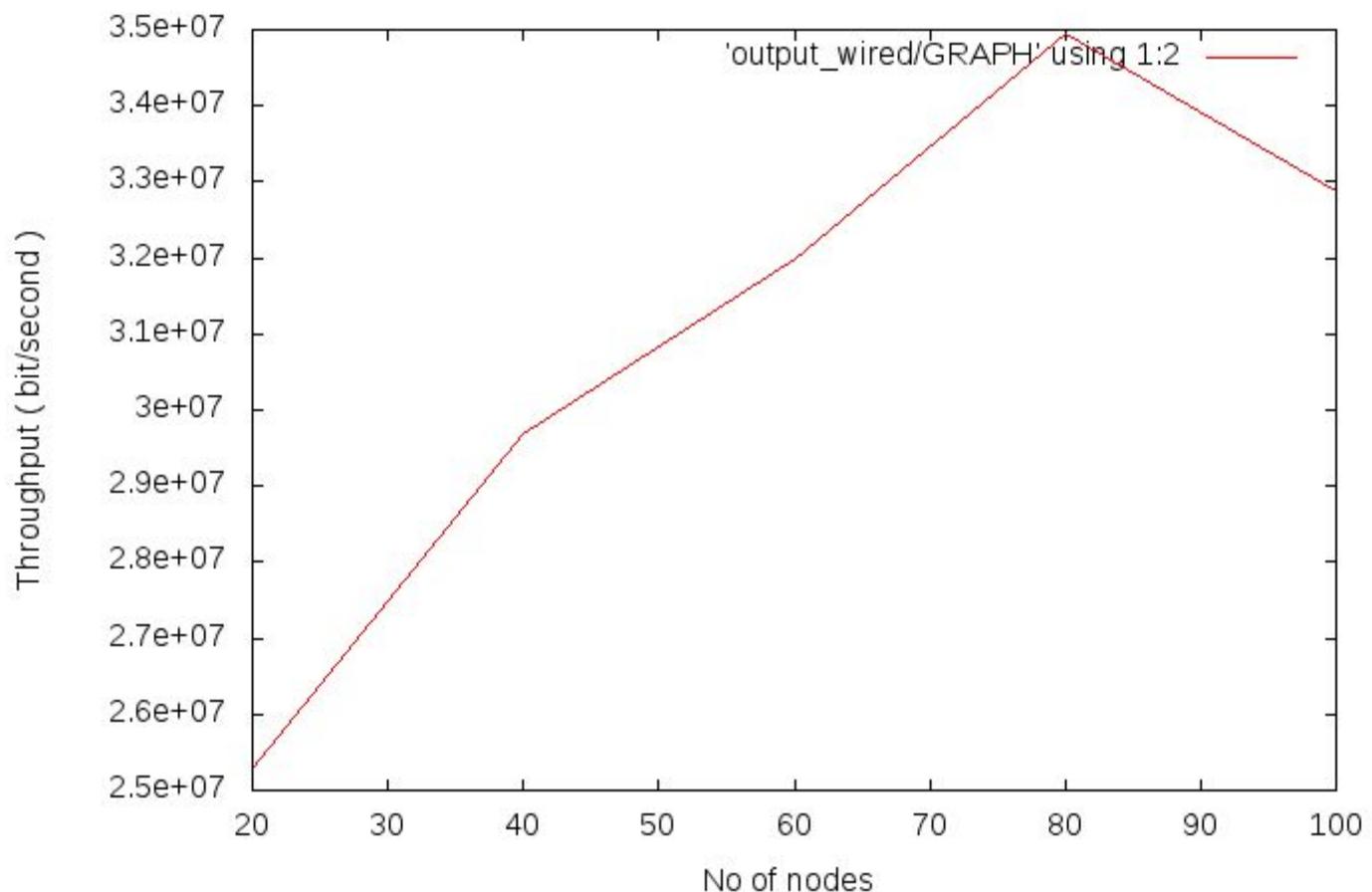




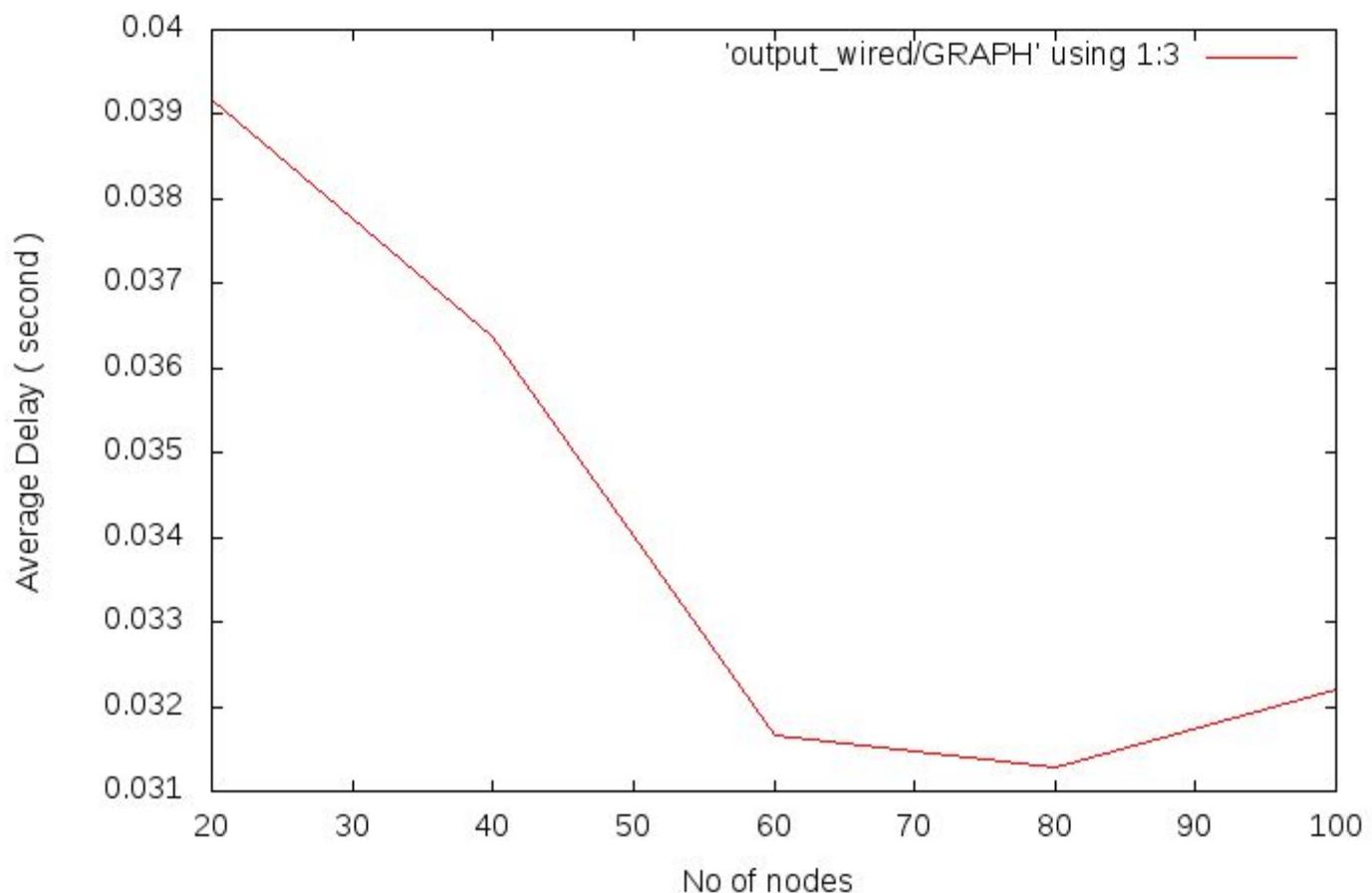
# **Wired (After Modification)**



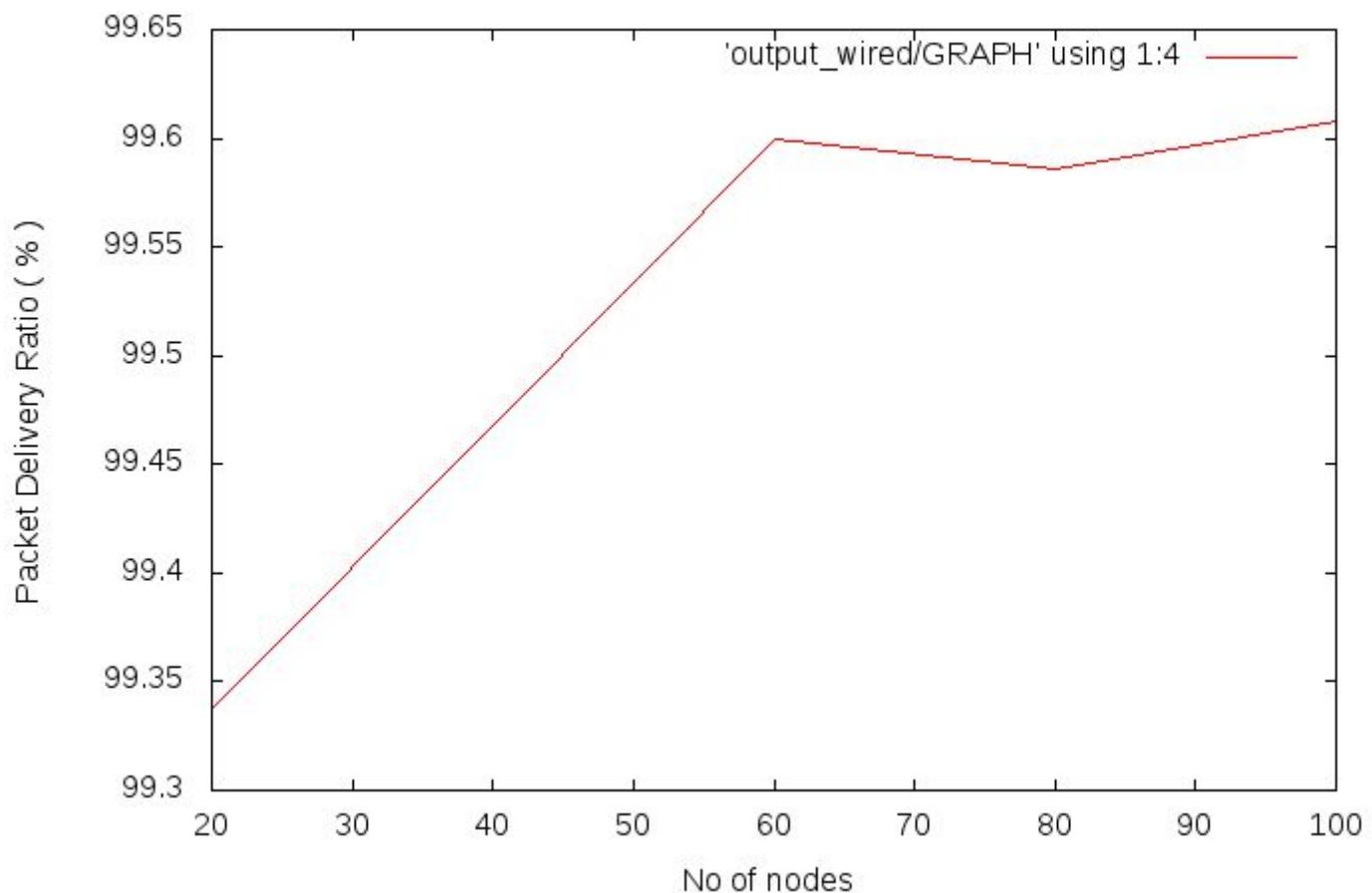
Wired (After Modification) : Throughput vs No of nodes

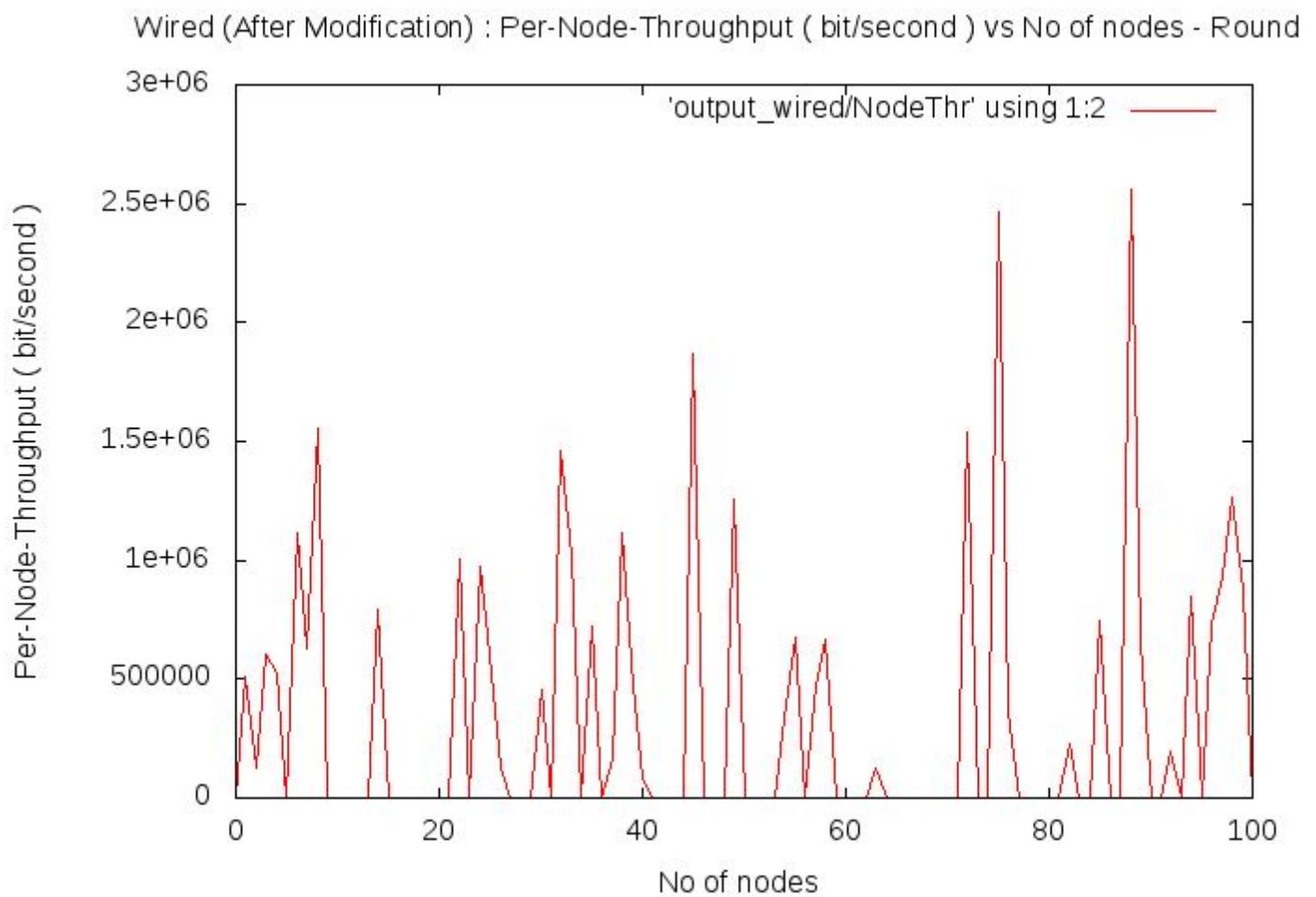


Wired (After Modification) : Average Delay vs No of nodes

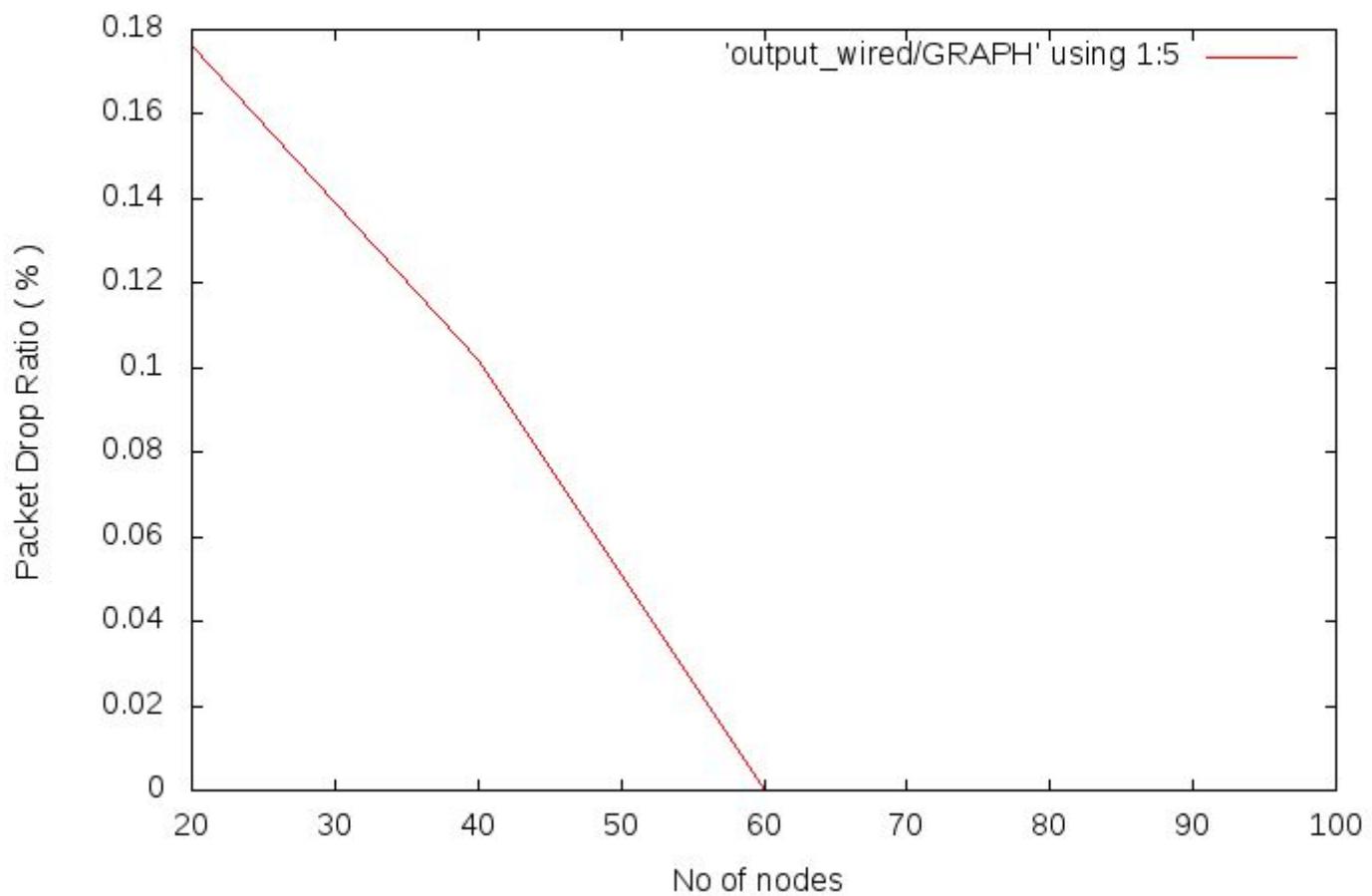


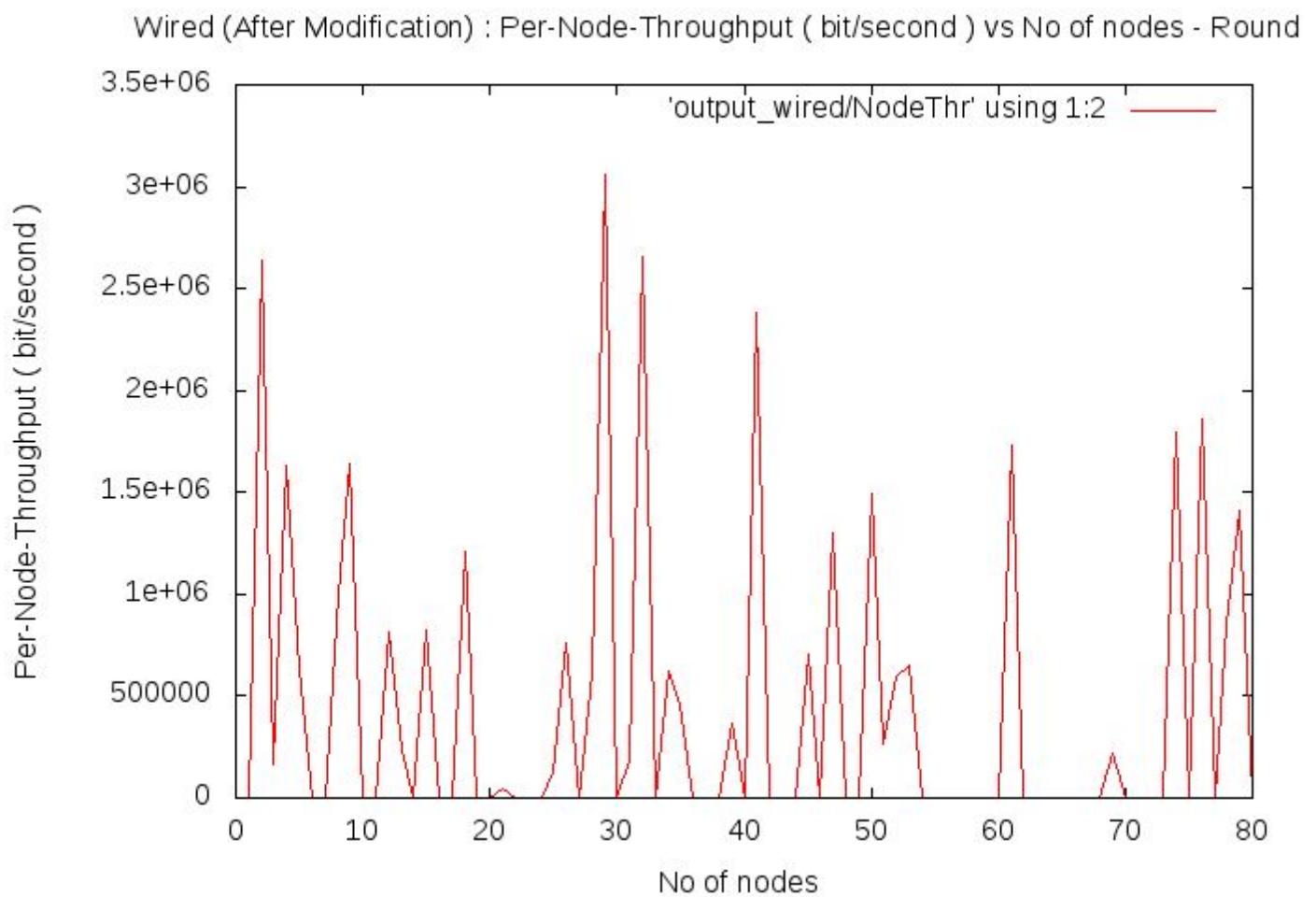
Wired (After Modification) : Packet Delivery Ratio vs No of nodes



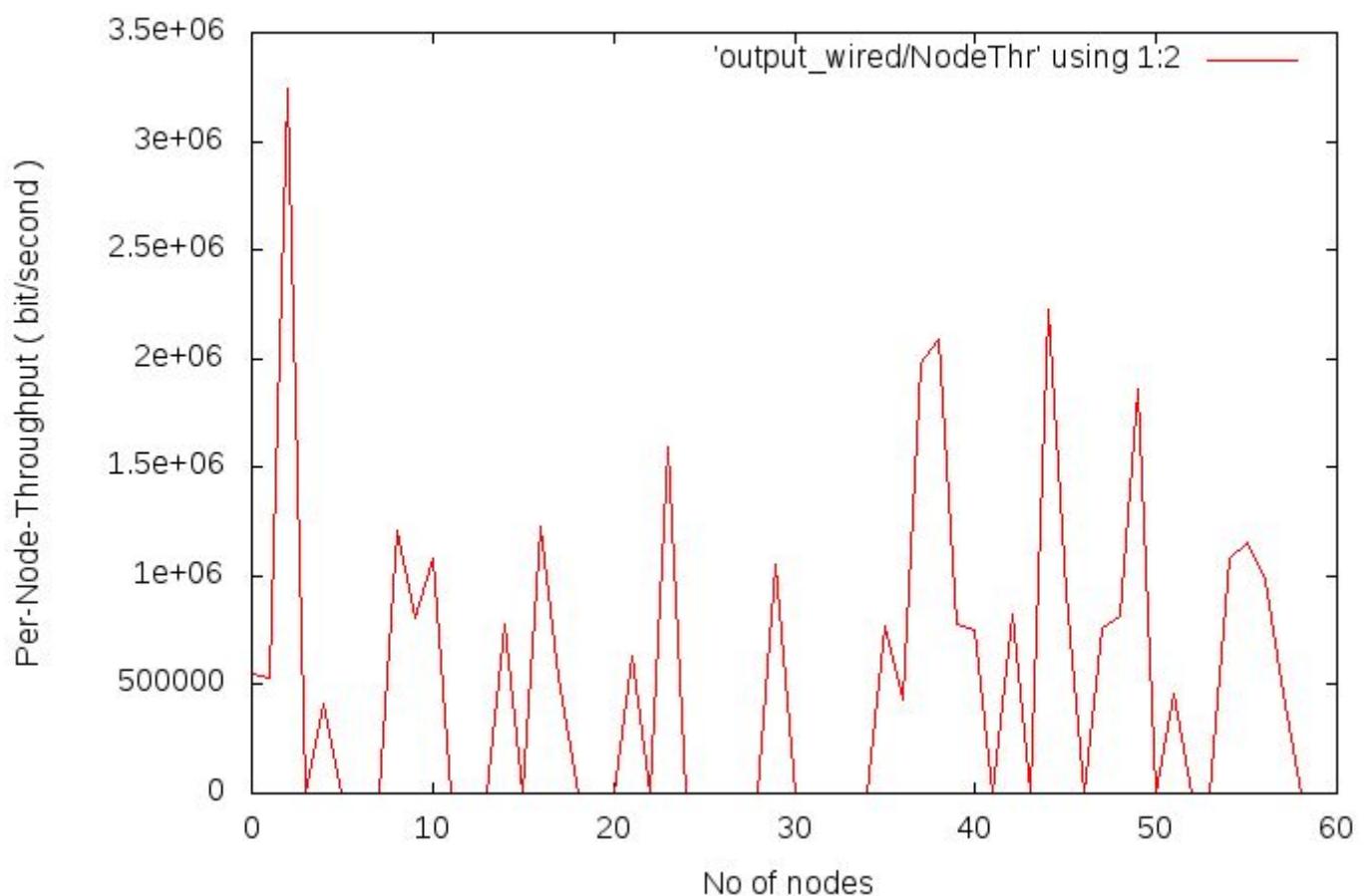


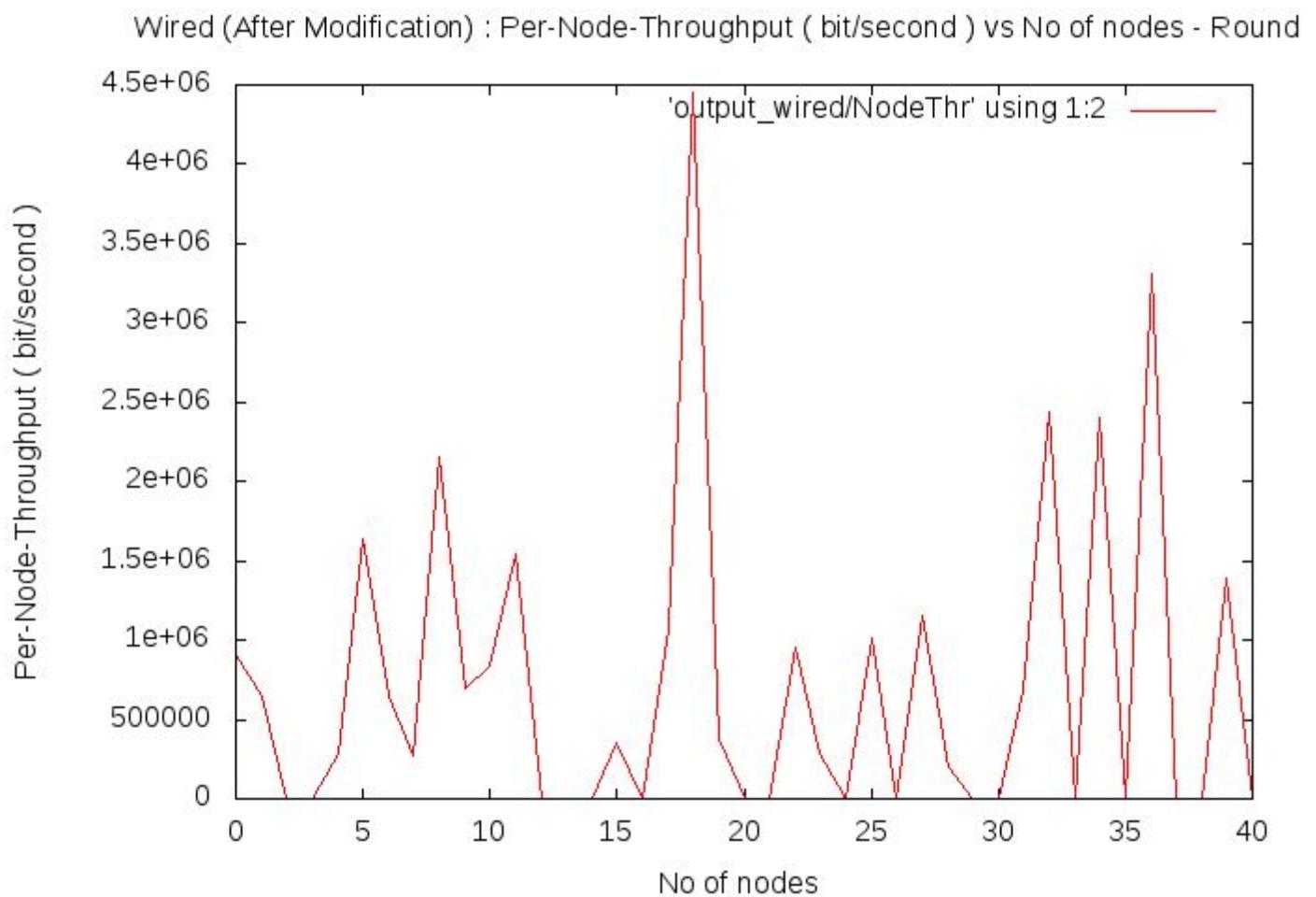
Wired (After Modification) : Packet Drop Ratio vs No of nodes



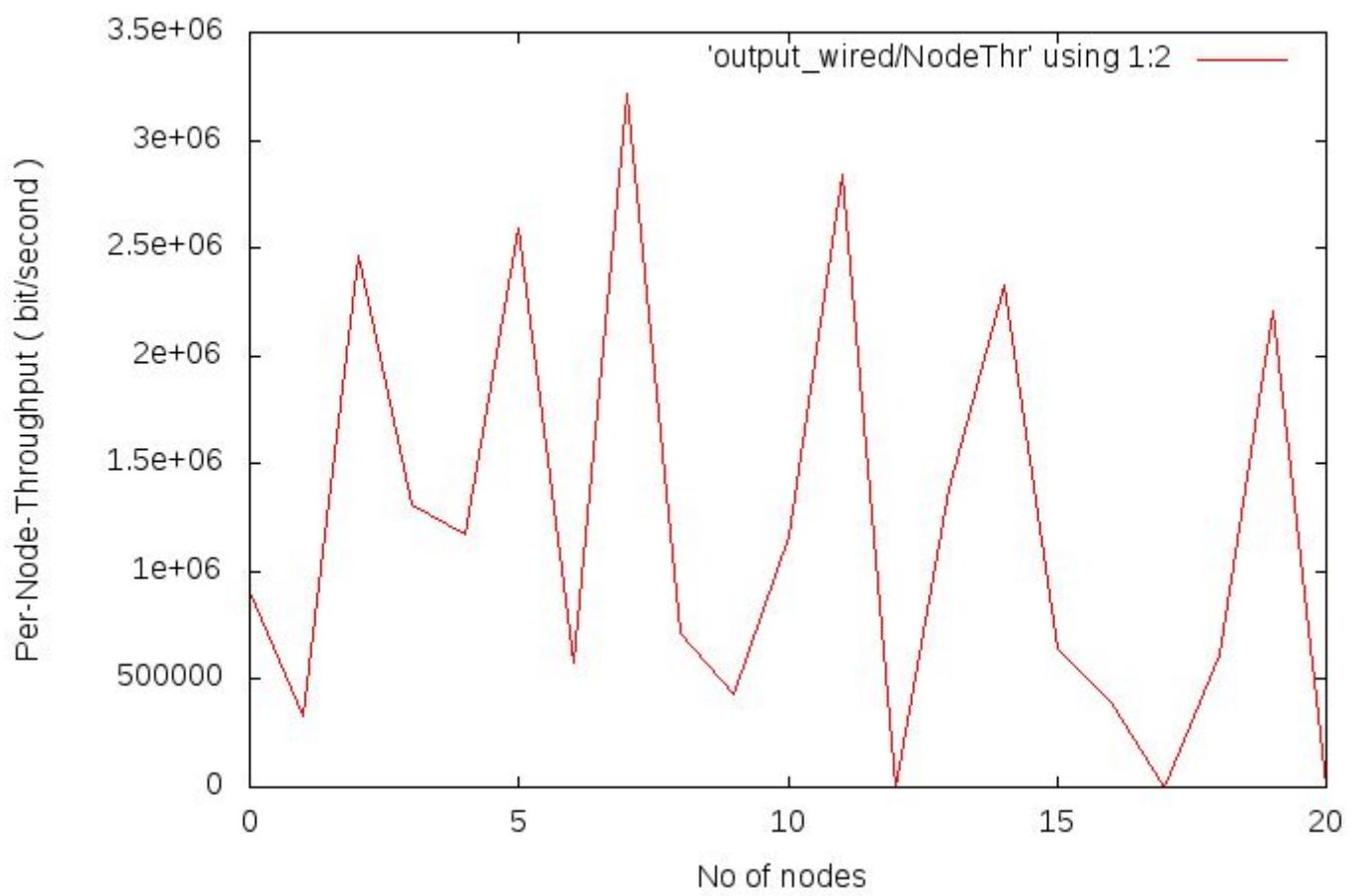


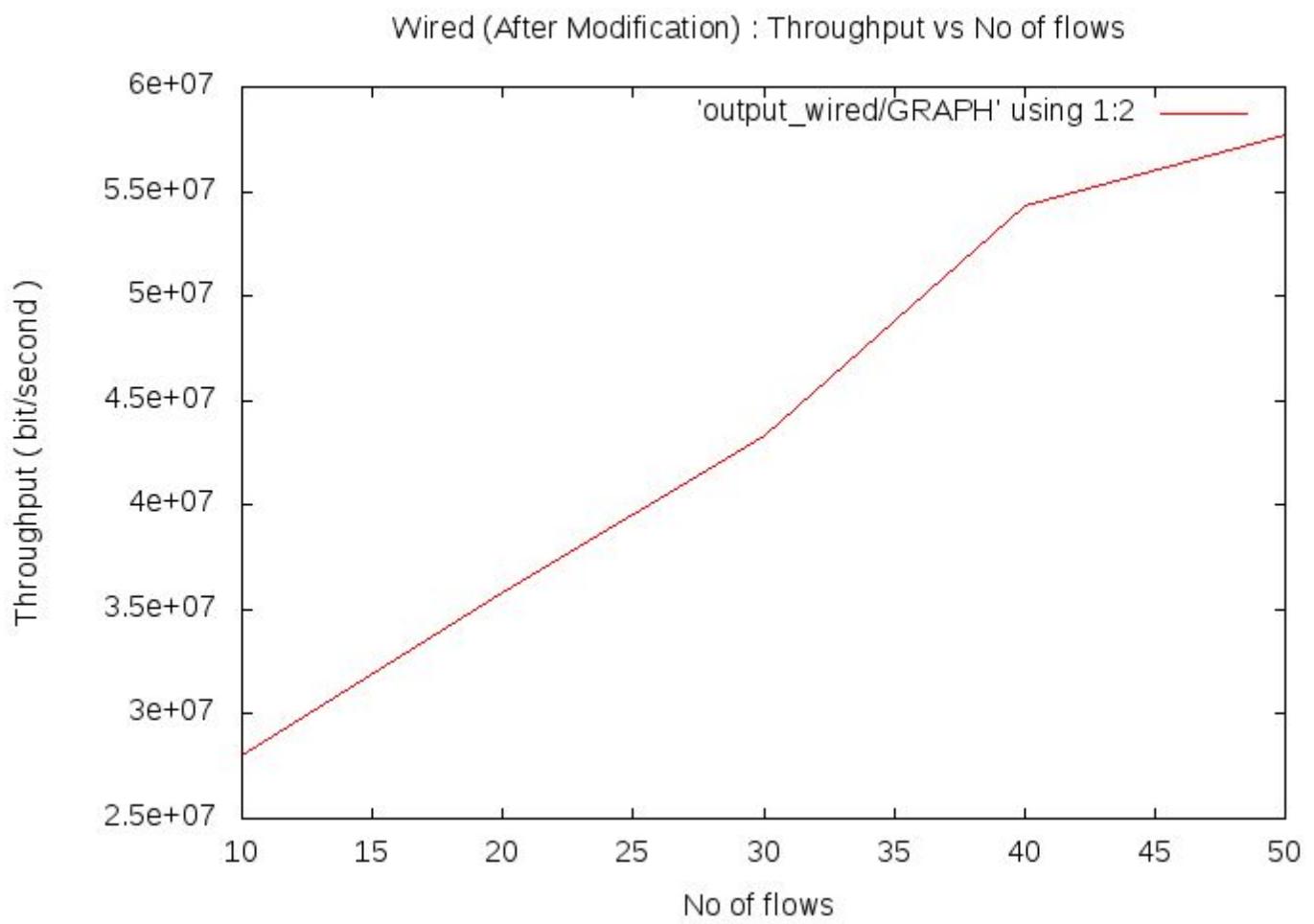
Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs No of nodes - Round



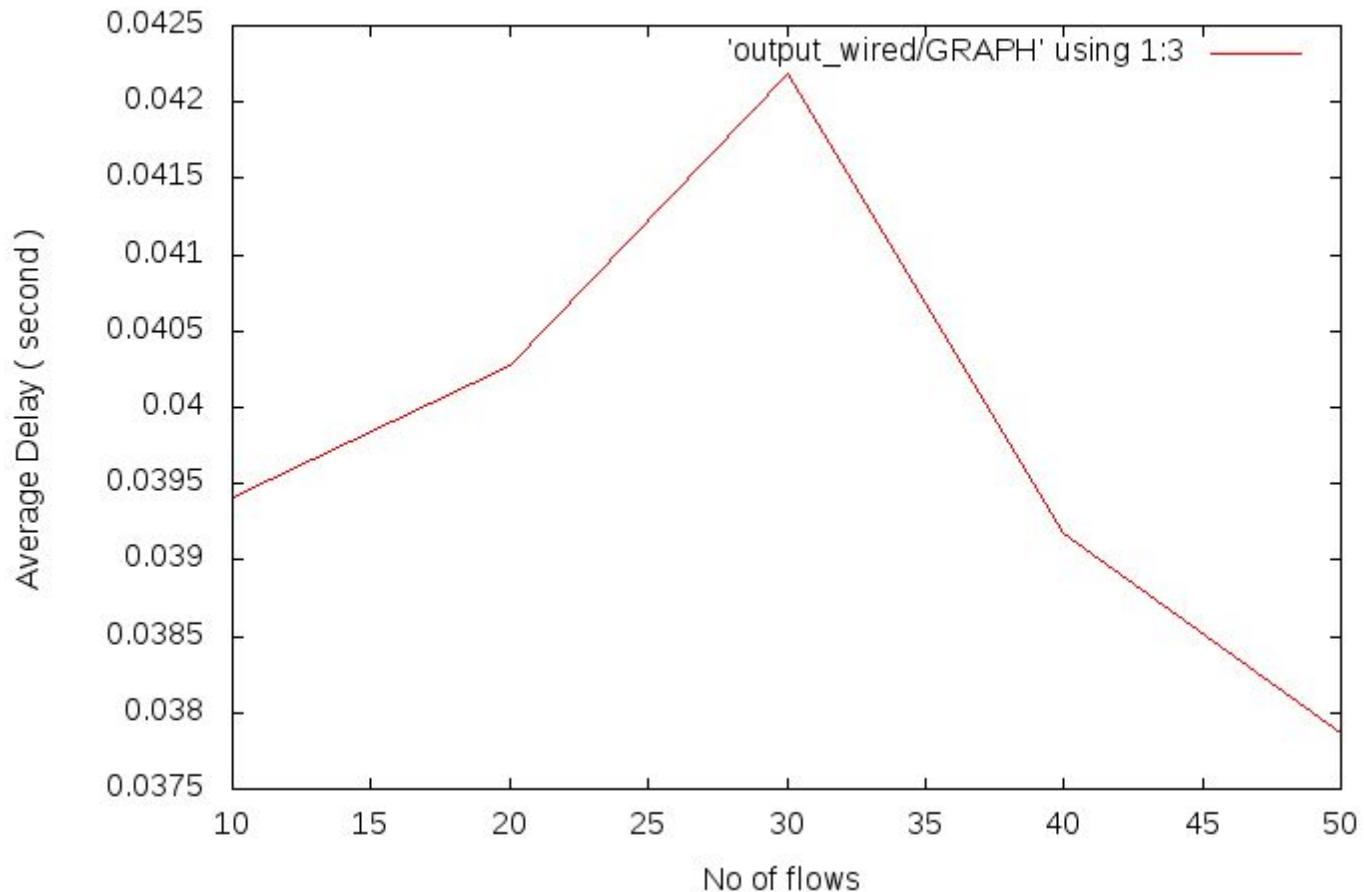


Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs No of nodes - Round



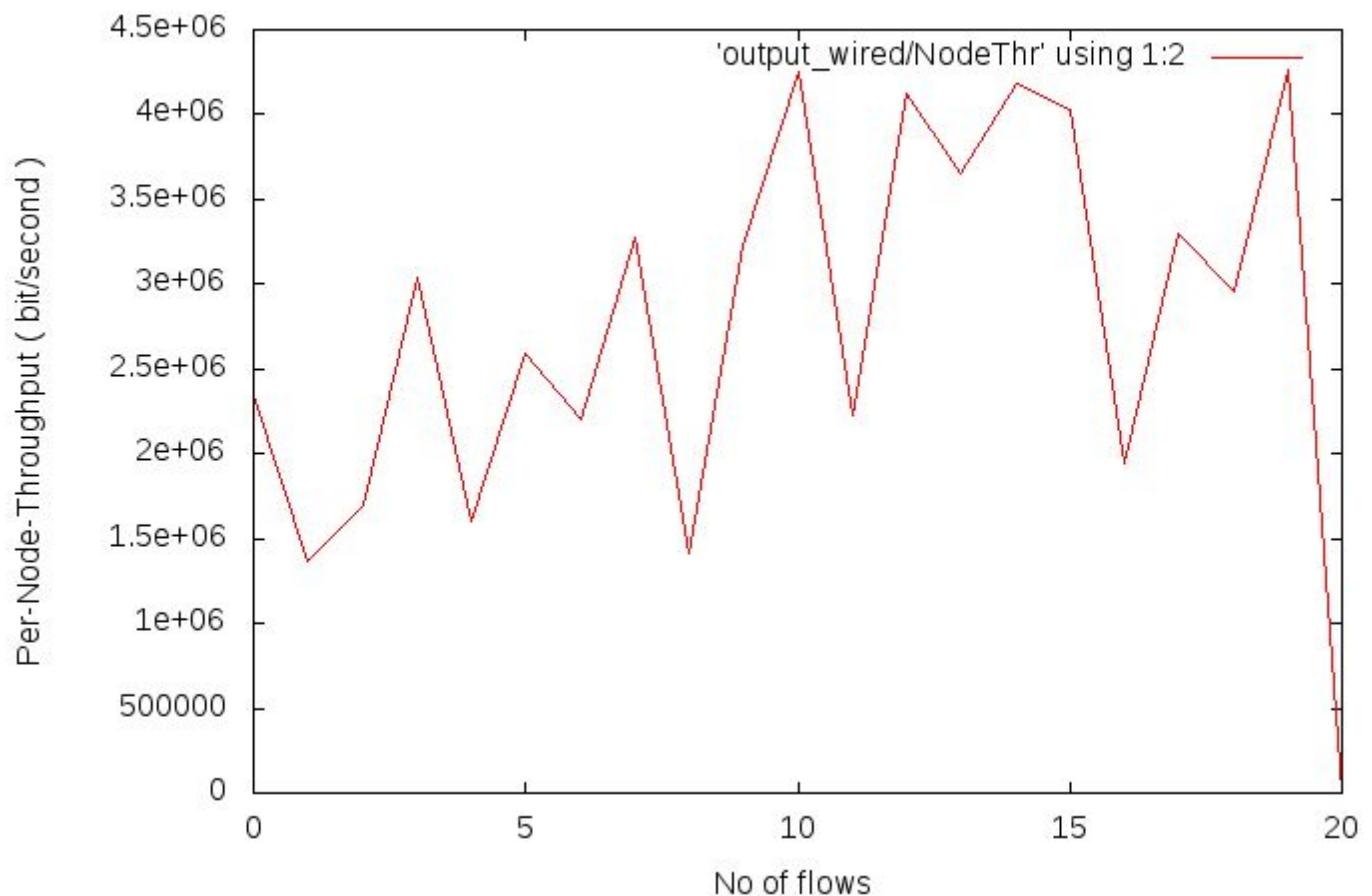


Wired (After Modification) : Average Delay vs No of flows

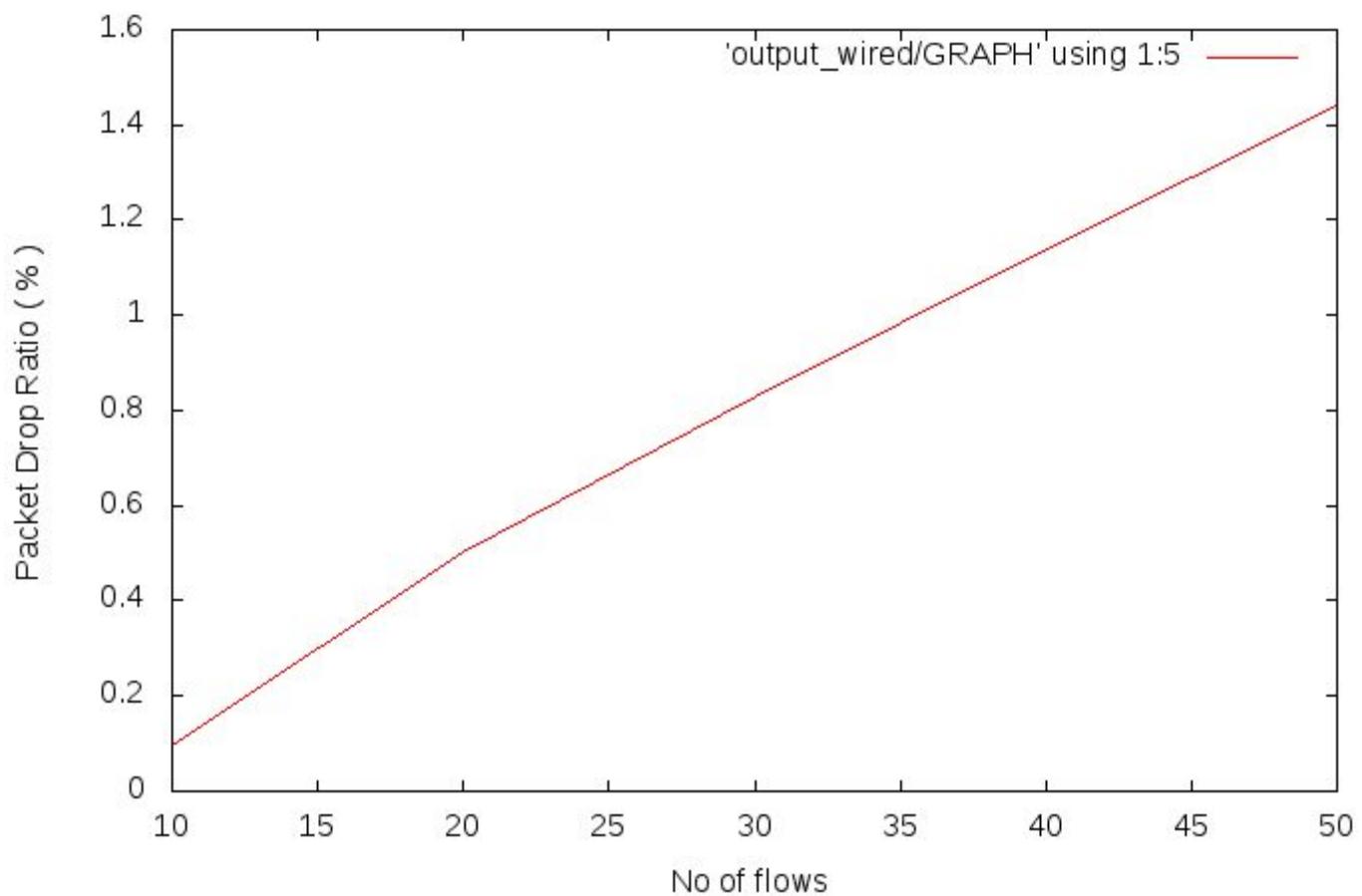




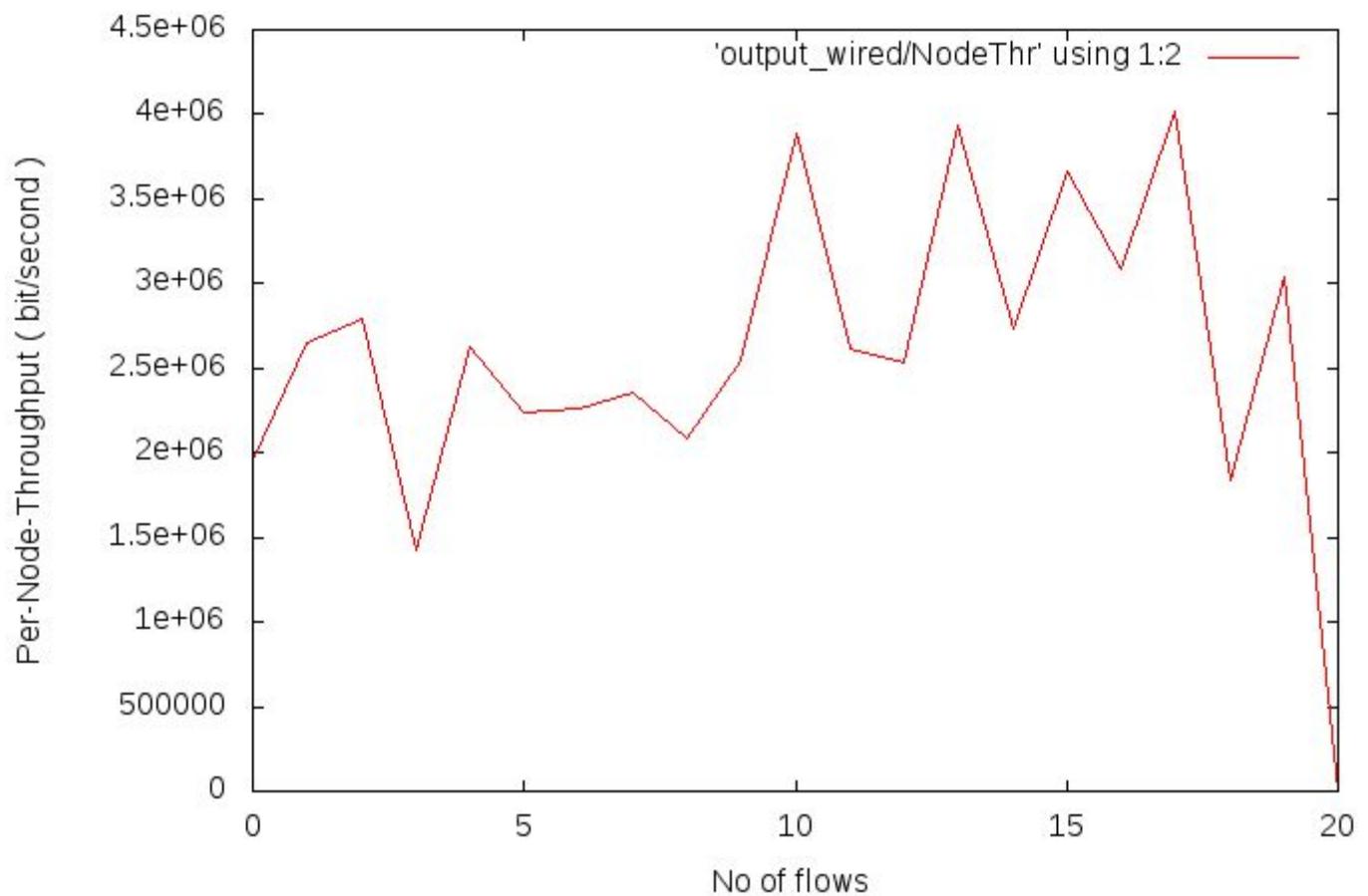
Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs No of flows - Round -

