Investigations and Performance Evaluation of Dynamic Routing Protocol with New Proposed Protocol for WAN

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Abstract - Routing is a relevant issue for maintaining good performance and successfully operating in a network. Routing Protocols allow routers to dynamically advertise and learn routes, determine which routes are available and which are the most efficient routes to a destination. In any IP network, routing protocols provide the intelligence that takes a collection of physical links and transforms them into a network that enables packets to travel from one host to another. In this paper we present performance evaluation for the combination of conventional model of "RIP" and "OSPF" routing protocols for network traffic over WAN using OPNET. There is significant improvement in the FTP download response time which is reduced by the order of 3sec. The performance metrics like: point-to-point link utilization has increased from 122% to 133% and throughput has increased from 1547 to 1703packets/sec without significant change in queuing delay for both the protocols.

KEYWORDS: RIP; OSP;, WAN; OPNET; Routing Protocol.

1. INTRODUCTION

A routing protocol is a set of rules or standard that determines how routers on a network communicate with each other and exchange information to enable them select best routes to a remote network while each router has knowledge only of networks attached to it directly. Routers running routing protocol share this information first among immediate neighbors, then throughout the entire network. Thus, routers gain insight knowledge of the topology of the network. Routing protocols perform several activities, including:

- Network discovery
- Updating and maintaining routing tables

The router which sits at the base of a network maintains a routing table, which is a list of networks known by the router. The routing table includes network addresses for its own interfaces which are the directly connected networks, as well as network addresses for remote networks. A remote network is a network that can only be reached by forwarding the packet to another router. Remote networks are added to the routing table in two ways:

- By the network administrator manually configuring static routes.
- By implementing a *dynamic* routing protocol.

Dynamic Routing protocols are used by routers to share information about the reachability and status of remote networks.

Several types and classification of protocols exist, but the focus is on two classes especially, routed protocols and routing protocols [1, 2].

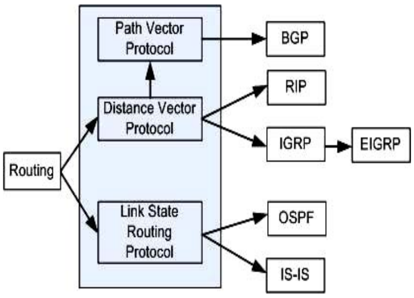


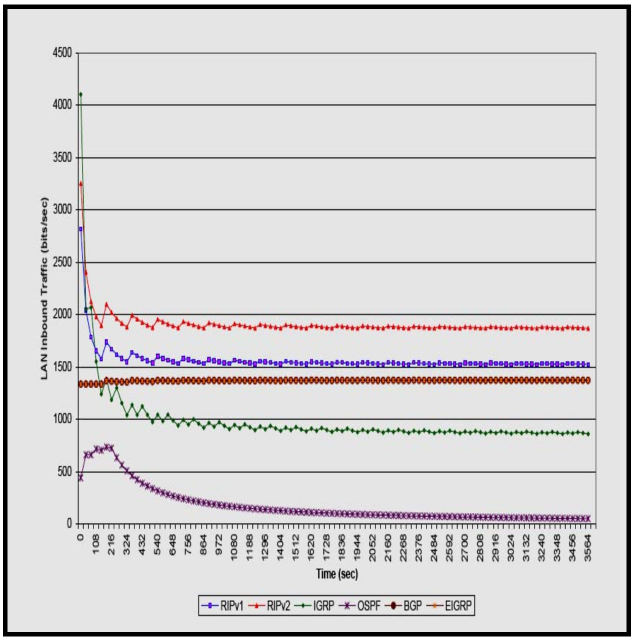
Figure 1: Routing protocols

RIP is intended for use within the IP-based Internet. The Internet is organized into a number of networks connected by gateways. Hosts and gateways are presented with IP datagrams addressed to some host. Routing is the method by which the host or gateway decides where to send the datagram. It may be able to send the datagram directly to the destination, if that destination is on one of the networks that are directly connected to the host or gateway. However, the interesting case is when the destination is not directly reachable. In this case, the host or gateway attempts to send the datagram to a gateway that is nearer the destination [3]. OSPF is a link-state routing protocol. It is designed to be run internal to a single Autonomous System. Each OSPF router maintains an identical database describing the Autonomous System's topology. From this database, a routing table is calculated by constructing a shortest- path tree. OSPF recalculates routes quickly in the face of topological changes, utilizing a minimum of routing protocol traffic. OSPF provides support for equal-cost multipath. An area routing capability is provided, enabling an additional level of routing protection and a reduction in routing protocol traffic. In addition, all OSPF routing protocol exchanges are authenticated [4].