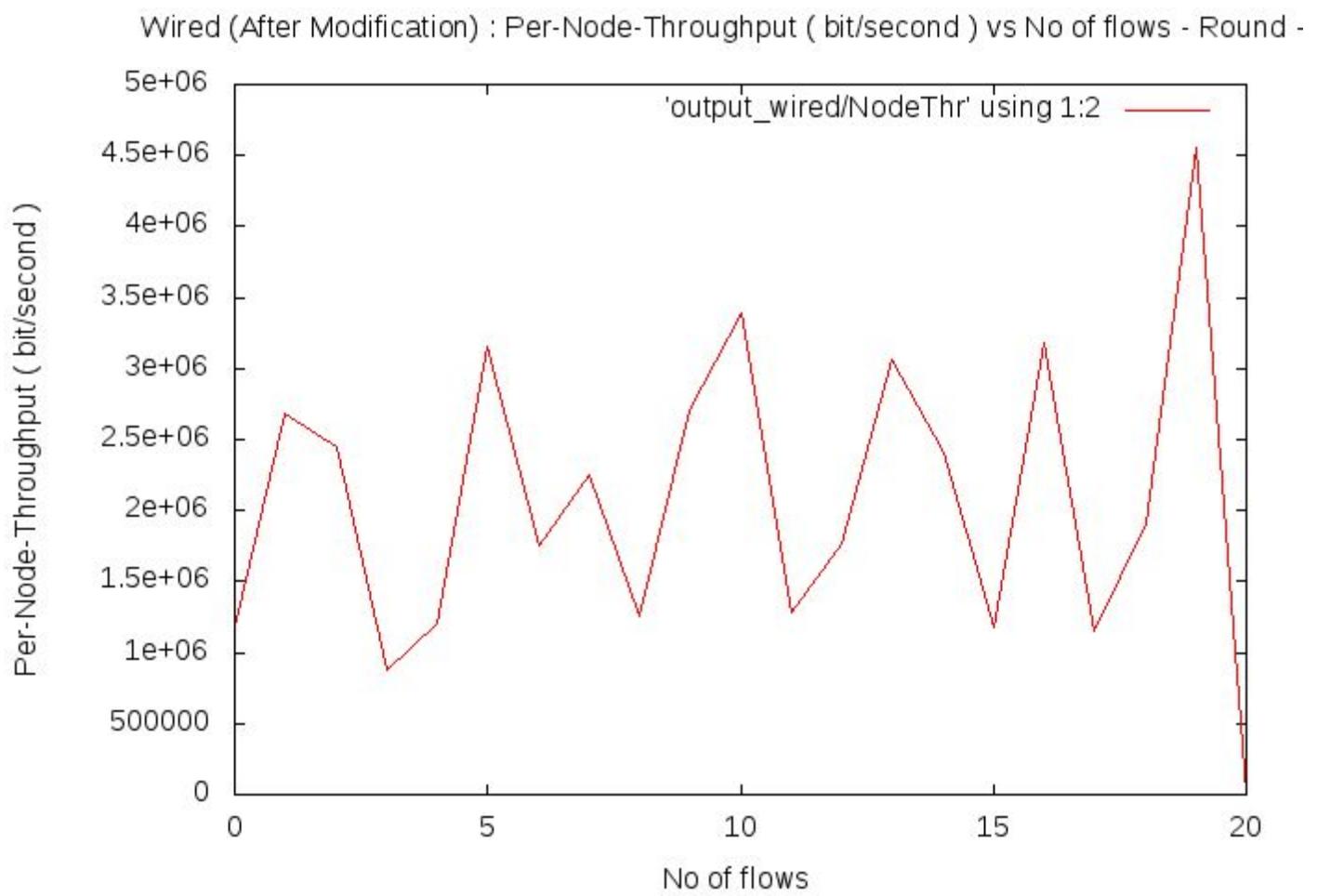


Wired (After Modification) : Packet Drop Ratio vs No of flows

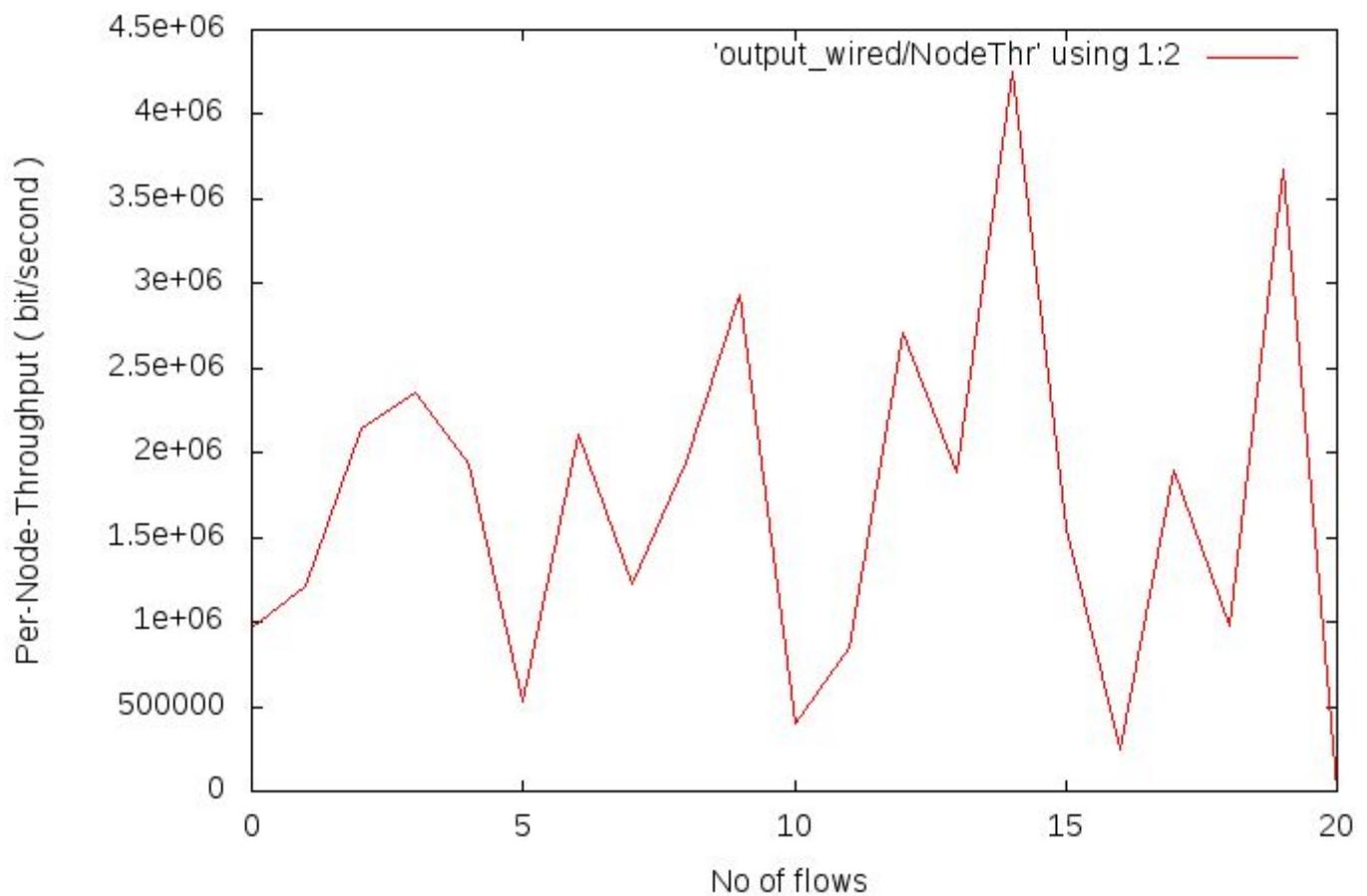


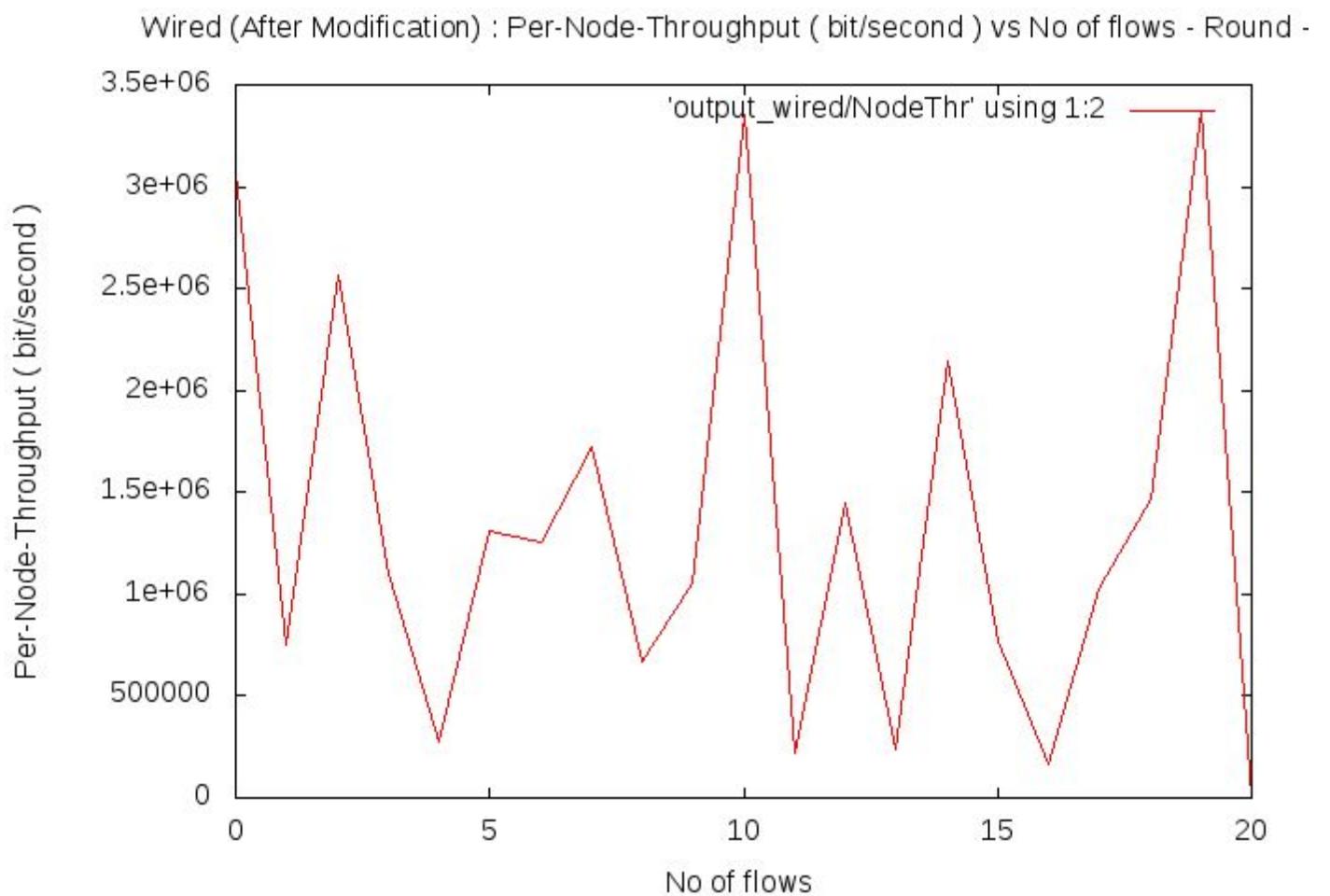
Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs No of flows - Round -

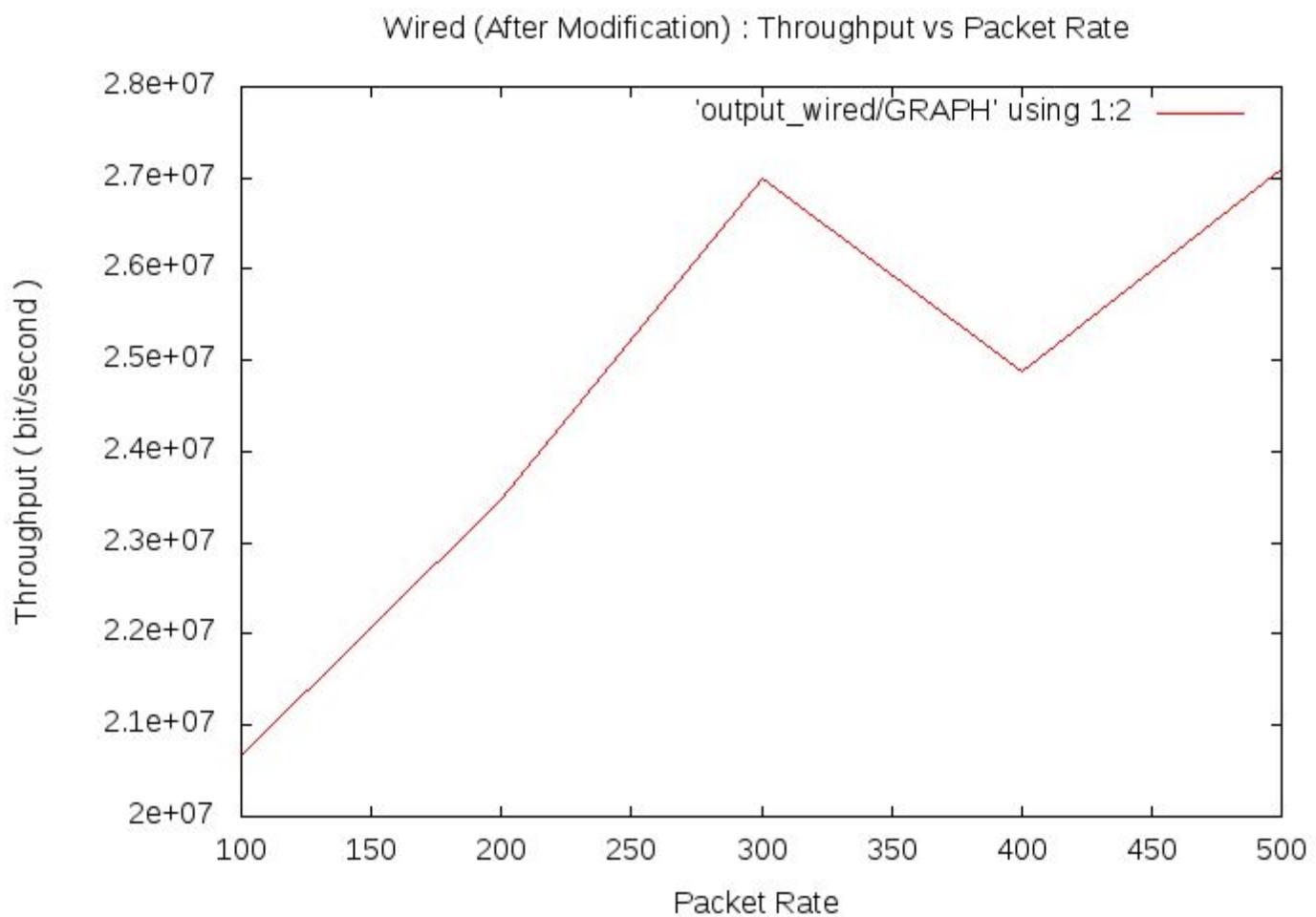




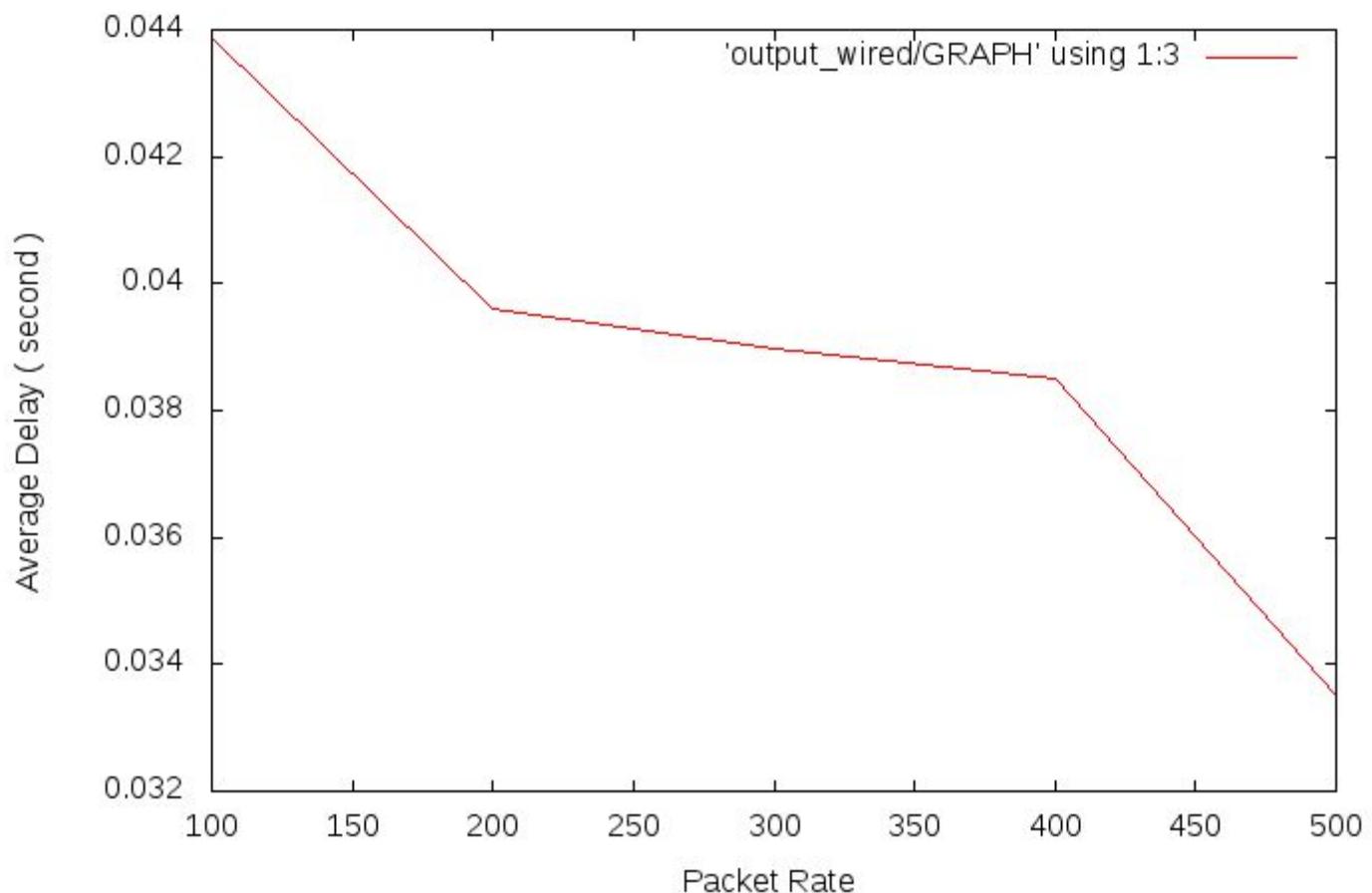
Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs No of flows - Round -



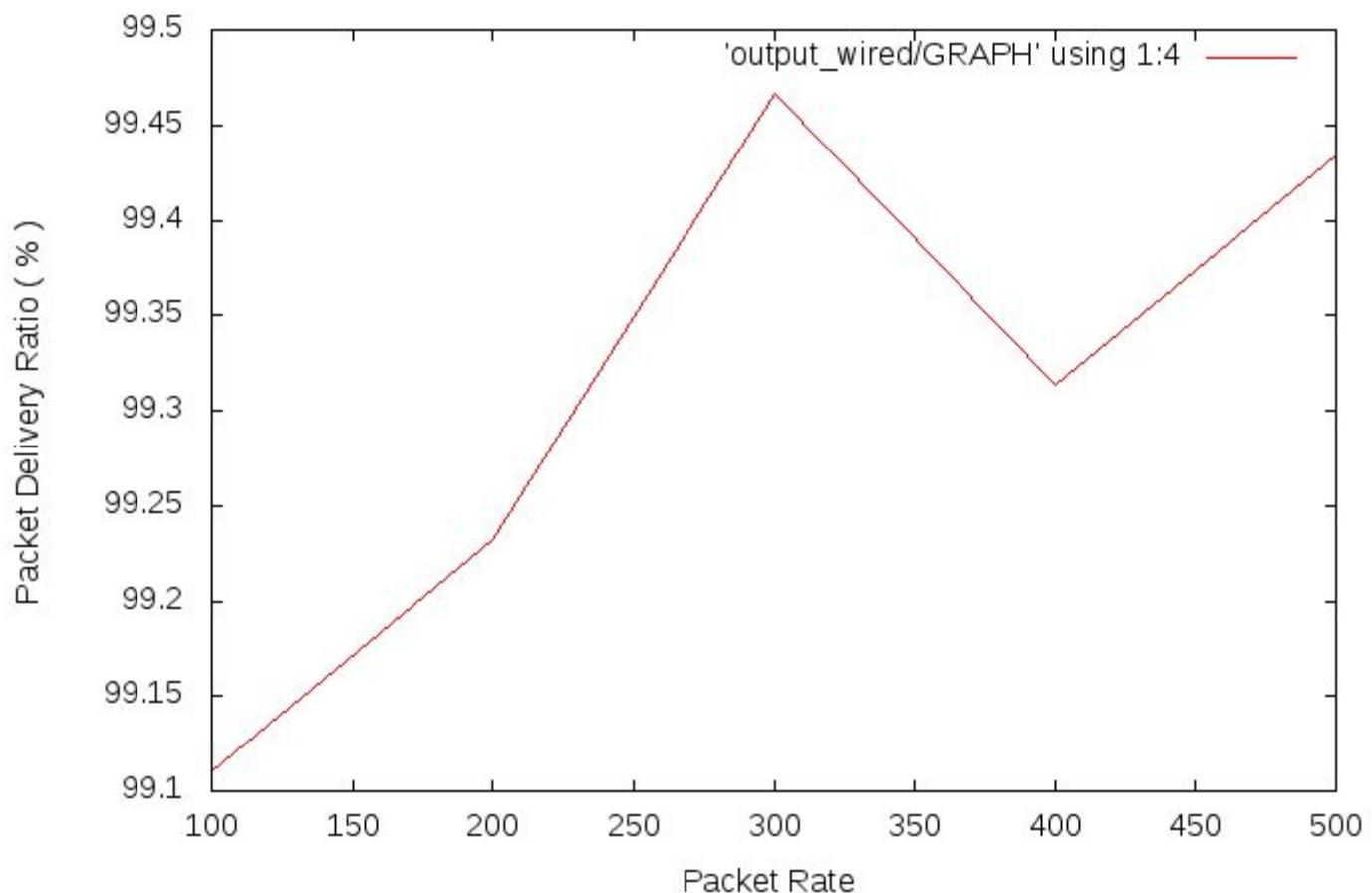




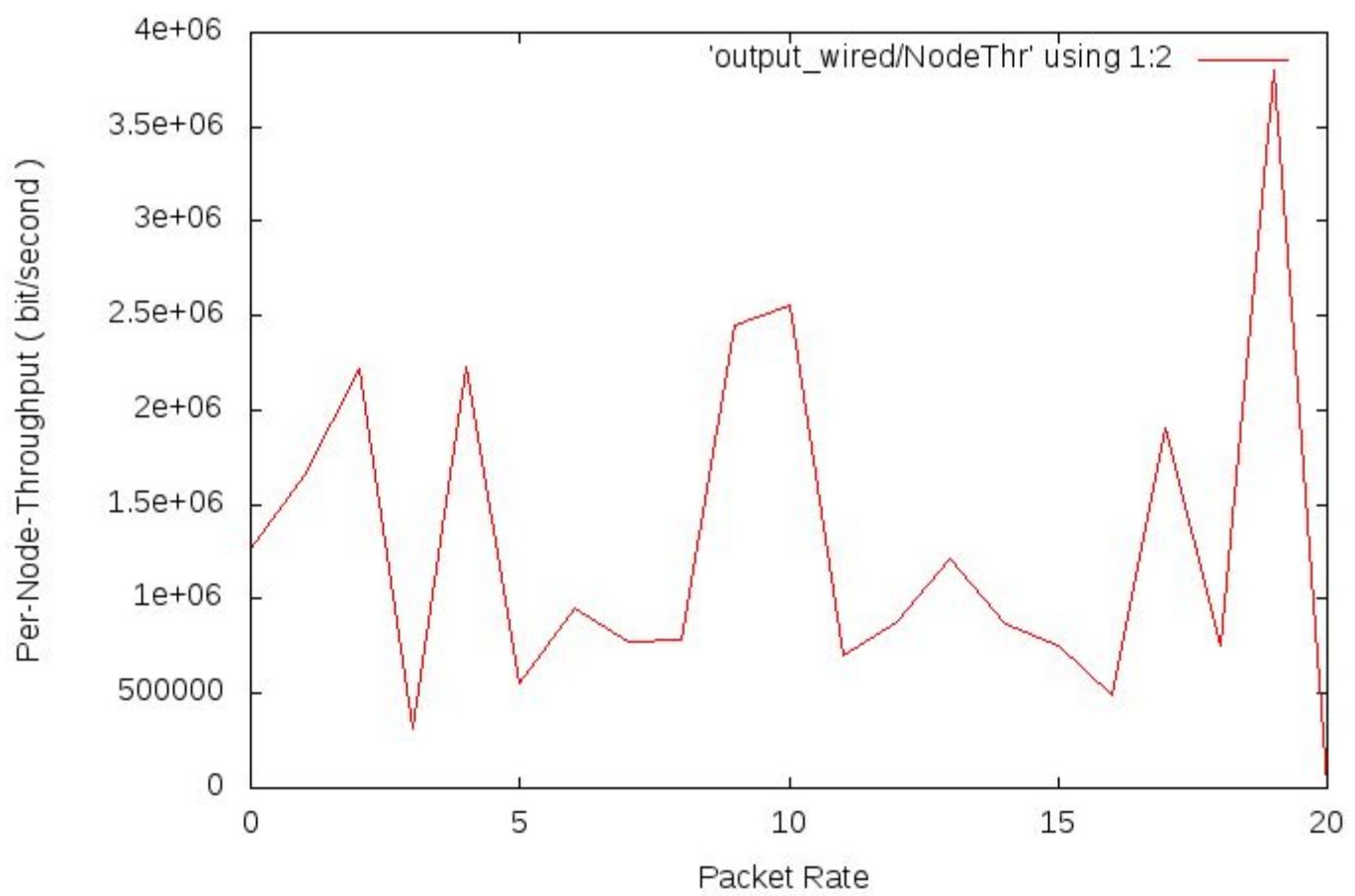
Wired (After Modification) : Average Delay vs Packet Rate



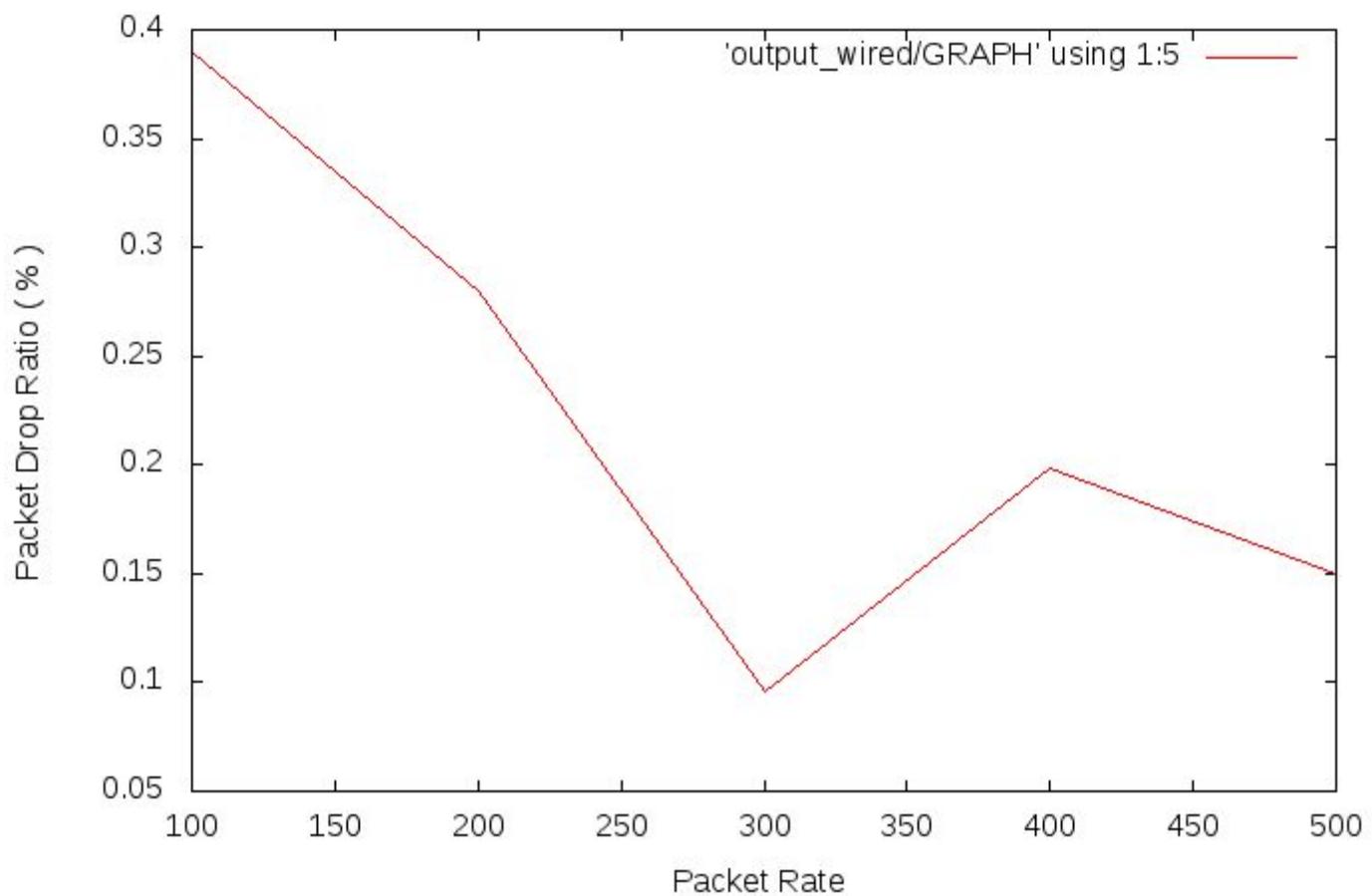
Wired (After Modification) : Packet Delivery Ratio vs Packet Rate



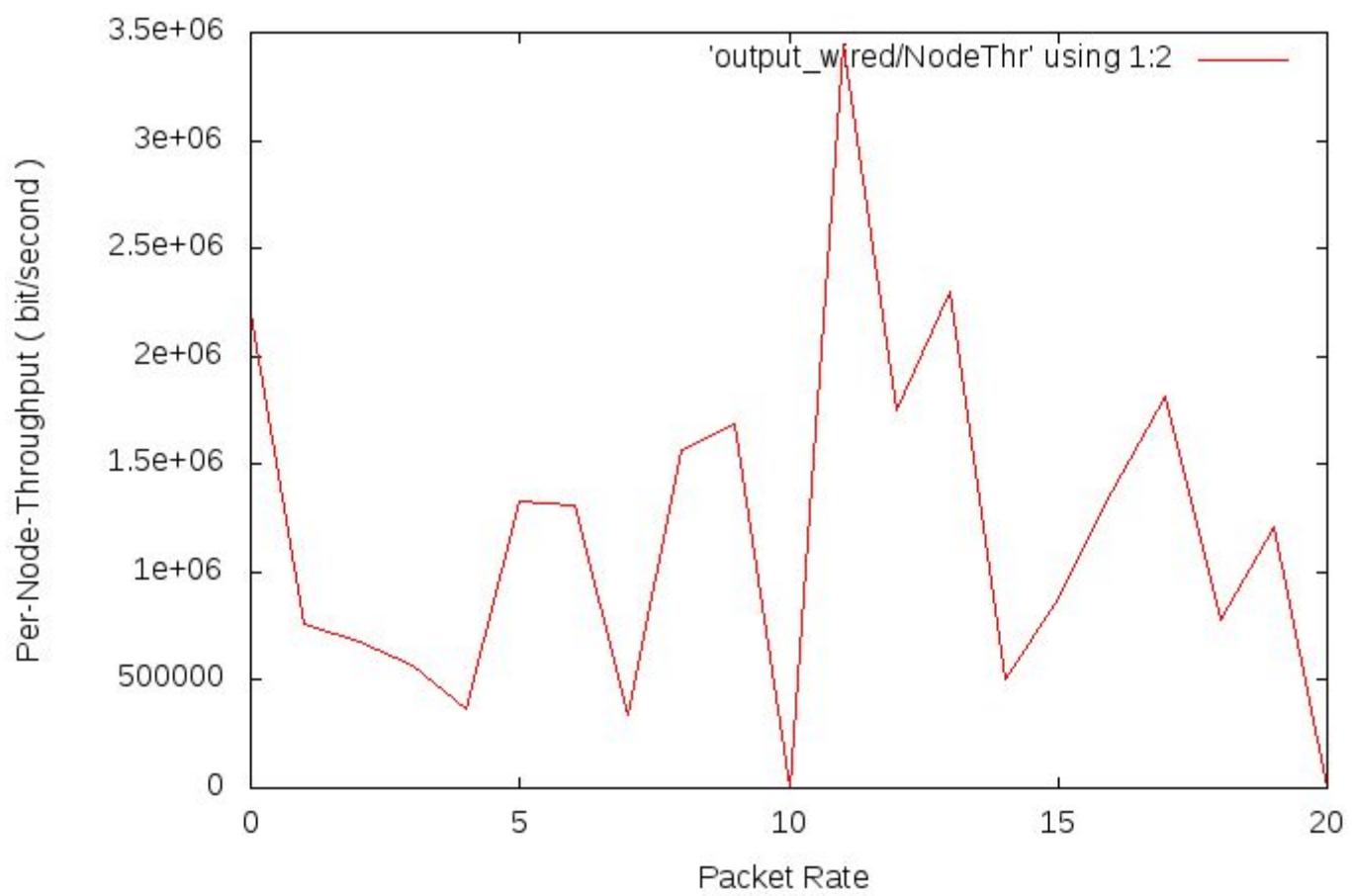
Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round

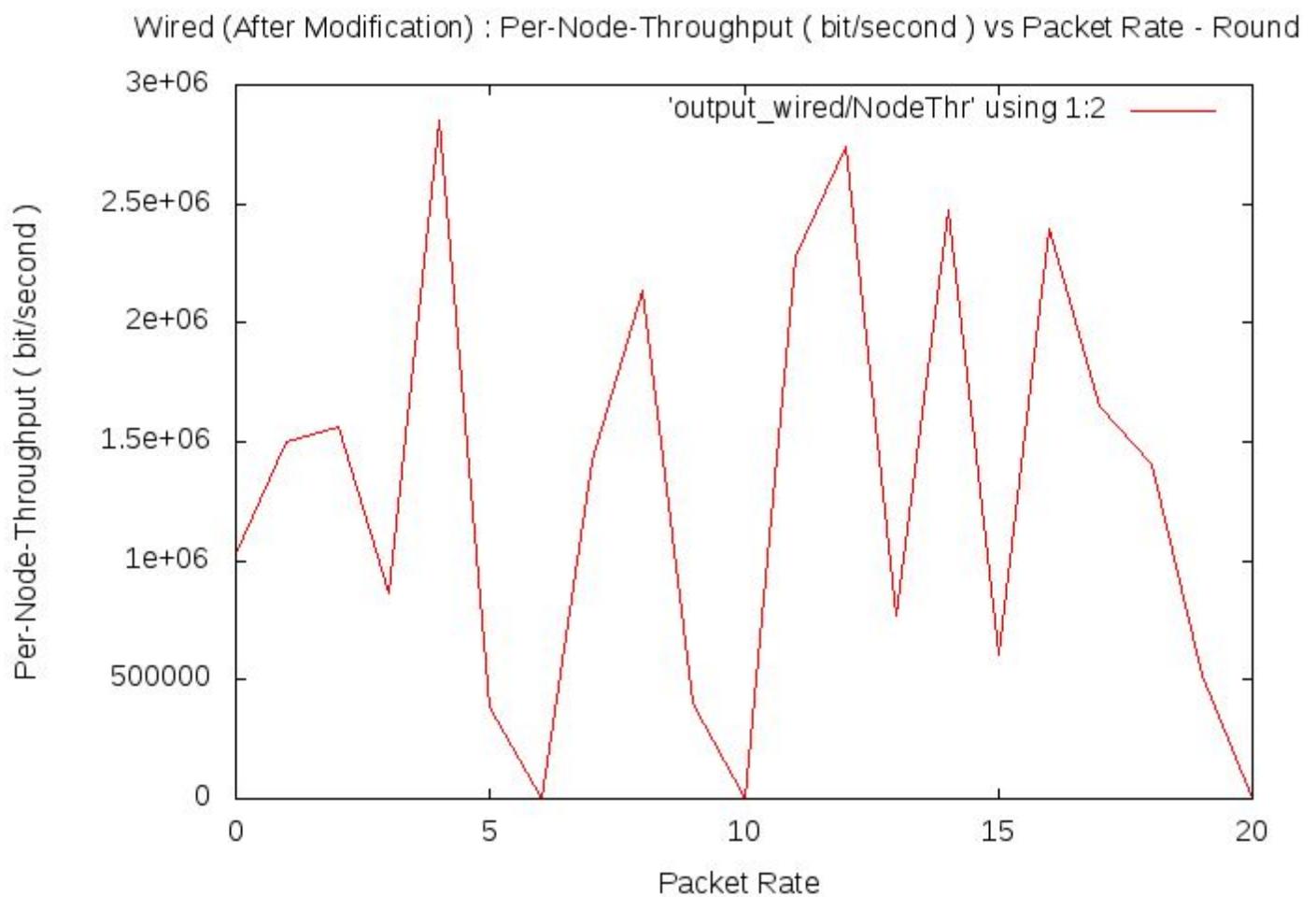


Wired (After Modification) : Packet Drop Ratio vs Packet Rate

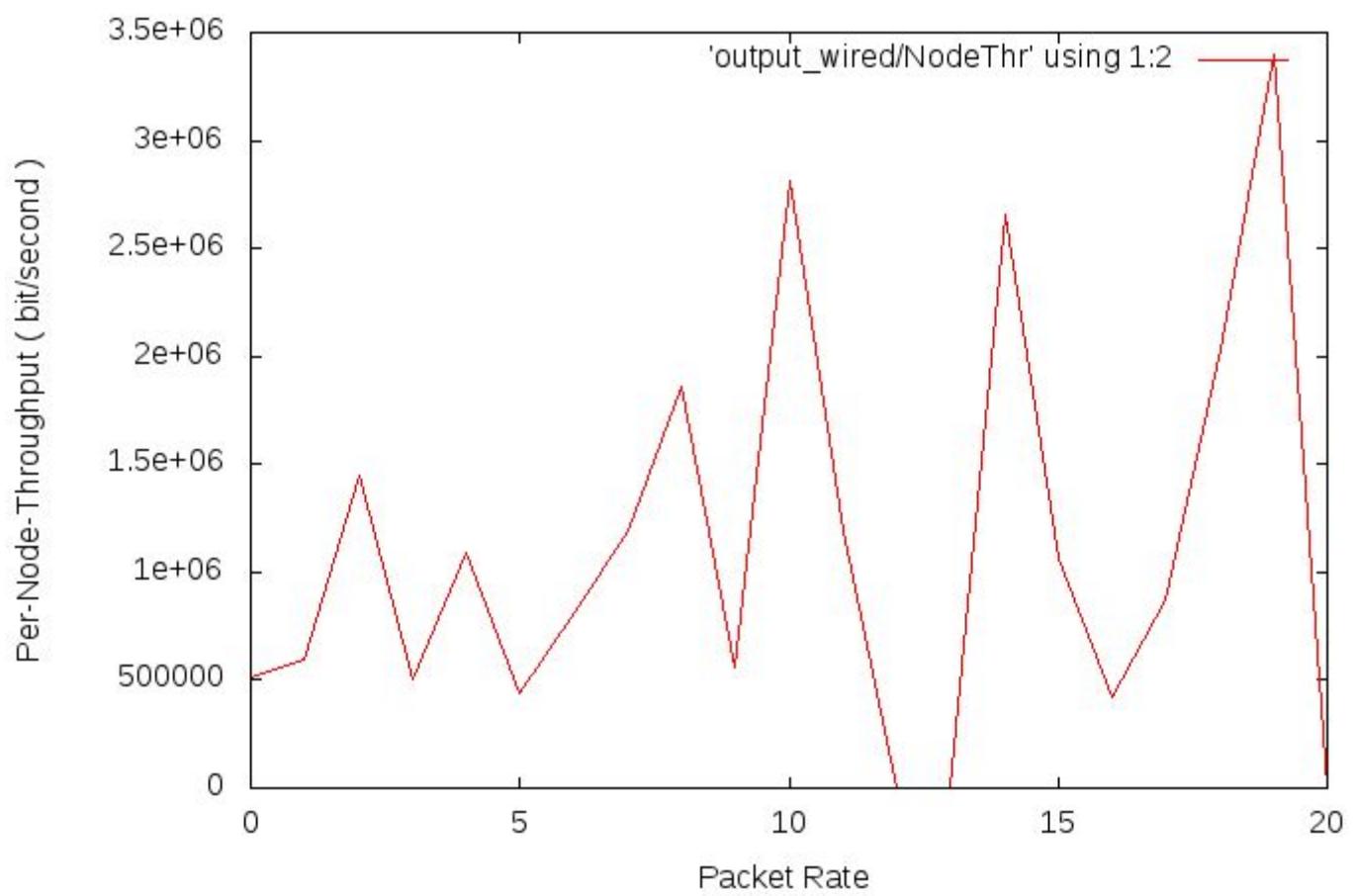


Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round

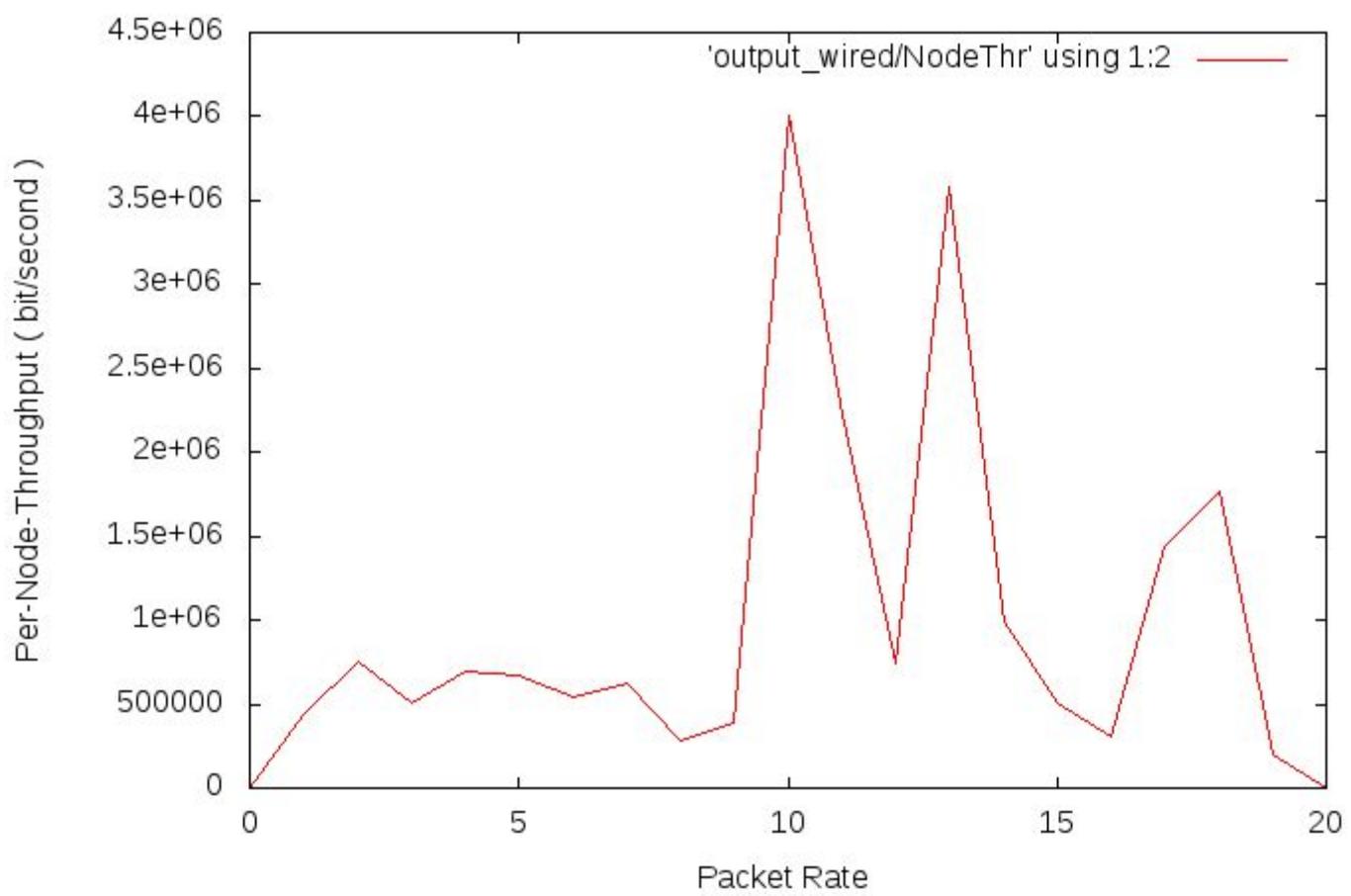




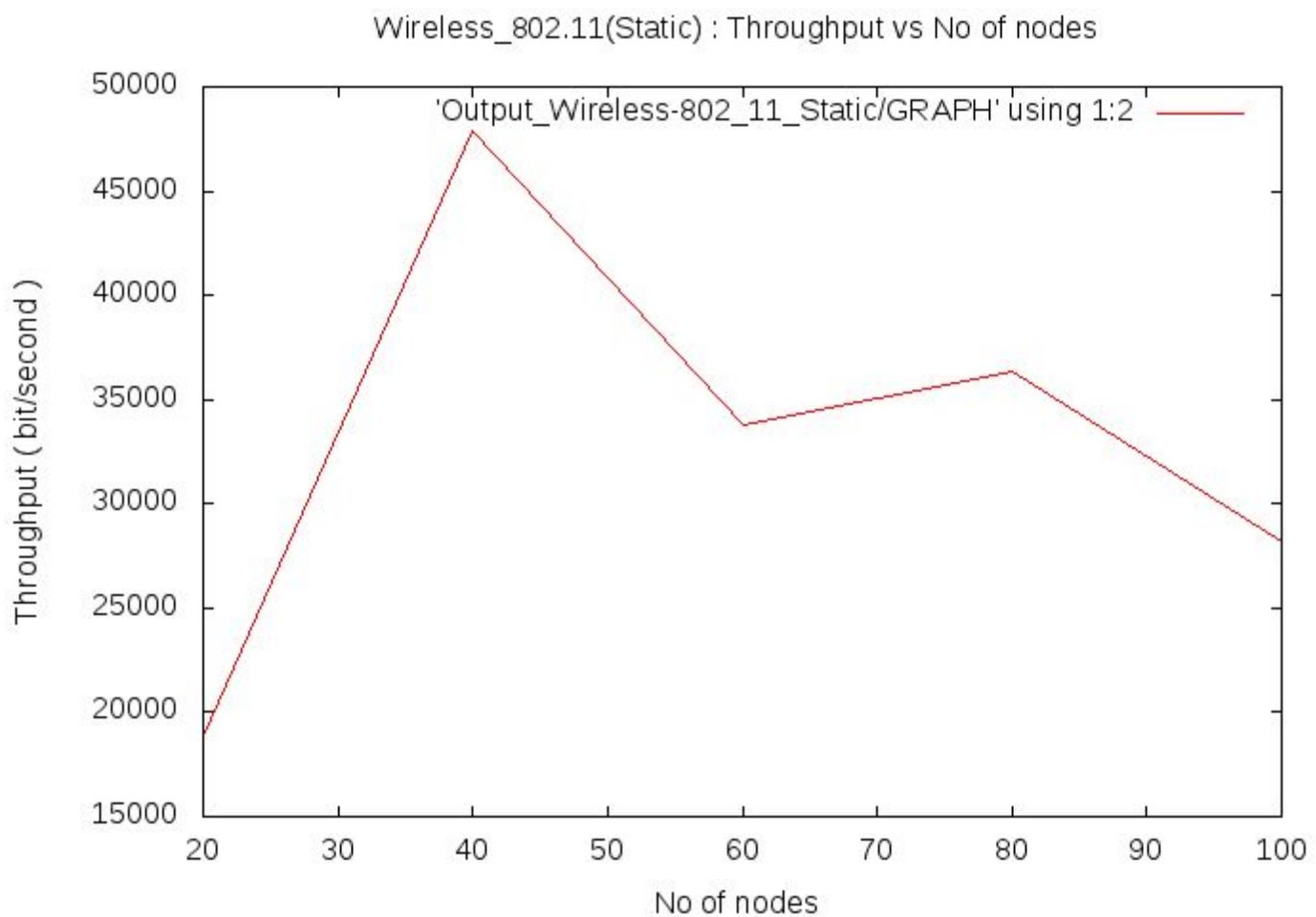
Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round



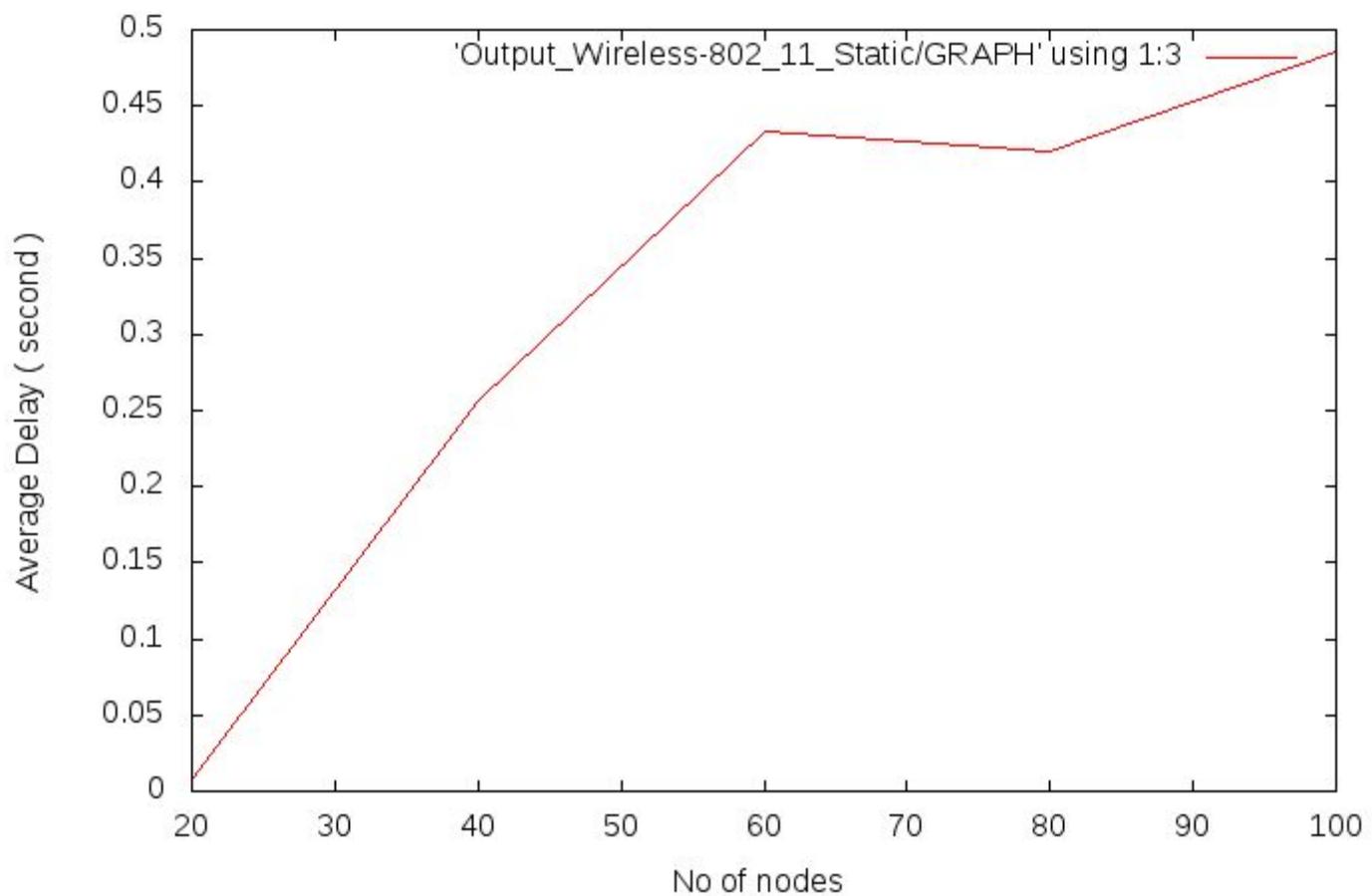
Wired (After Modification) : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round



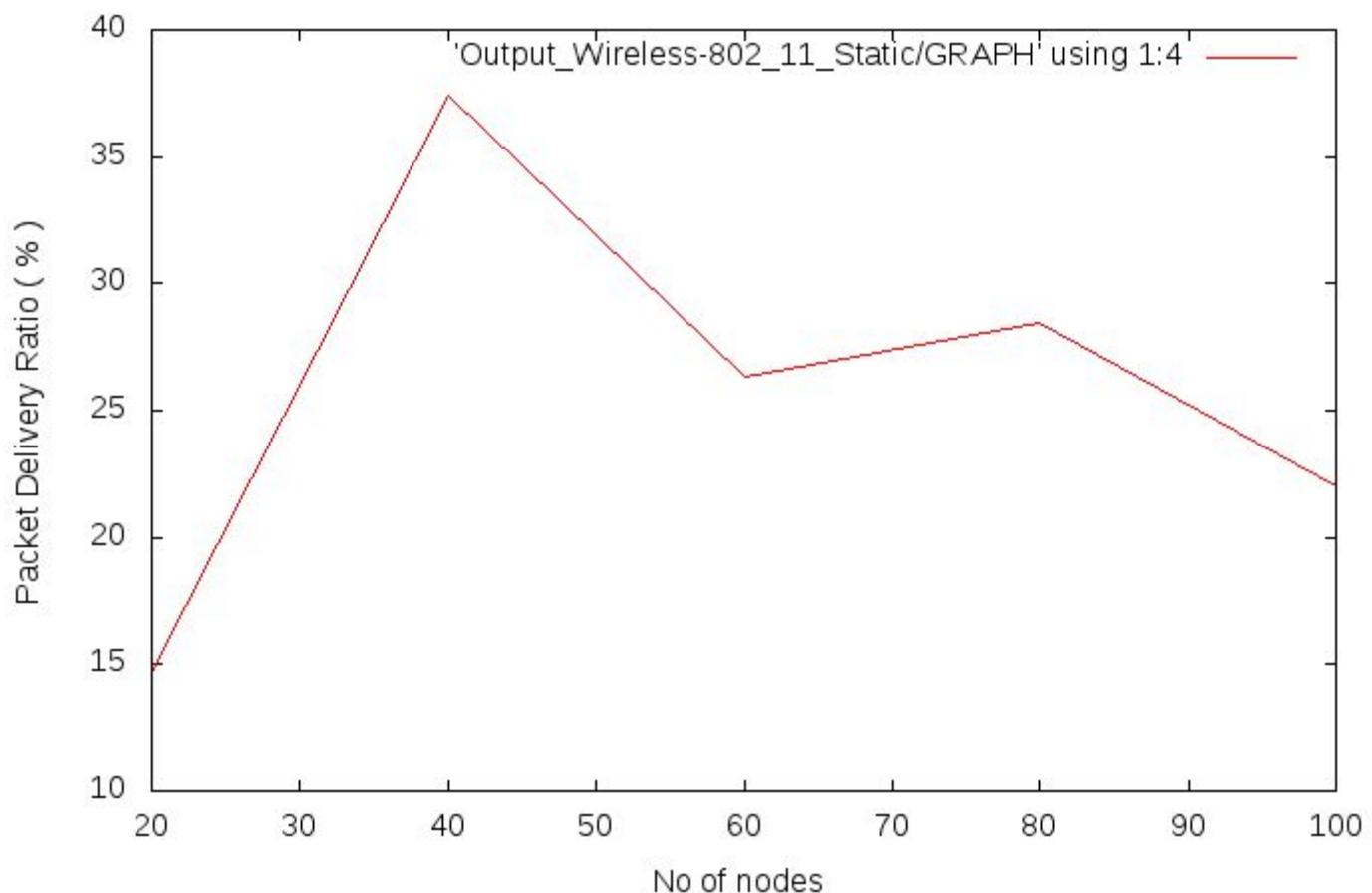
# **Wireless 802.11 (Static) (Before Modification)**



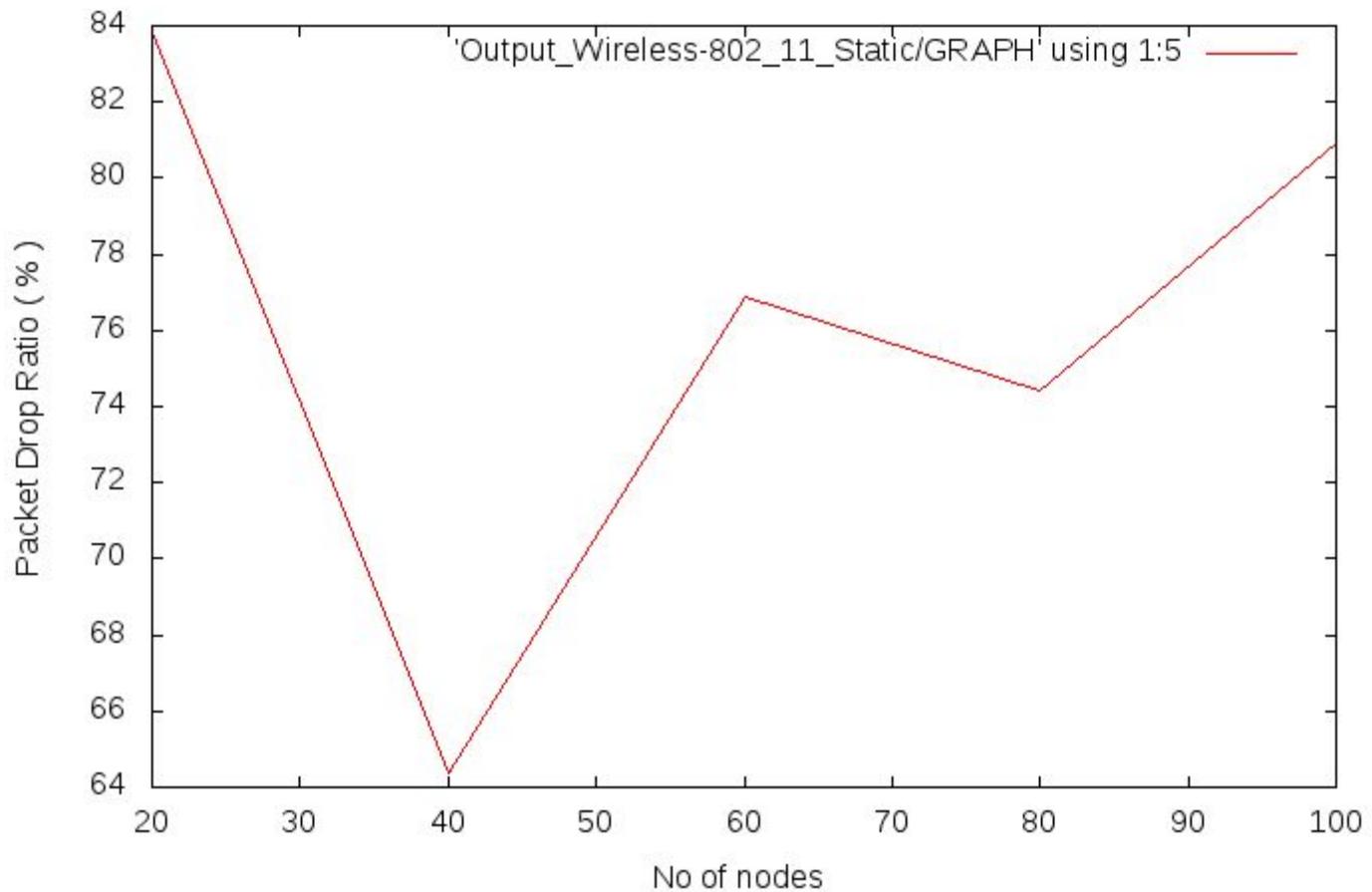
Wireless\_802.11(Static) : Average Delay vs No of nodes



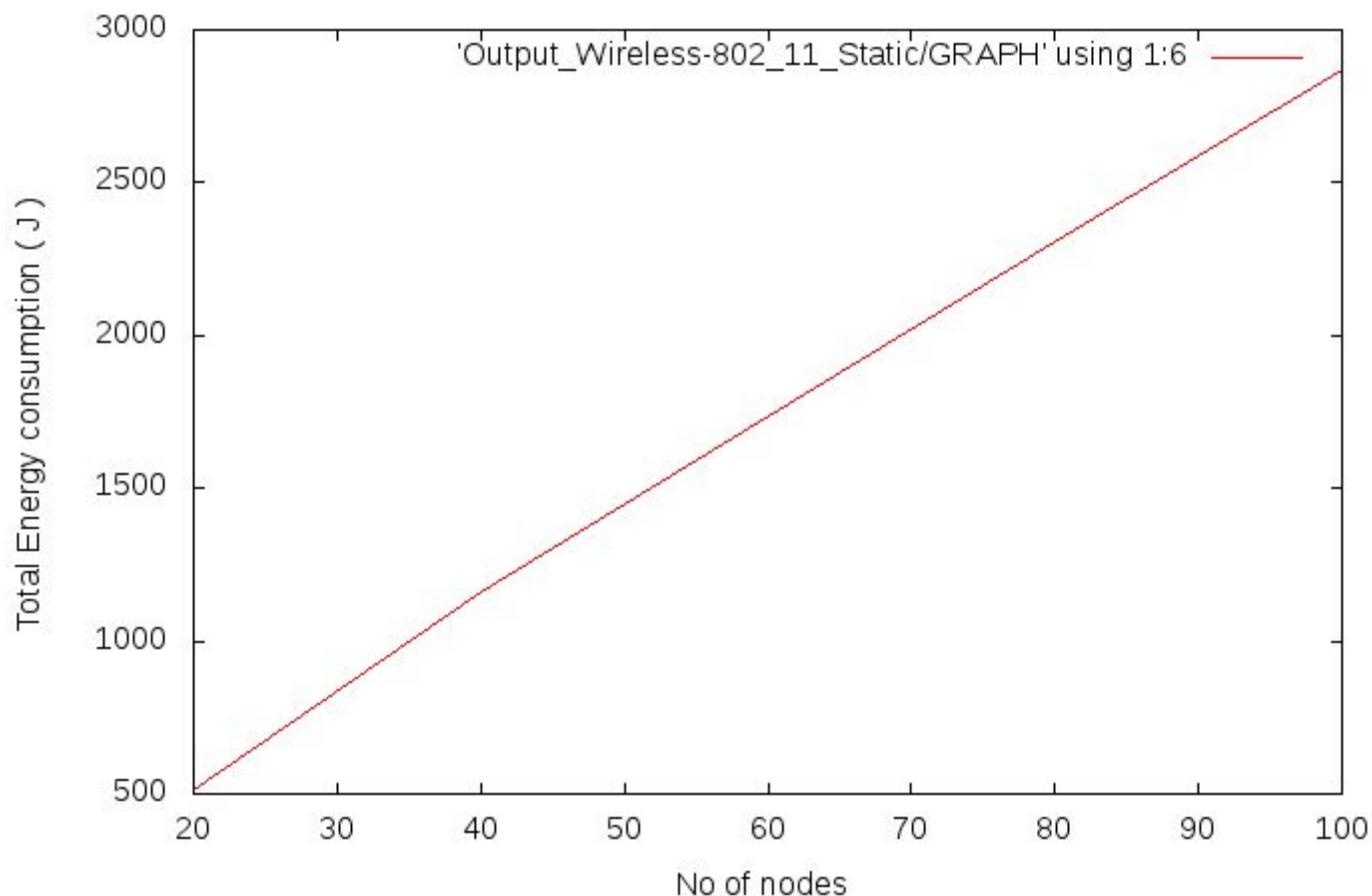
Wireless\_802.11(Static) : Packet Delivery Ratio vs No of nodes



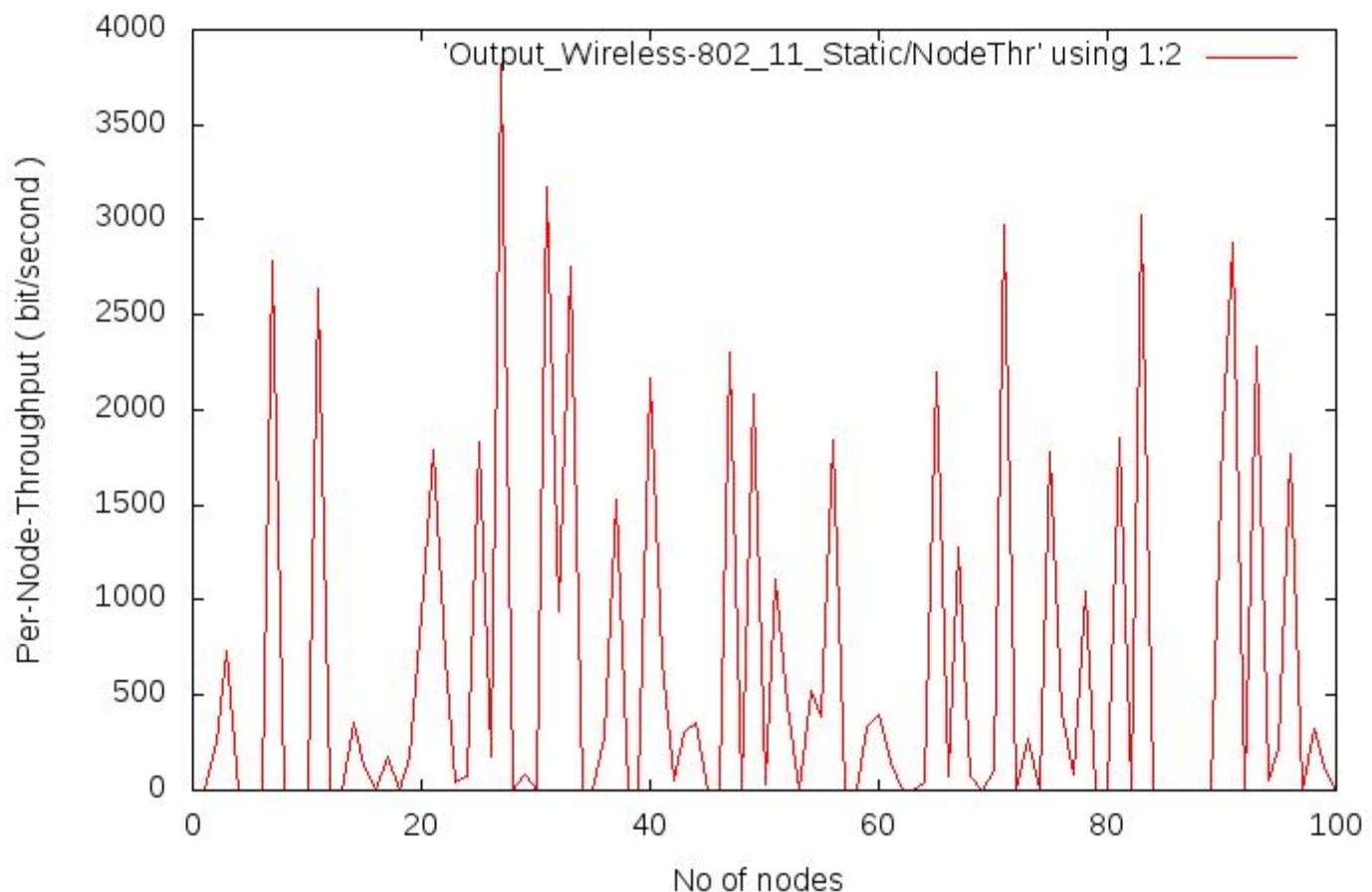
Wireless\_802.11(Static) : Packet Drop Ratio vs No of nodes



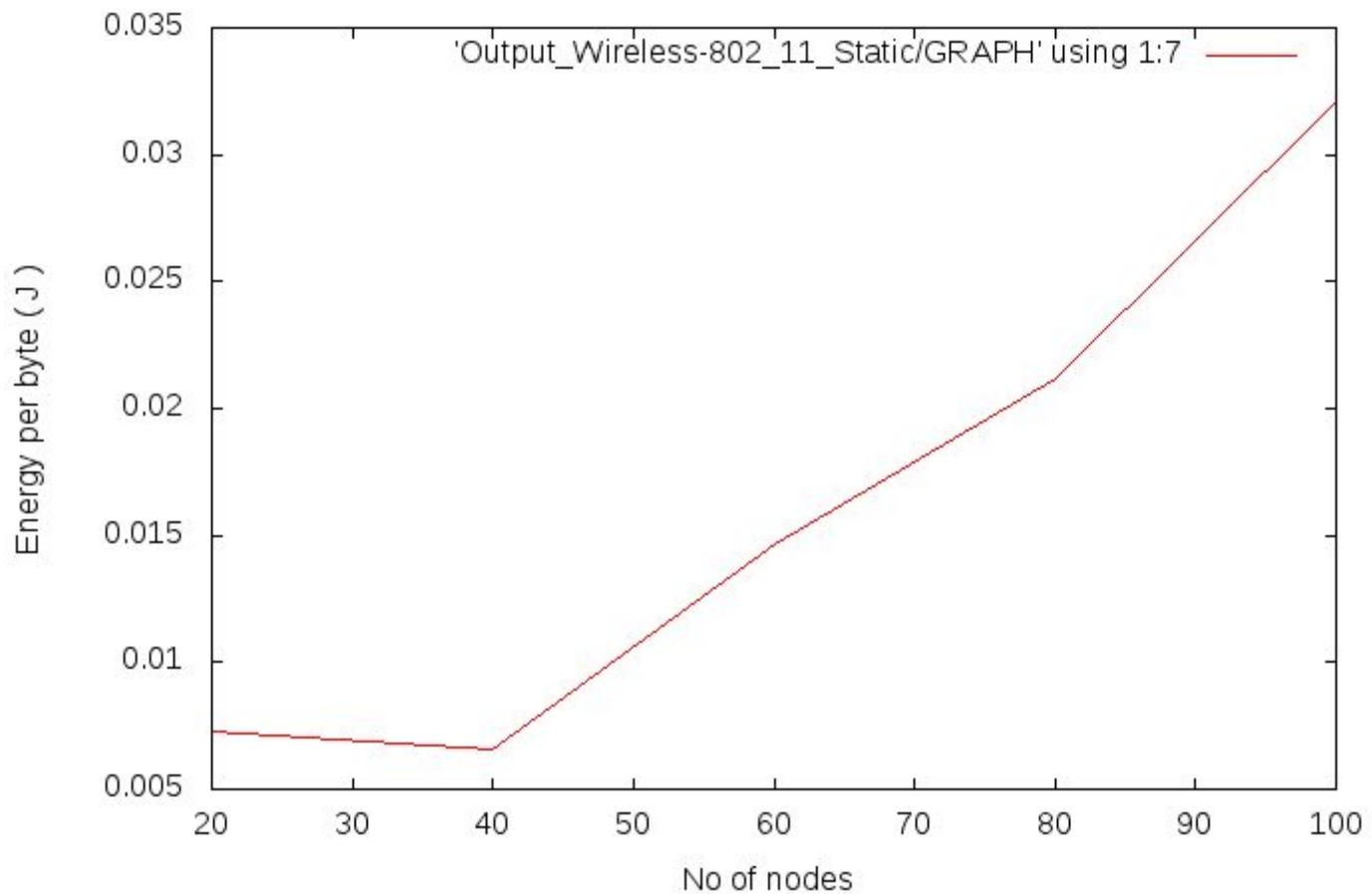
Wireless\_802.11(Static) : Total Energy consumption vs No of nodes



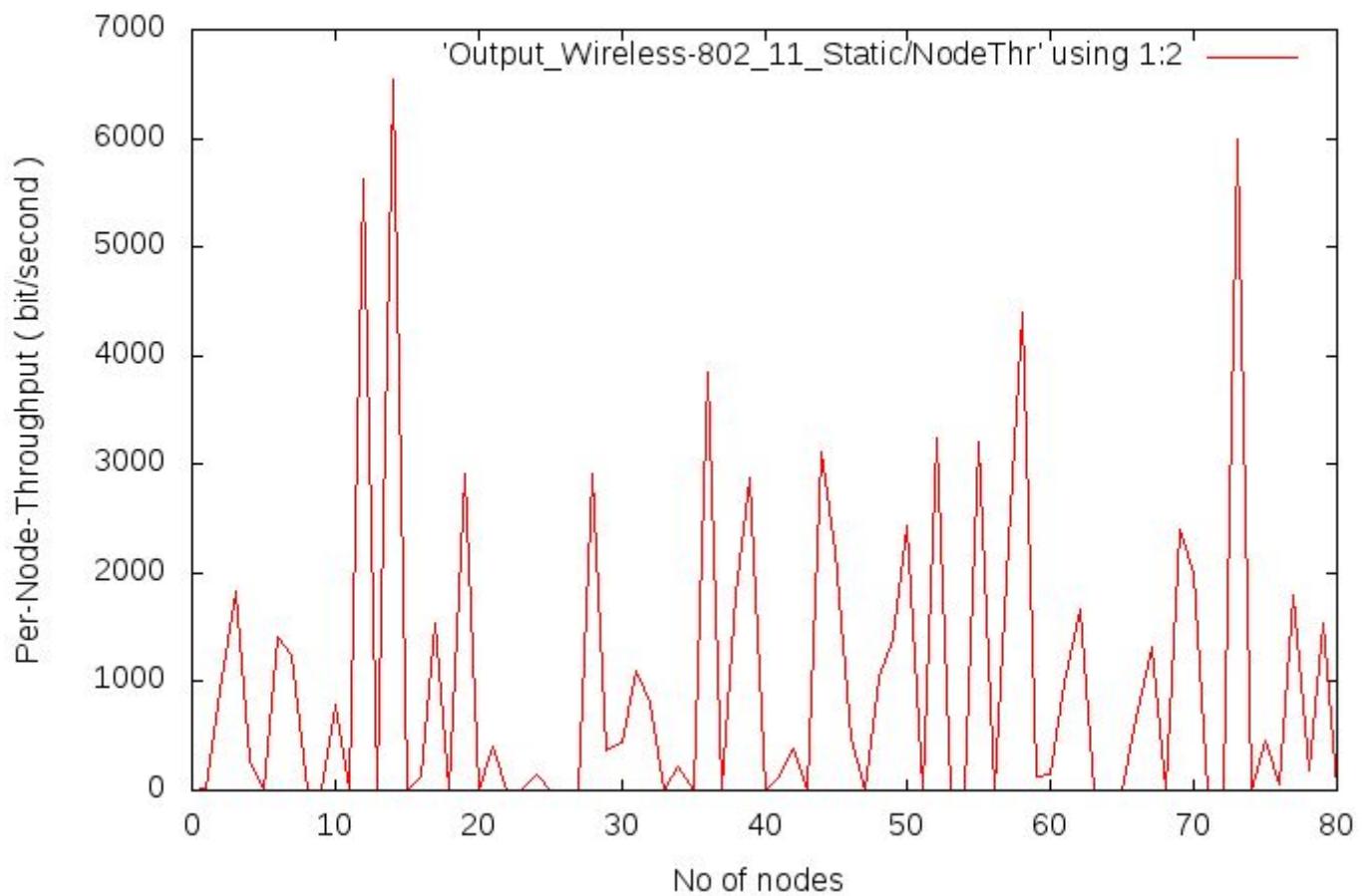
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 5



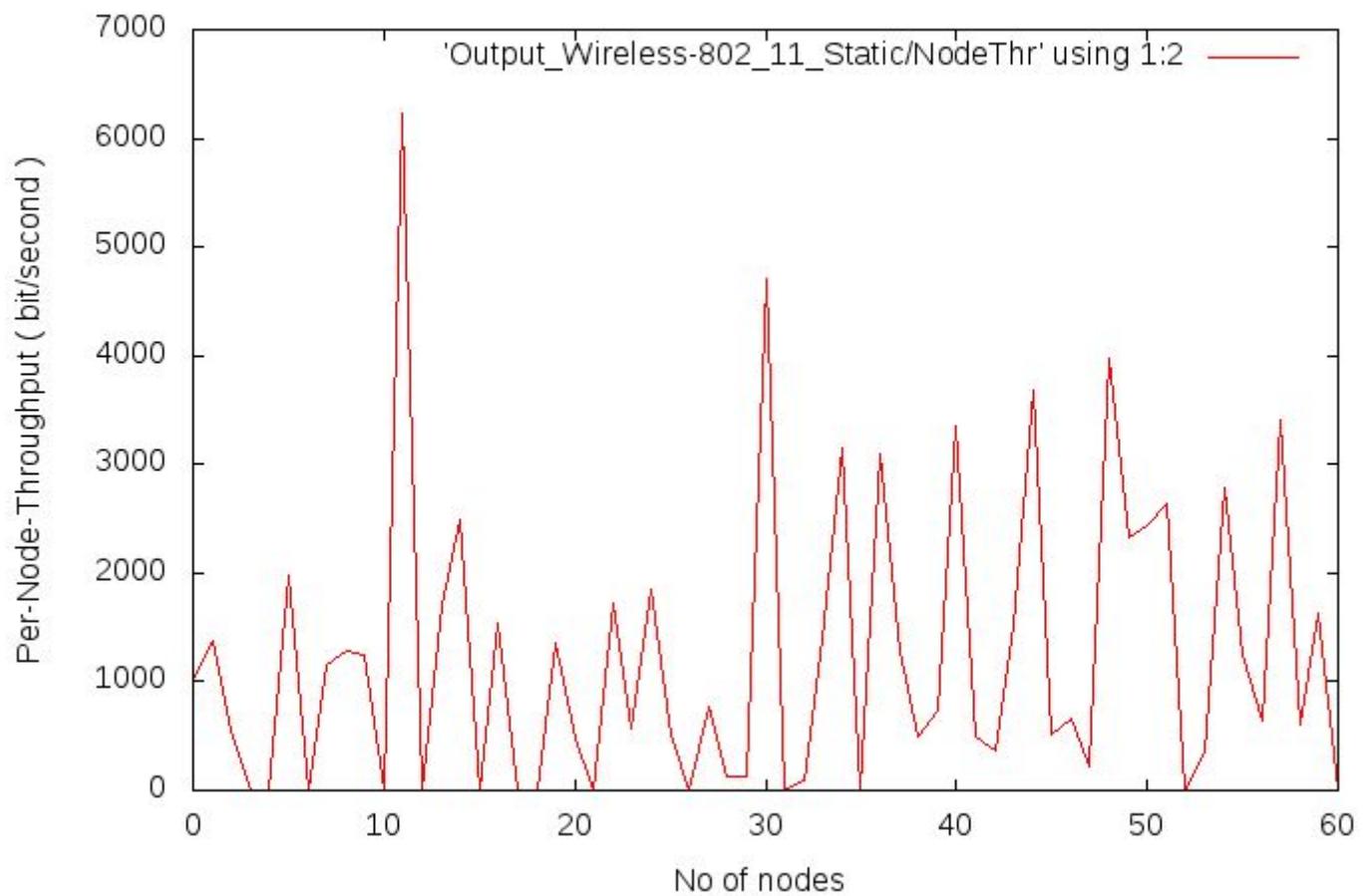
Wireless\_802.11(Static) : Energy per byte vs No of nodes



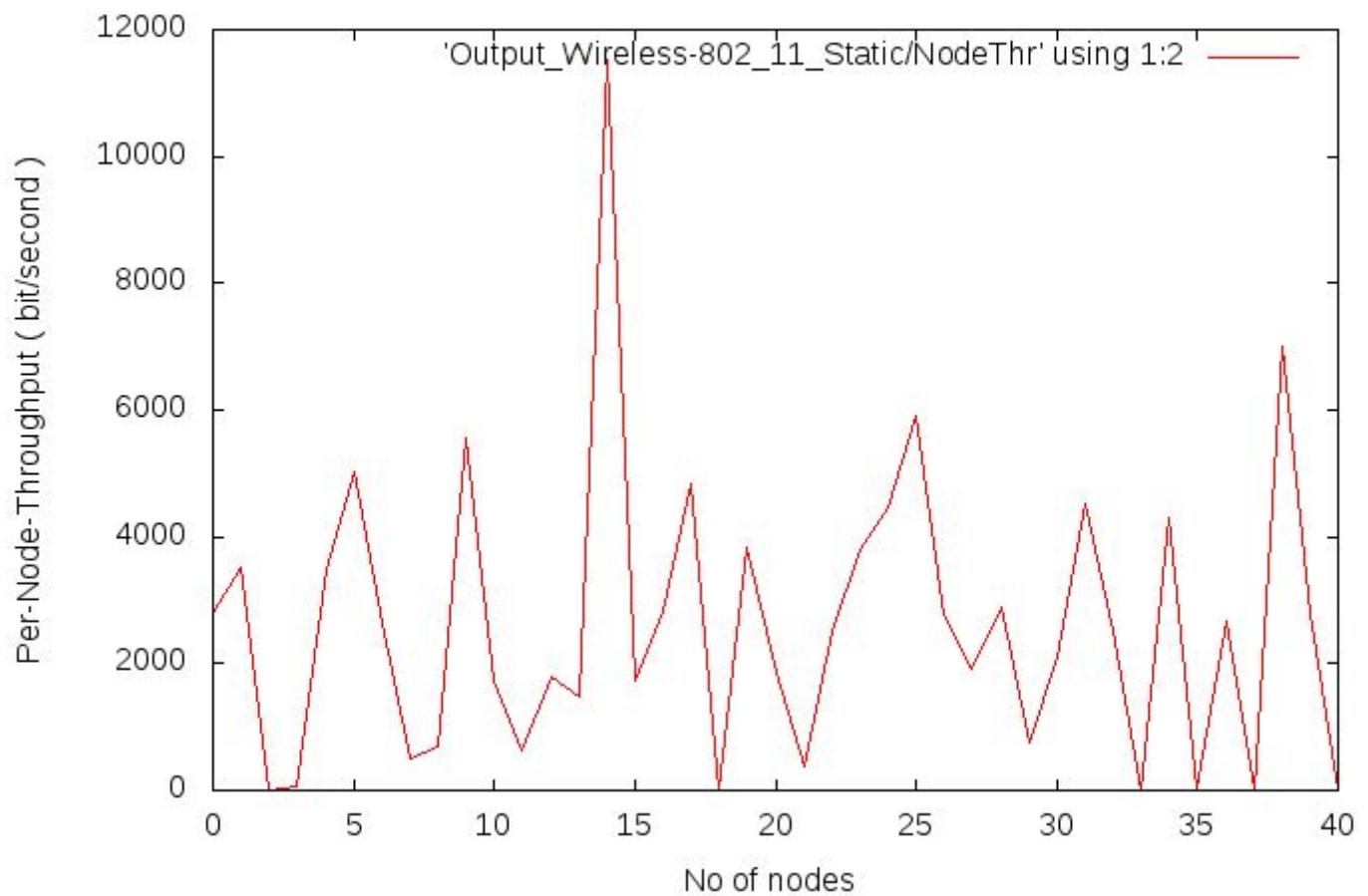
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 4



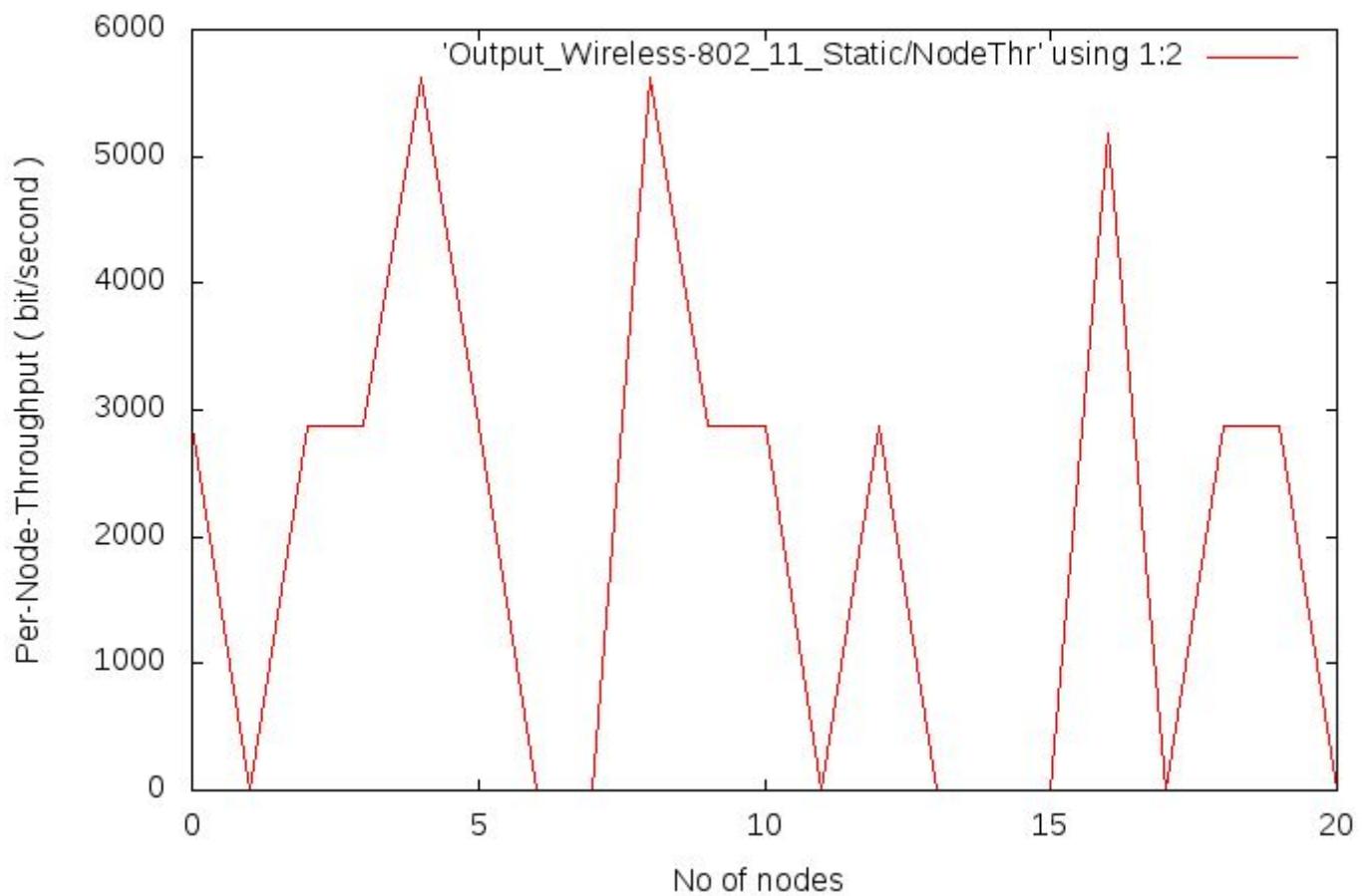
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 3



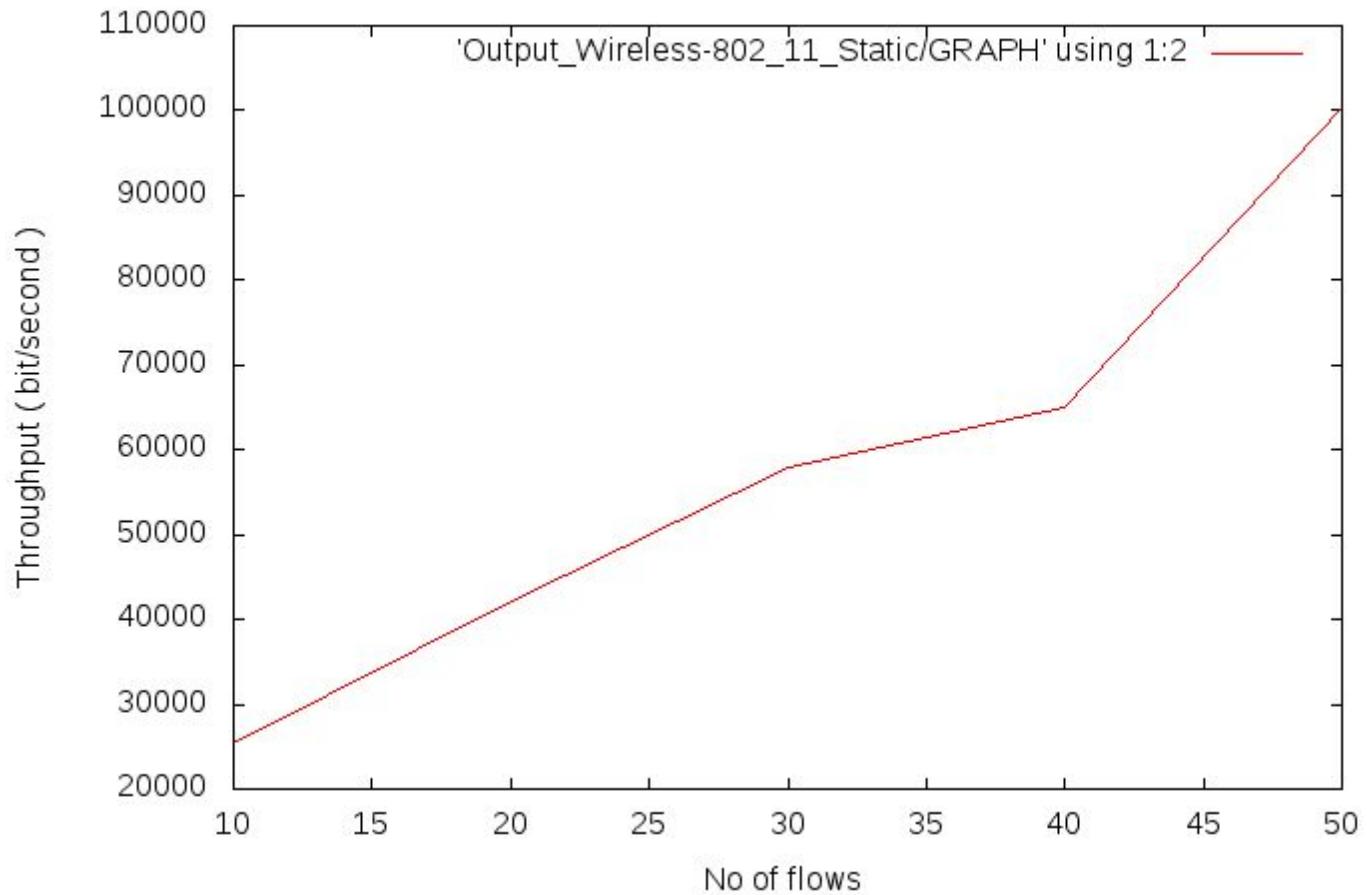
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 2



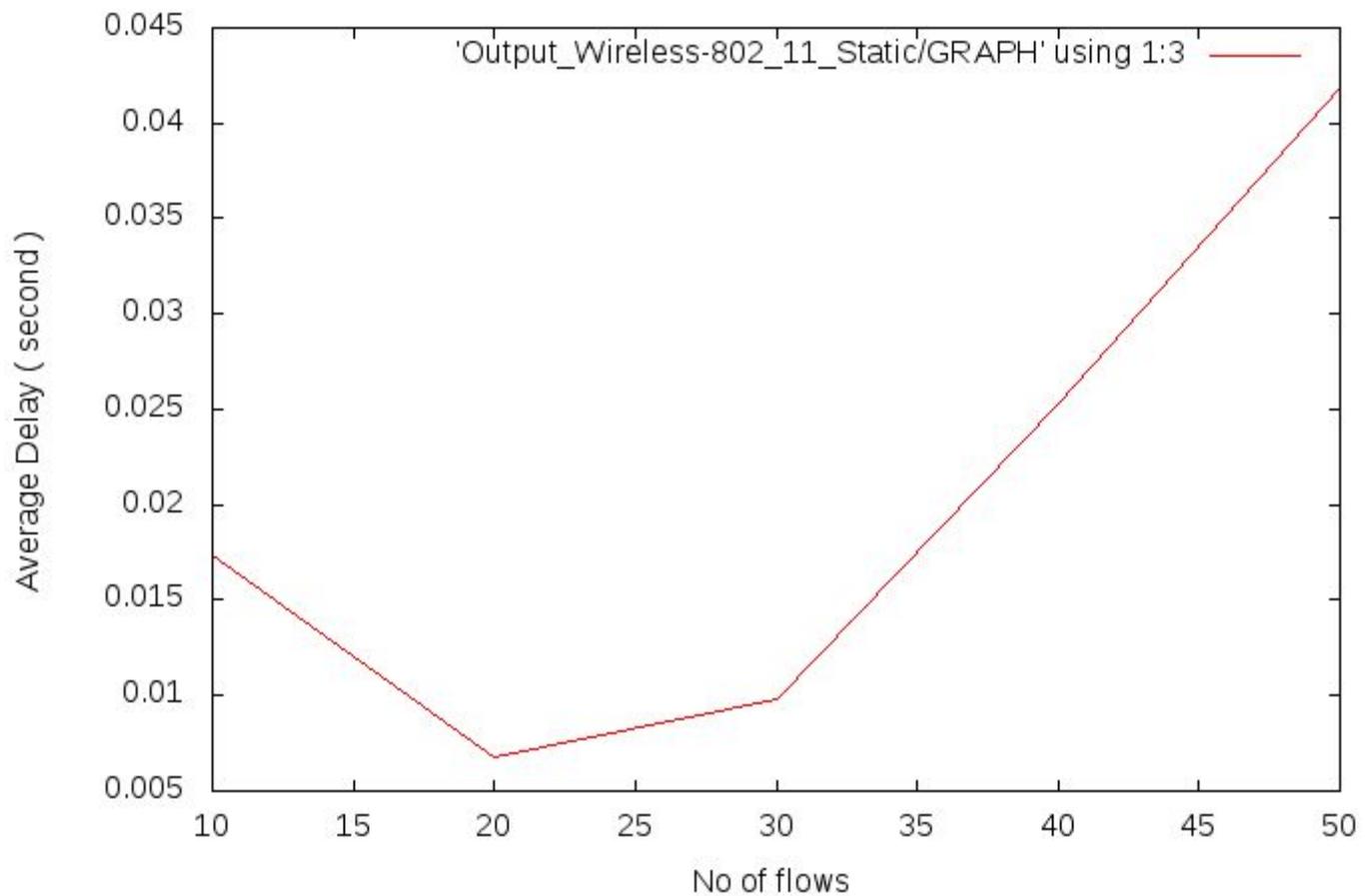
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 1



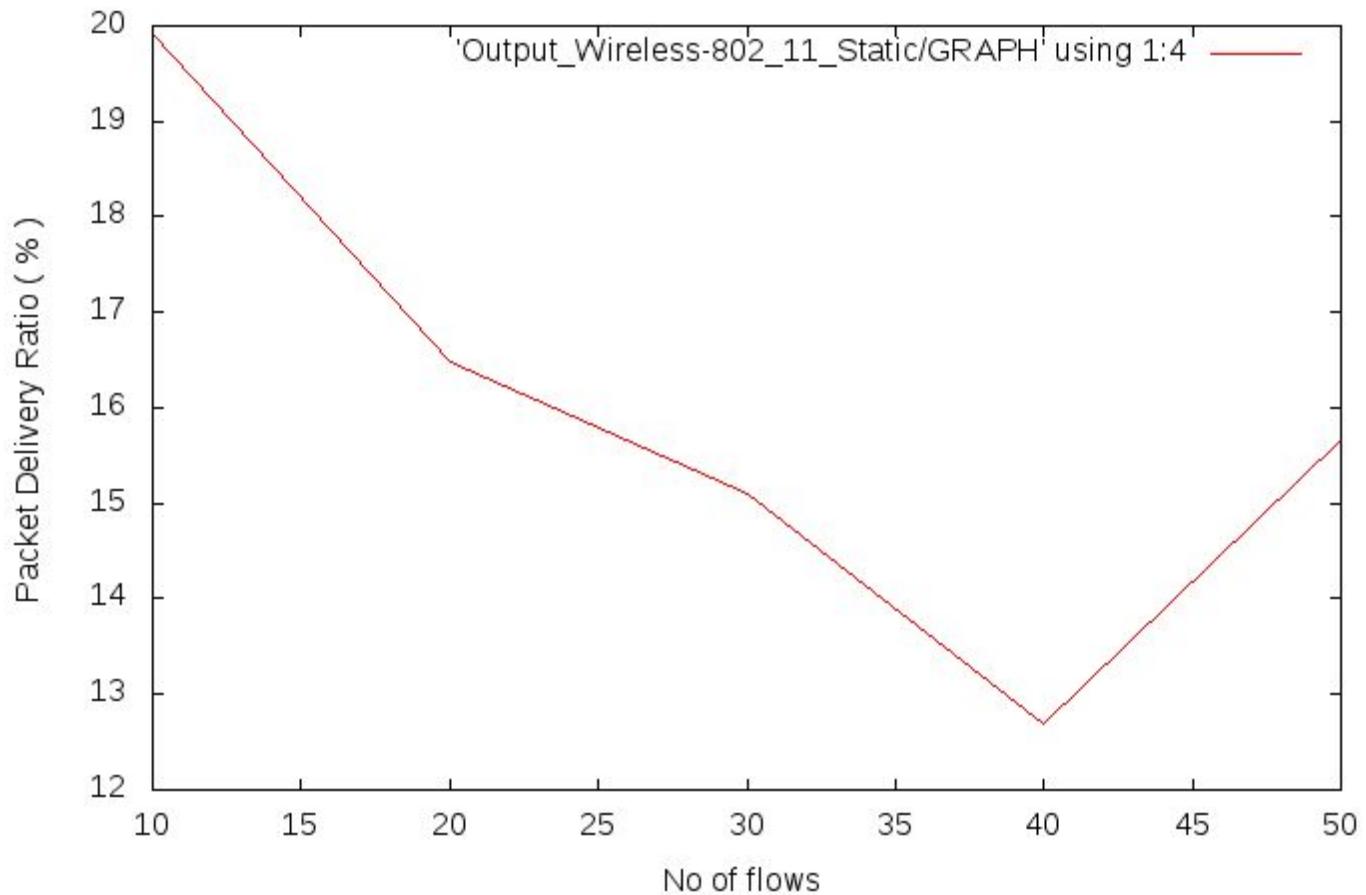
Wireless\_802.11(Static) : Throughput vs No of flows



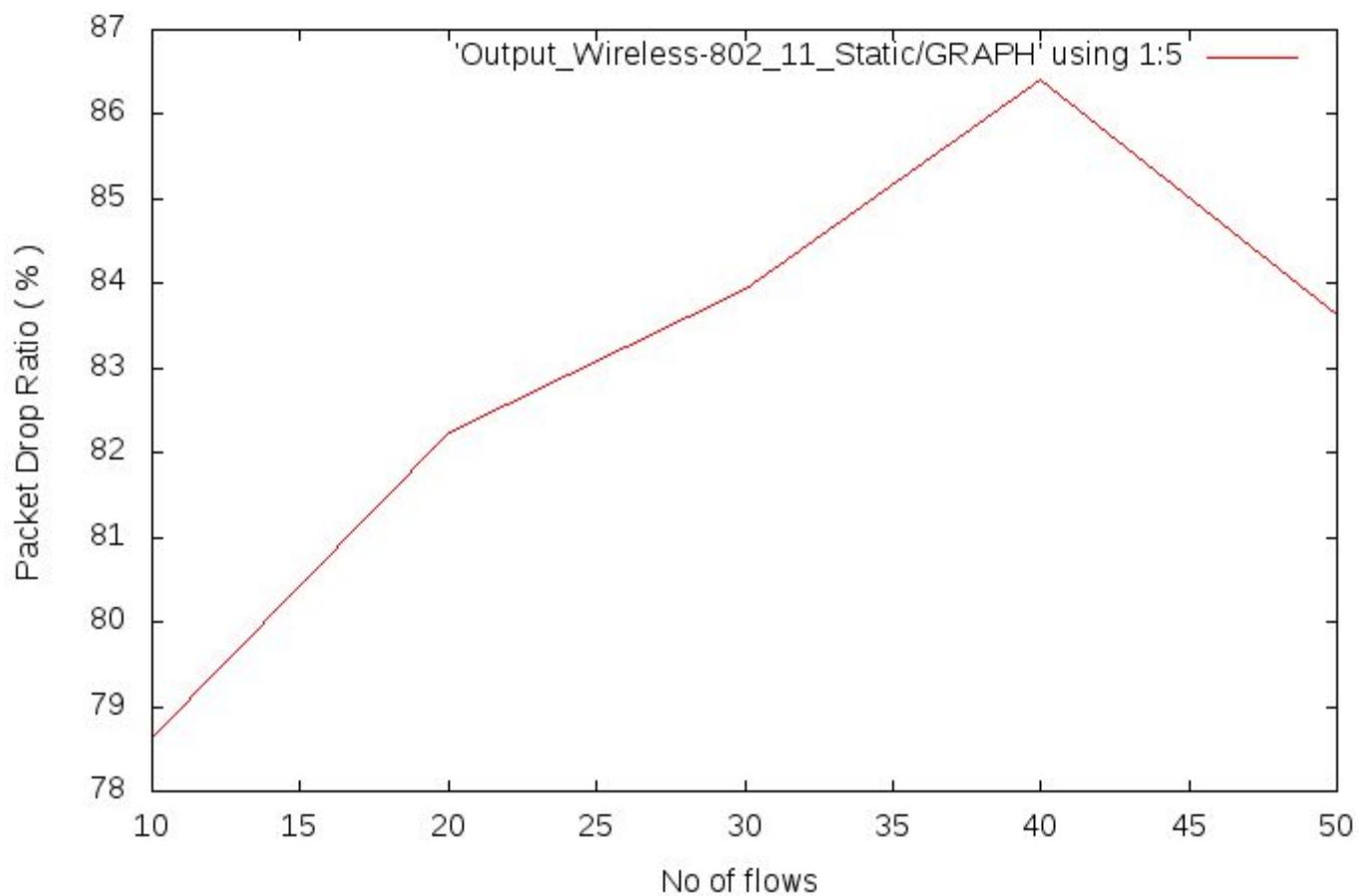
Wireless\_802.11(Static) : Average Delay vs No of flows



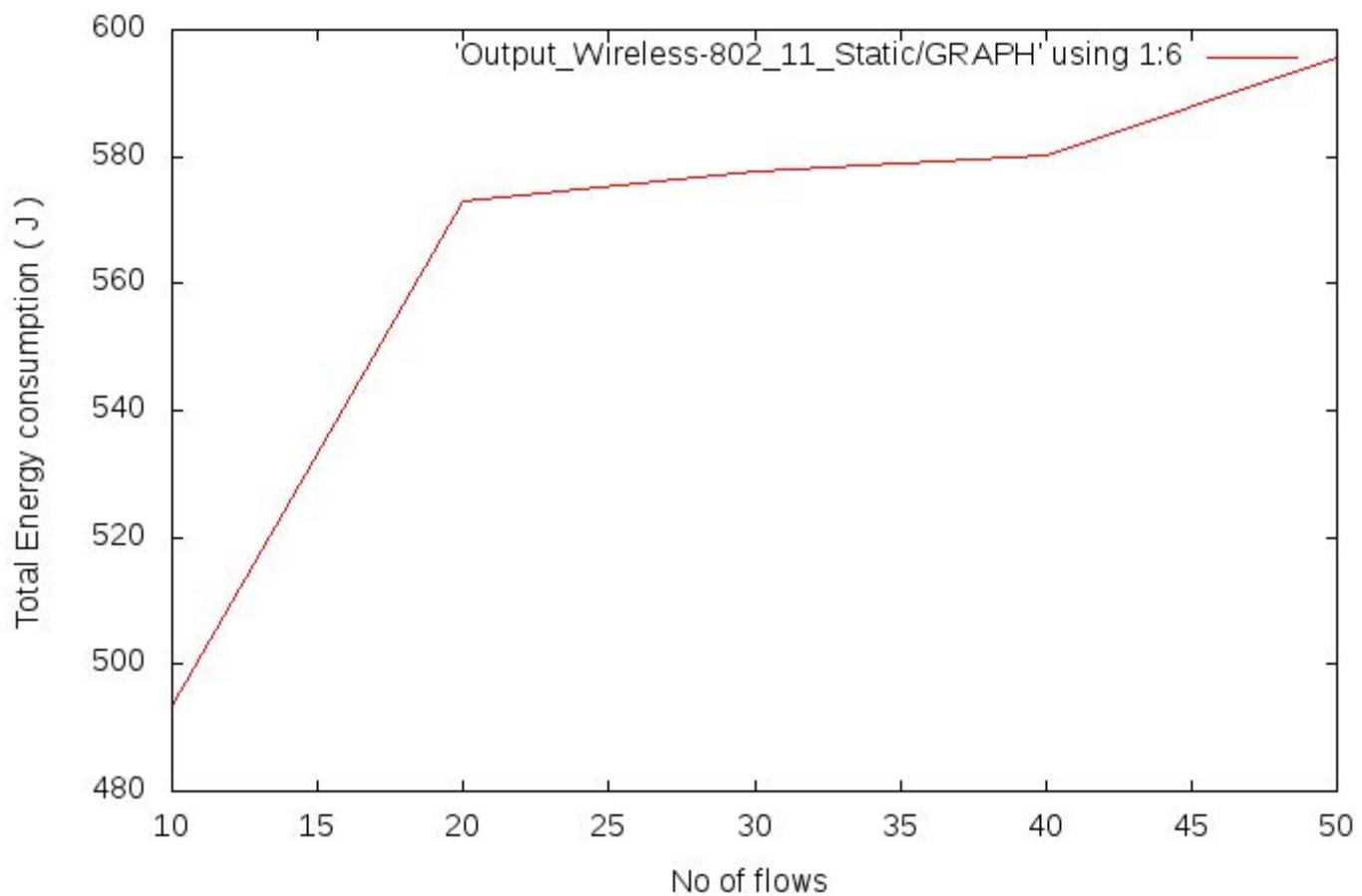
Wireless\_802.11(Static) : Packet Delivery Ratio vs No of flows



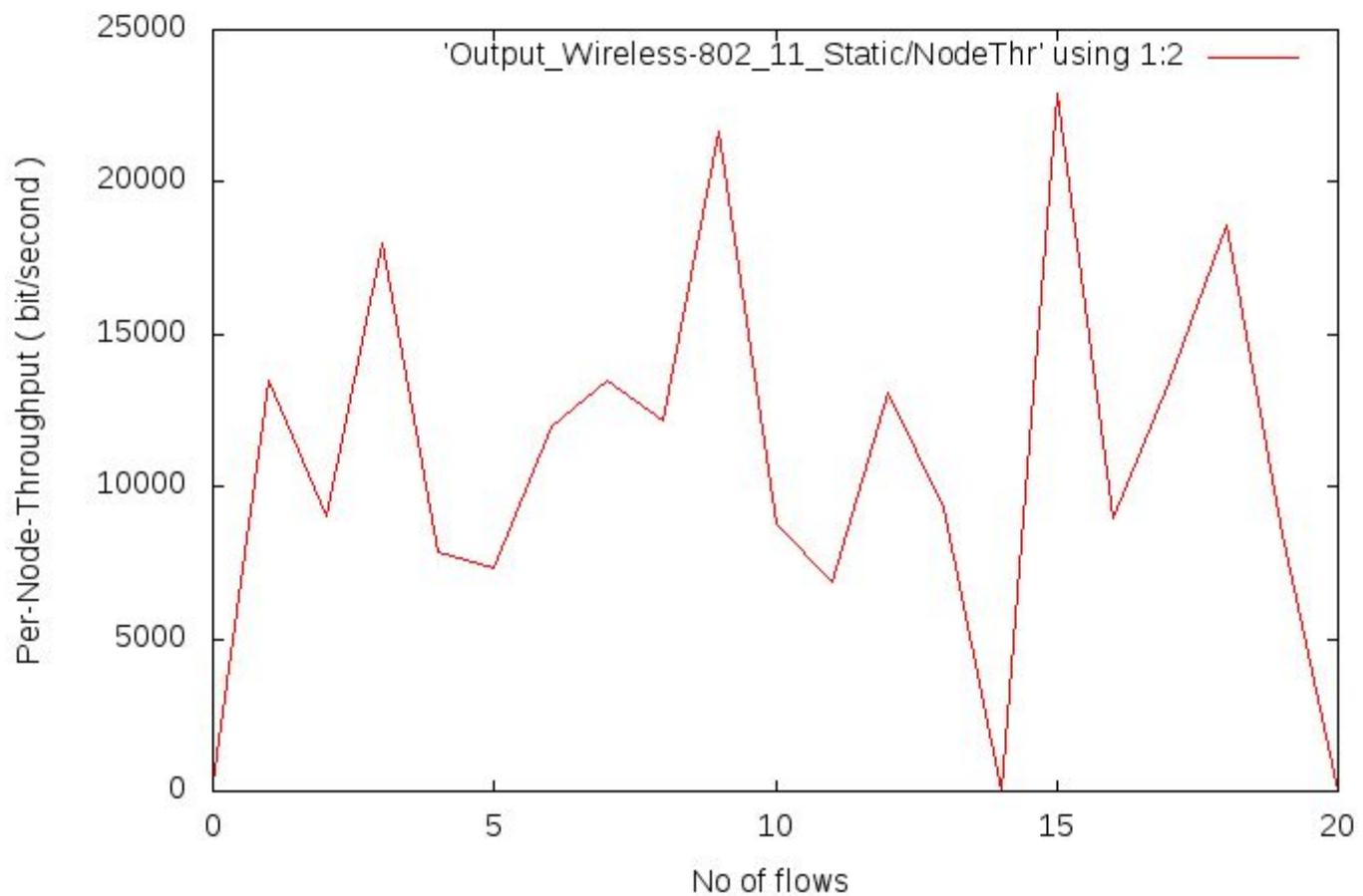
Wireless\_802.11(Static) : Packet Drop Ratio vs No of flows



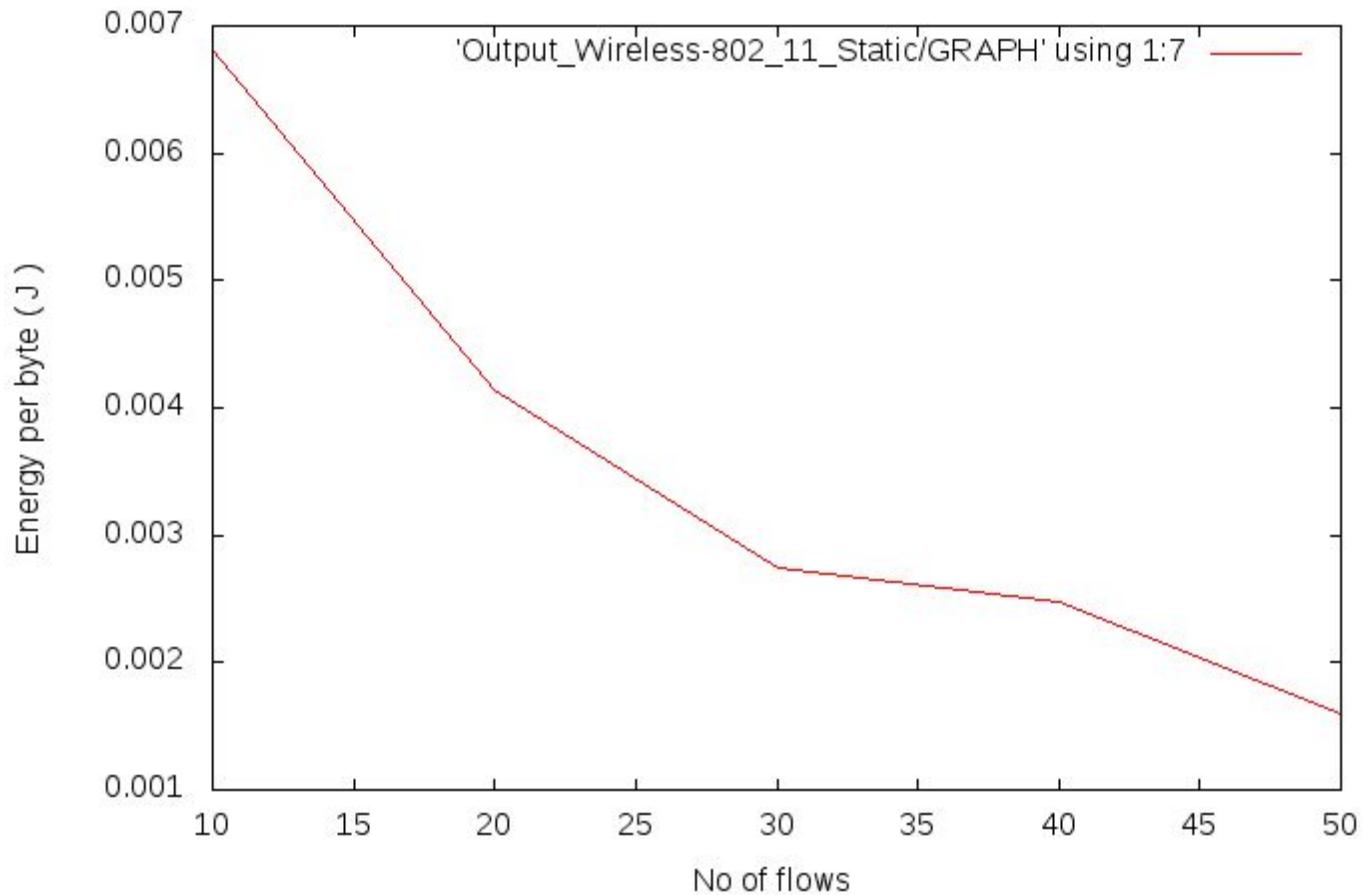
Wireless\_802.11(Static) : Total Energy consumption vs No of flows



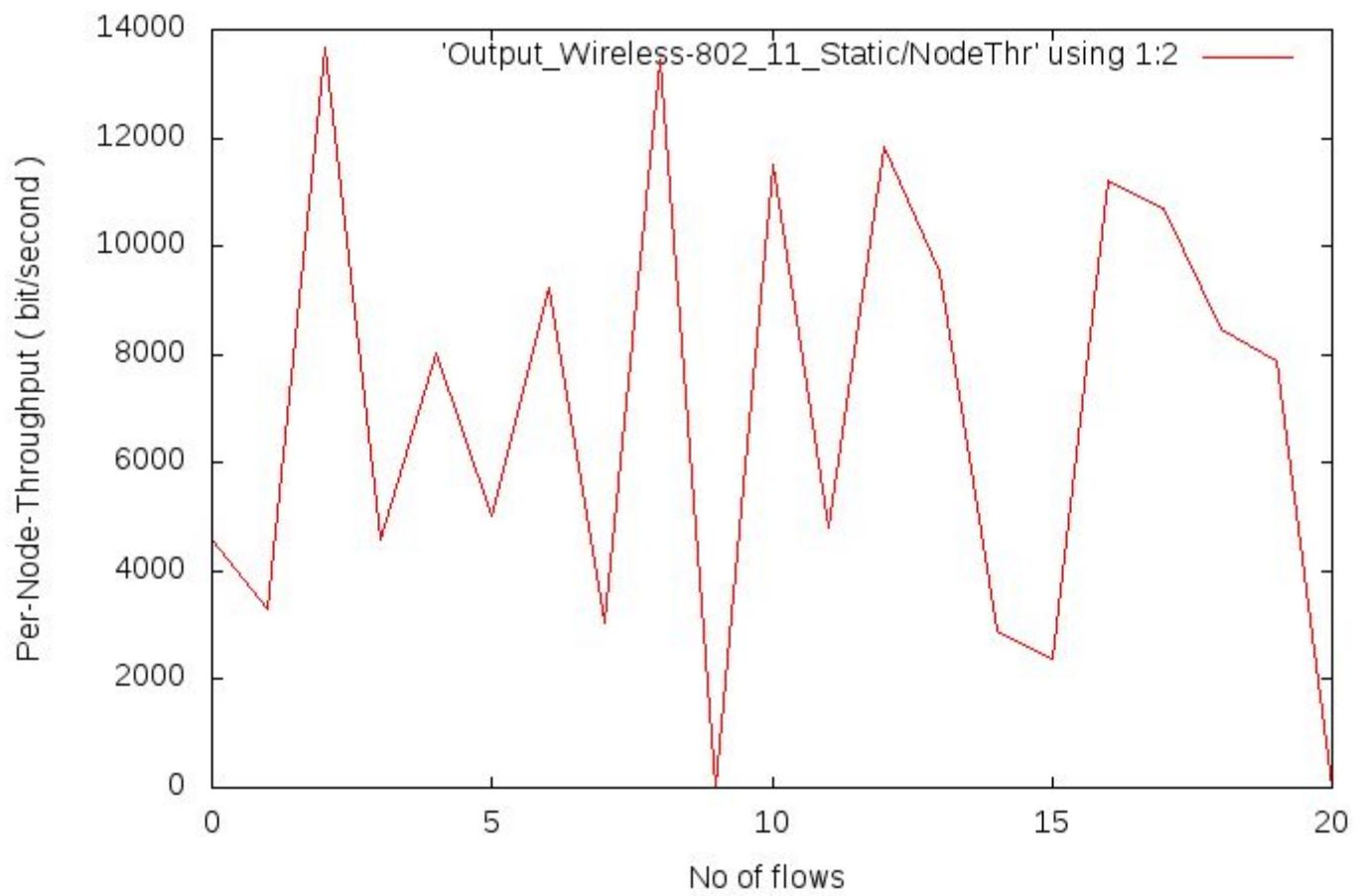
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 5