A network facilitates the delivery of packets from a source to destination. This delivery is possible through routers. Packets have destination addresses that let routers to determine how to route the data packets. A router has a routing table which stores network-topology information. With the help of network-topology information, the router forwards packets to the destination. A routing protocol consists of methods to select the best path and exchange topology information. There are two main classes of routing protocols: distance vector routing protocols, e.g. RIP and IGRP, and link-state routing protocols, e.g. OSPF. For enterprise networks, OSPF is often preferred [5], [6].
To exchange service availability and network reachability information, router implements one or more routing protocols. In a specific implementation, the border router implements RIP, OSPF, IGRP, EIGRP, or BGP [7].

Routing protocols accept network state information and then on the basis of such accepted information, update network topology information. Routing protocols also distribute the network state information. Path generation and forwarding information generation are also duties of the routing protocols [8], [9].
The paper [10] studies the effect of routing tables update-time on networks' performability, i.e. the ability of network to deliver services at predefined level. A sample network is studied and the simulation results show that faster updates of routing table, improve network's performability in the presence of failures. Since it may not worth or even be practical to accelerate all routers in the network, this paper suggests finding bottleneck routers and accelerating them in order to improve the performability of the network. The simulation results show that by speeding-up the bottleneck routers of the network, instead of all routers, the desired performability could be achieved. By reducing router update time in all routers of a network, the performability of the network improves. It showed that 100% speed-up in updating routing table, results in about 8% to 10% improvement in network’s performability and also the faster routing updates, the higher Performability [10]. The graph 1 indicates the LAN for inbound traffic with different routing protocols. The traffic received for RIPv2, RIPv1, IGRP, OSPF, EIGRP and BGP is 1.893, 1.576, 0.972, 0.086, 1.370 and 1.360kb/sec respectively. It has been observed that the inbound traffic in case RIPv2 is highest while it is lowest in case of OSPF [11].

The paper [12] presents Performance Analysis of Wired and Wireless LAN Using Soft Computing Techniques.



Graph 1. LAN Inbound Traffic (bits/sec) [11]

As it has been observed that the traffic is highest I case of RIP but at the same time due to rapid growth and expansion of today's networks has pushed RIP to its limits. Specifically, RIP does not address well these major types of problems:

- There is no protection from routing loops within RIP based networks. Therefore, the implementation must trust all network participants to prevent such loops.
- RIP uses a hop count of 15 do denote infinity, which makes it unsuitable for large networks.
- RIP has the so called slow convergency or count-to-infinity problem, in which inconsistencies arise because routing update message propagate slowly across the network. Particularly, in large networks (or networks with slow links), some routers may still advertise a route that has vanished. (That, by the way, was one of the reasons 15 was chosen as the value of infinity to limit the slow convergency).

Slow convergency can be addressed by a technique called hold down, which forces the router to ignore information about a network for a fixed period of time (typically, 60 seconds). The idea is to wait long enough so that all machines receive the bad news of the vanished link and do not mistakenly accept outdated information. The disadvantage of this technique is that incorrect routes and routing loops will be preserved for the duration of the hold down, even when a valid alternate path is available.

OSPF, as defined by RFC 1131 (781K PostScript file) , is a link-state algorithm. In contrast to a distance-vector algorithm, where a router ``tells all neighbors about the world," link-state routers ``tell the world about the neighbors." OSPF specifies a class of messages called link-state advertisements (LSAs) that allow routers to update each other about the LAN and WAN links to which they are connected. When a change is made to the network, LSAs flow between routers. OSPF routers receive link-state updates and store them in a topology database in memory.

OSPF addresses all RIP shortcomings and thus is better suited for modern large, dynamic networks. For example, in contrast to RIP sending the entire routing table from router to router every 30 seconds, OSPF sends its link state information every 30 minutes. OSPF can get away with this, because OSPF routers also send each other small update messages (typically less than 75 bytes), whenever they detect a change in the network (for instance, a failure or a new link). When routers exchange updates that reflect changes in the network, they ``"converge" on a new representation of the topology quickly and accurately.

This paper presents the modeling and simulation of WAN based on OPNET™ to investigate the performance of integration of RIP with OSPF. Using the model we have studied behaviour of FTP traffic, wireless load and delays. We have investigated FTP Download Response Time (sec), FTP Upload Response Time (sec), Wireless

LAN Load(bits/sec), Wireless LAN Throughput(bits/sec), Point-to-Point Utilization of Link(%), Point-to-Point Throughput(packets/sec), Wireless LAN Delay(sec), Wireless LAN Media Access Delay (sec), Point-to-Point Queuing Delay (sec) the for two routed network consisting of 50 wireless workstations each.