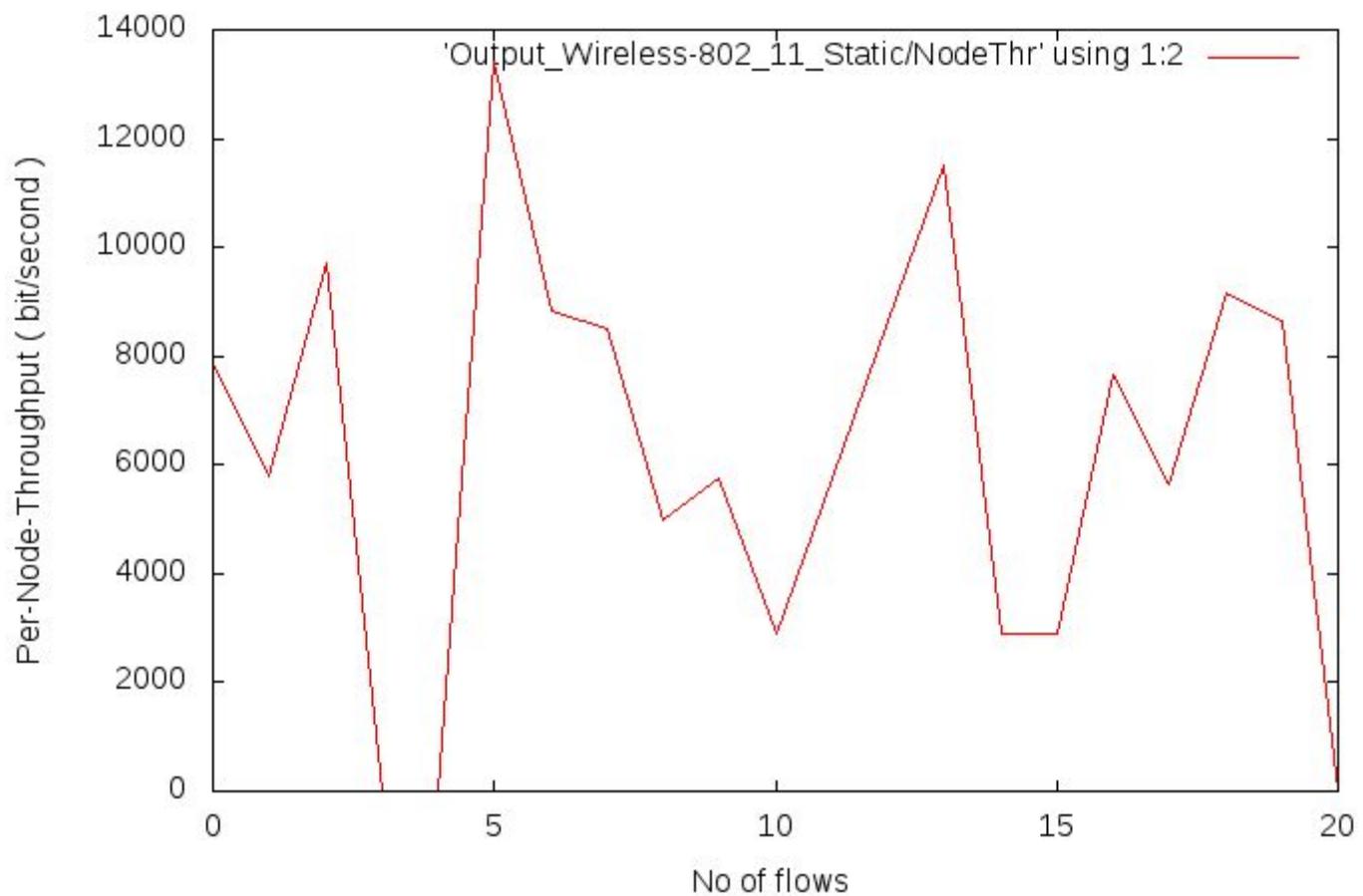
Wireless\_802.11(Static) : Energy per byte vs No of flows



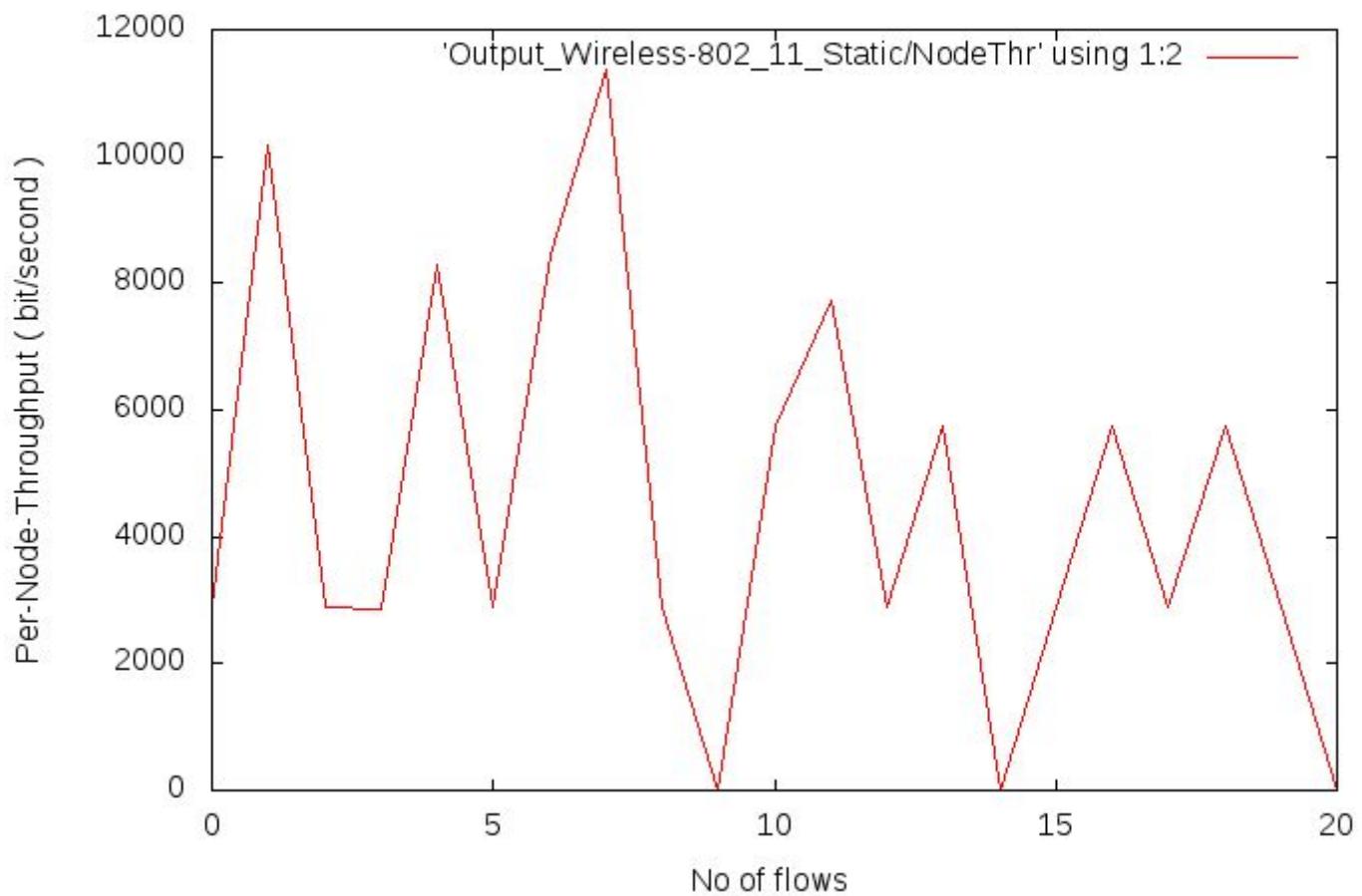
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 4



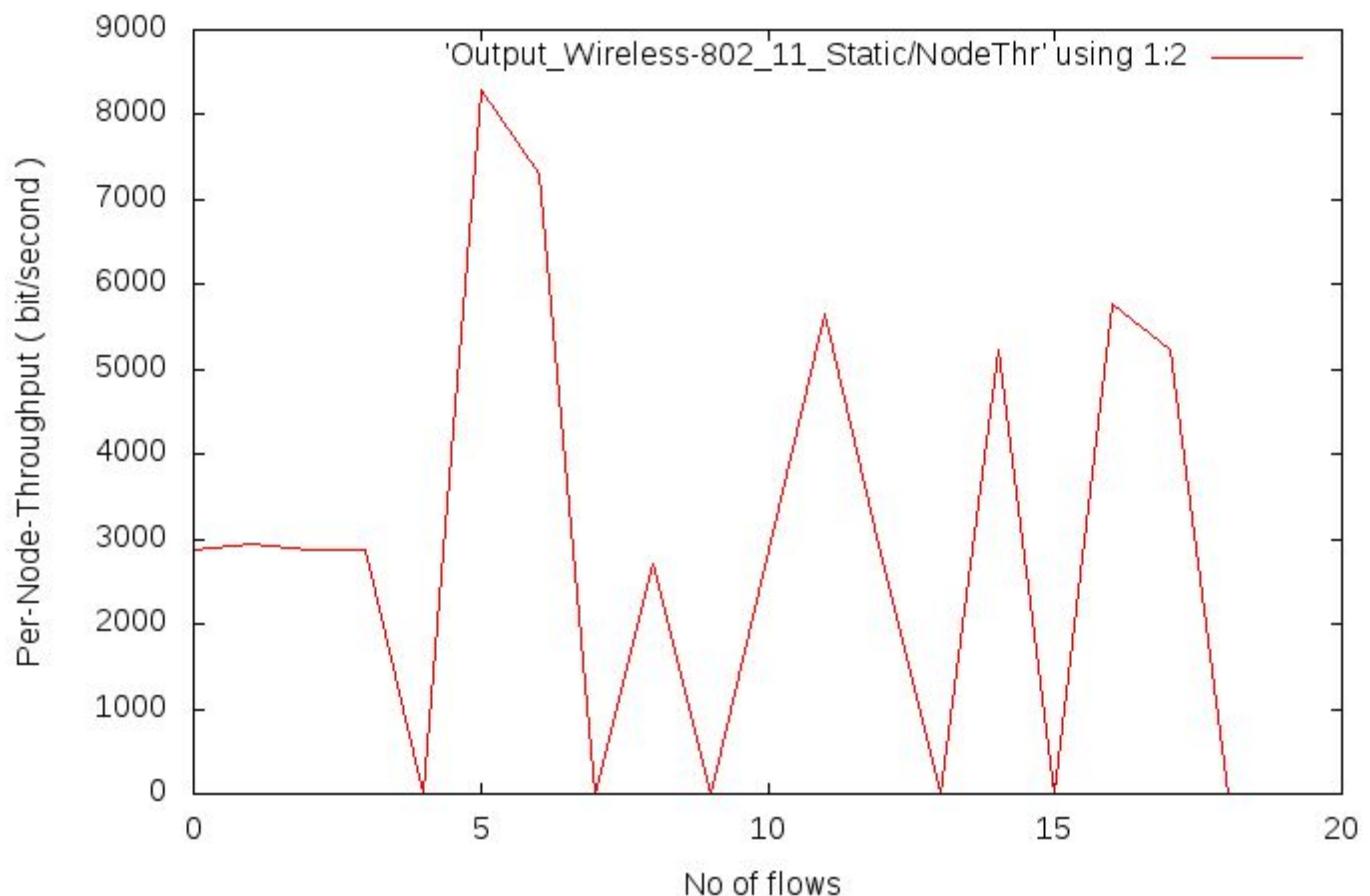
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 3

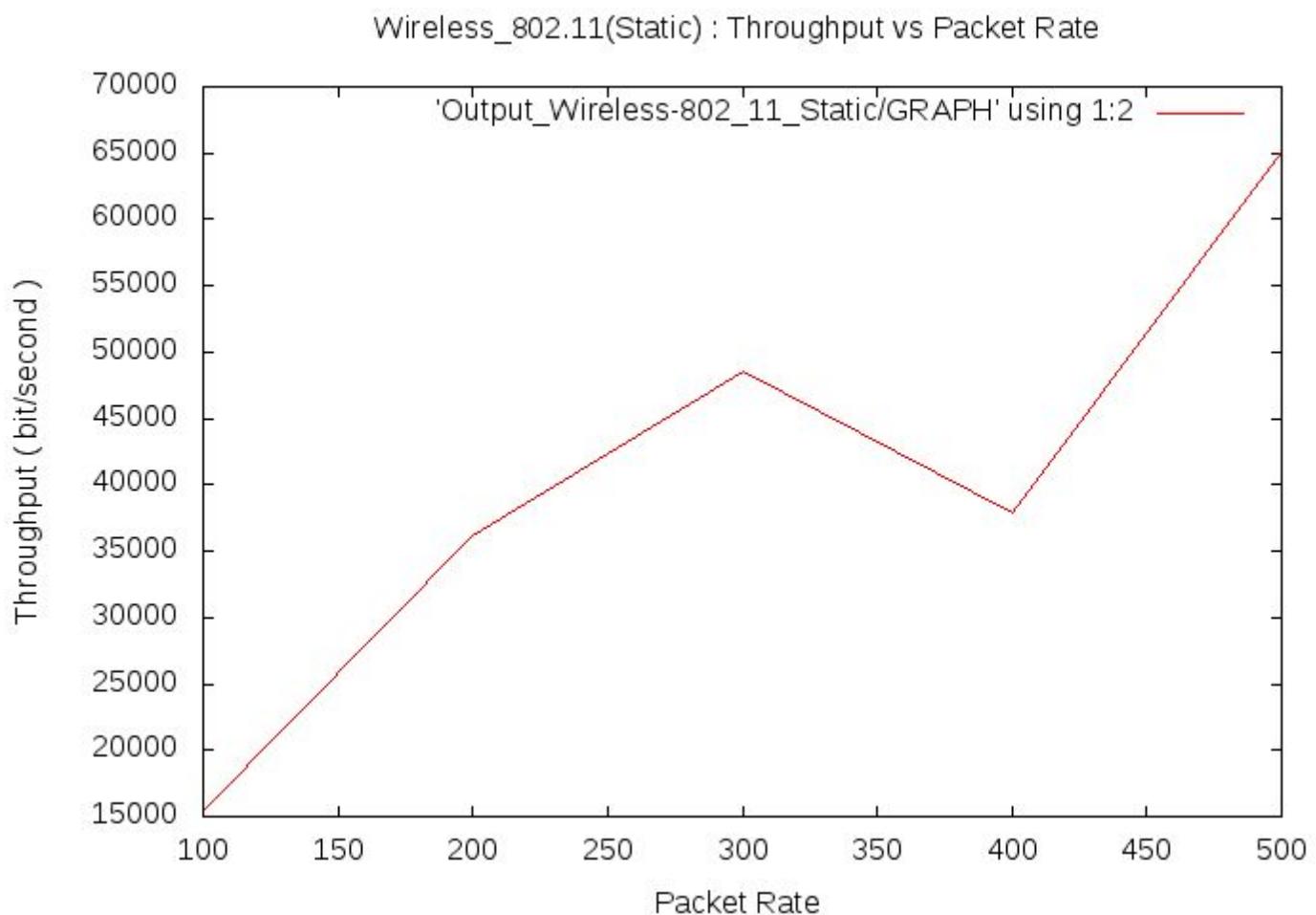


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 2

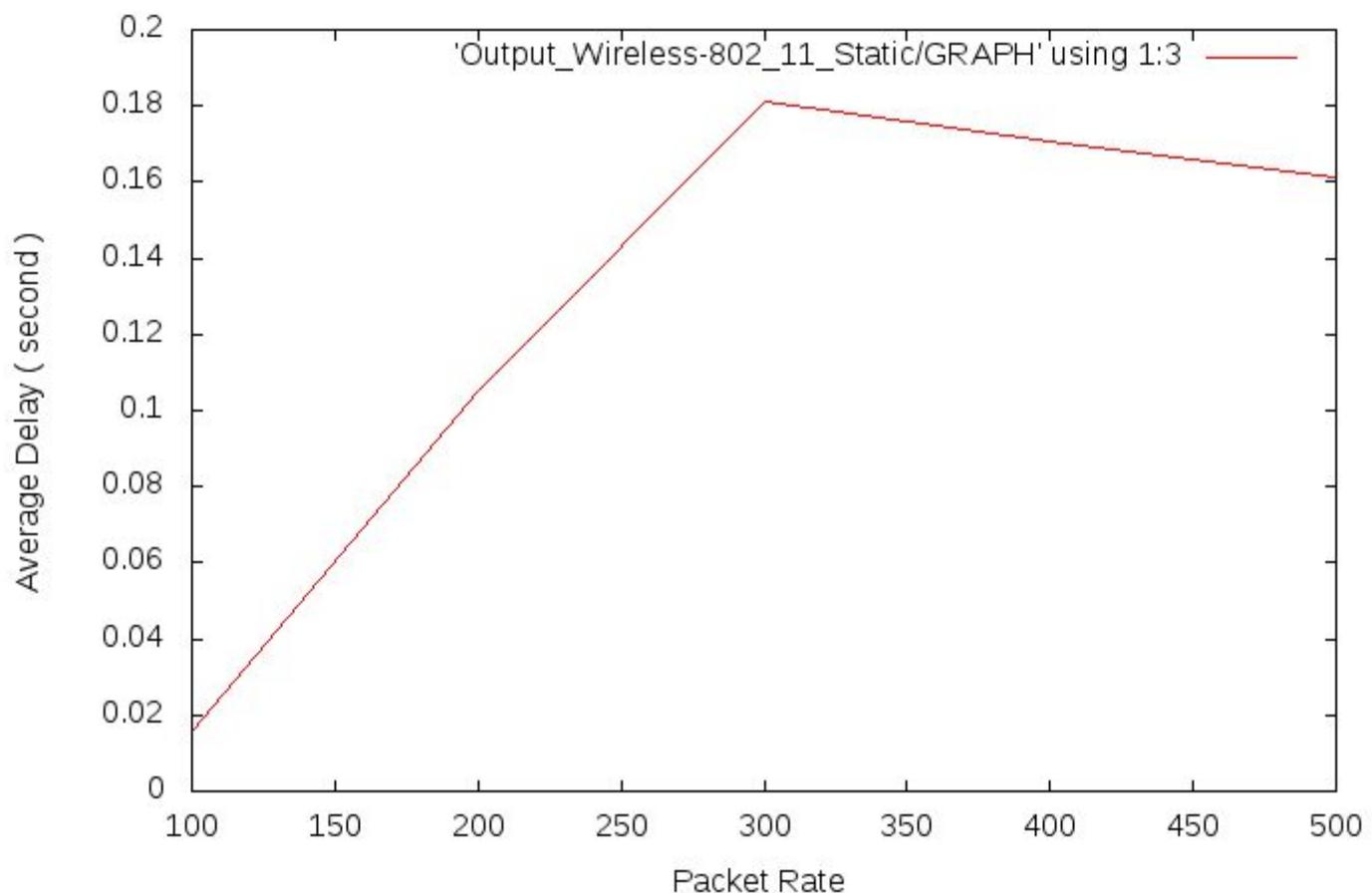


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 1

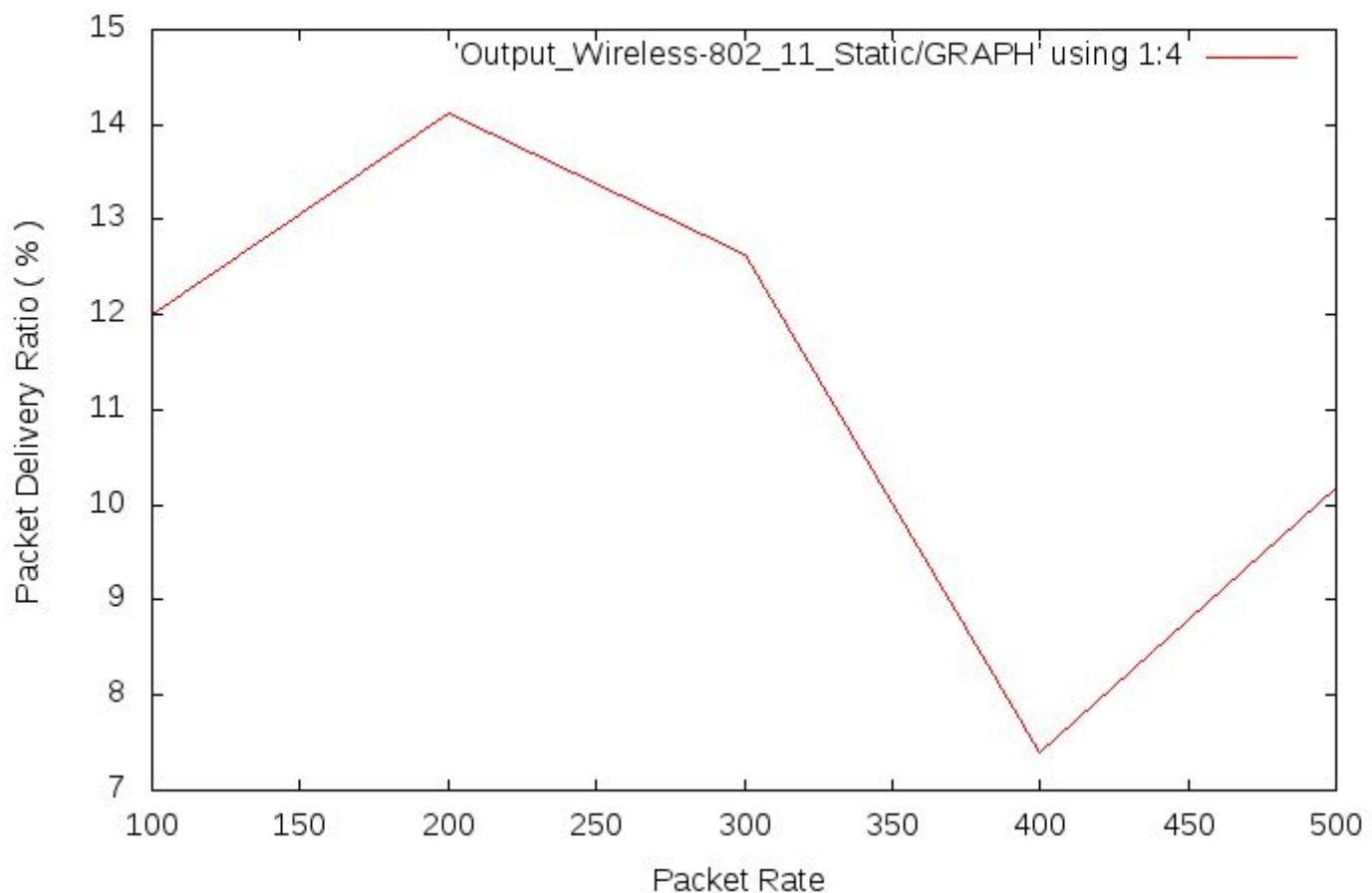




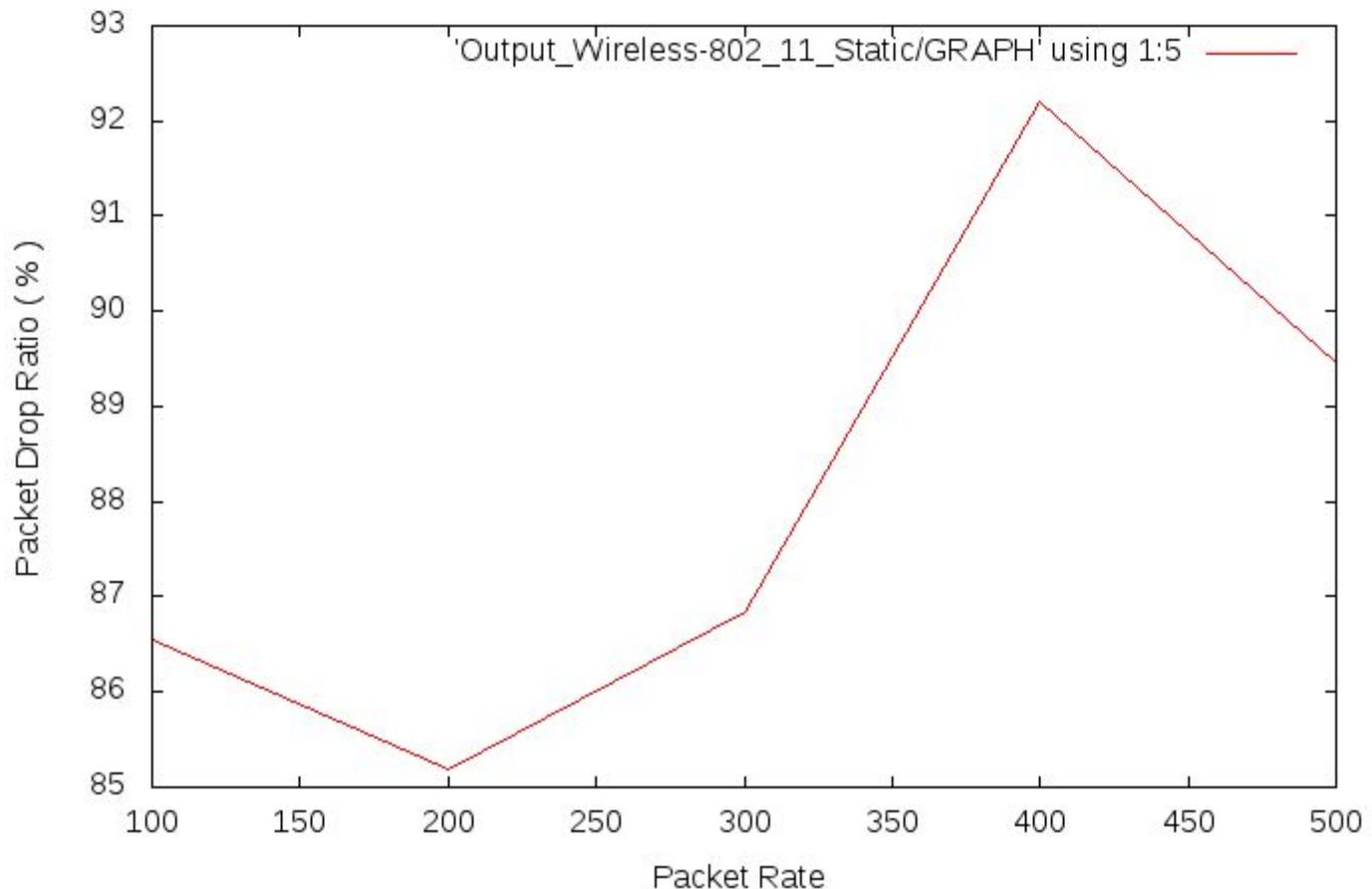
Wireless\_802.11(Static) : Average Delay vs Packet Rate

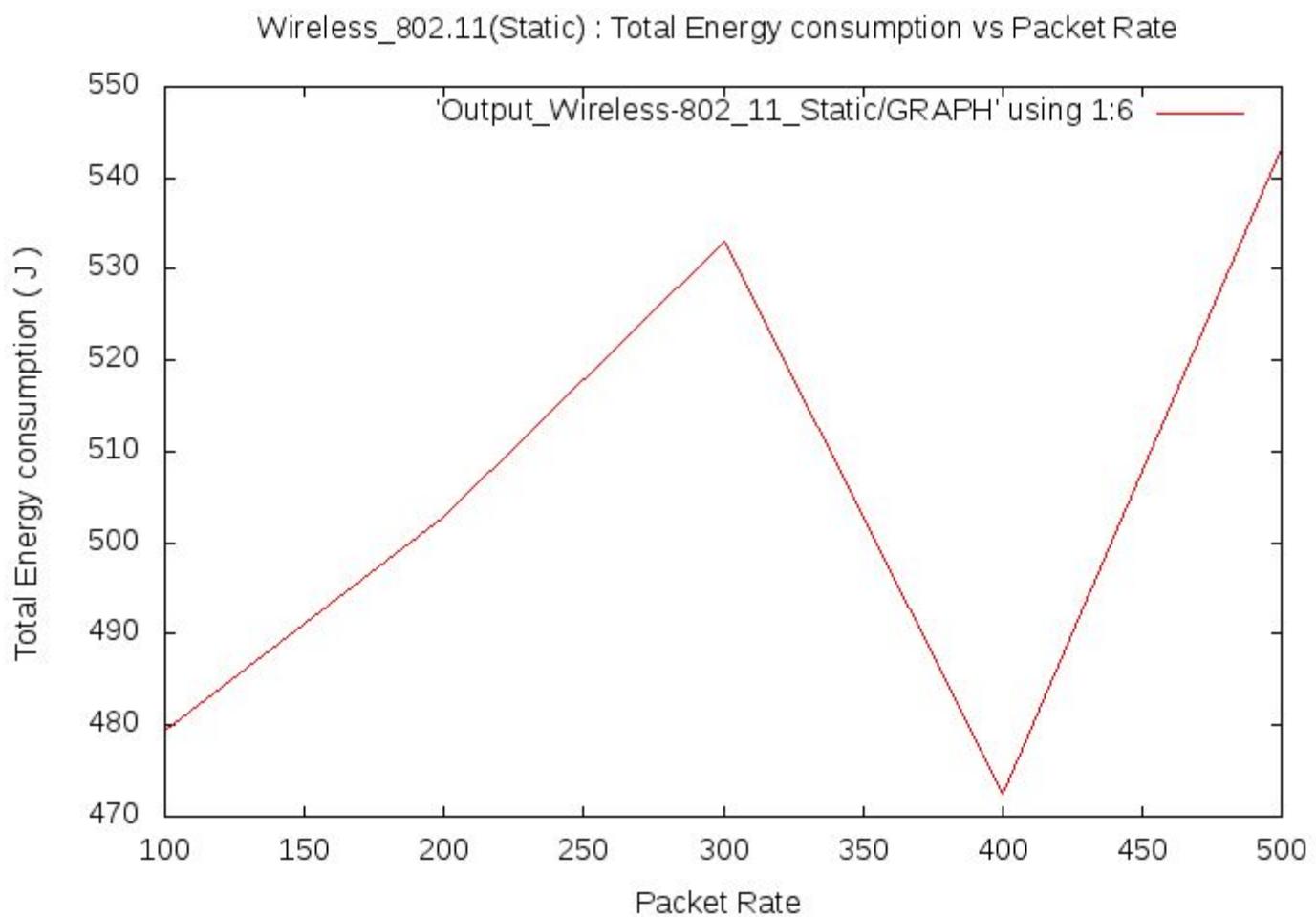


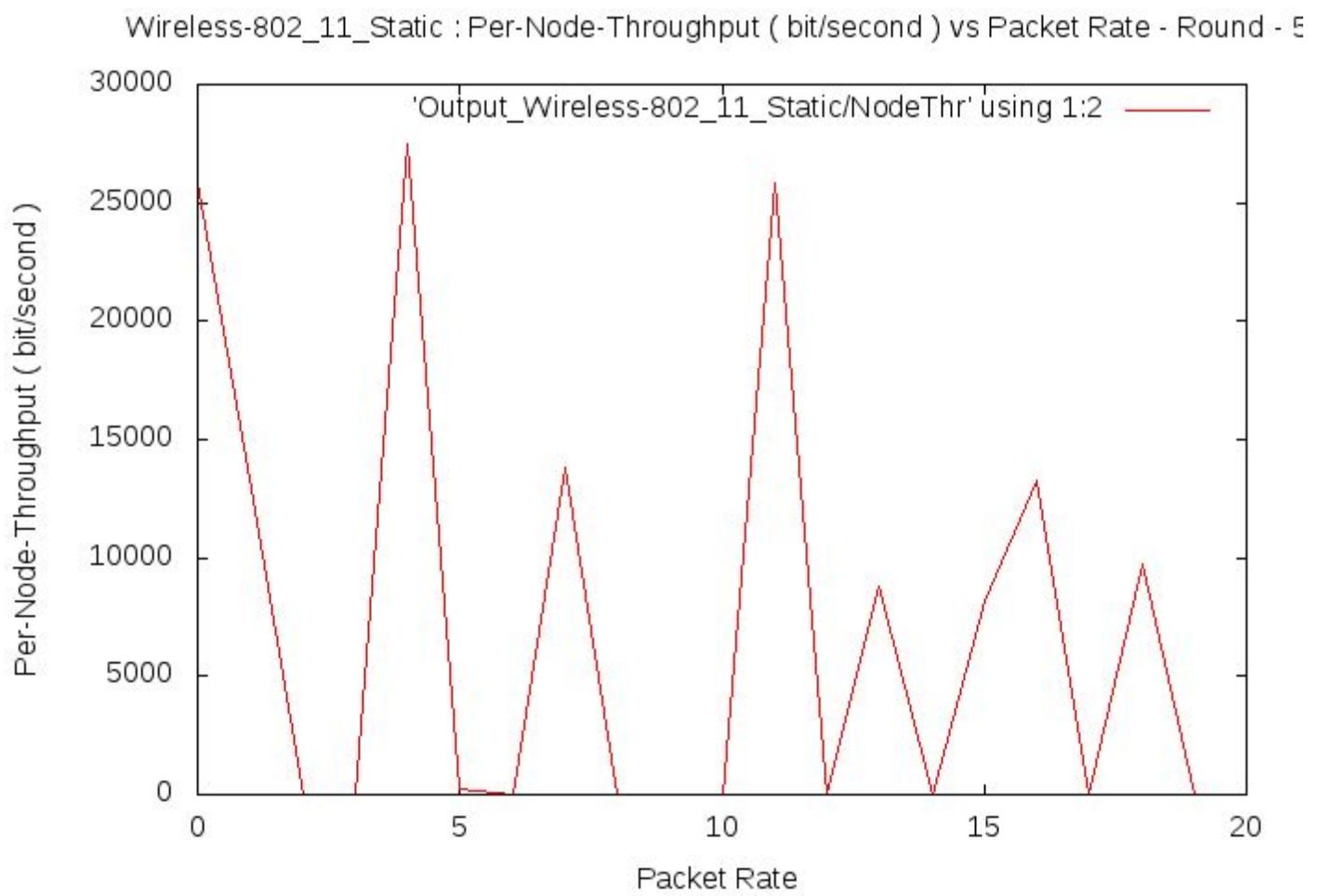
Wireless\_802.11(Static) : Packet Delivery Ratio vs Packet Rate

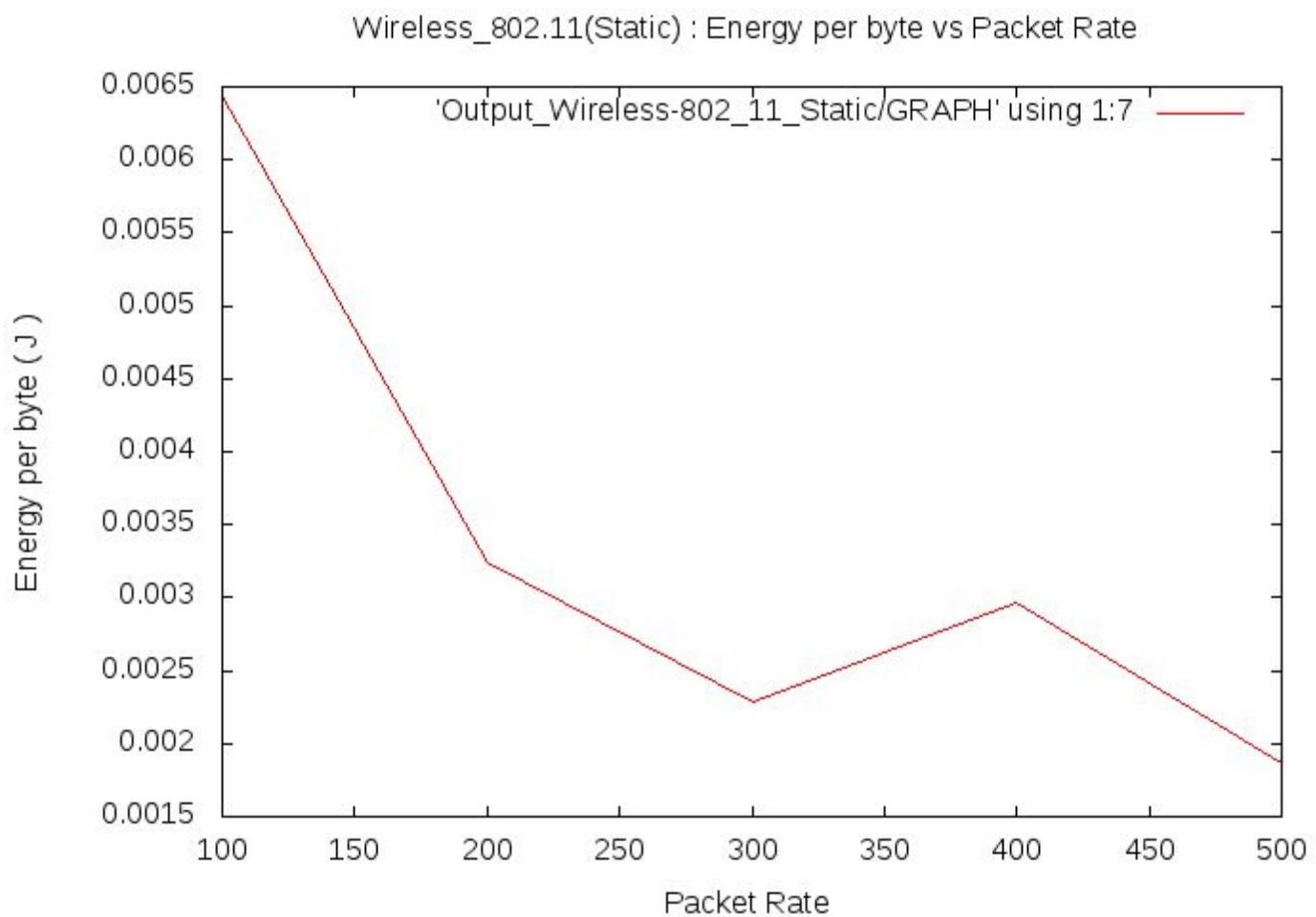


Wireless\_802.11(Static) : Packet Drop Ratio vs Packet Rate

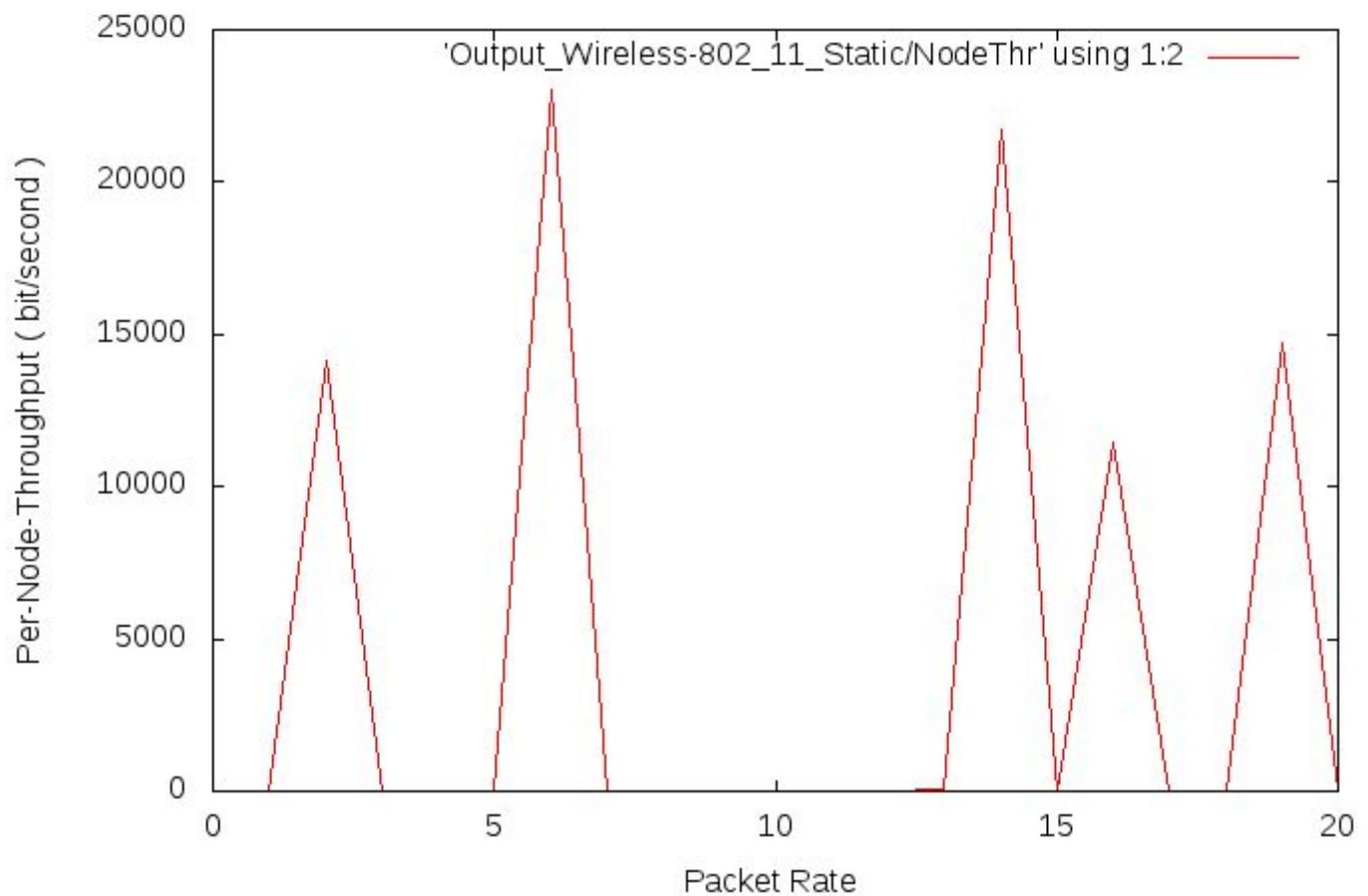




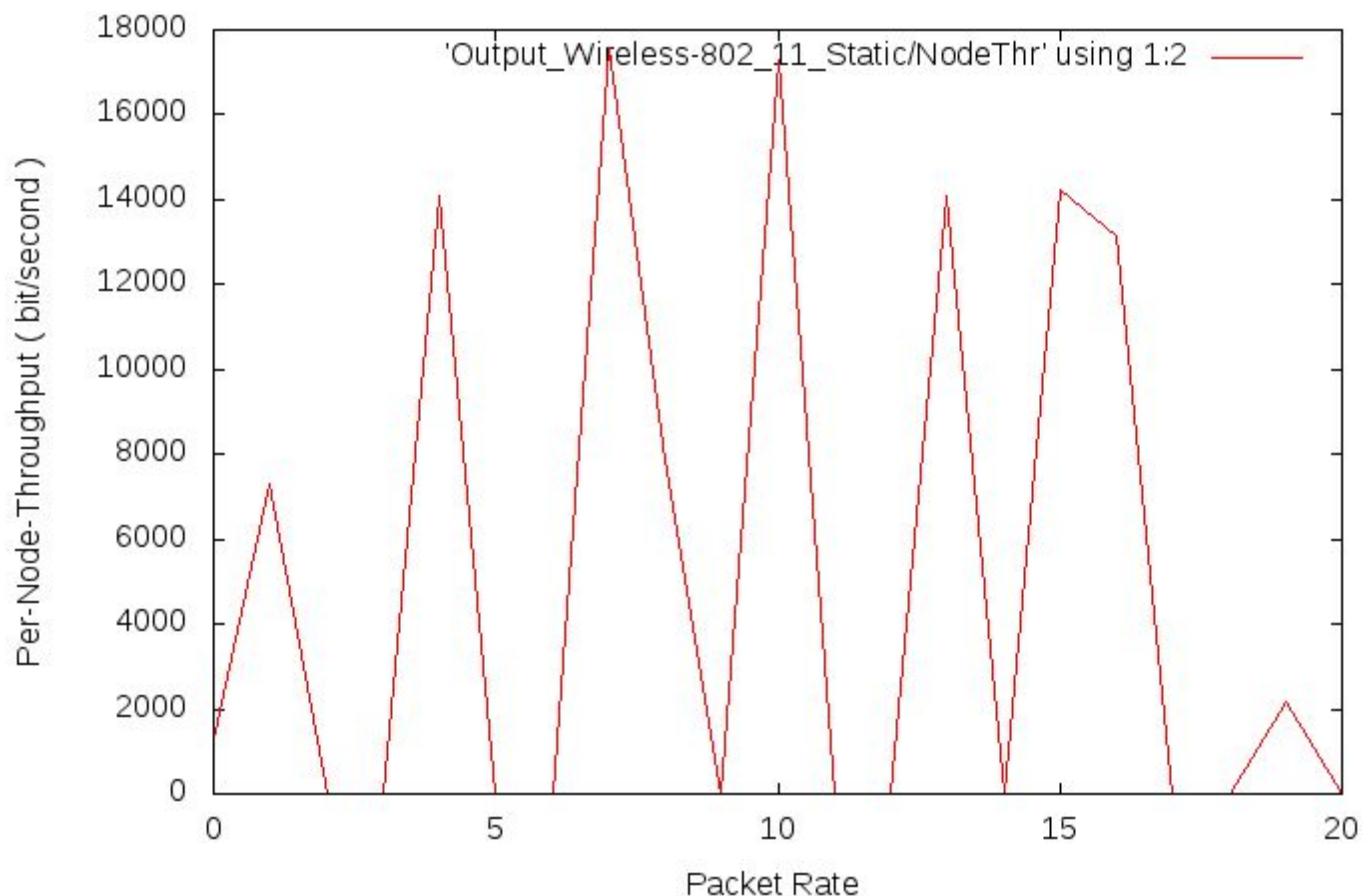




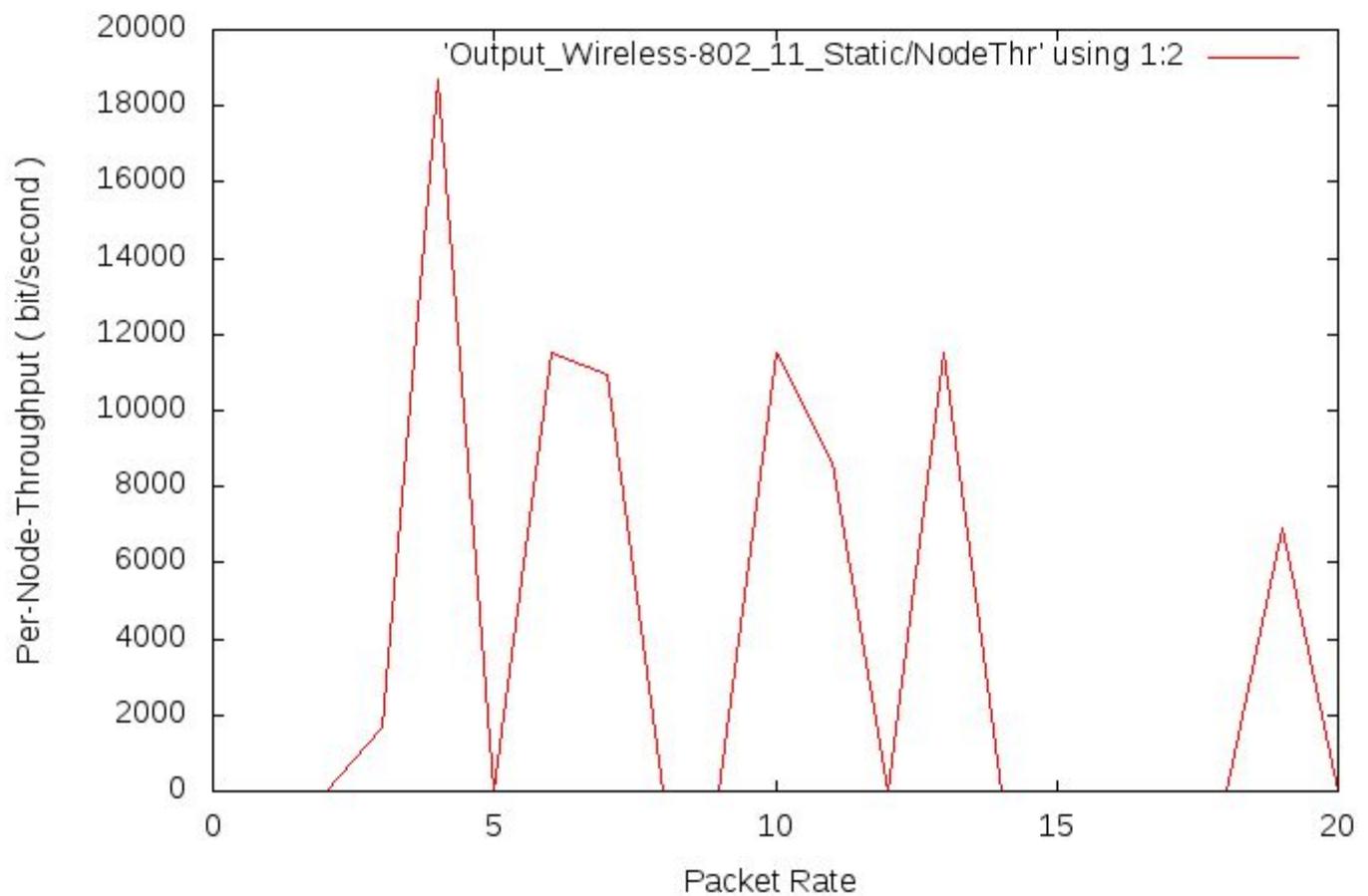
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 4



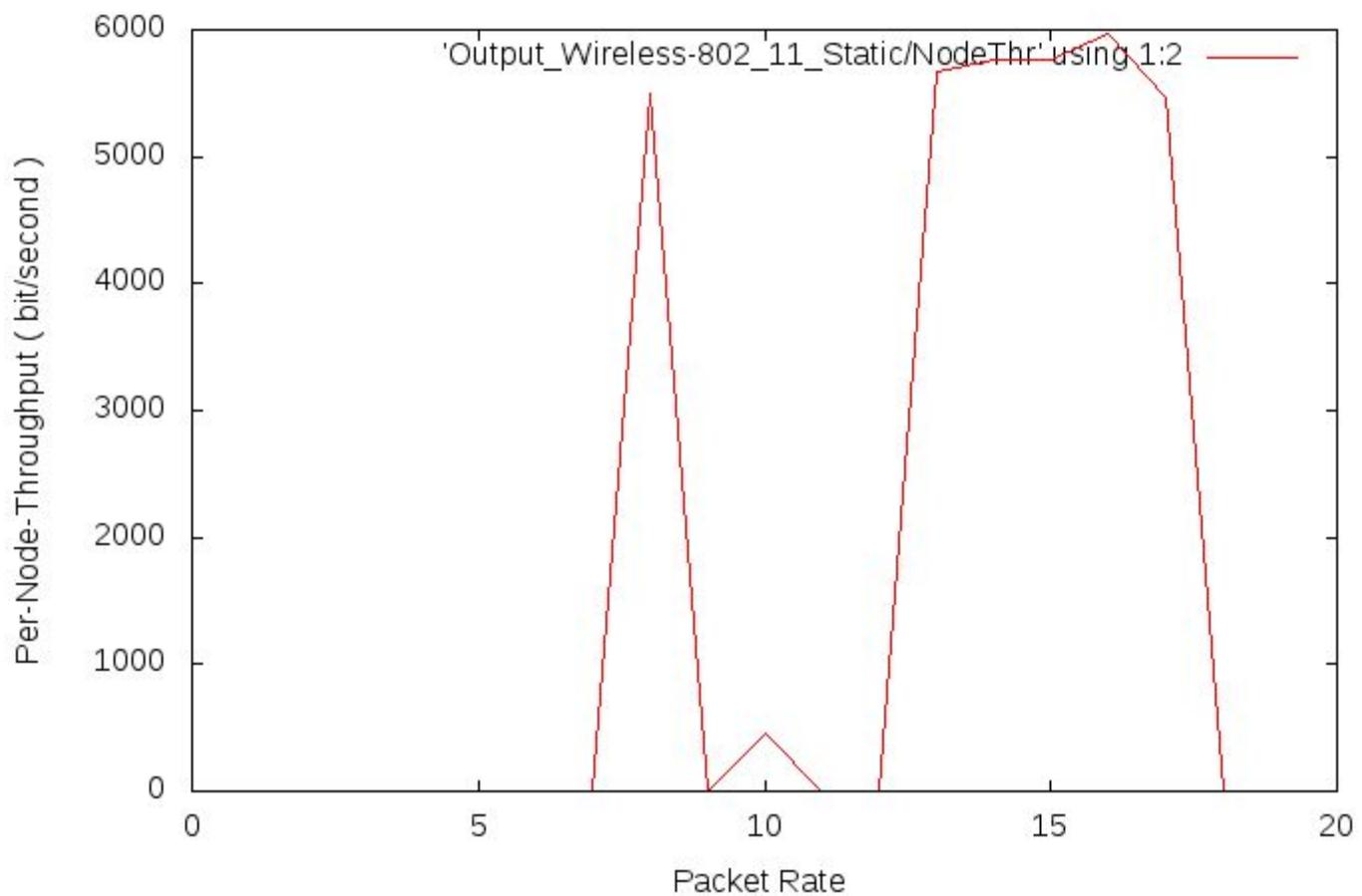
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 3

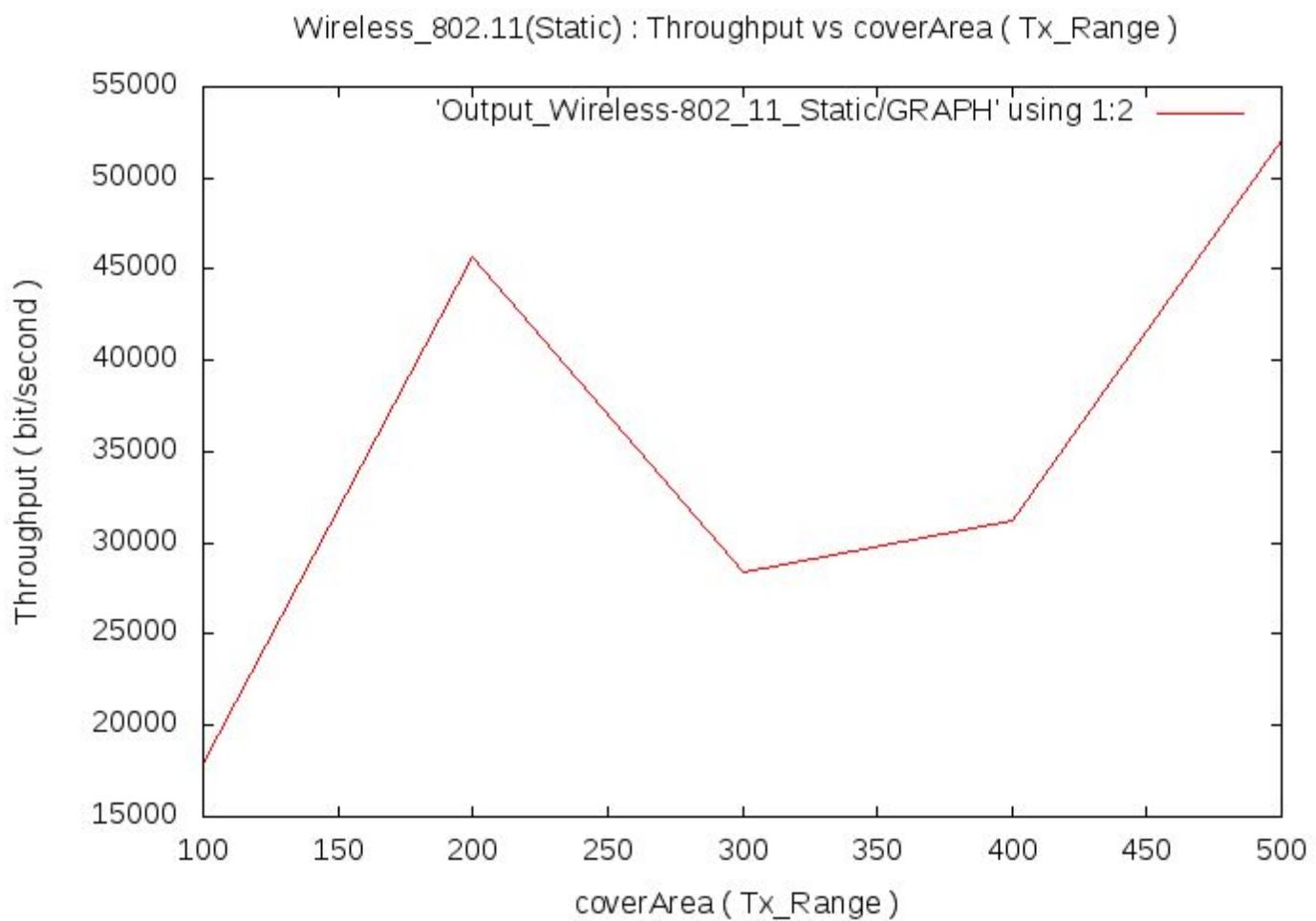


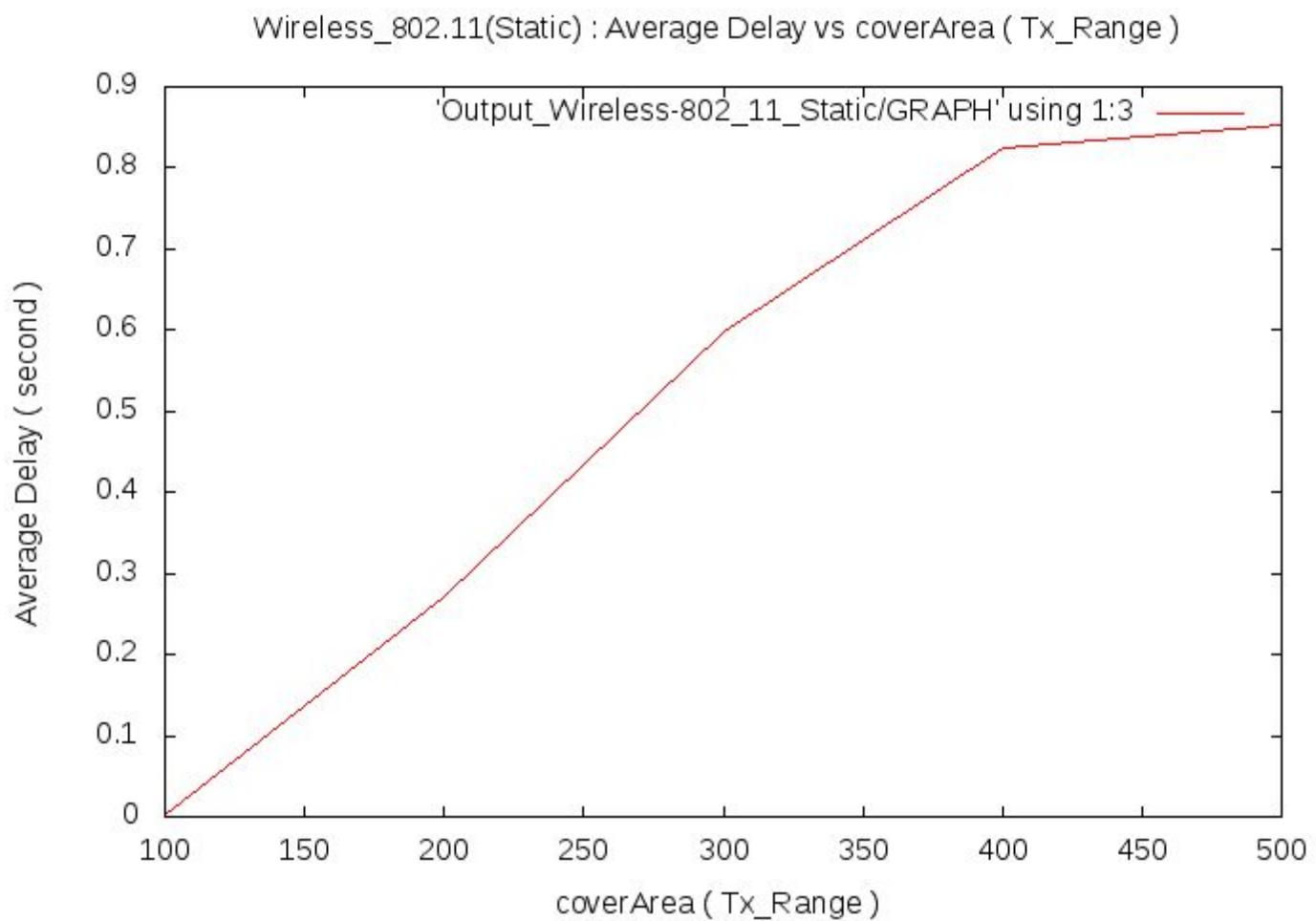
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 2



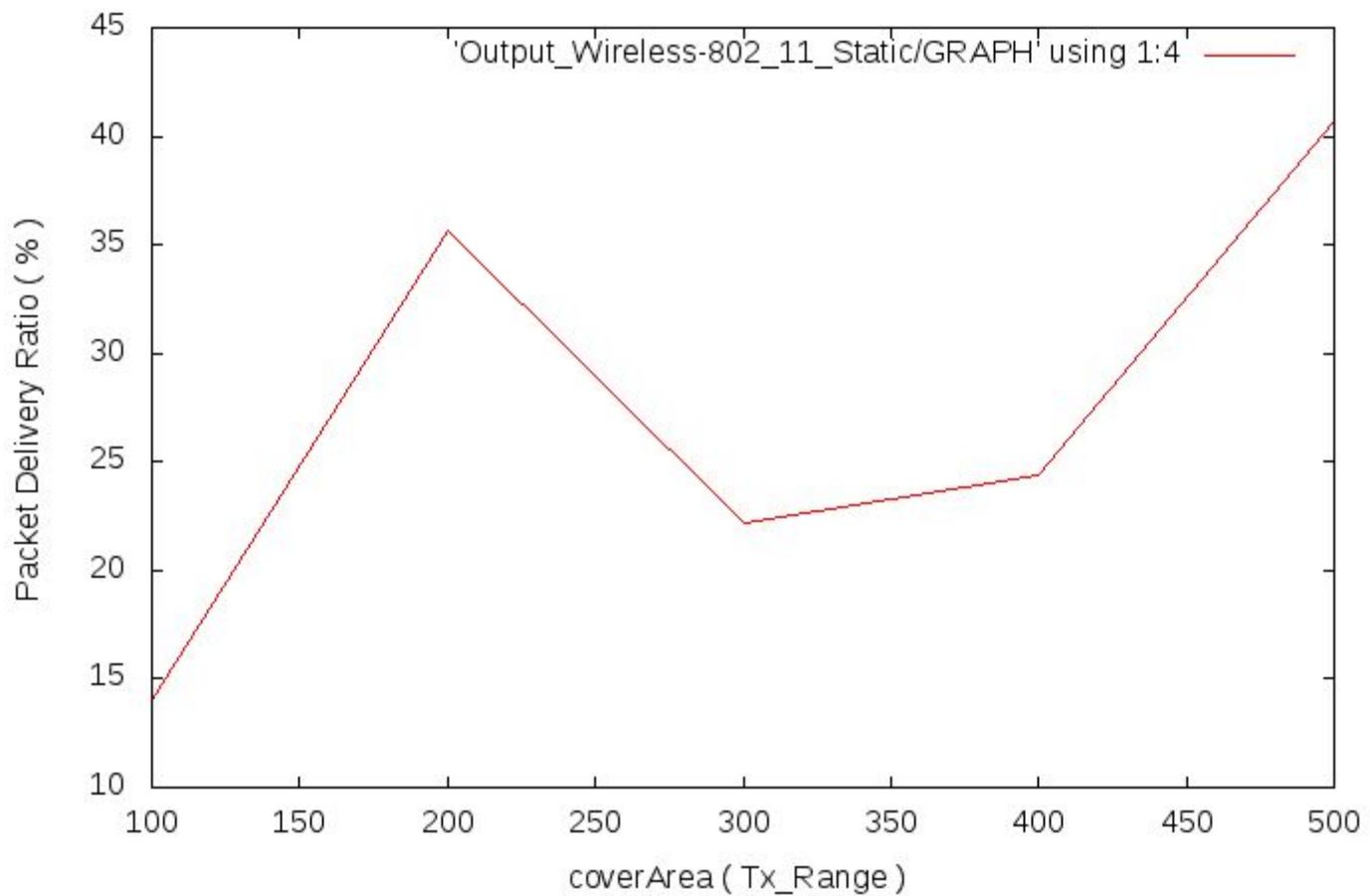
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 1

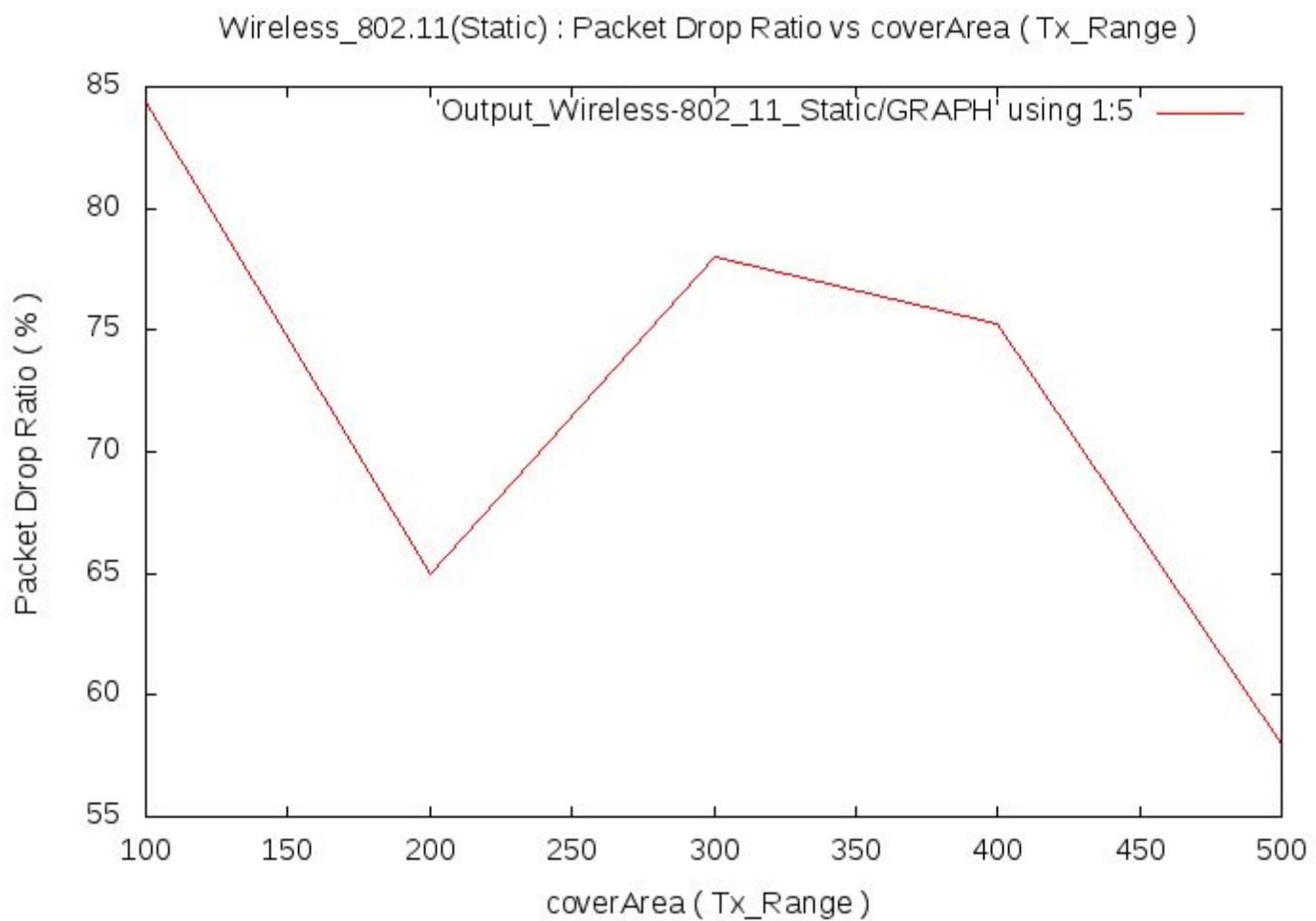




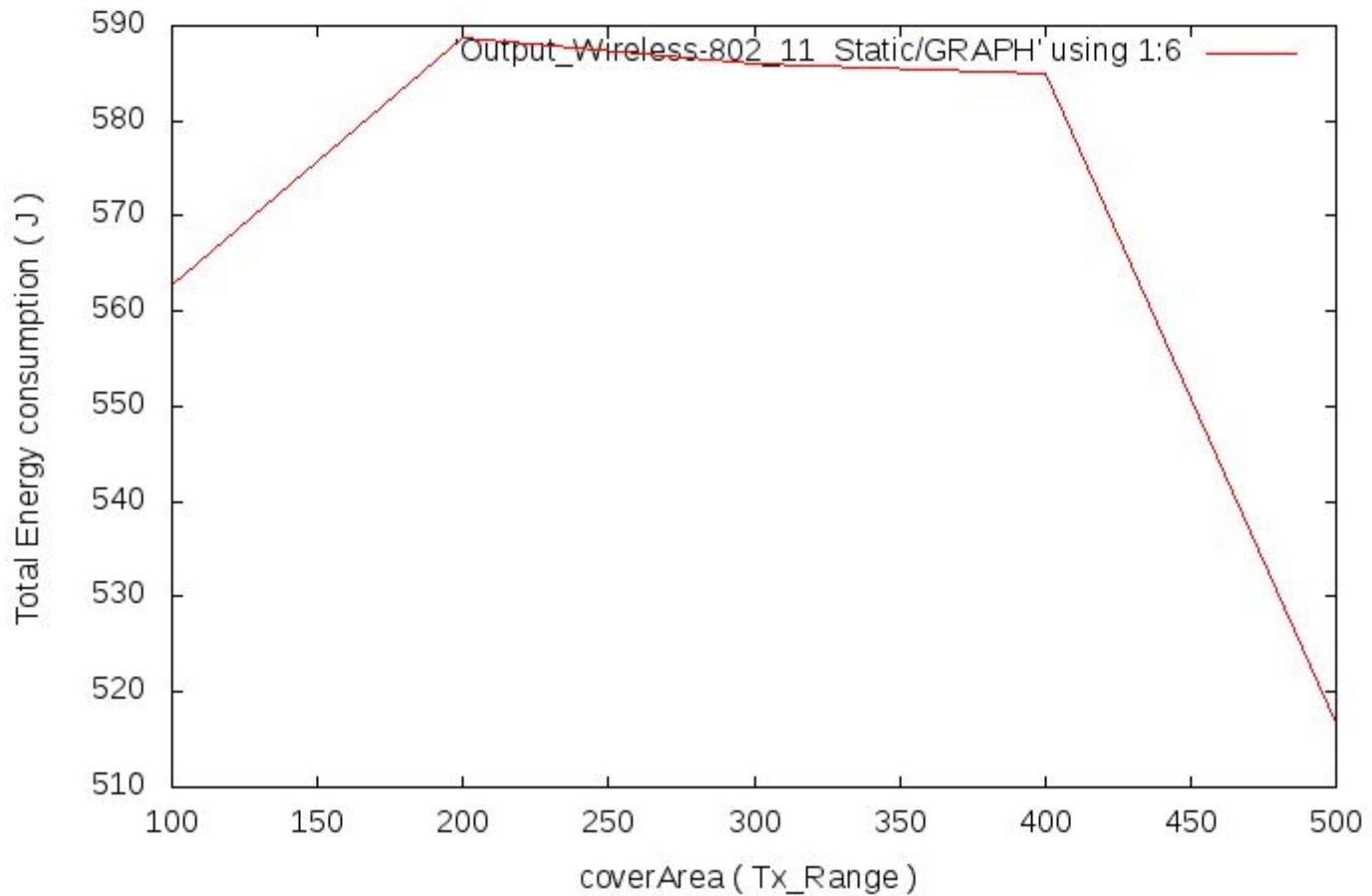


Wireless\_802.11(Static) : Packet Delivery Ratio vs coverArea ( Tx\_Range )

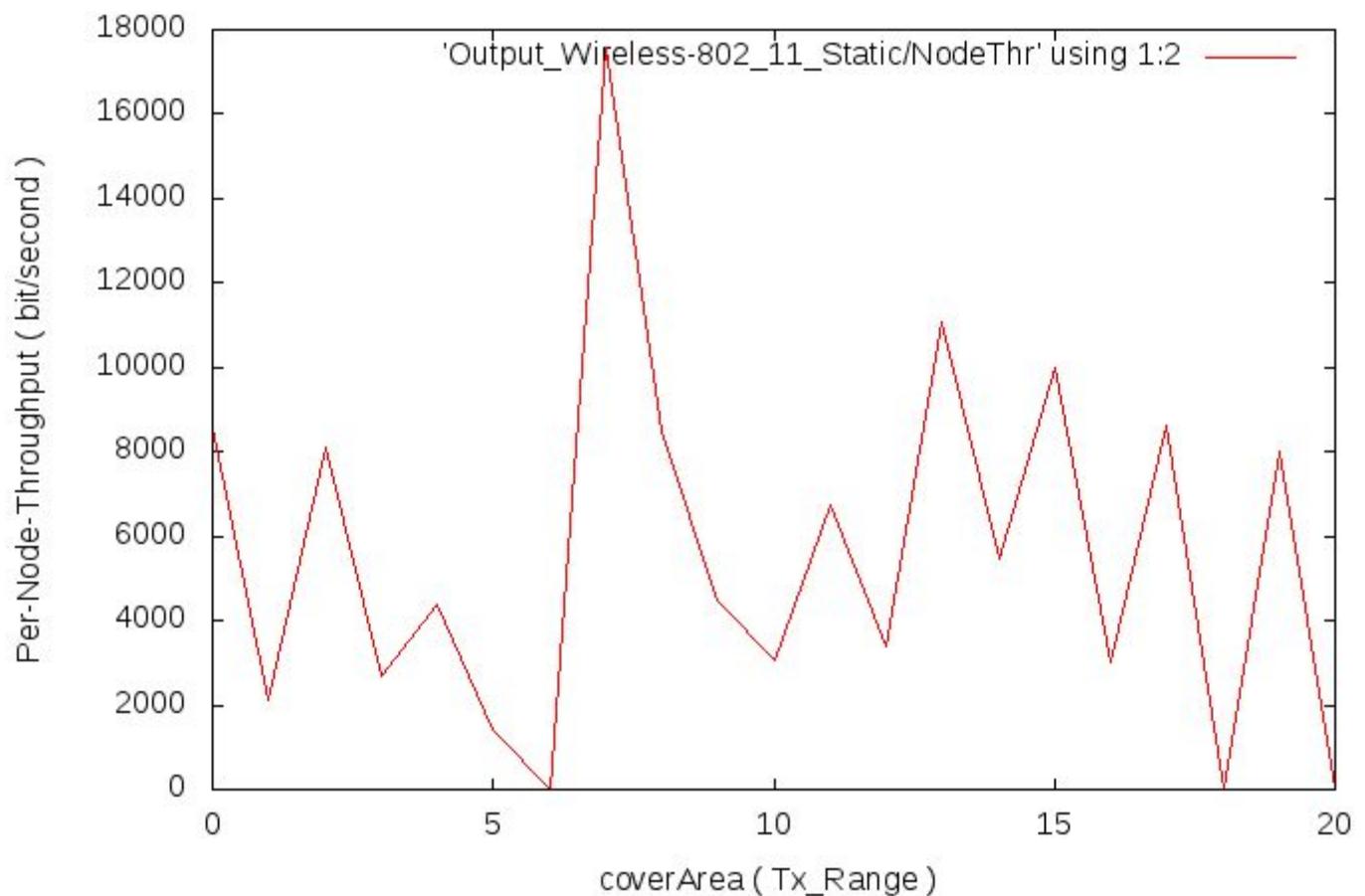


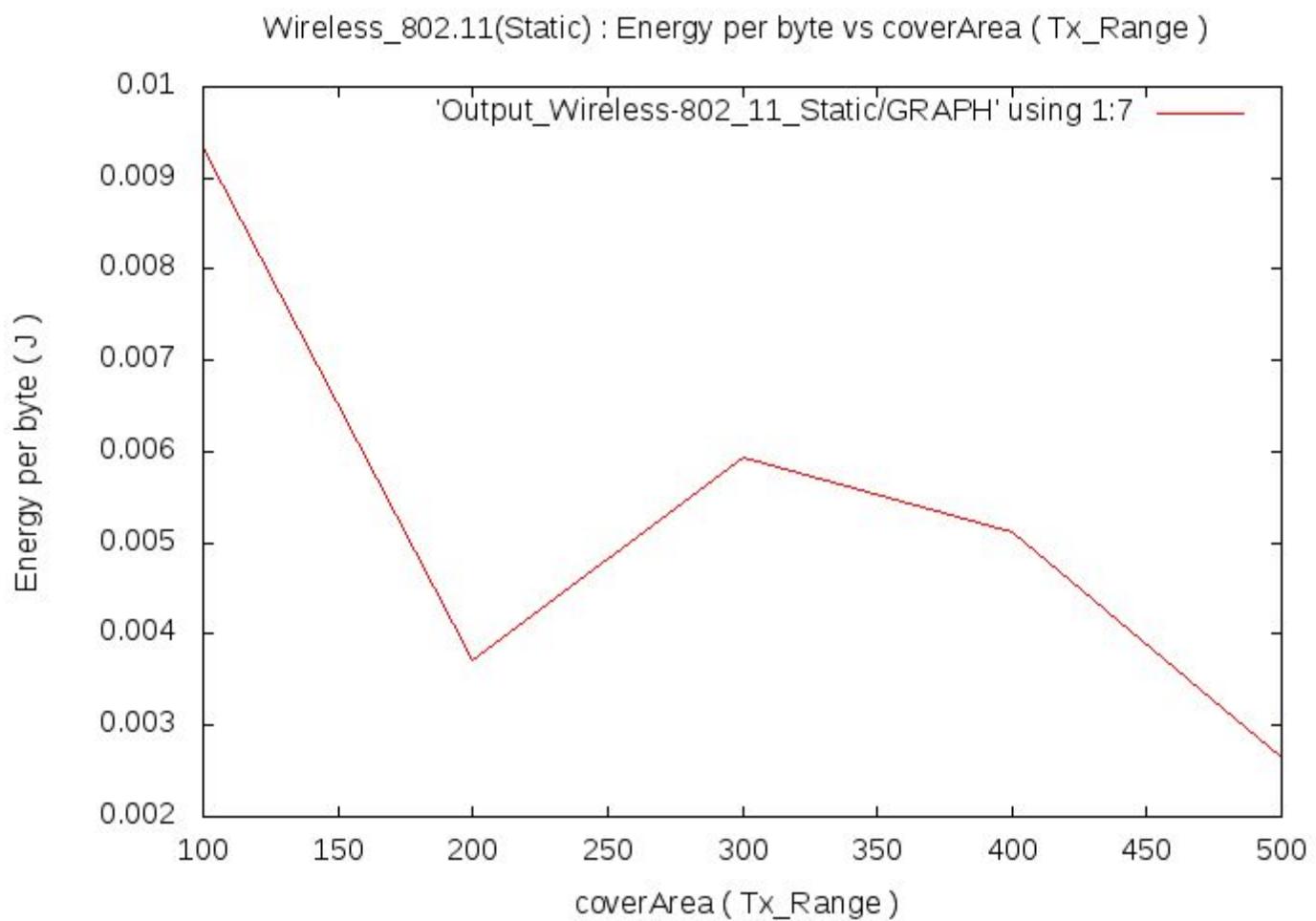


Wireless\_802.11(Static) : Total Energy consumption vs coverArea ( Tx\_Range )

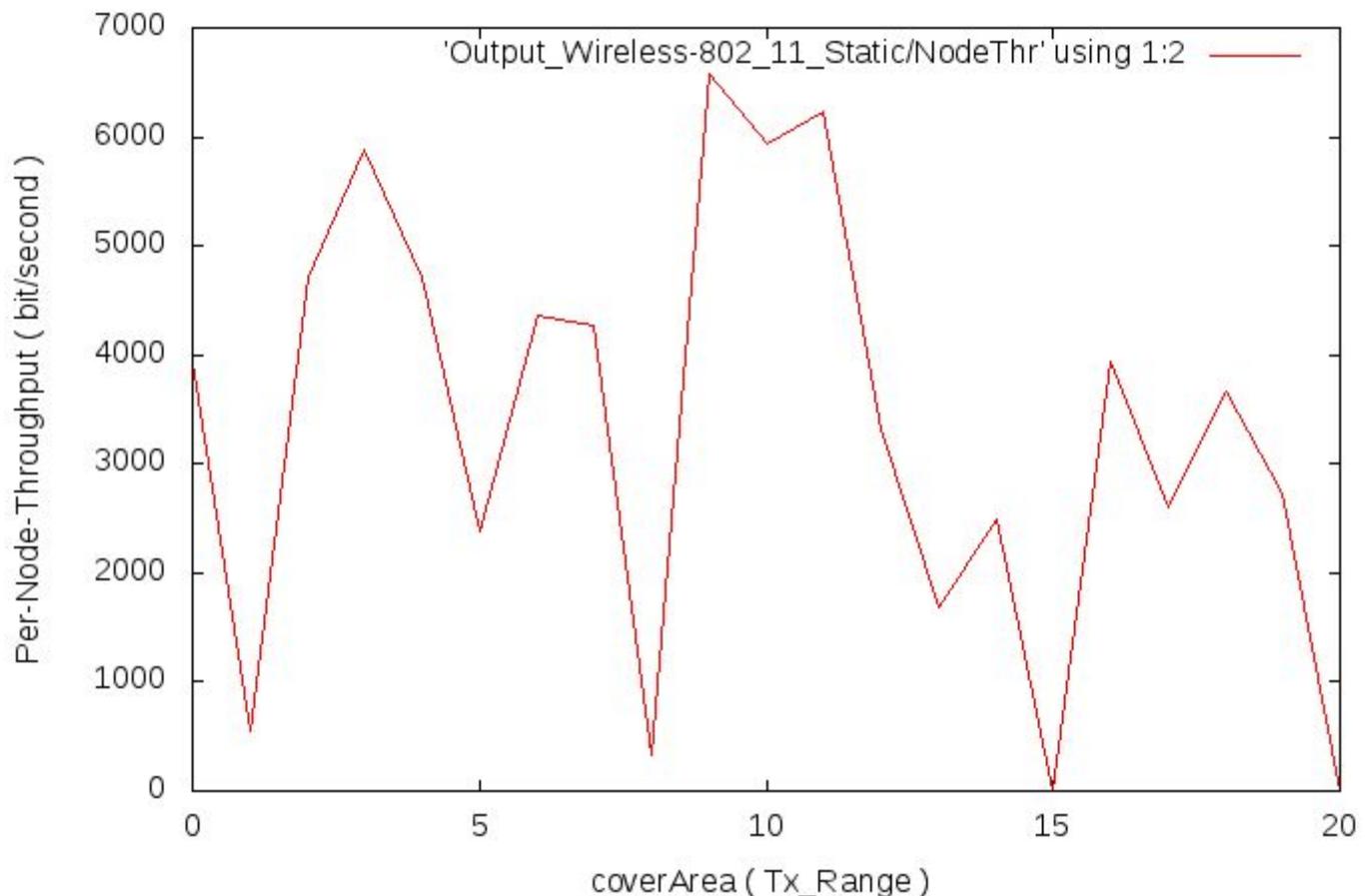


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - RoU

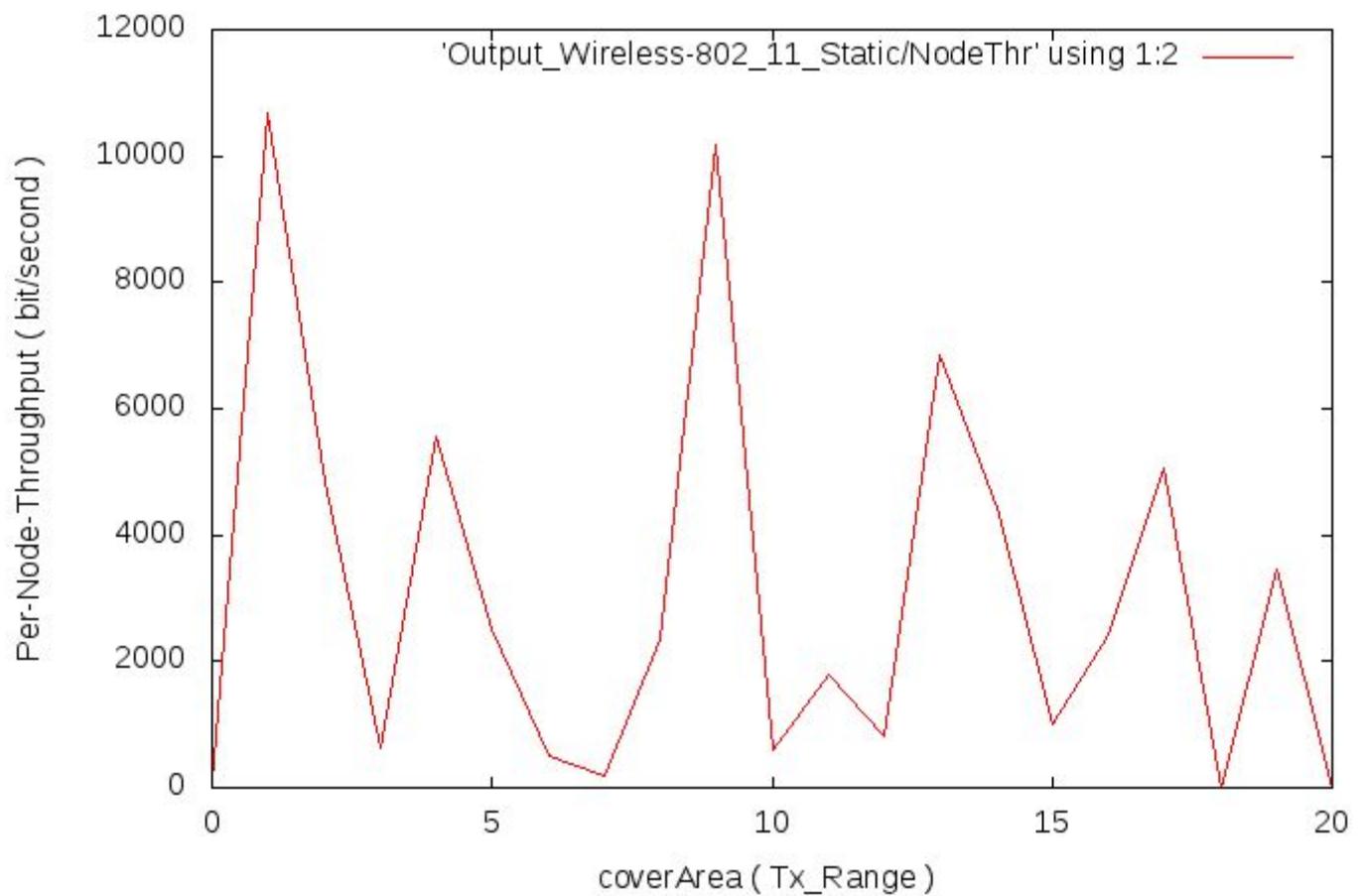




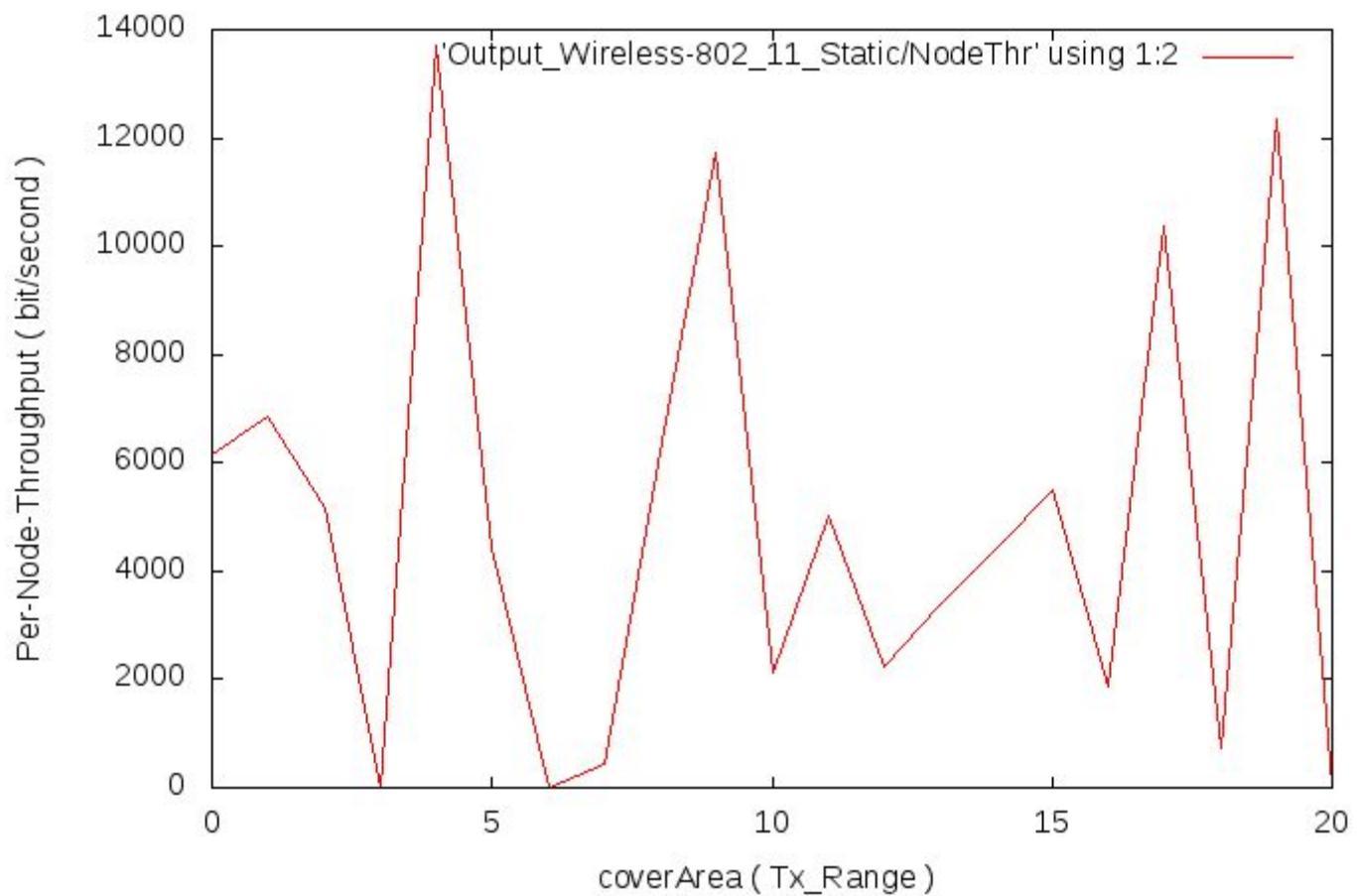
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - Rou



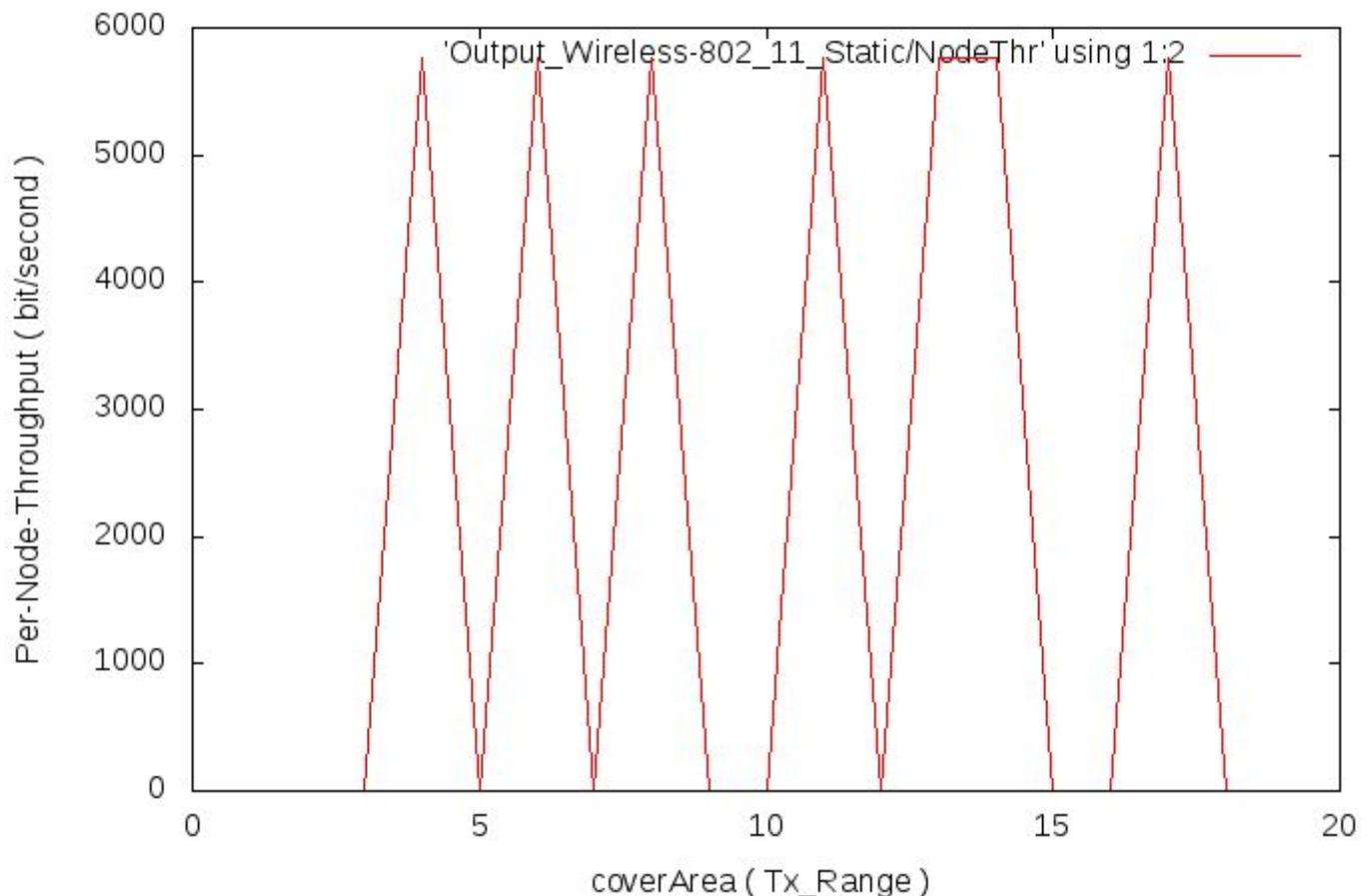
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - RoU



Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - RoU

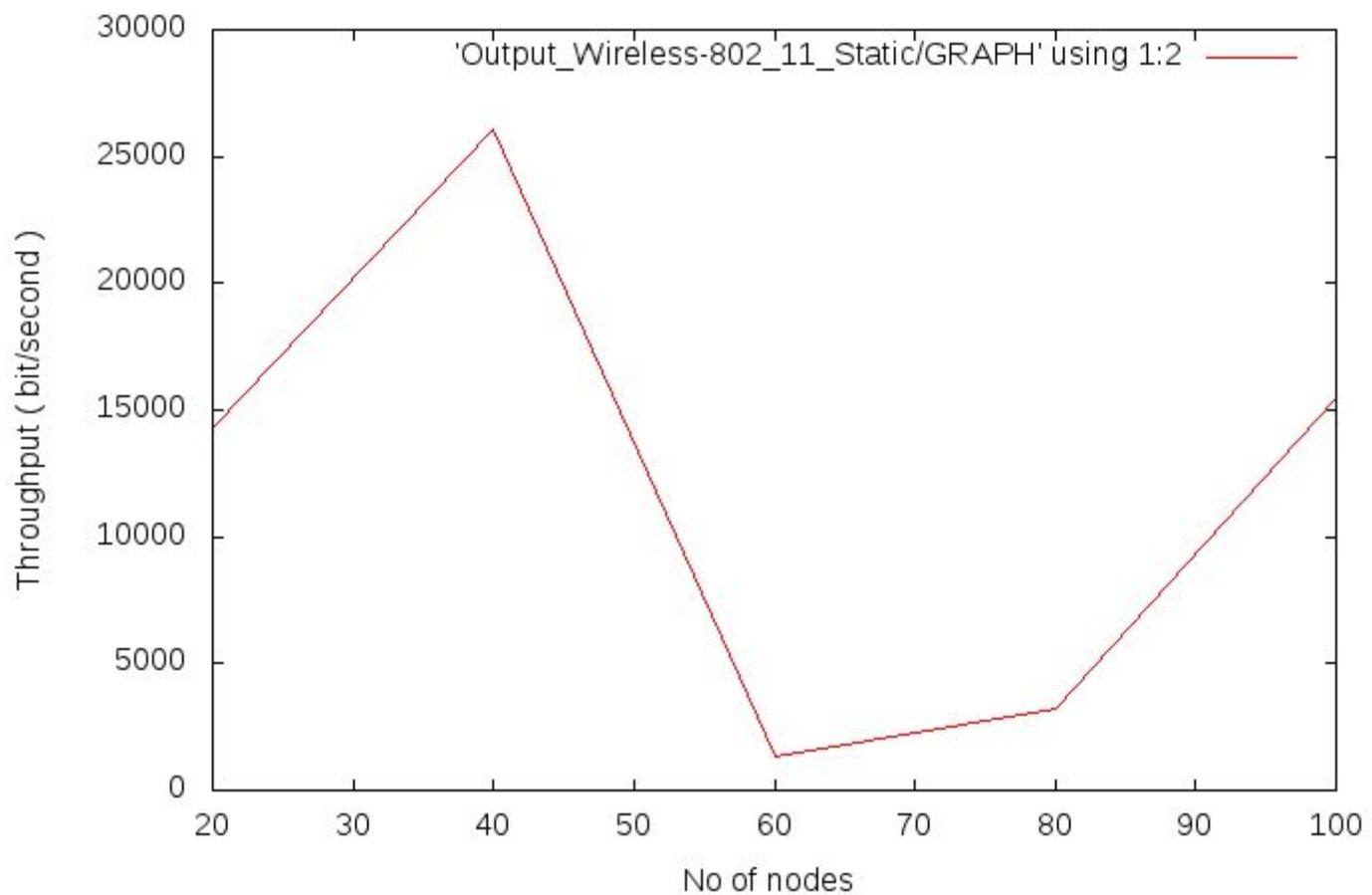


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - Rou

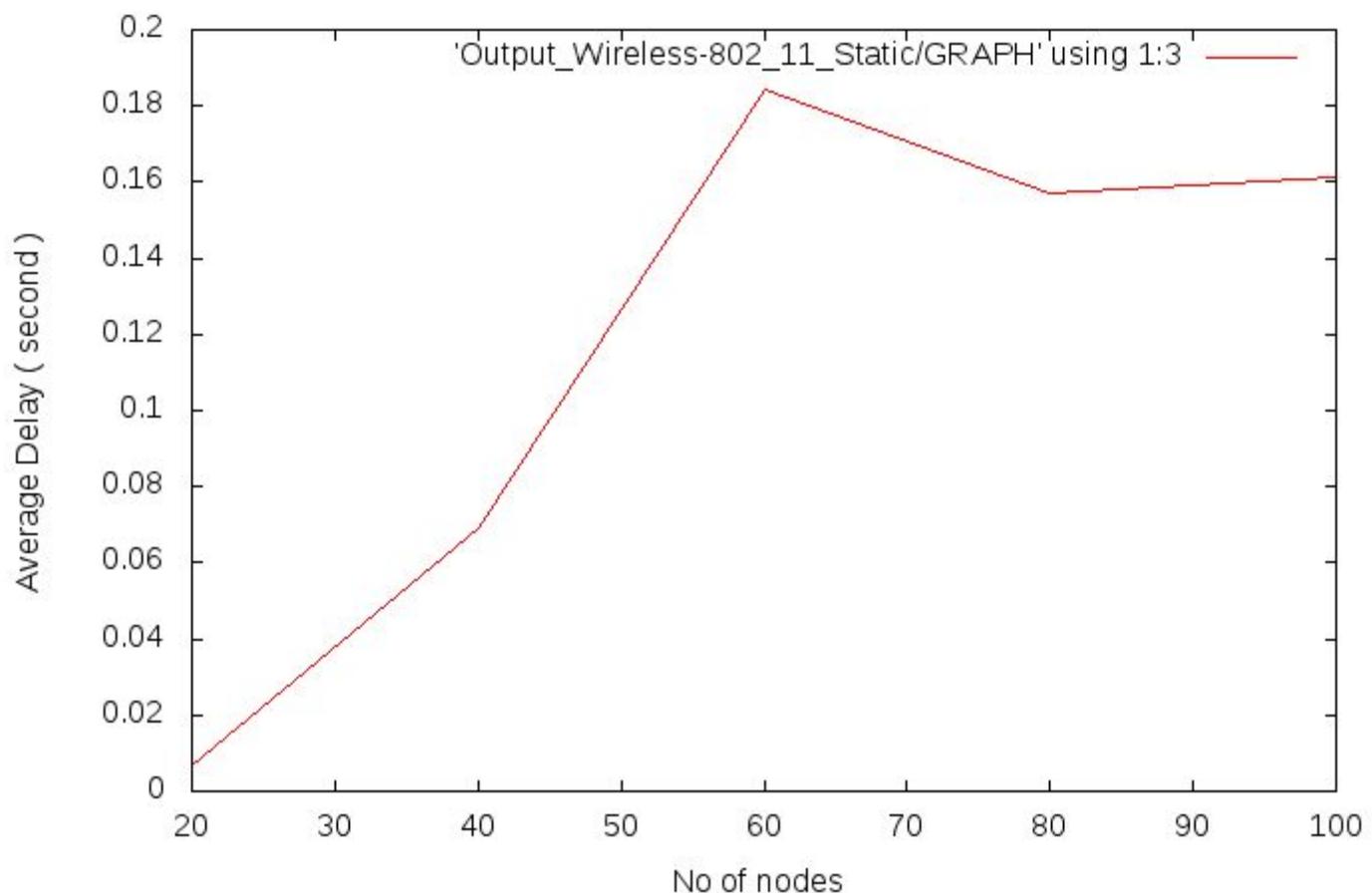


# **Wireless 802.11 (Static) (After Modification)**

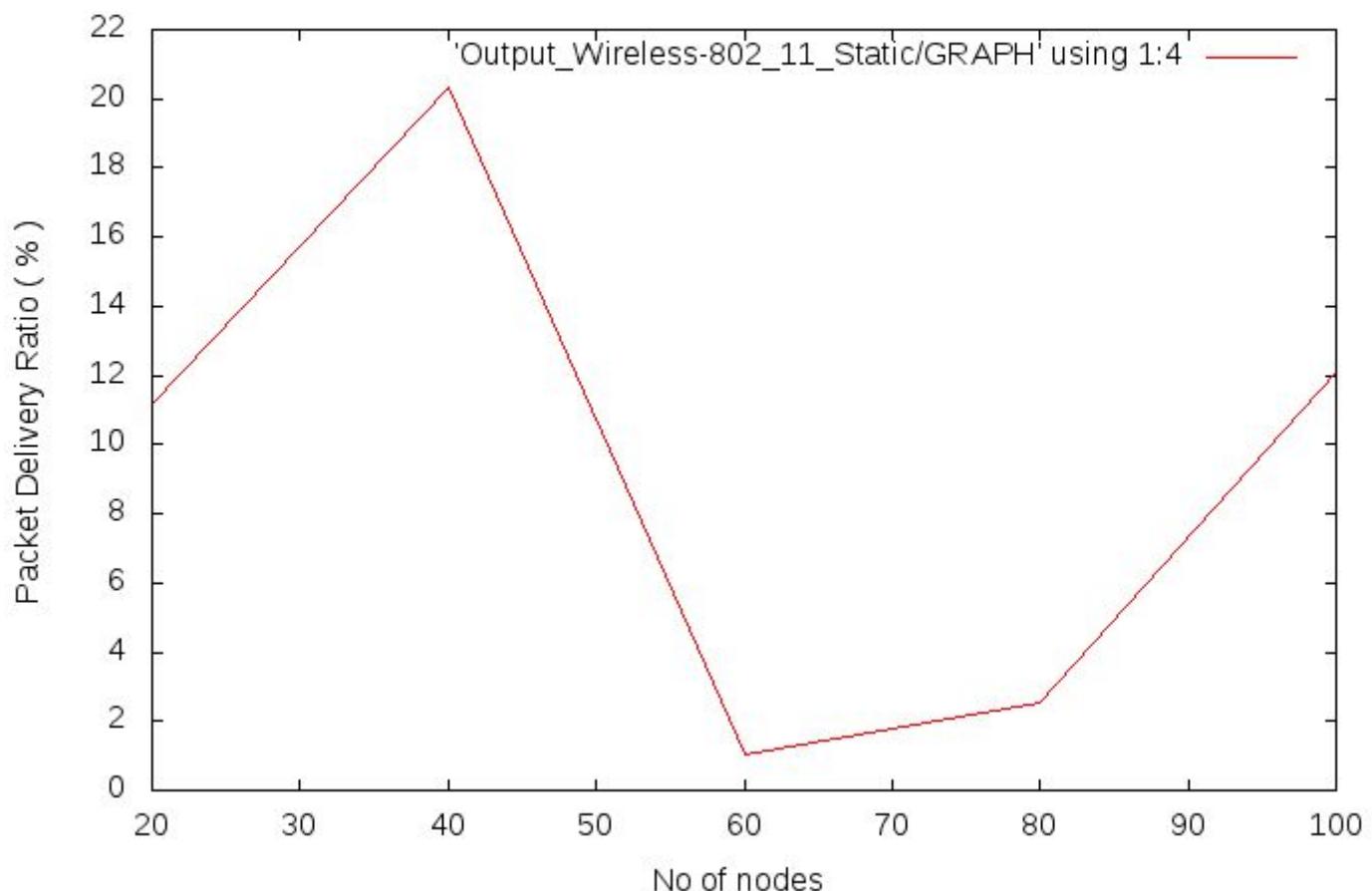
Wireless\_802.11(Static) (After modification): Throughput vs No of nodes



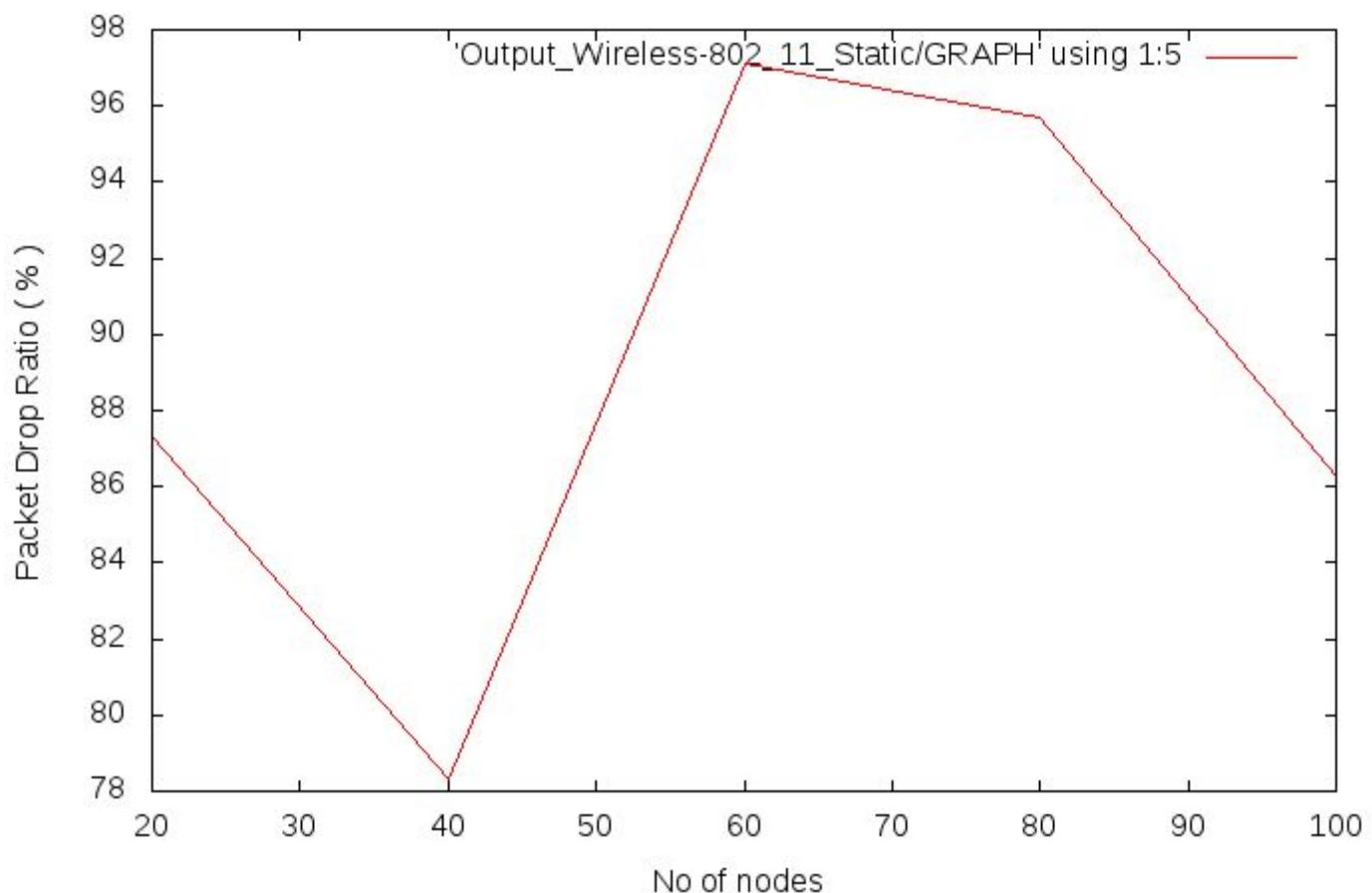
Wireless\_802.11(Static) (After modification): Average Delay vs No of nodes



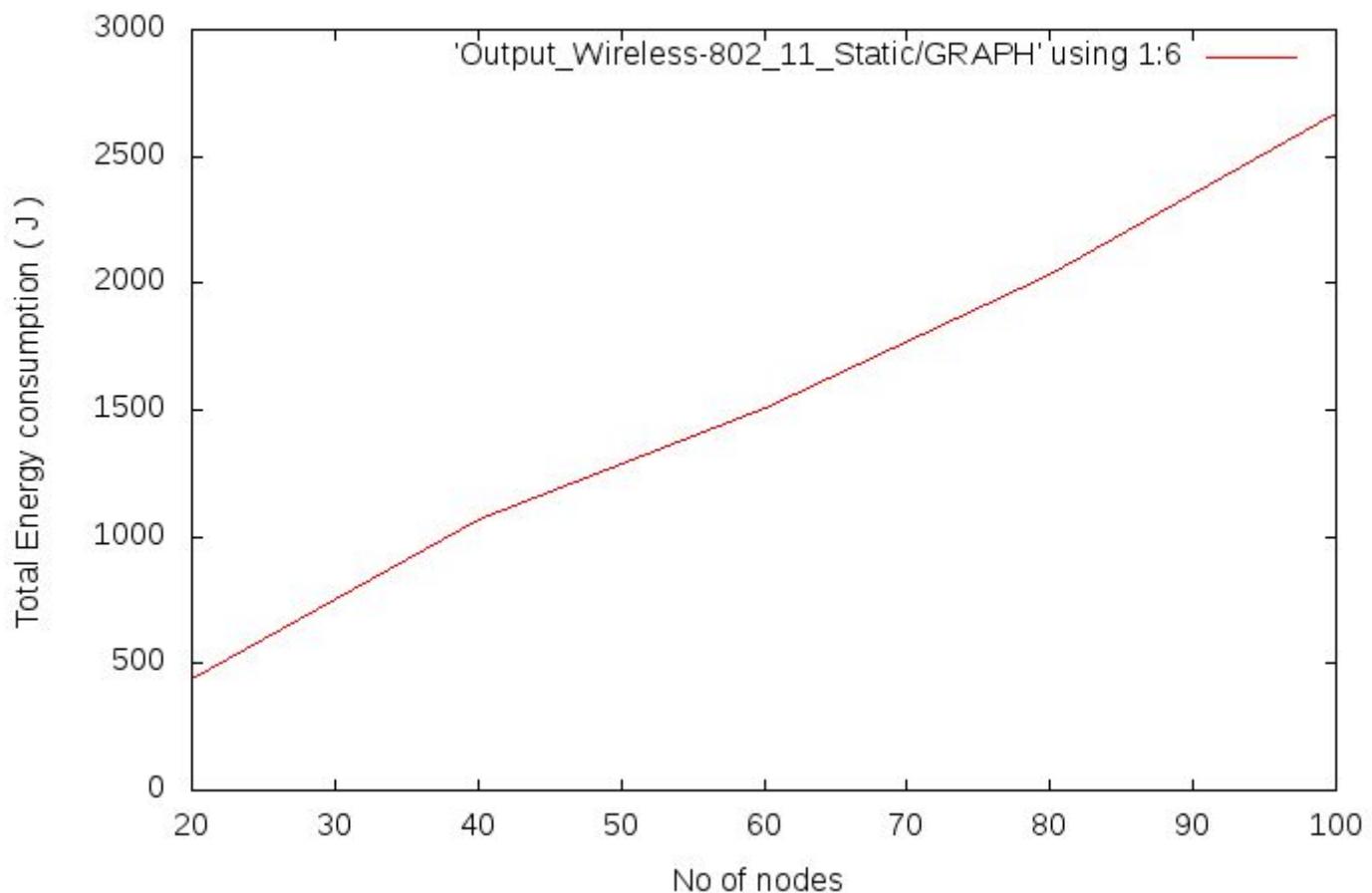
Wireless\_802.11(Static) (After modification): Packet Delivery Ratio vs No of nodes



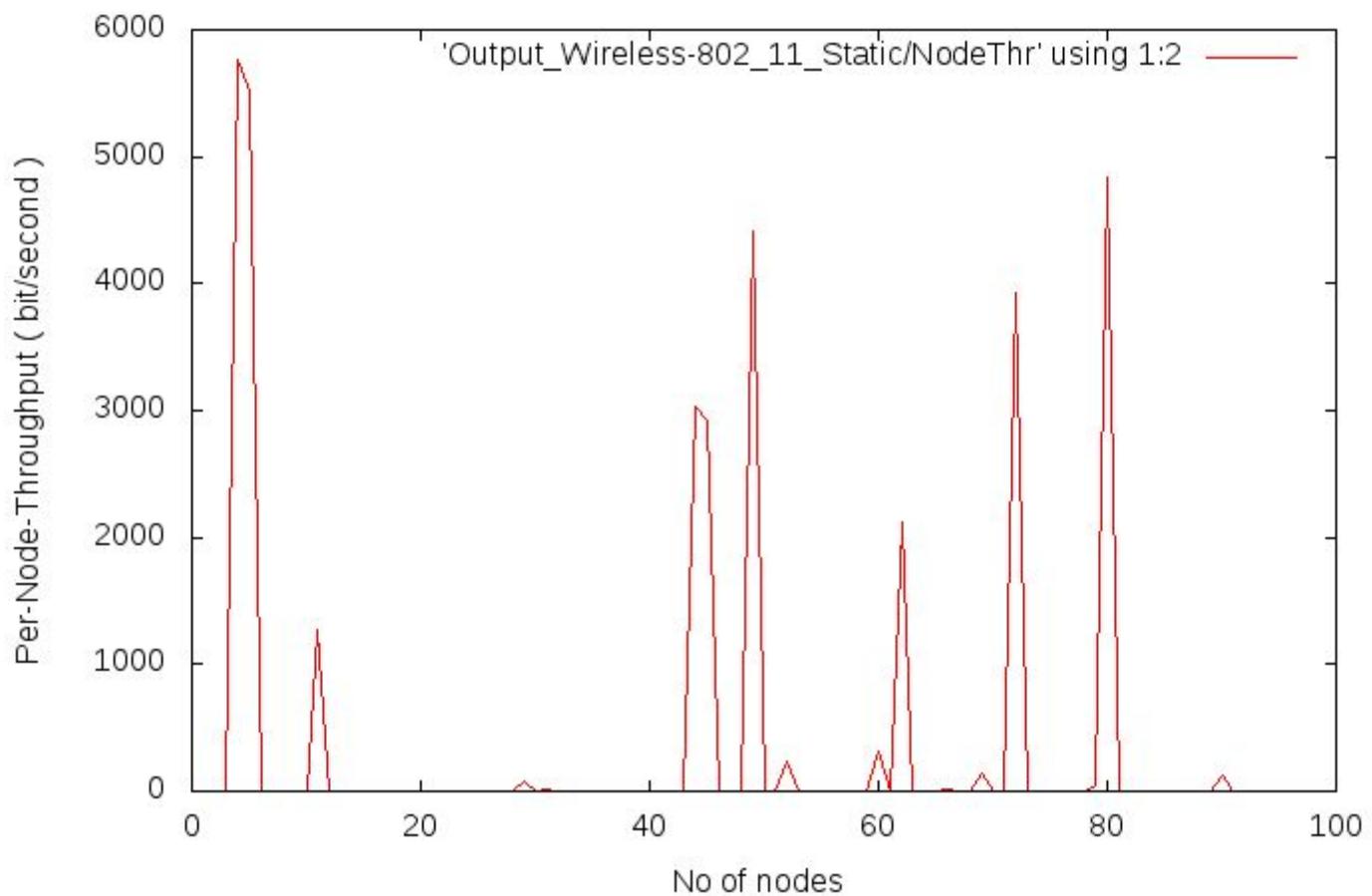
Wireless\_802.11(Static) (After modification): Packet Drop Ratio vs No of nodes



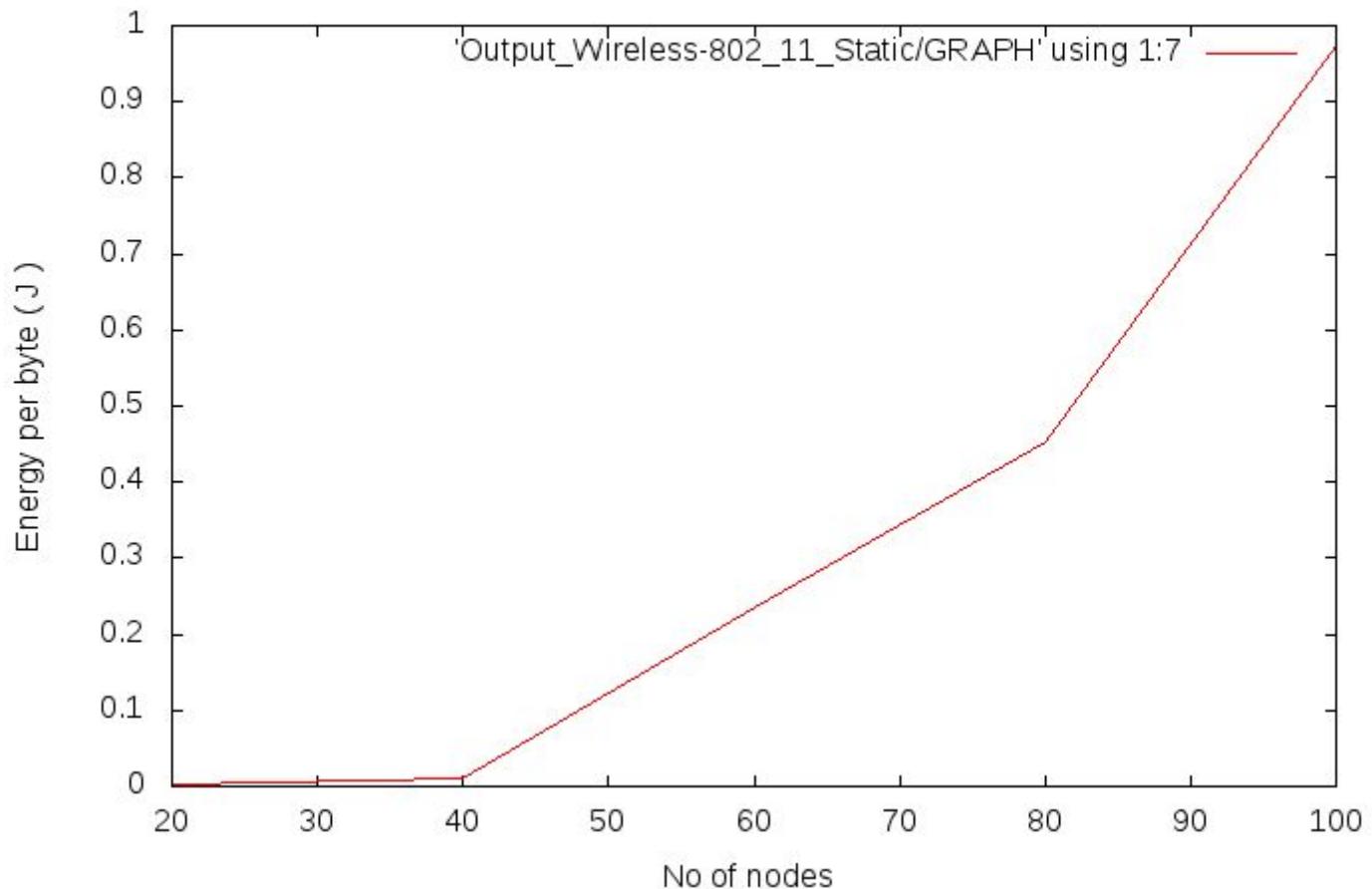
Wireless\_802.11(Static) (After modification): Total Energy consumption vs No of nodes



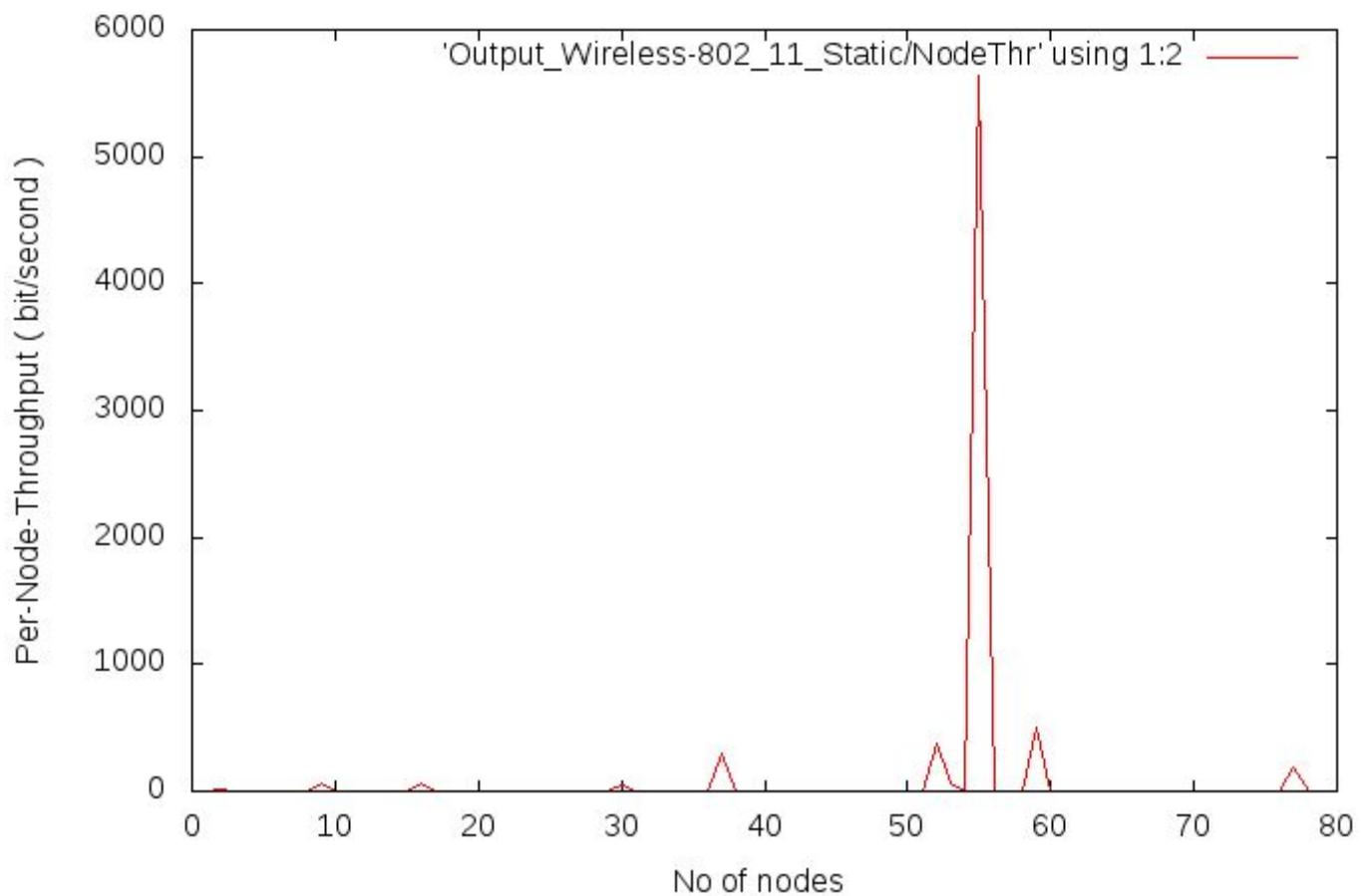
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 5



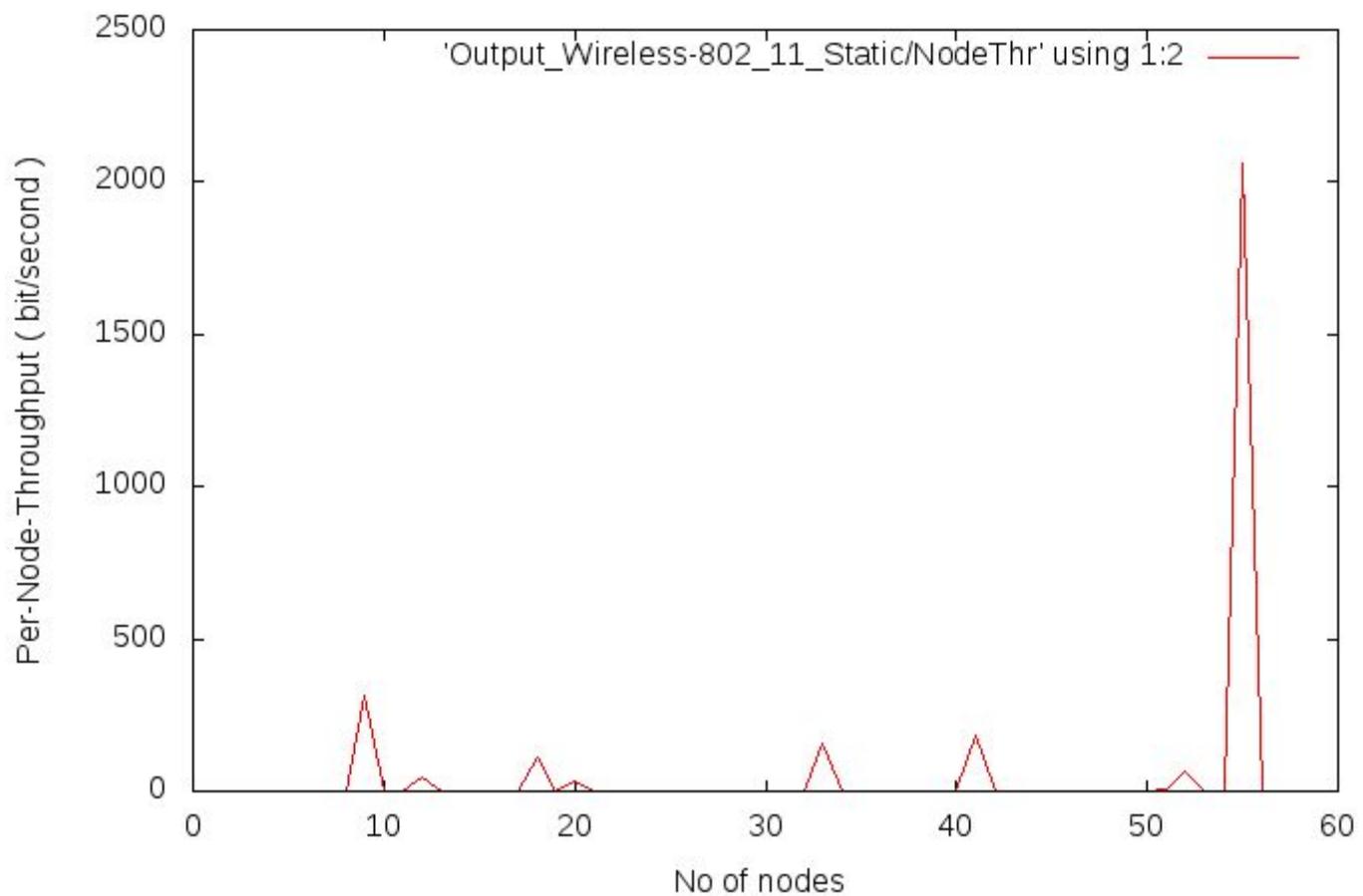
Wireless\_802.11(Static) (After modification): Energy per byte vs No of nodes



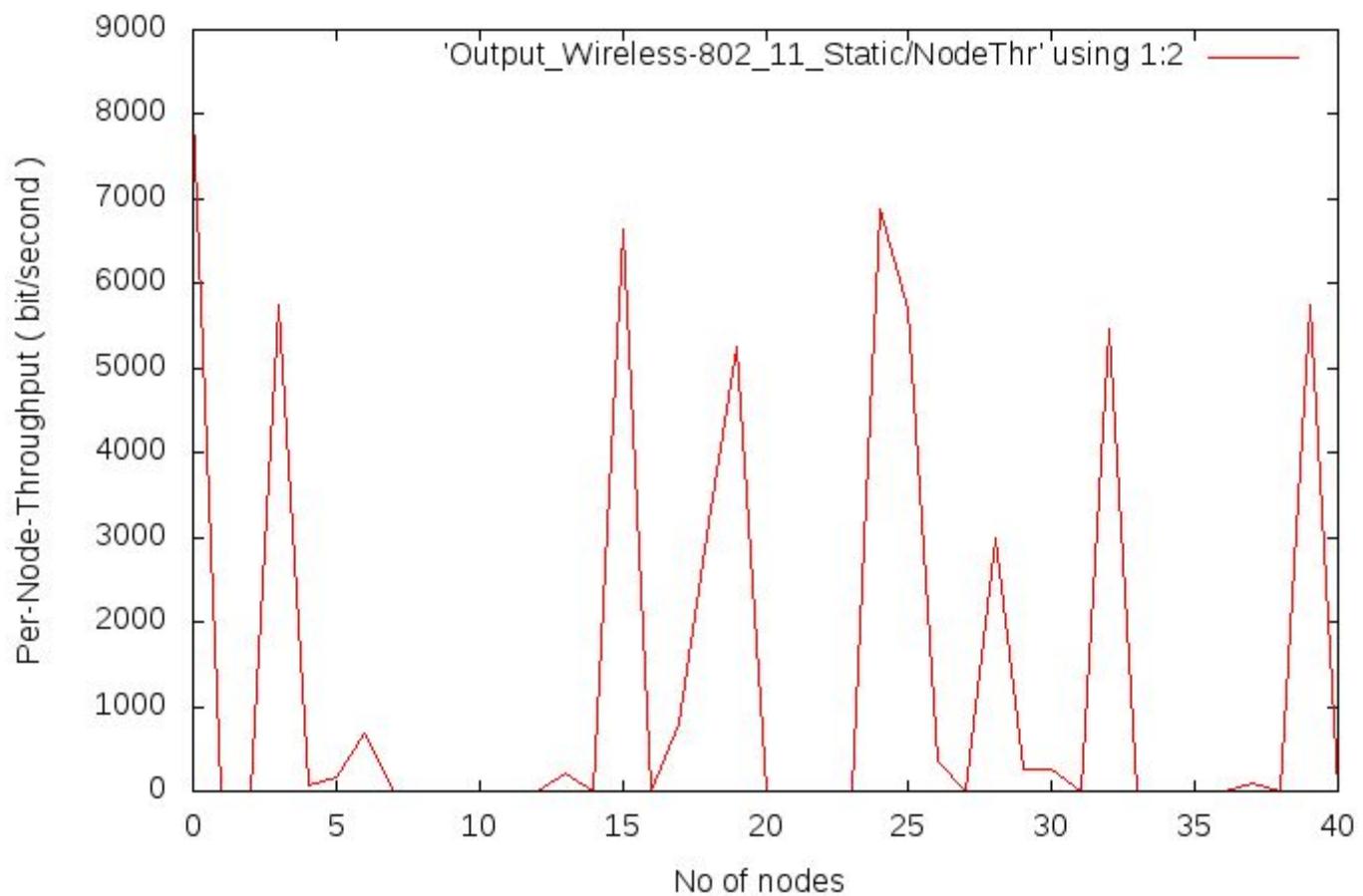
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 4



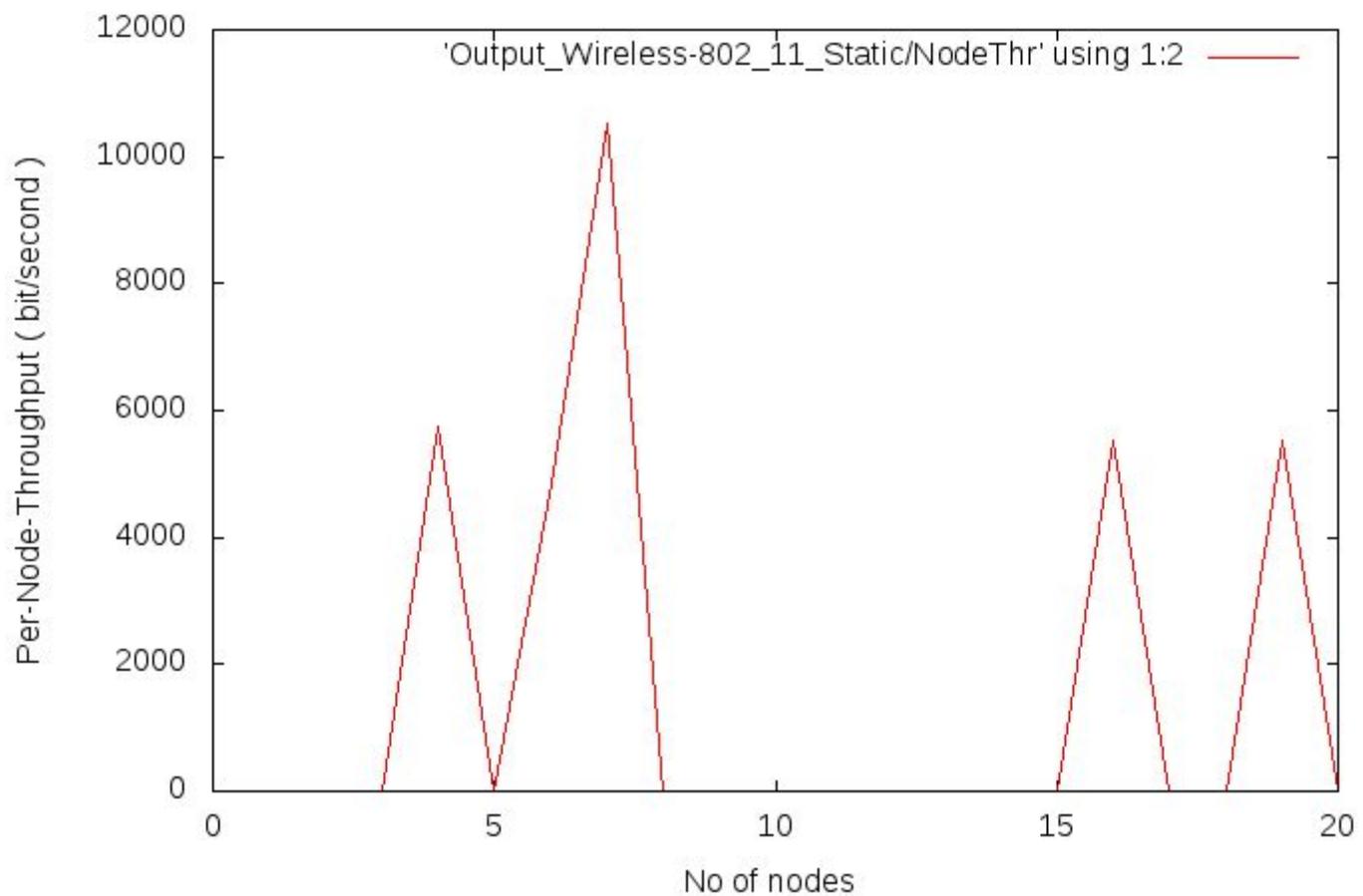
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 3

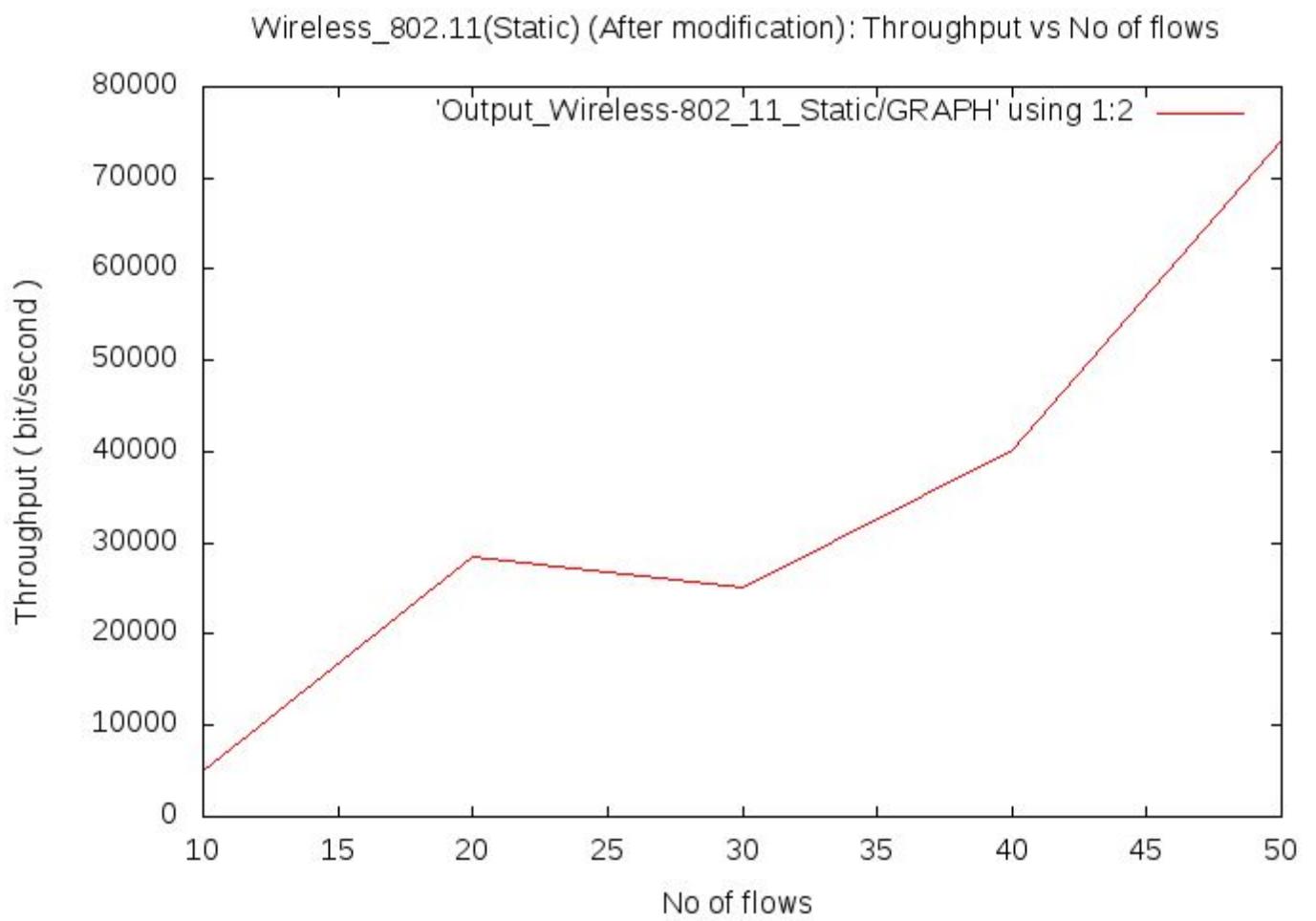


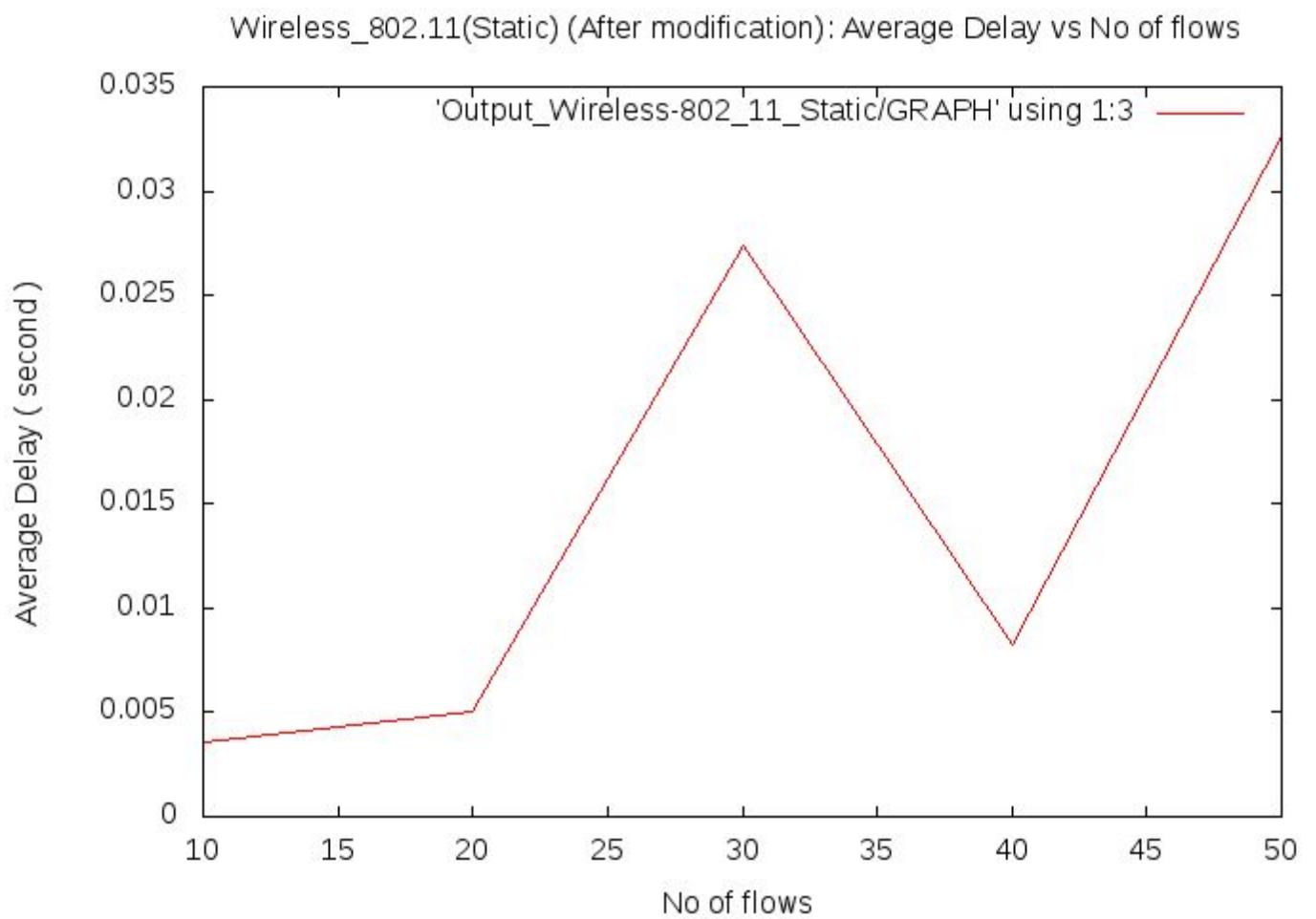
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 2



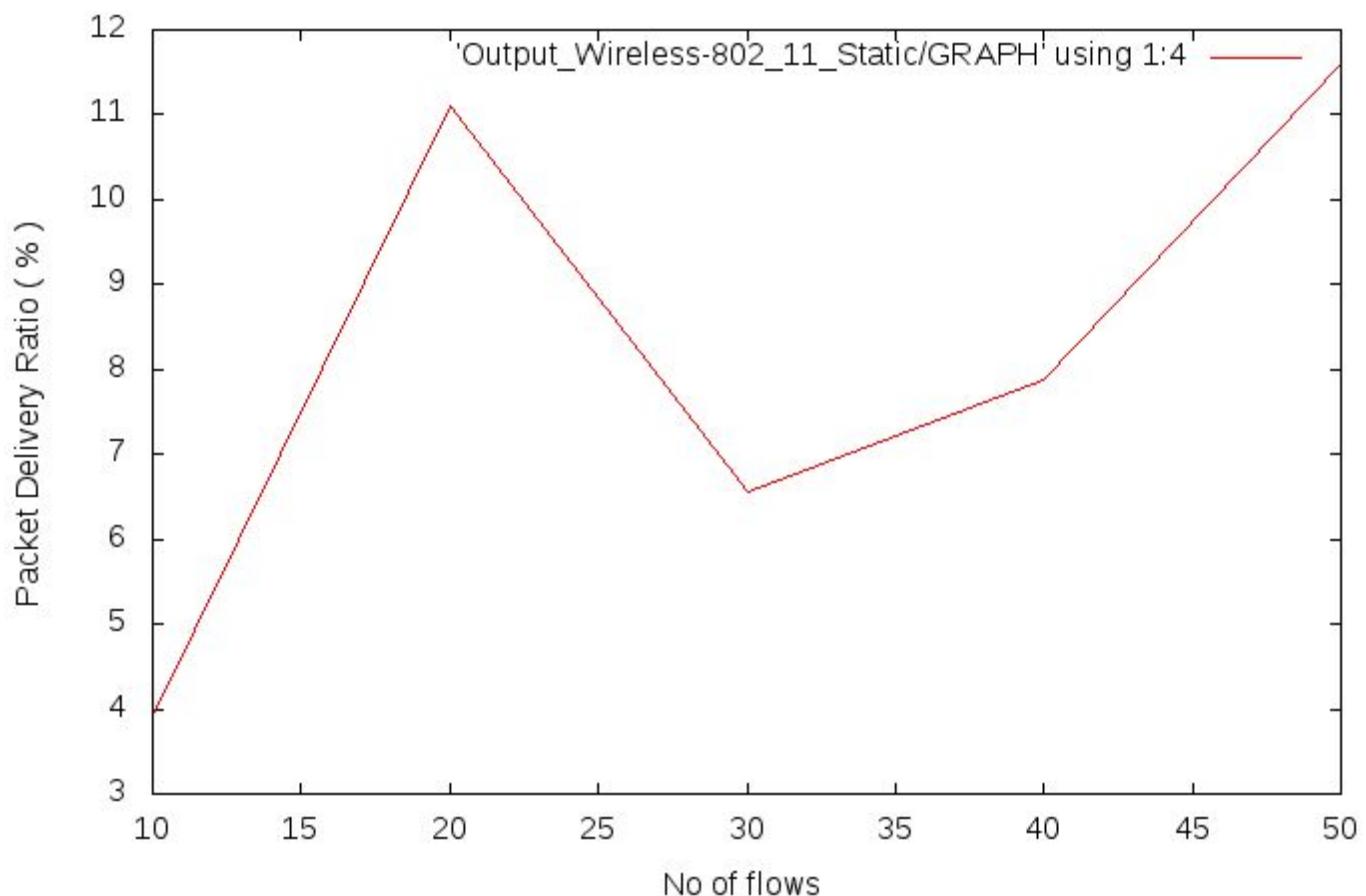
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of nodes - Round - 1



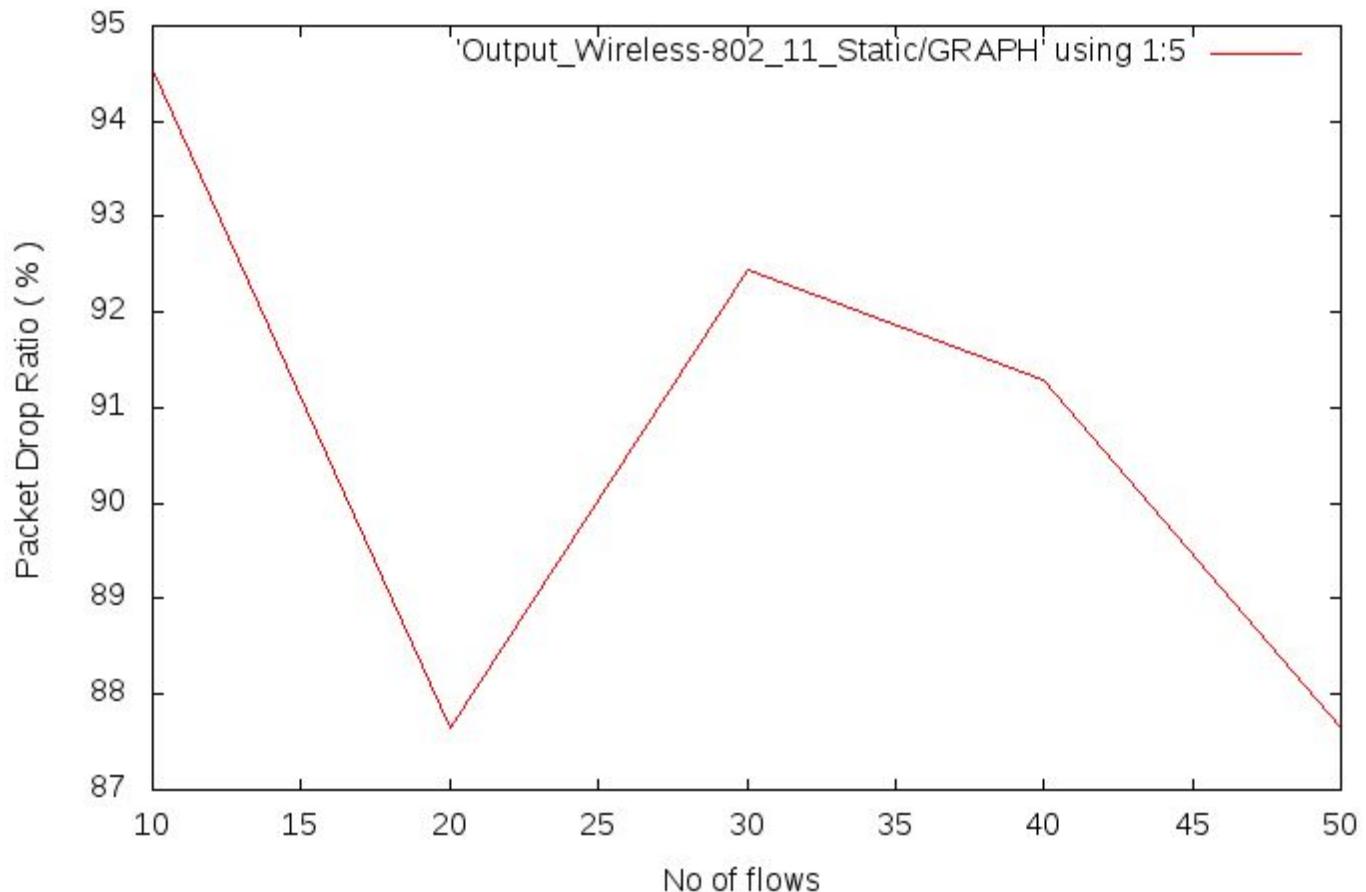




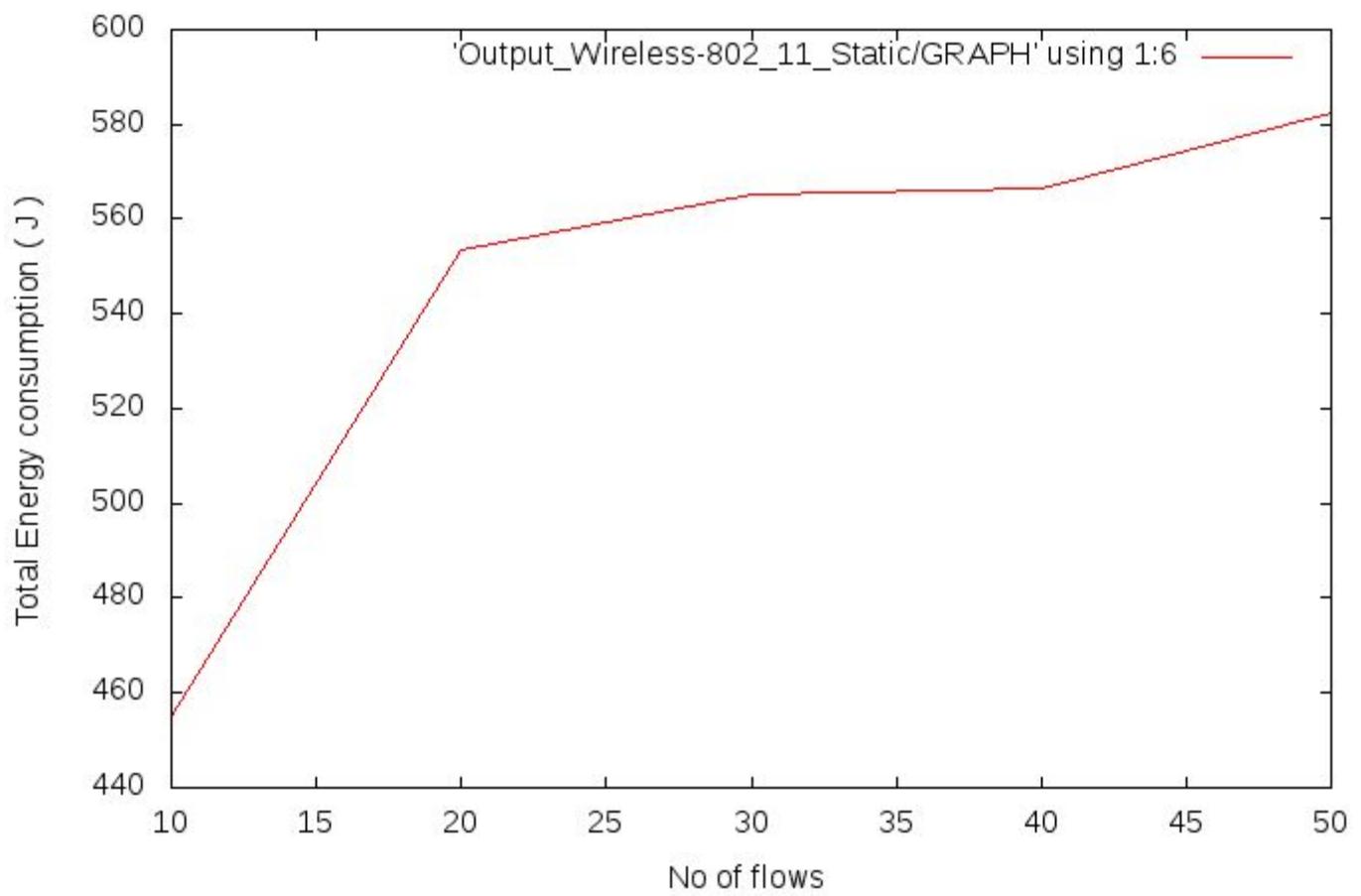
Wireless\_802.11(Static) (After modification): Packet Delivery Ratio vs No of flows



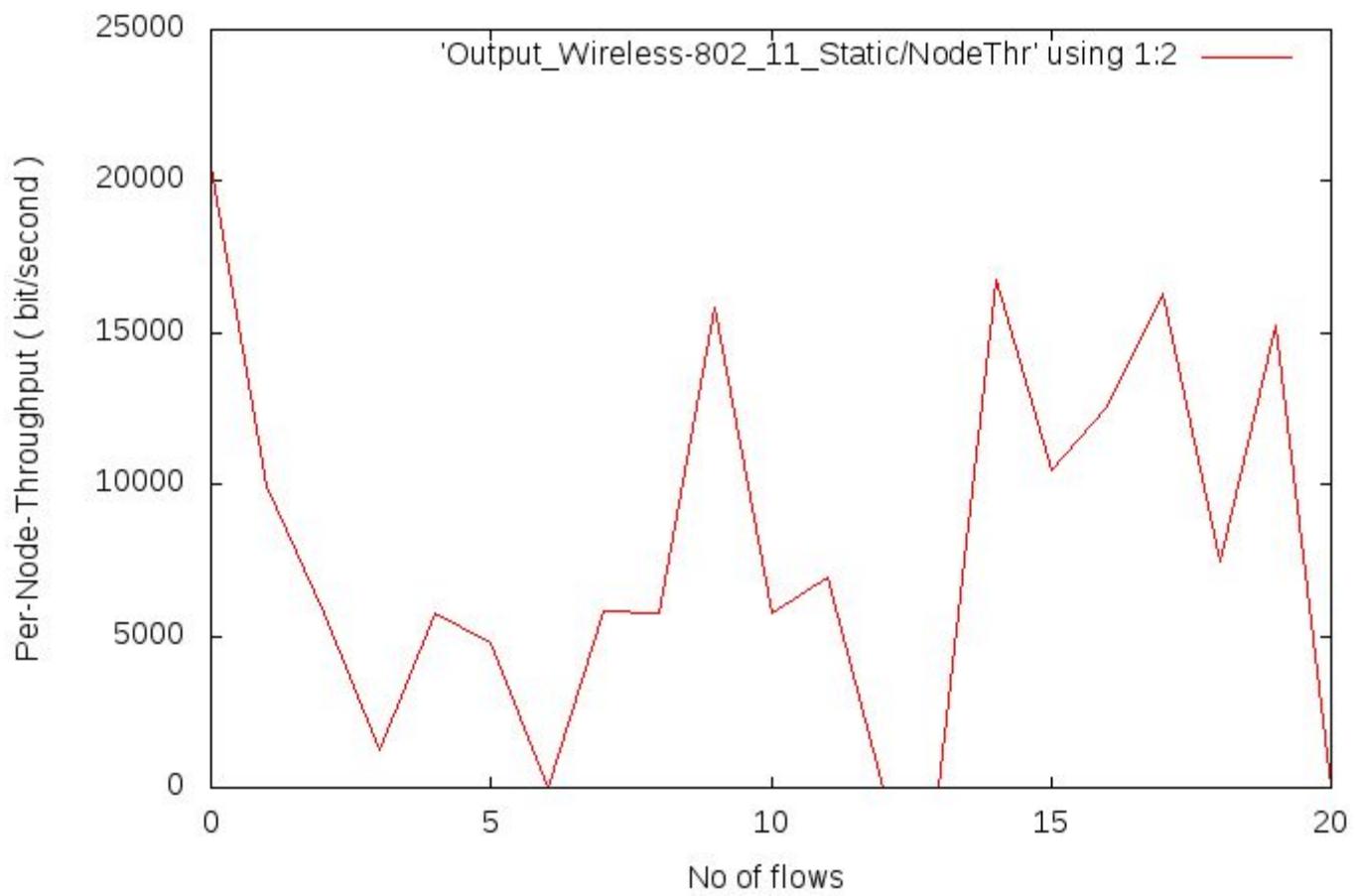
Wireless\_802.11(Static) (After modification): Packet Drop Ratio vs No of flows

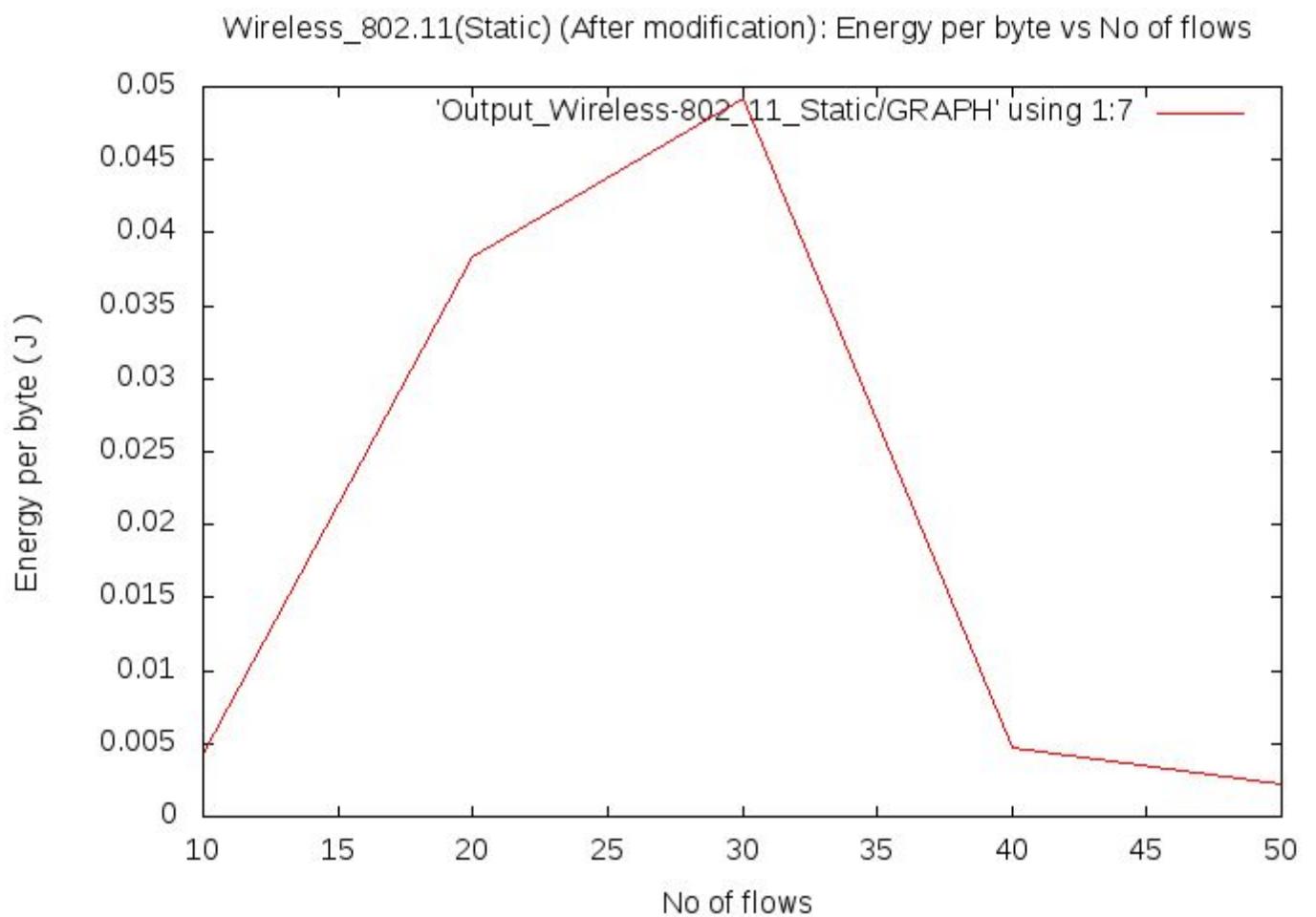


Wireless\_802.11(Static) (After modification): Total Energy consumption vs No of flows

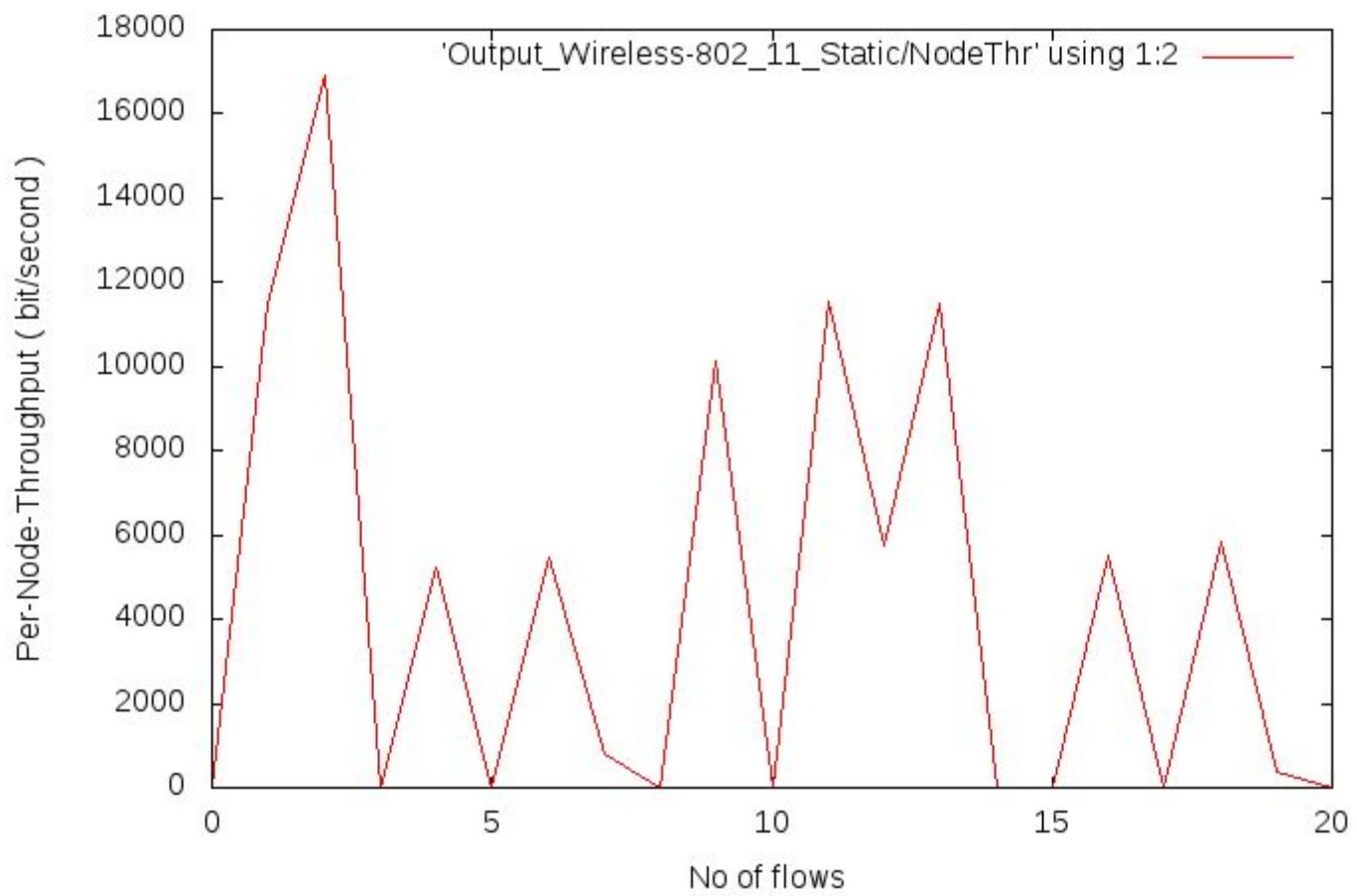


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 5

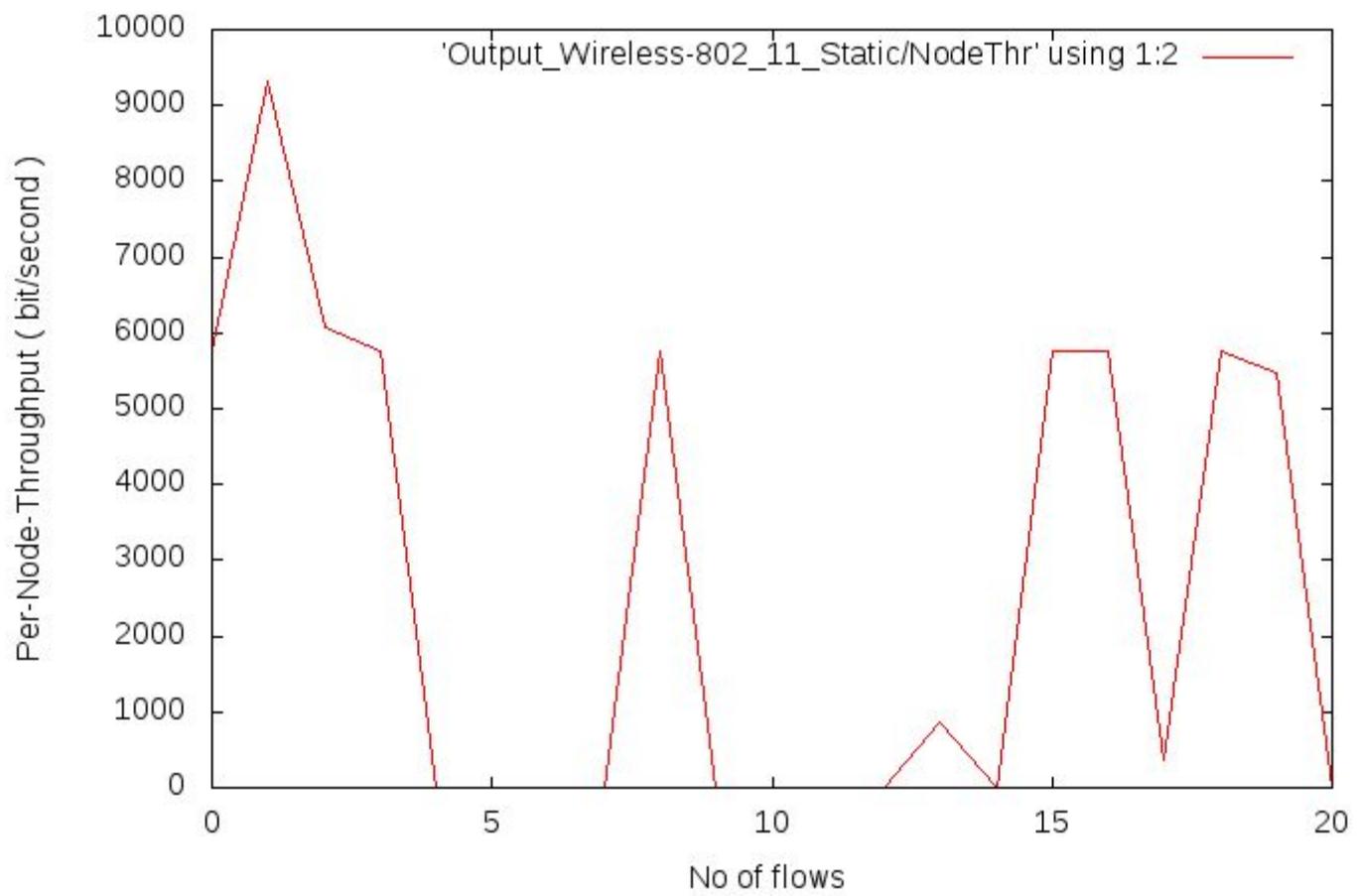




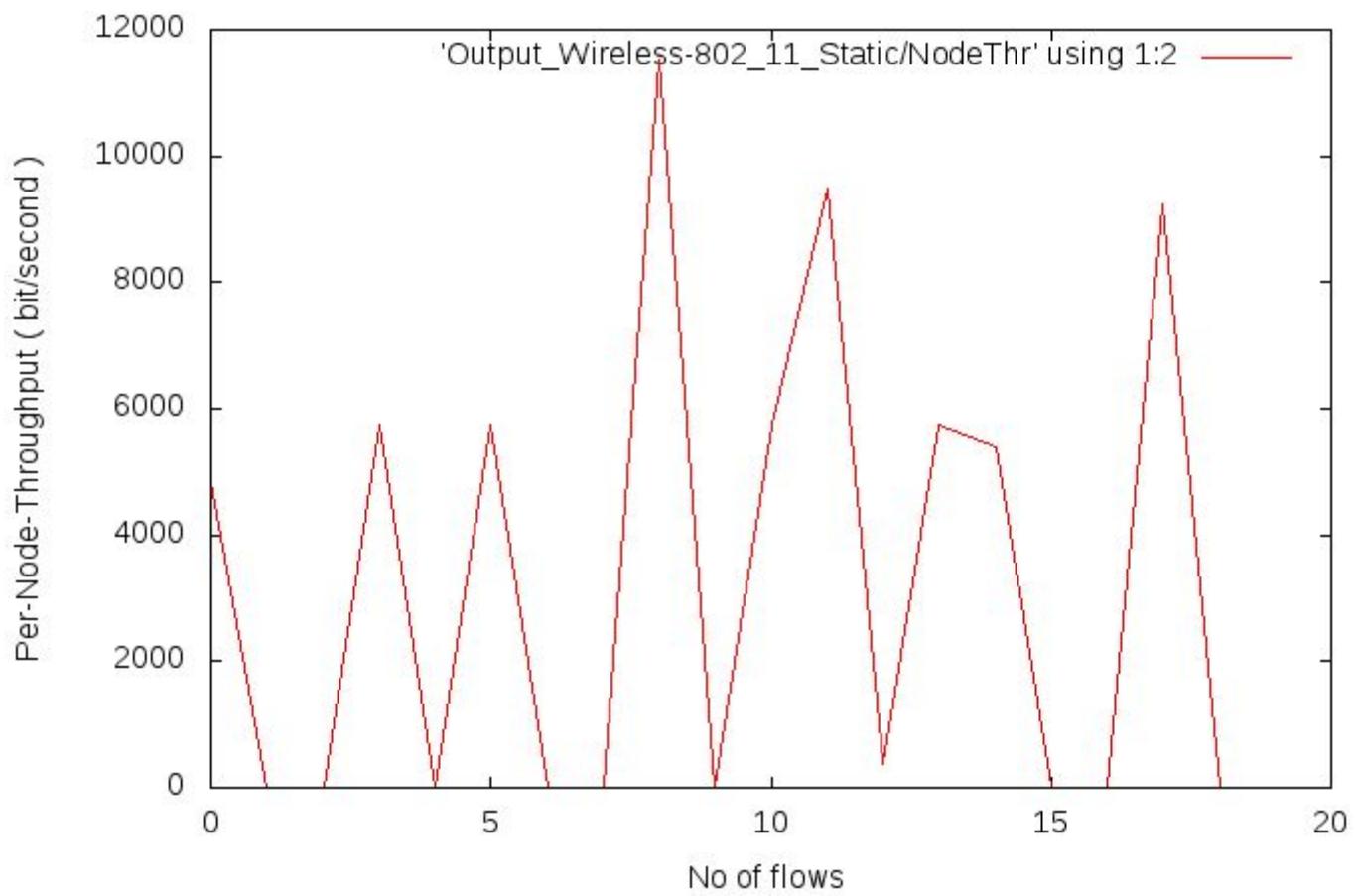
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 4



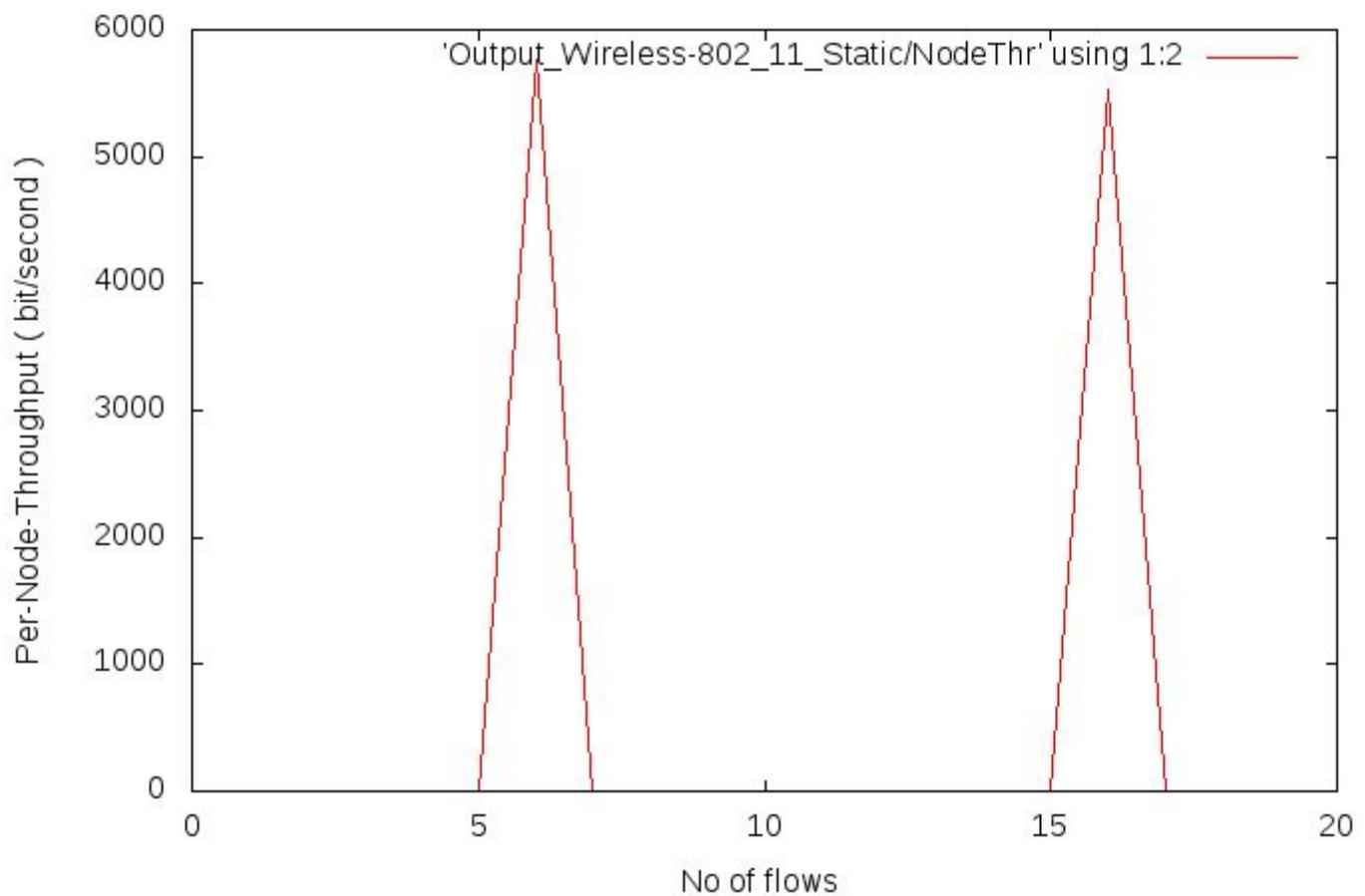
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 3

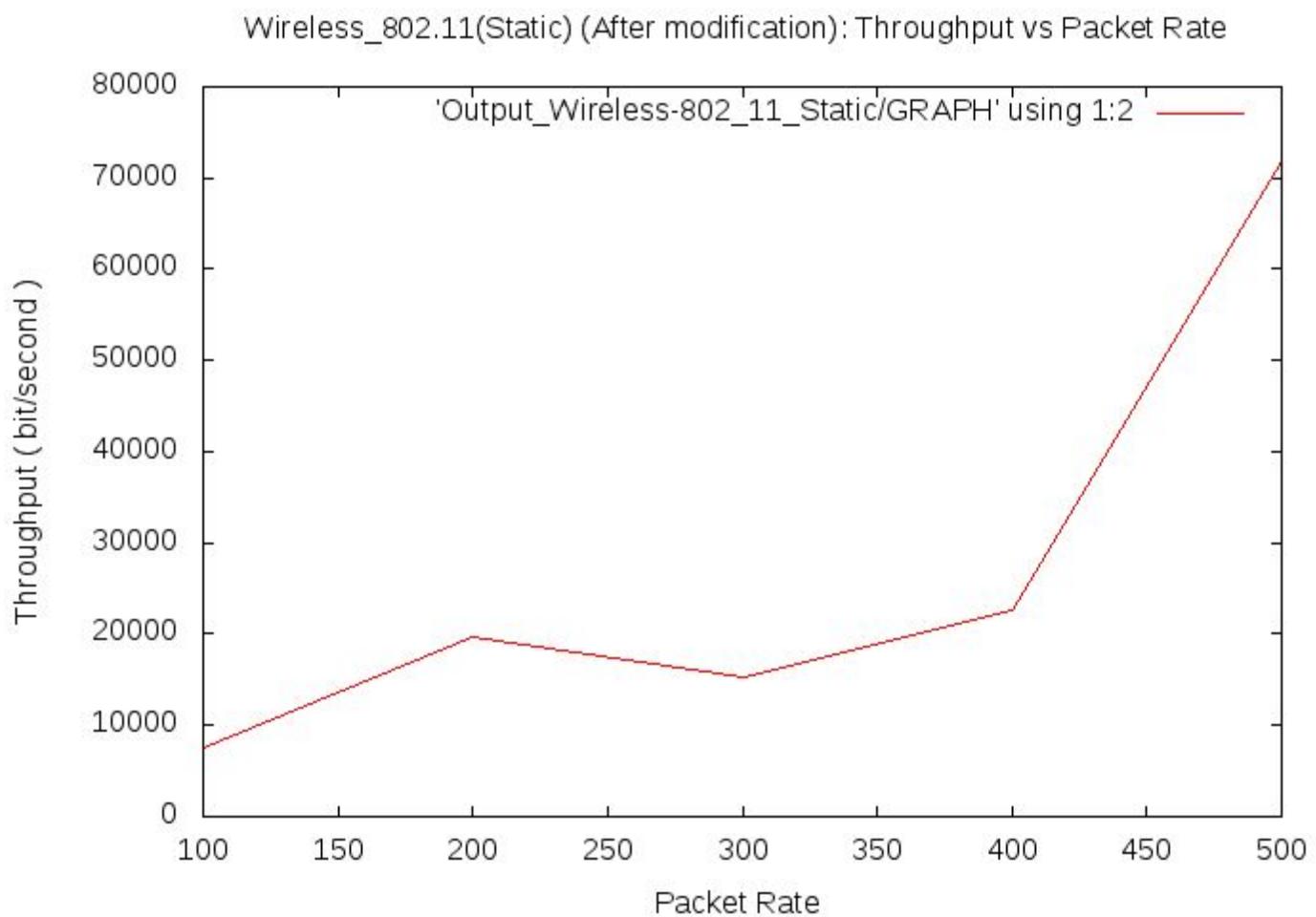


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 2

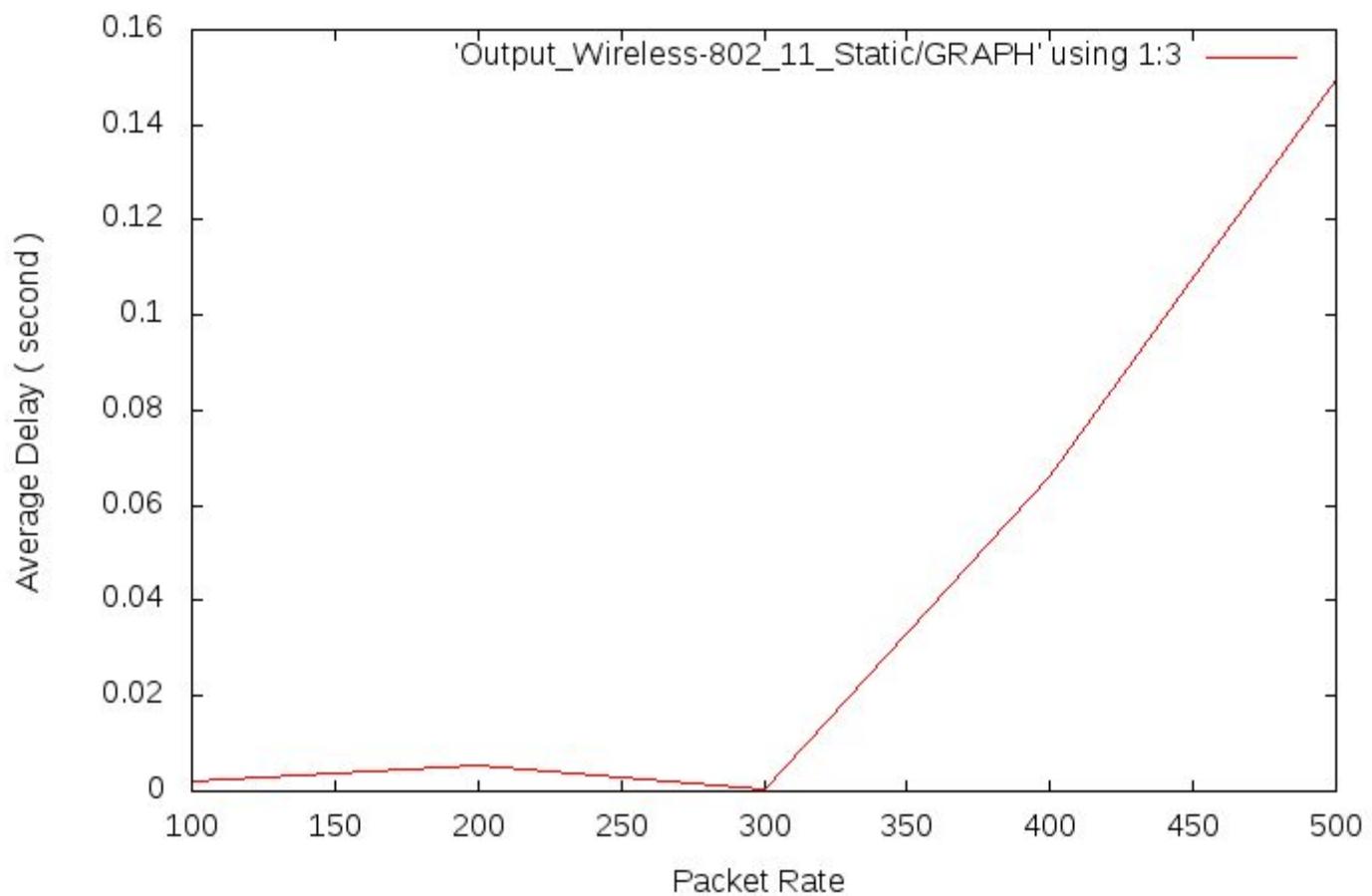


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs No of flows - Round - 1

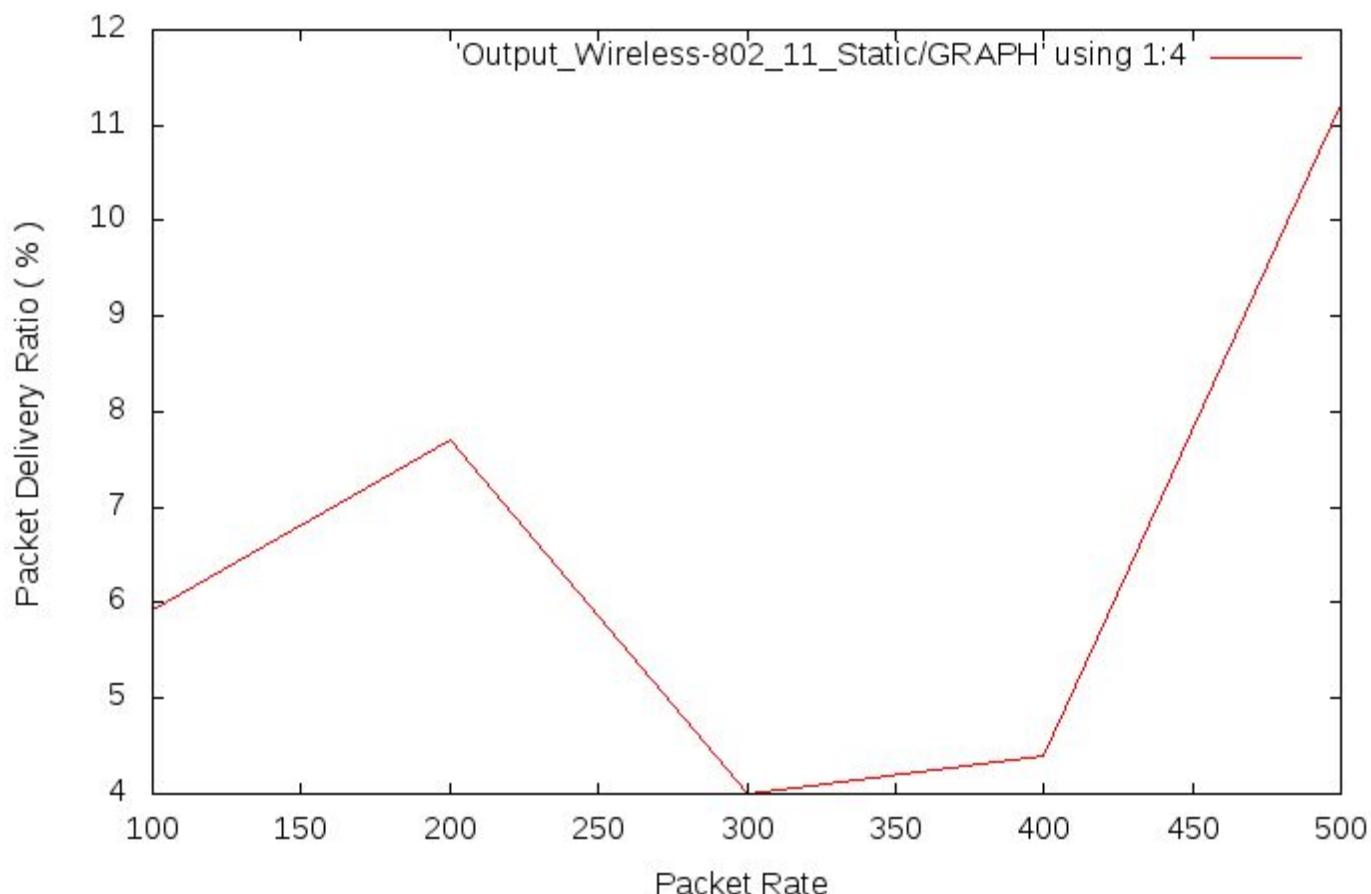




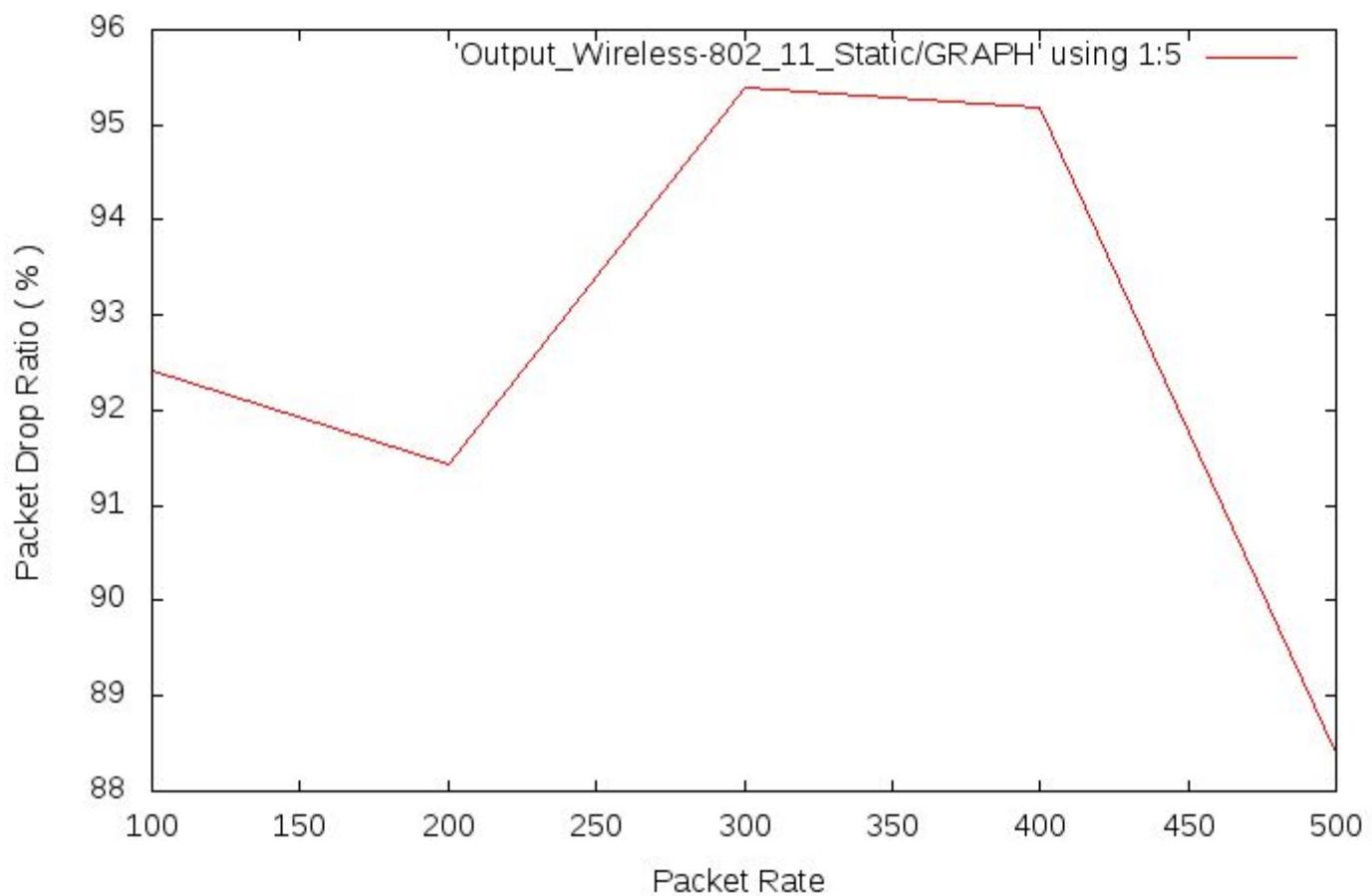
Wireless\_802.11(Static) (After modification): Average Delay vs Packet Rate



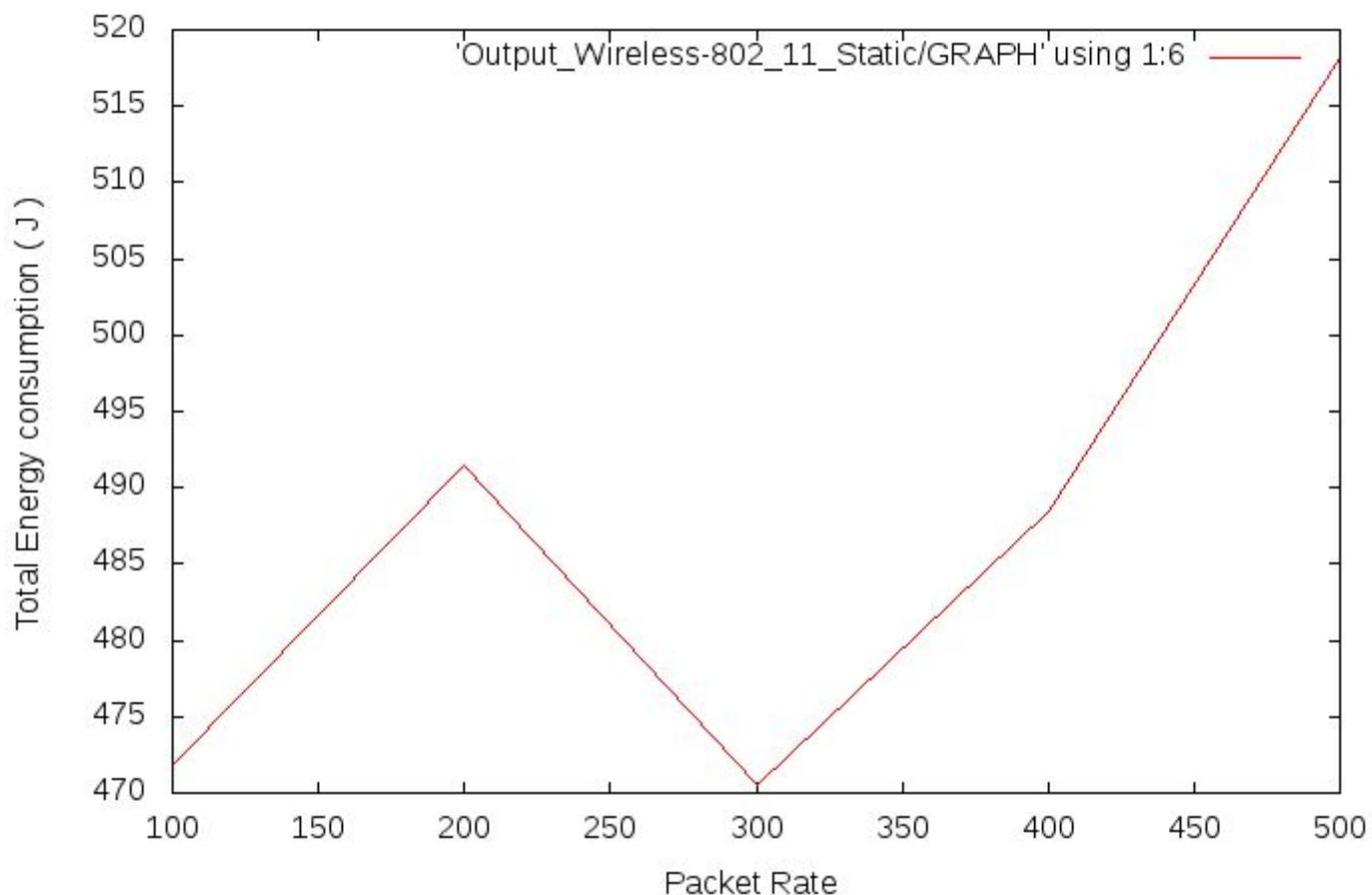
Wireless\_802.11(Static) (After modification): Packet Delivery Ratio vs Packet Rate

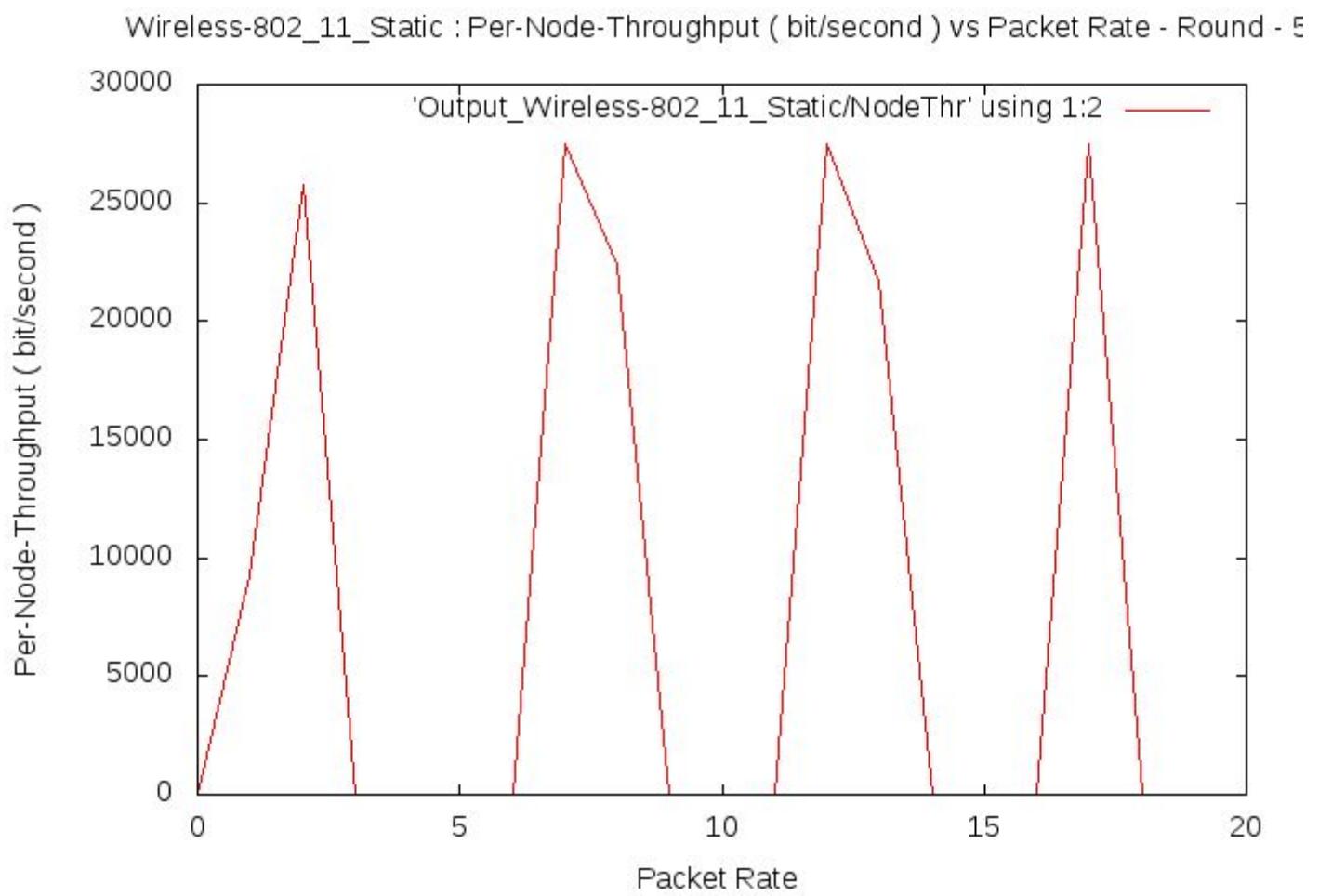


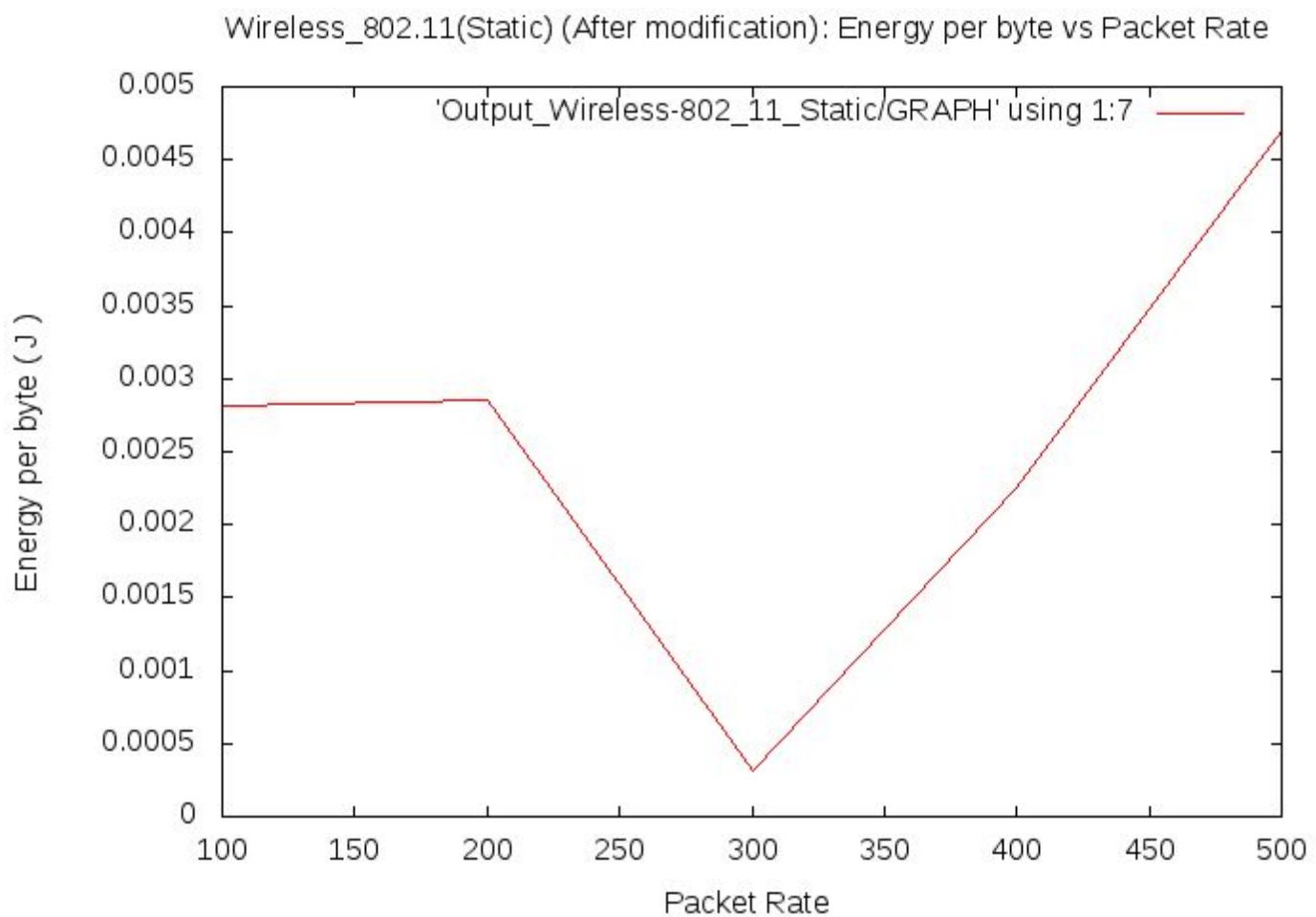
Wireless\_802.11(Static) (After modification): Packet Drop Ratio vs Packet Rate



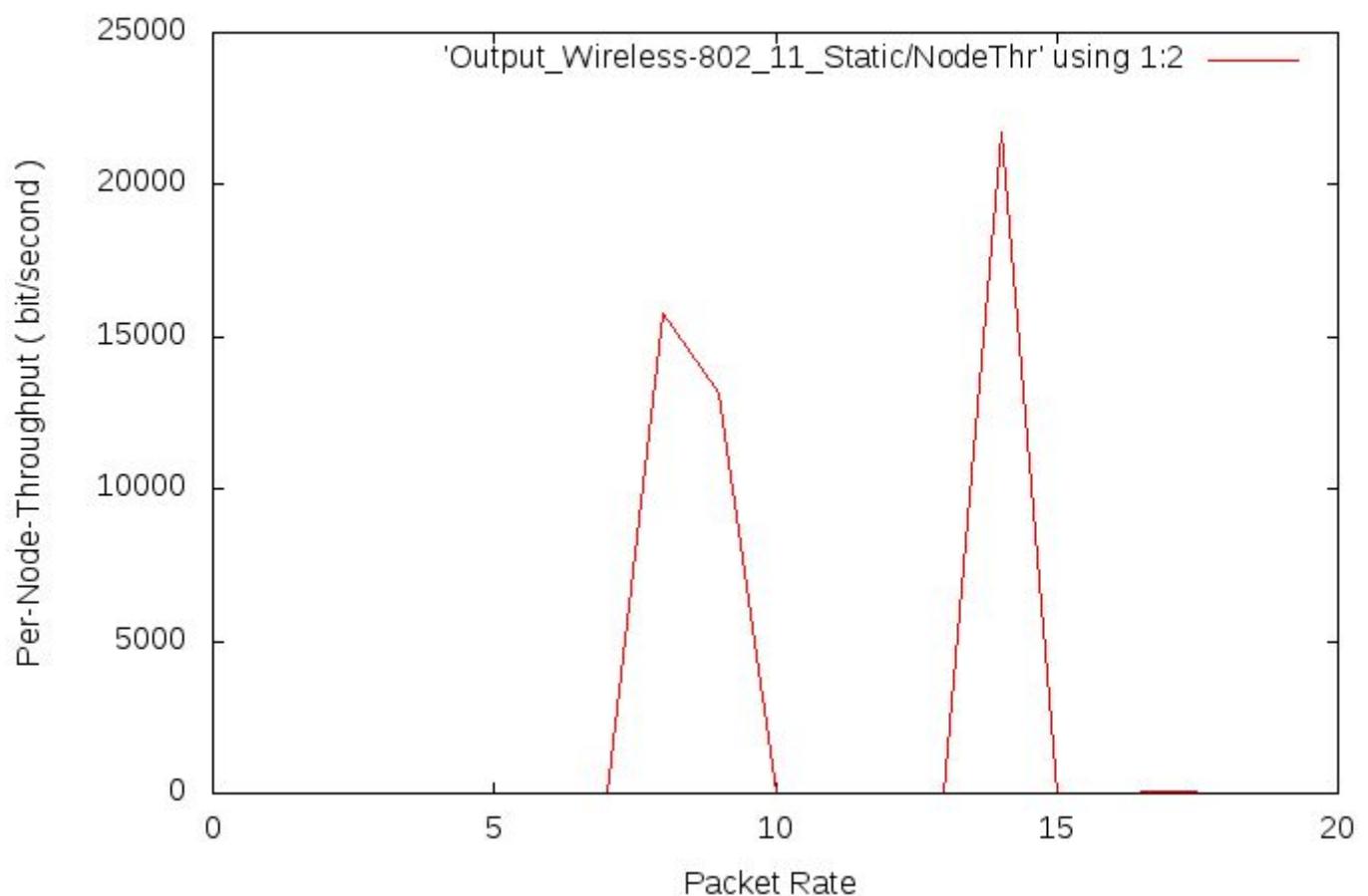
Wireless\_802.11(Static) (After modification): Total Energy consumption vs Packet Rate



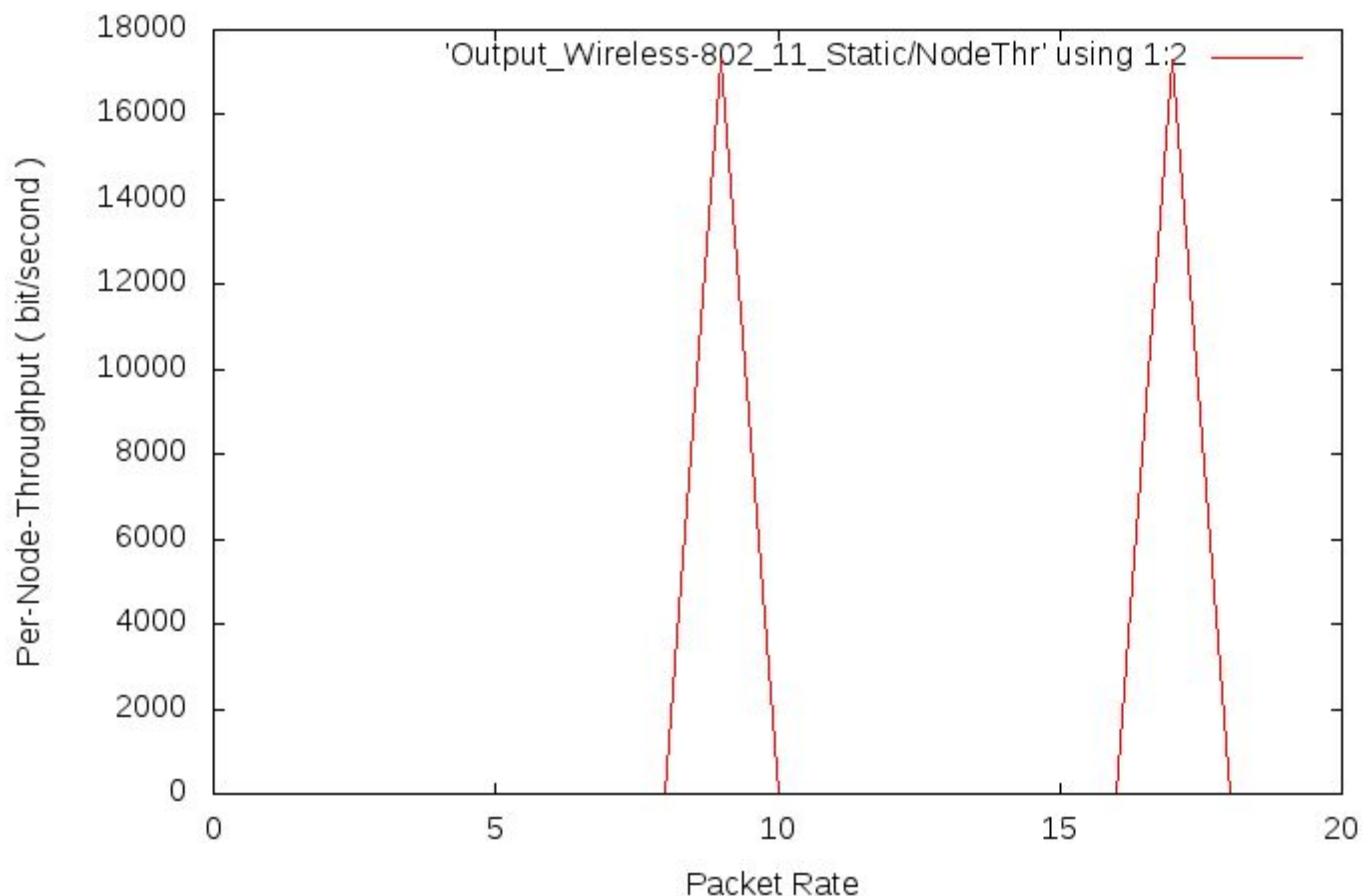




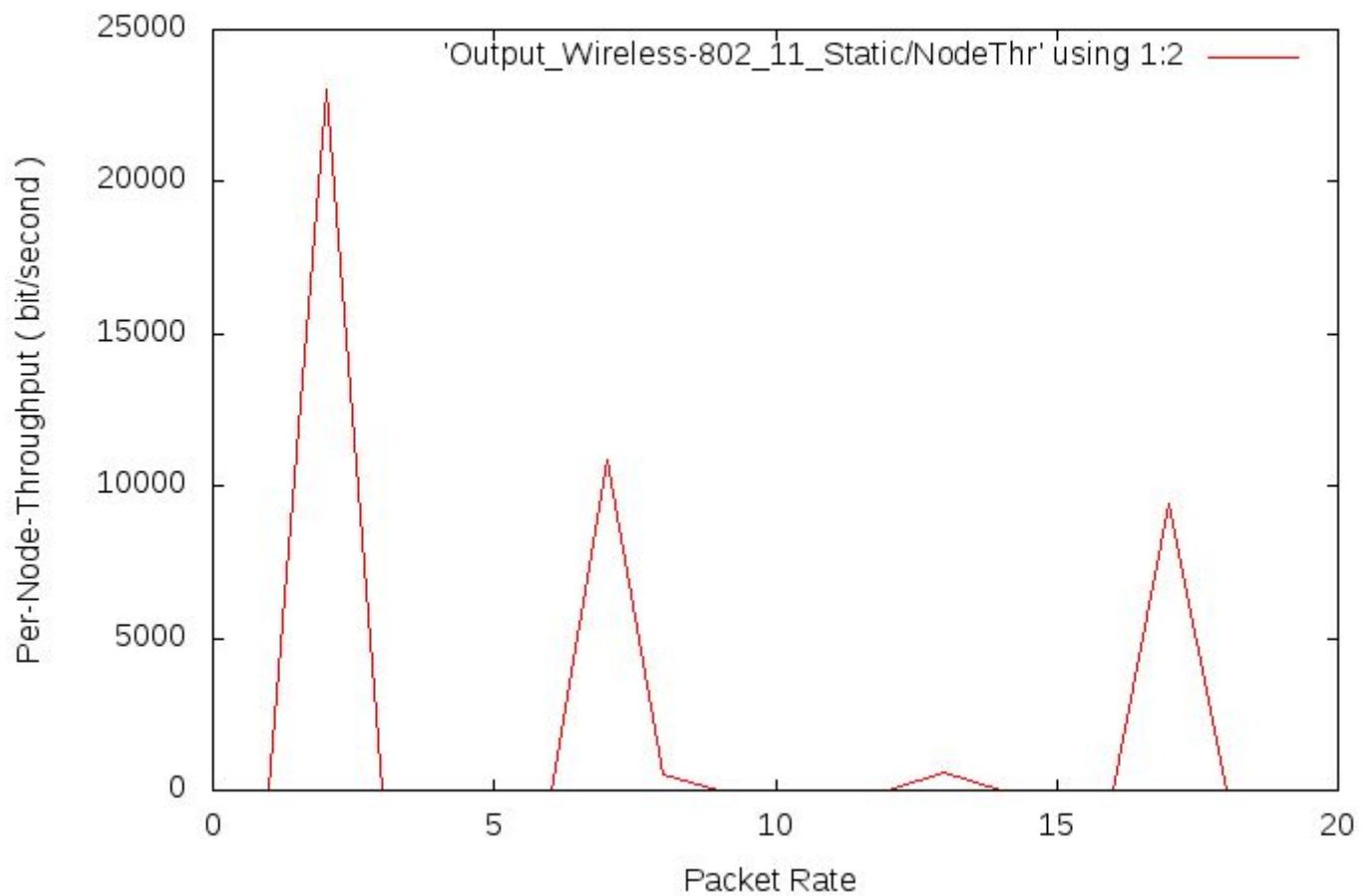
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 4



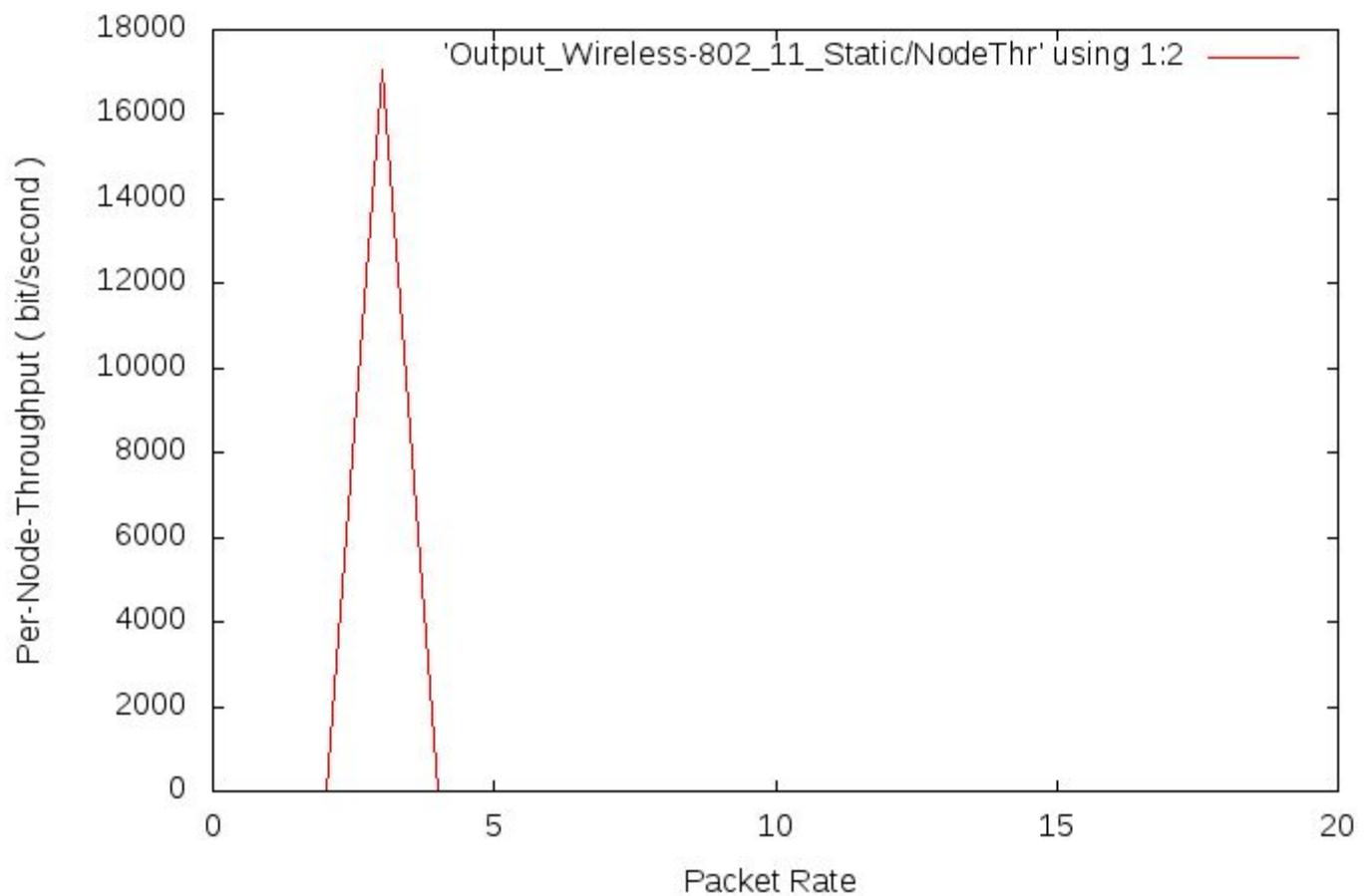
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 3

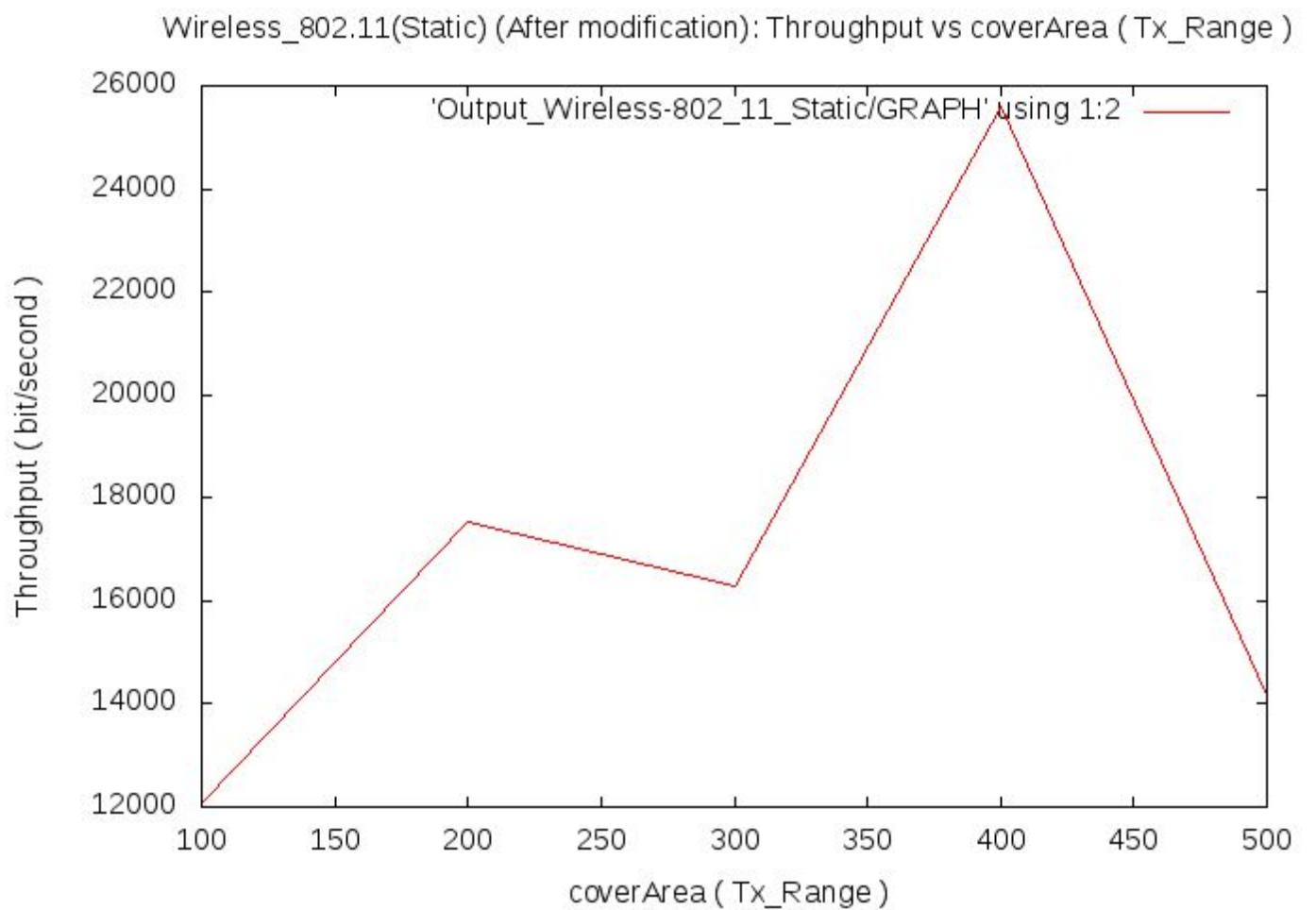


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 2

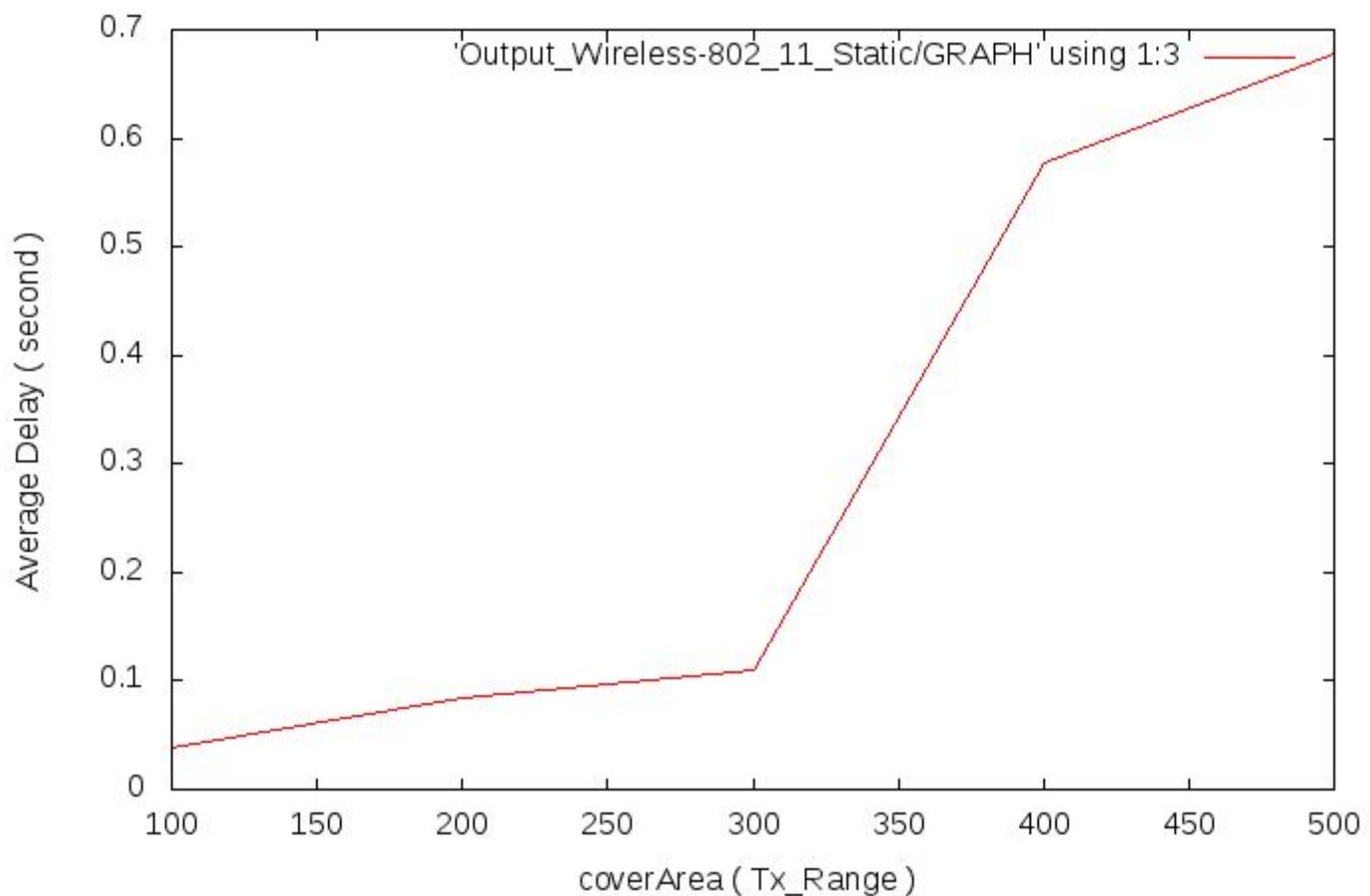


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs Packet Rate - Round - 1

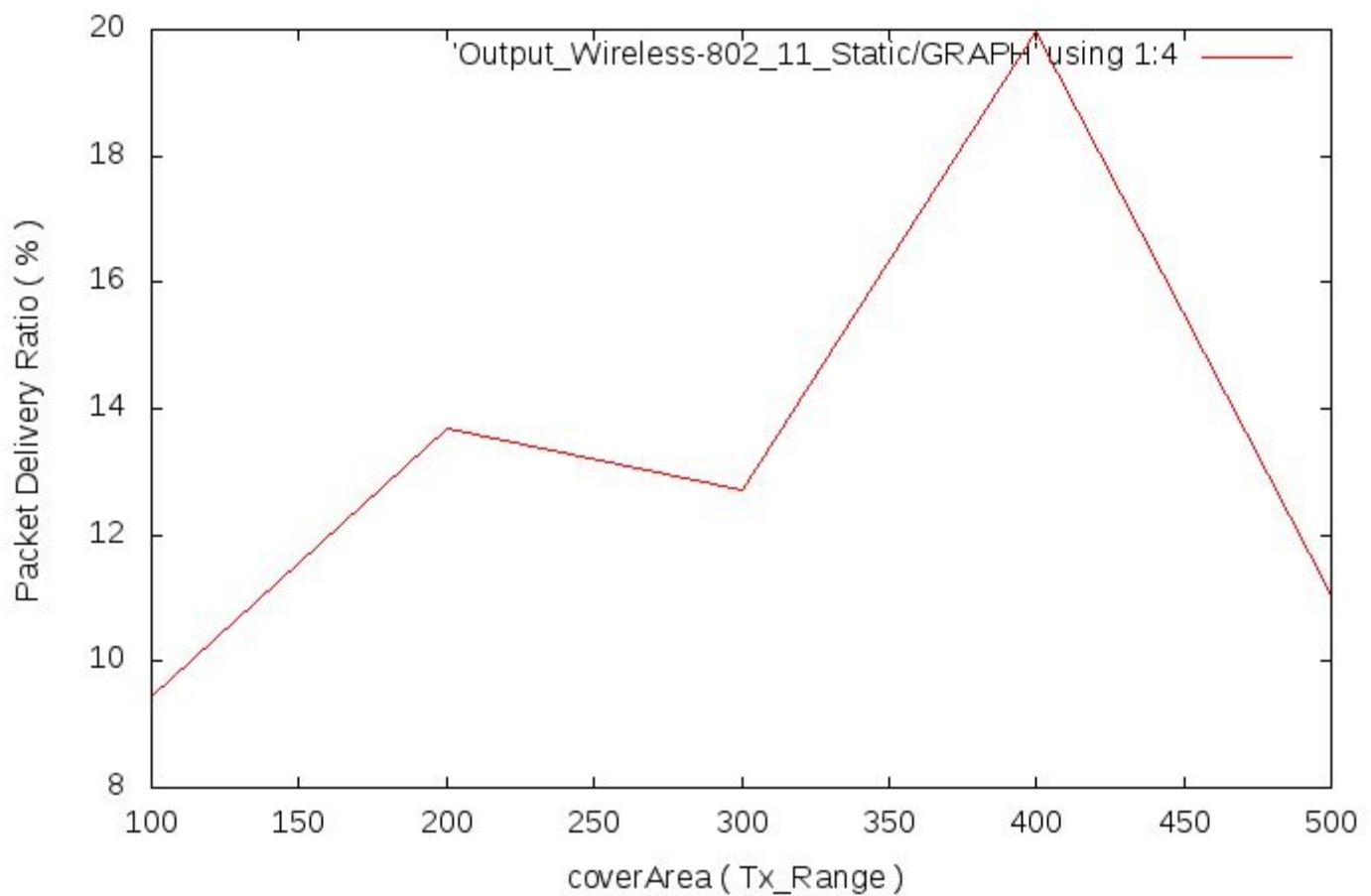




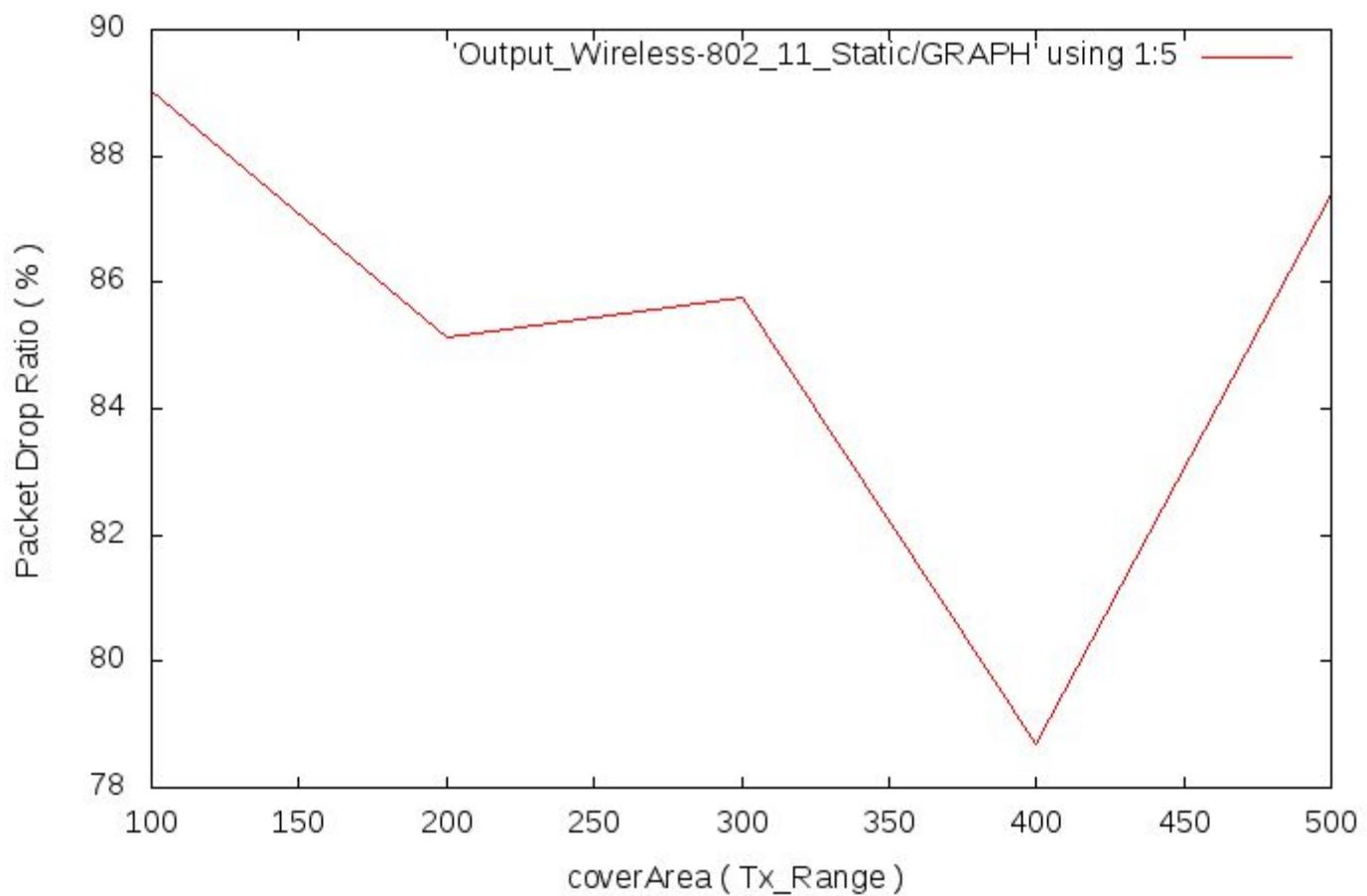
Wireless\_802.11(Static) (After modification): Average Delay vs coverArea ( Tx\_Range )



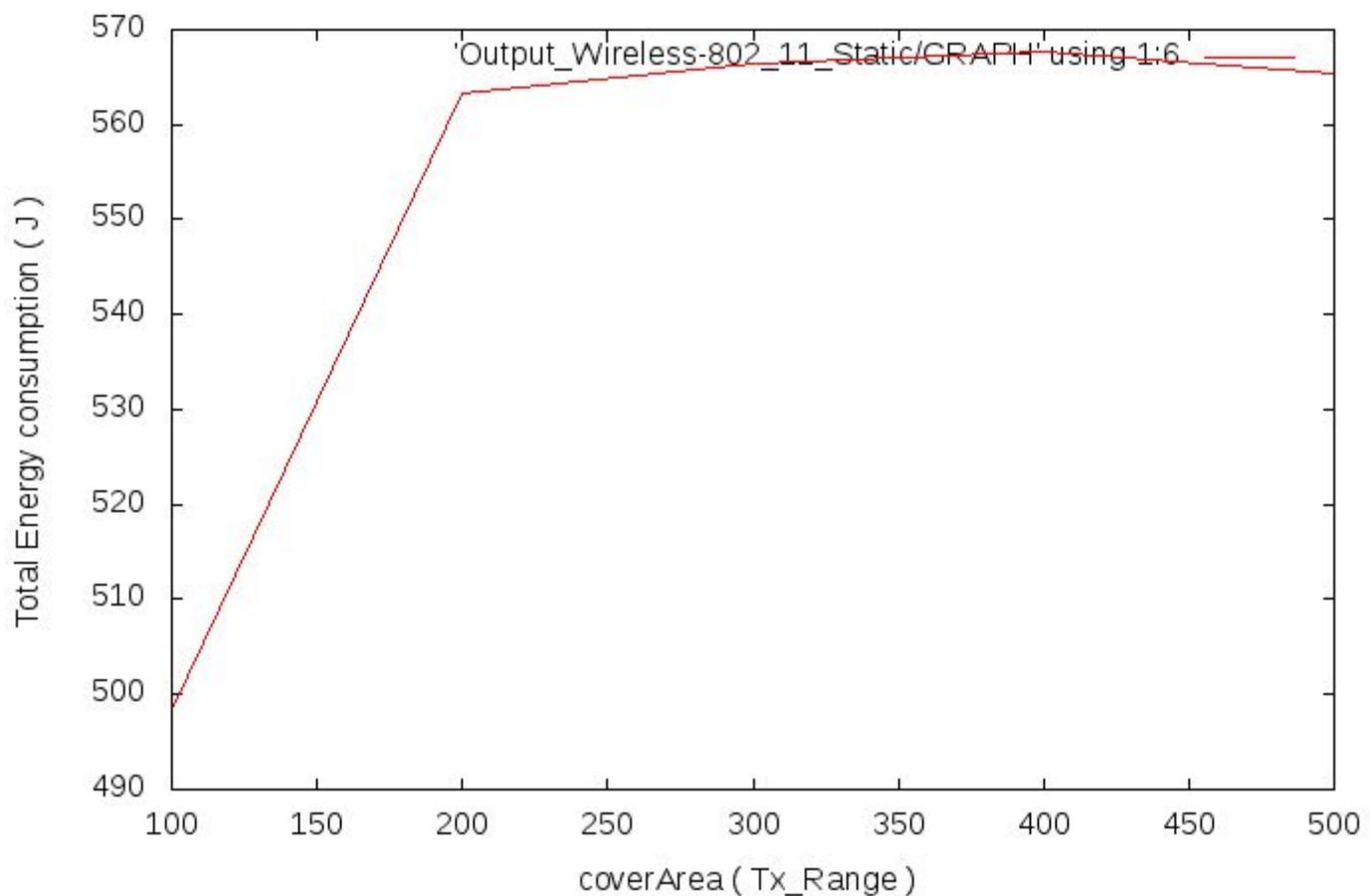
Wireless\_802.11(Static) (After modification): Packet Delivery Ratio vs coverArea ( Tx\_Range )



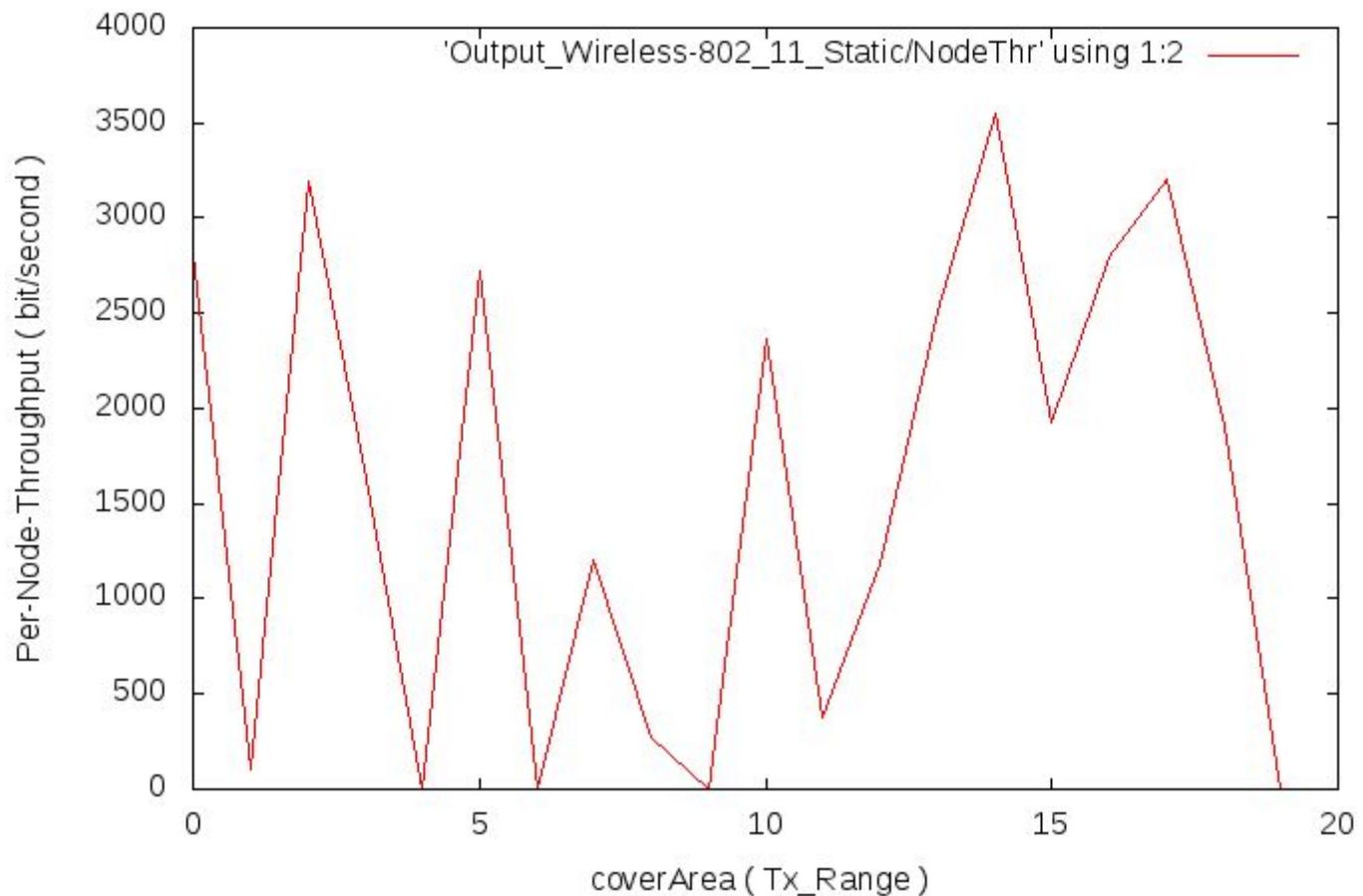
Wireless\_802.11(Static) (After modification): Packet Drop Ratio vs coverArea ( Tx\_Range )

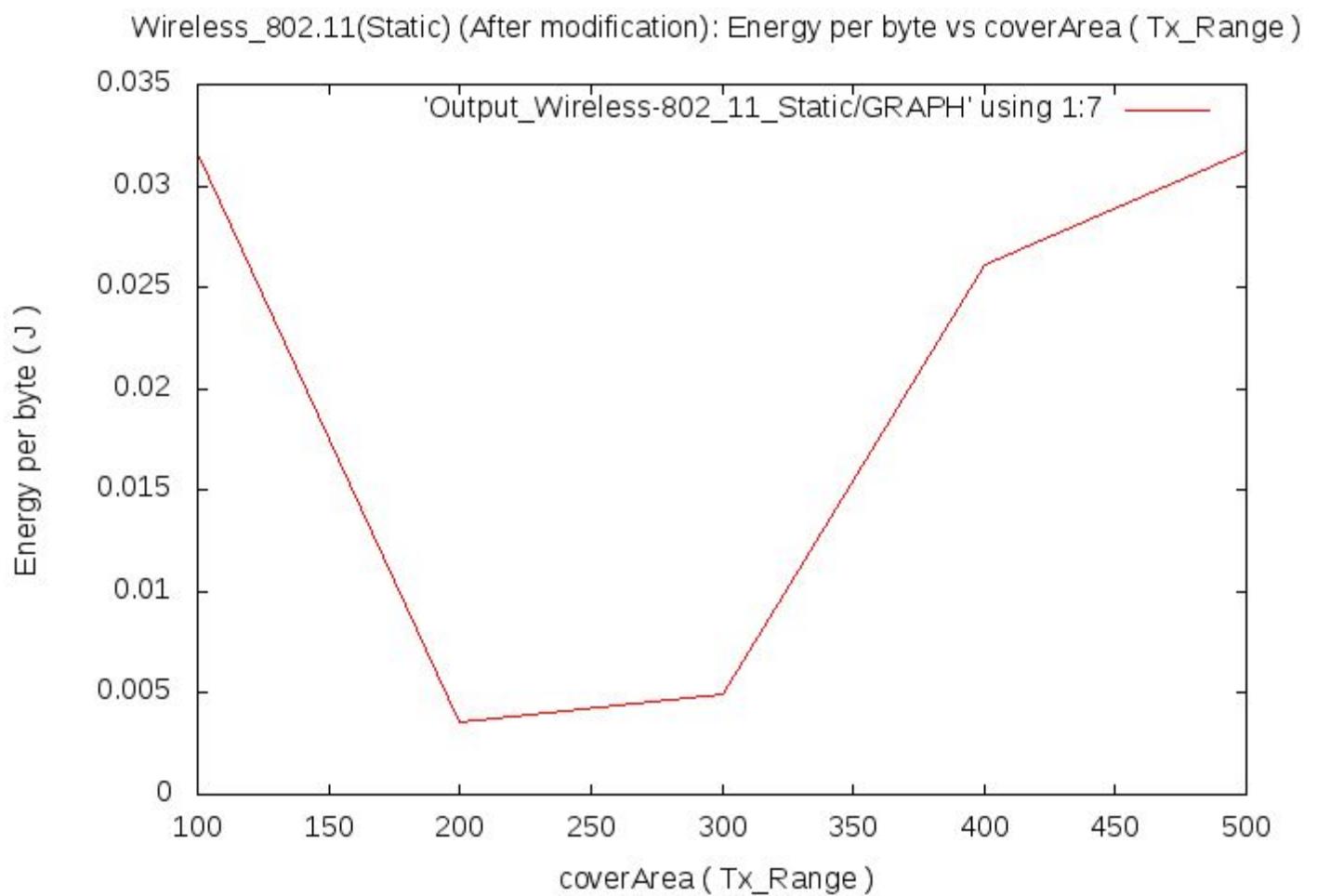


Wireless\_802.11(Static) (After modification): Total Energy consumption vs coverArea ( Tx\_Ran

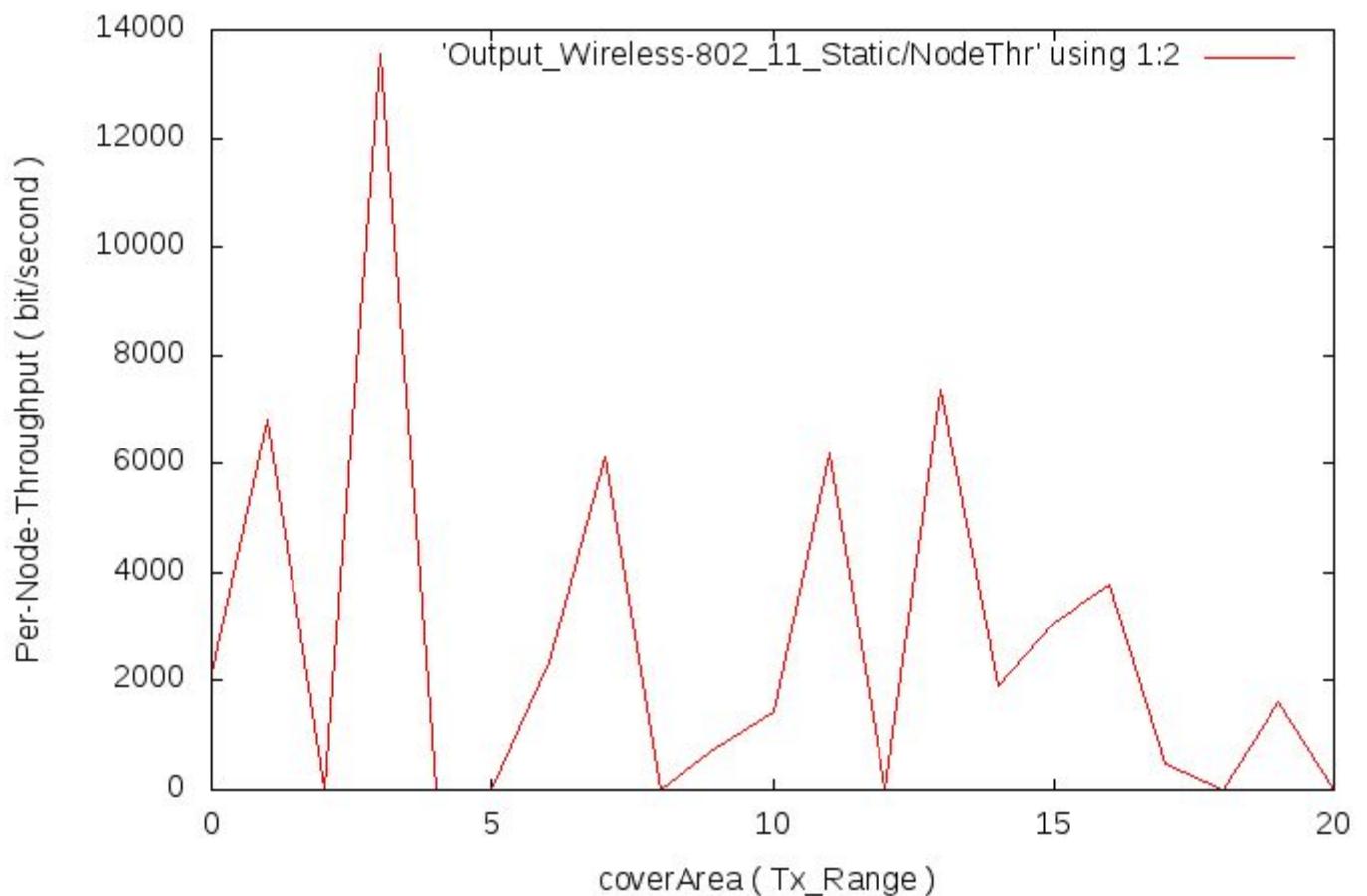


Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - Rou

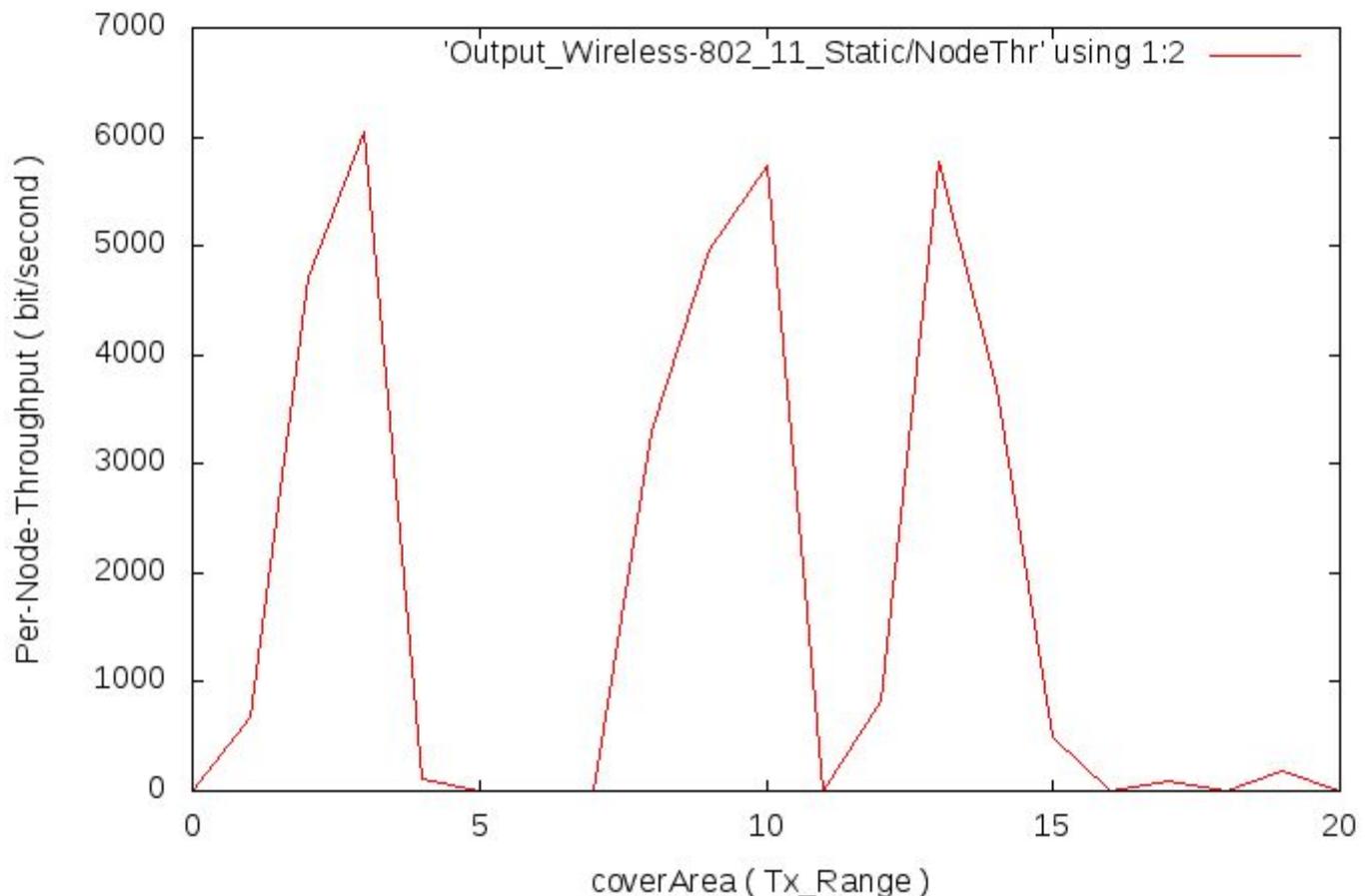




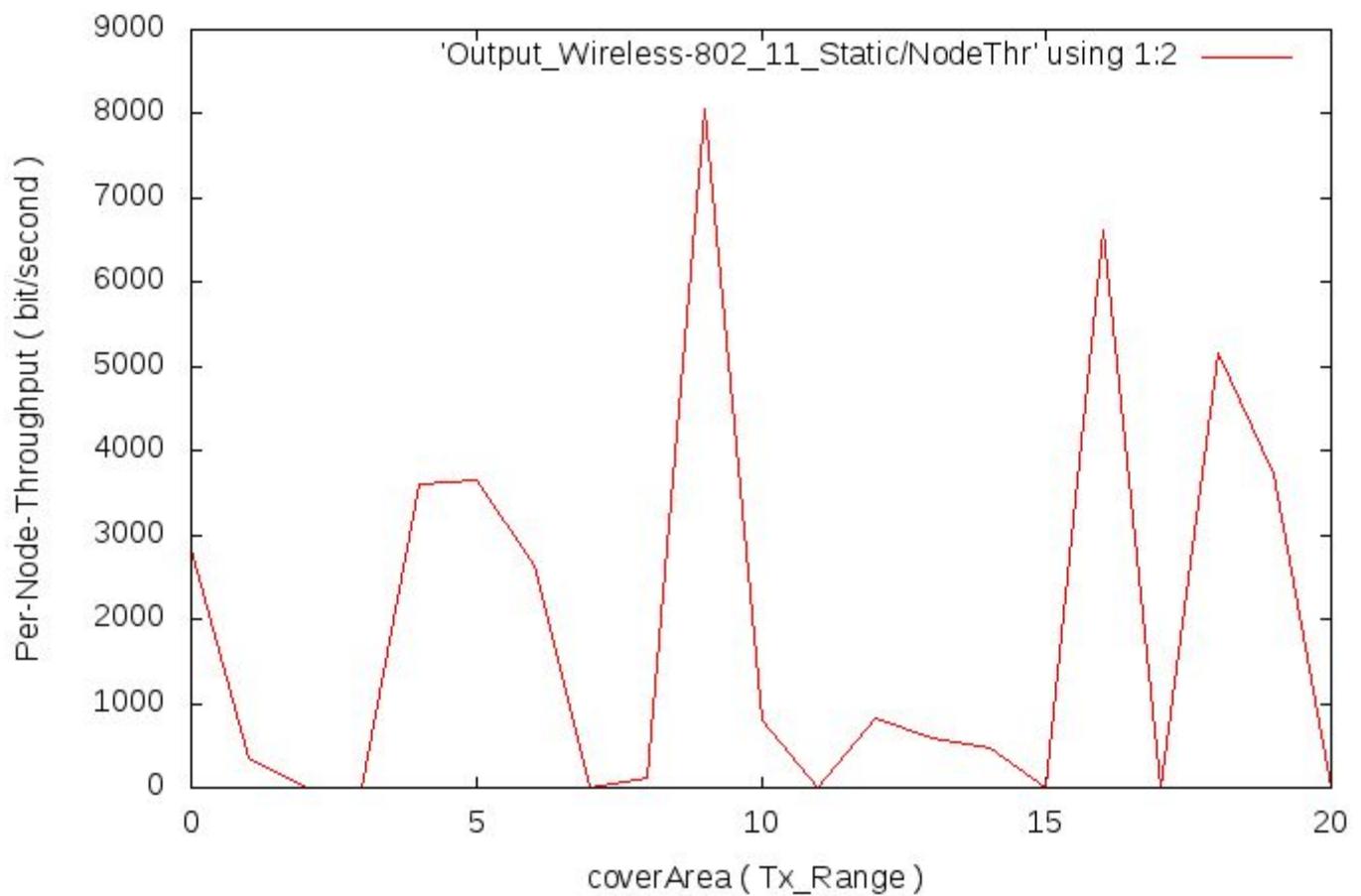
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - RoU



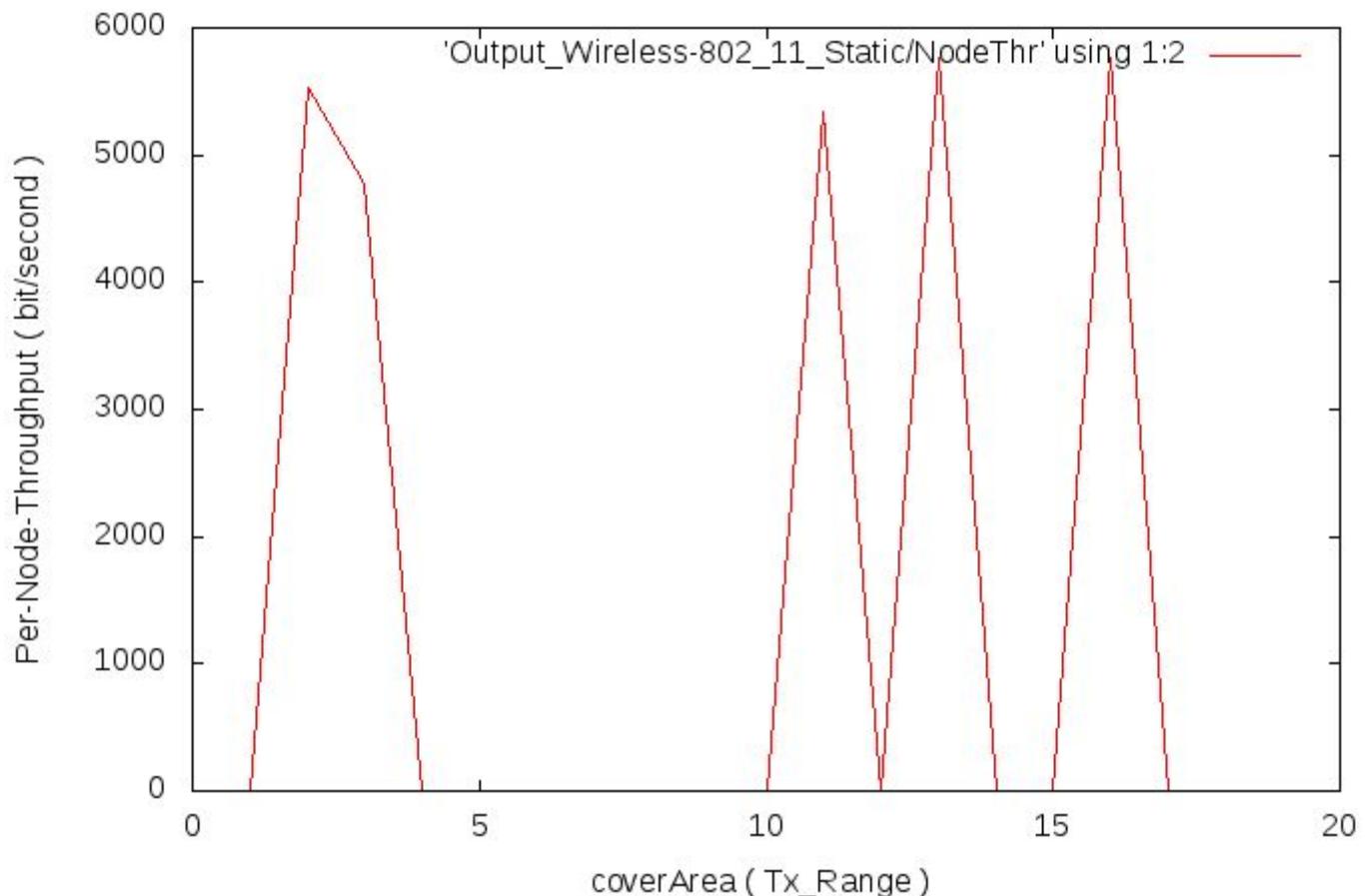
Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - Rou



Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - Rou



Wireless-802\_11\_Static : Per-Node-Throughput ( bit/second ) vs coverArea ( Tx\_Range ) - Rou



**Summary Findings:**

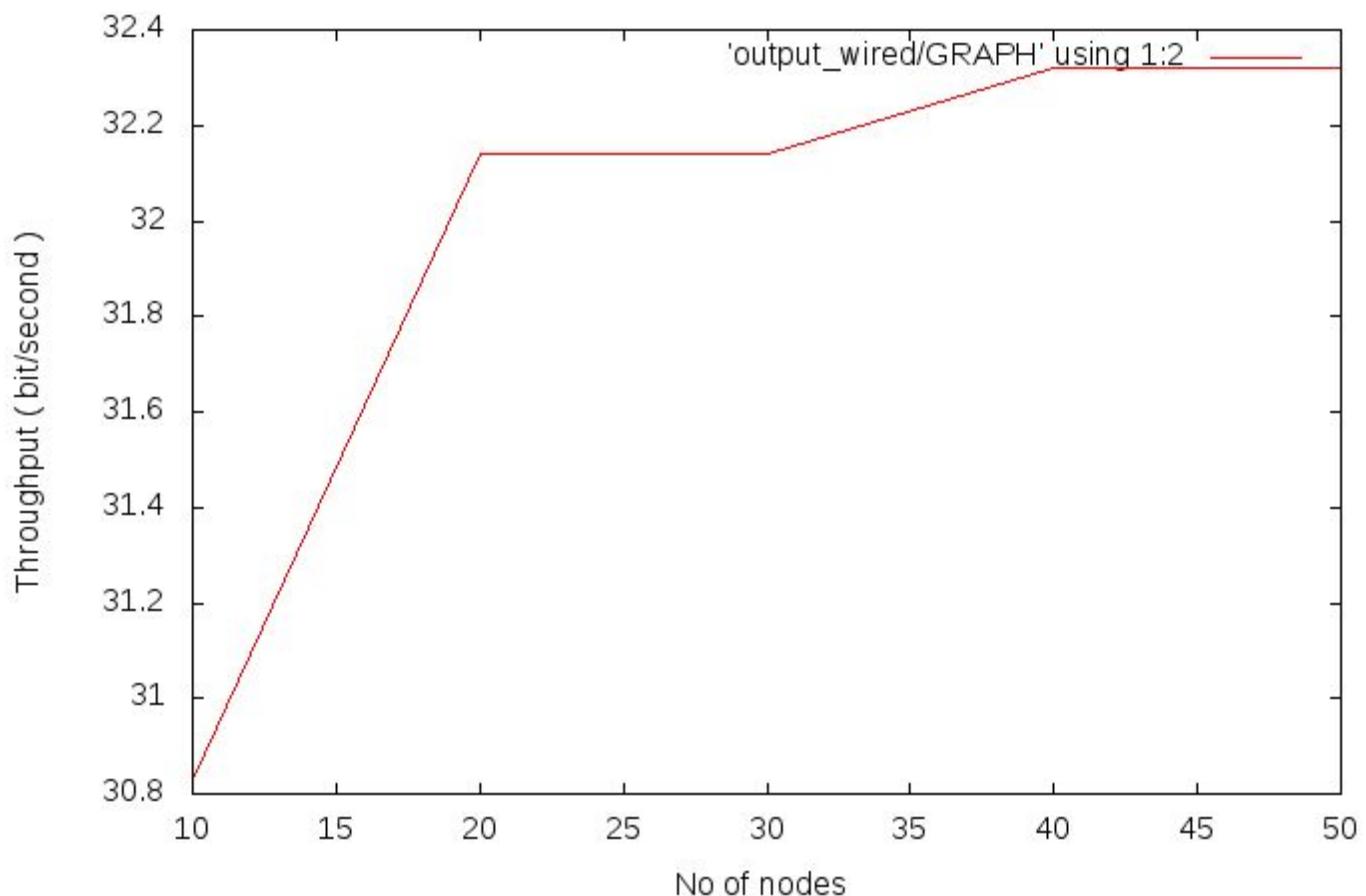
1.

# **Bonus**

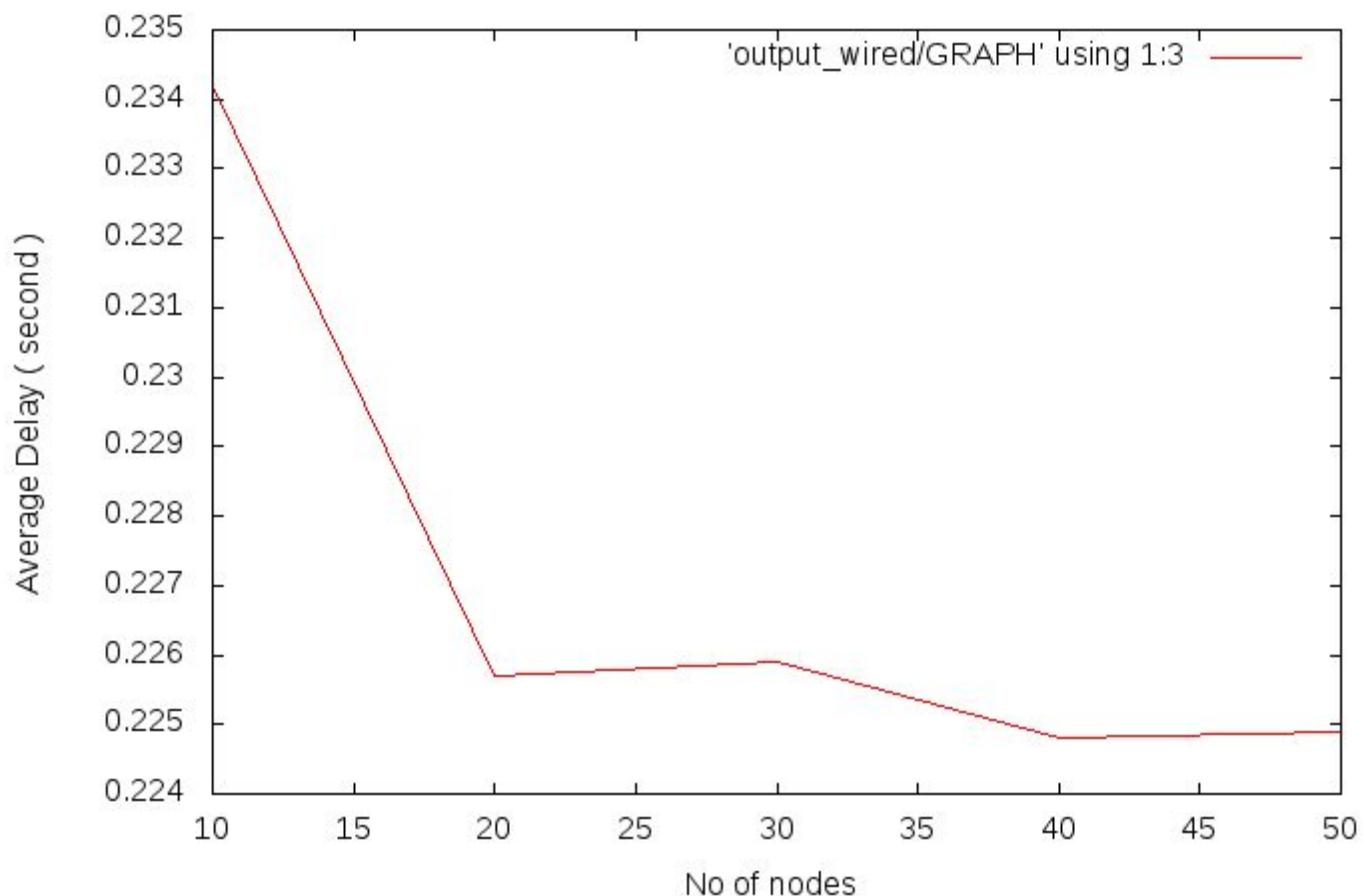
# **Satellite**



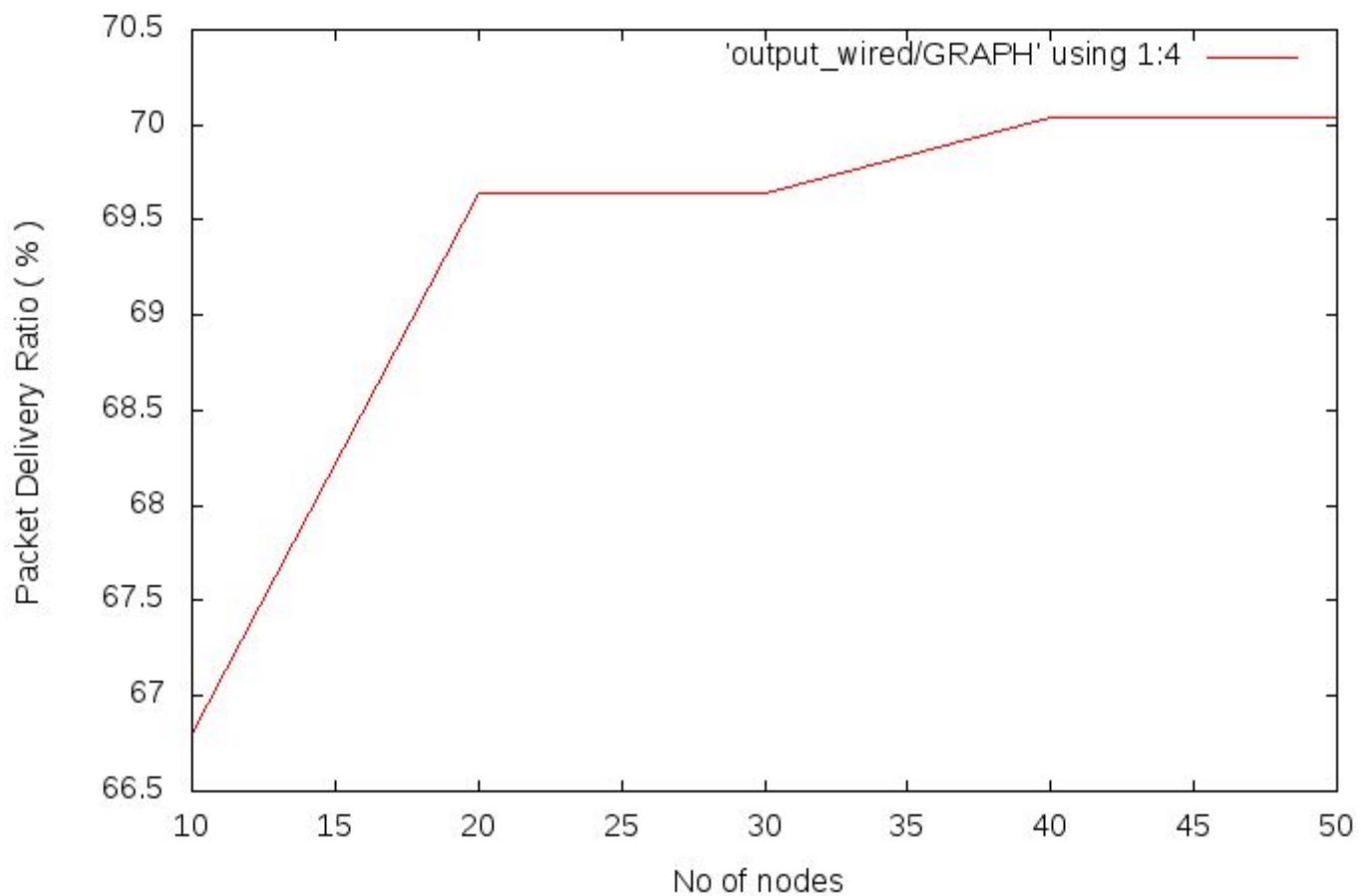
Satellite : Throughput vs No of nodes



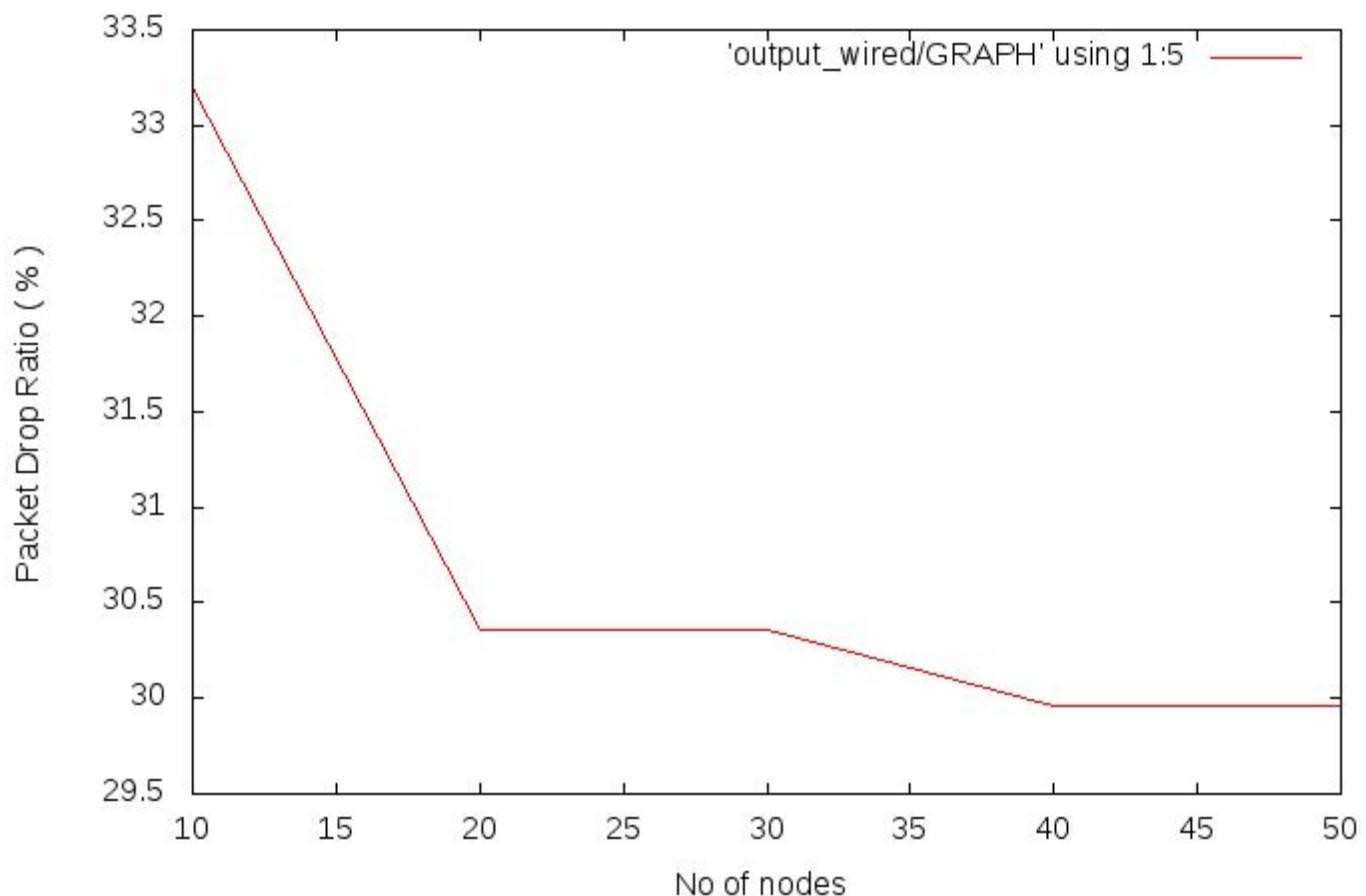
Satellite : Average Delay vs No of nodes



Satellite : Packet Delivery Ratio vs No of nodes

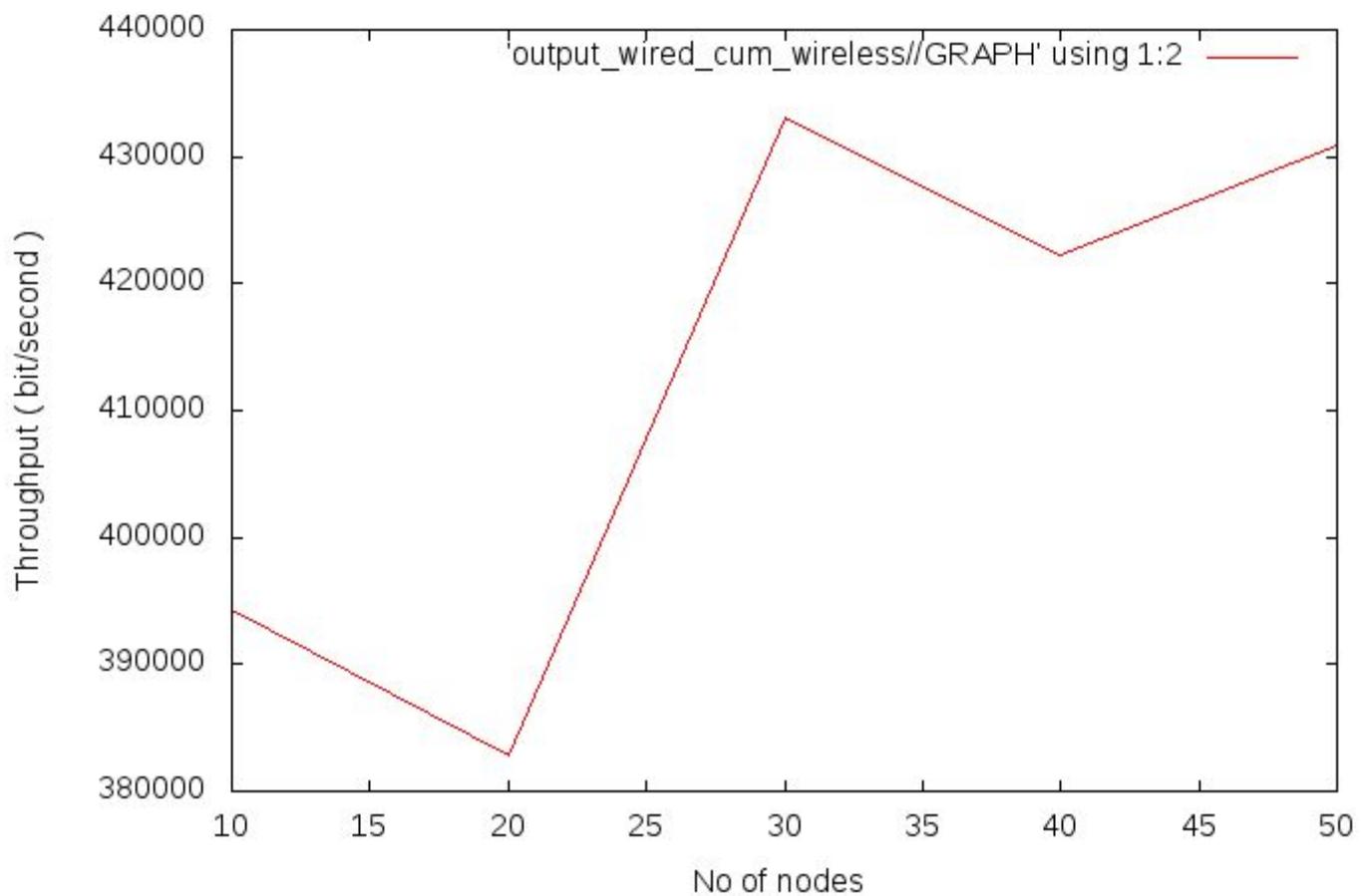


Satellite : Packet Drop Ratio vs No of nodes

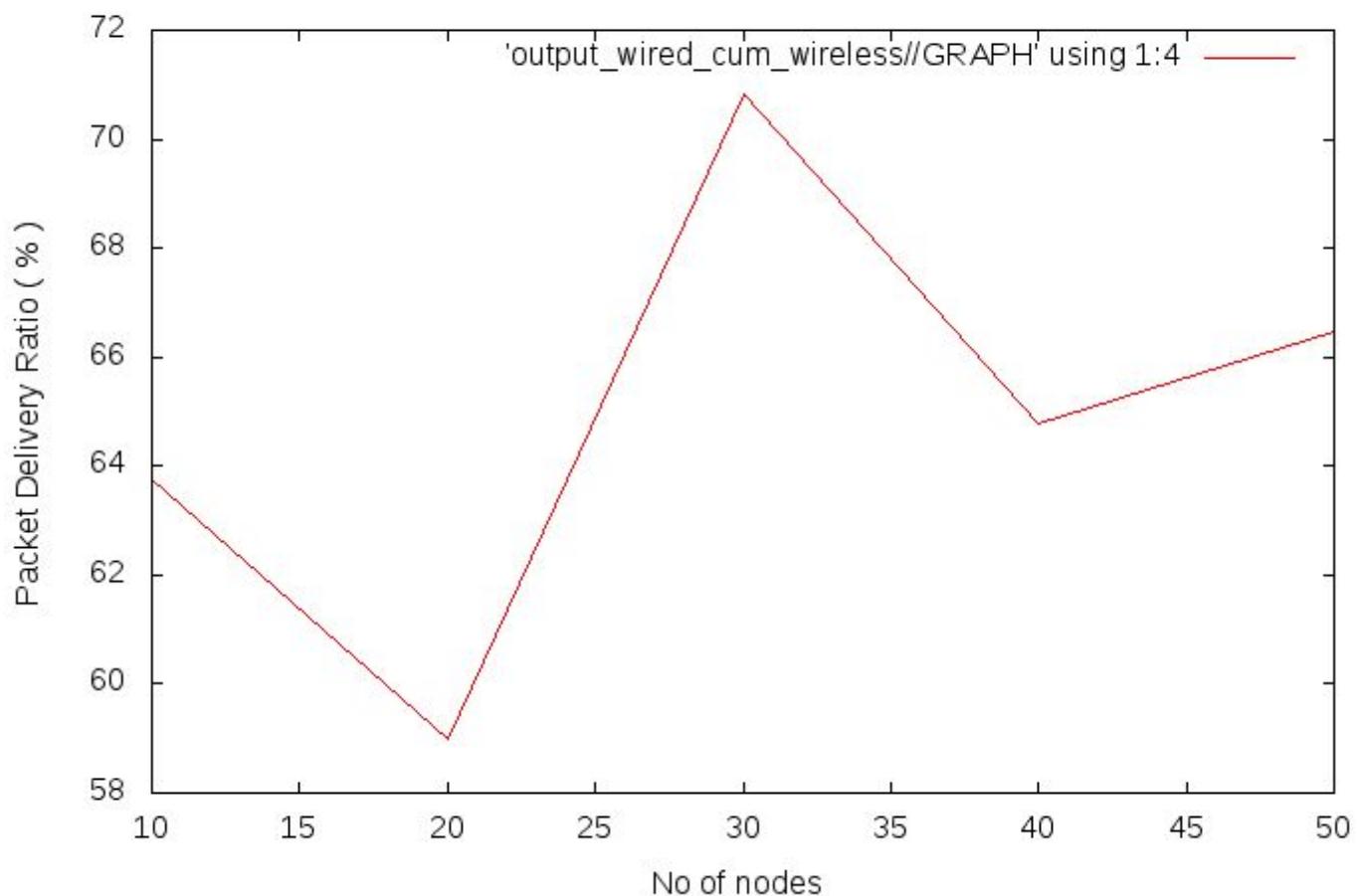


# **Wired to Wireless Cross Connection**

Wired-cum-Wireless : Throughput vs No of nodes



Wired-cum-Wireless : Packet Delivery Ratio vs No of nodes



Wired-cum-Wireless : Packet Drop Ratio vs No of nodes