The rest of this paper is organized as follows: In section 3 information about the network model is presented, section 4 introduces the simulations of network and output result analysis is reported and section 5 concludes the paper.

2. NETWORK SIMULATION TOOL

Simulation modeling is becoming popular method for network performance analysis because: of its Capability to simulate complex architectures and topologies. It is user friendly (GUI) and designers can test their new ideas and carry out performance related studies and it is free from the burden of the "trial and error" hardware implementations. Therefore, keeping in view the above mentioned advantages we have preferred to use OPNET^{TM} (Optimized Network Engineering Tool)[13], key features being:

- Modeling and Simulation Cycle: OPNET provides powerful tools to assist user to go through important three phases in a design circle (i.e. the building of models, the execution of a simulation and the analysis of the output data)
- Hierarchical Modeling: OPNET employs a hierarchical structure to modeling. Each level of the hierarchy describes different aspects of the complete model being simulated.
- Specialized in communication networks: Detailed library models provide support for existing protocols and allow researchers and developers to either modify these existing models or develop new models of their own.
- Automatic simulation generation: OPNET models can be compiled into executable code. An executable discrete-event simulation can be debugged or simply executed, resulting in output data.

3. MODEL DESCRIPTION AND SCENARIOS

In this section, we consider a WAN deployment network of two wireless LANs connected with router. The network infrastructure is shown in figure 1. The network has two subnet each consisting of 50 workstations and the subnets have been connected with router via 100BaseT. The network is connected over IP cloud with remote site (wireless network) with FTP and Web server over firewall. Two different scenarios with modification in routing protocols metrics have been considered to investigate the performance issues in the network.

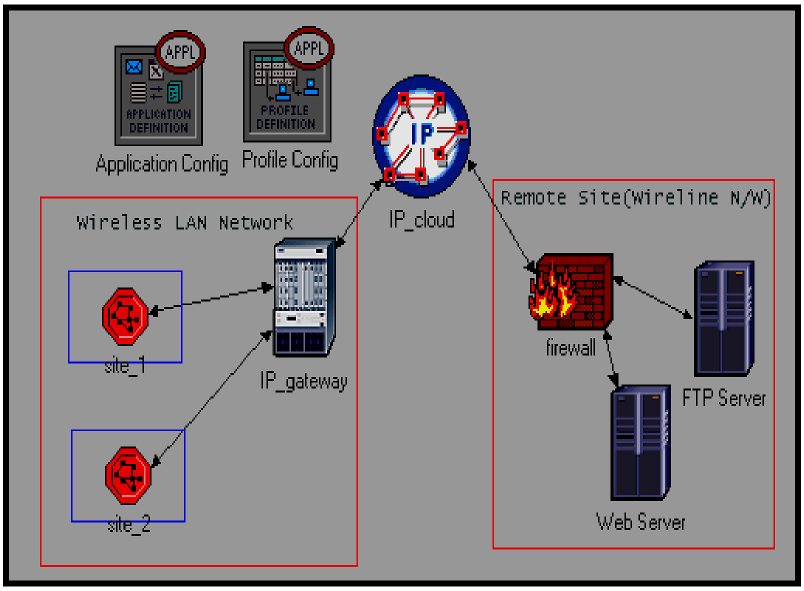


Figure 2: Network Layout

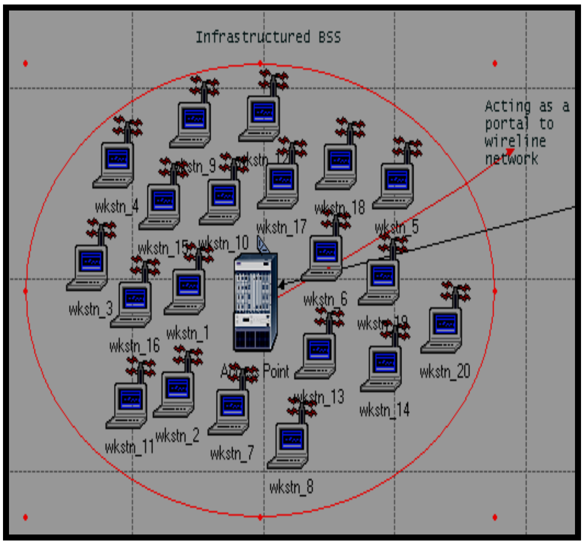


Figure 3: Subnet 1 & Subnet 2

Attribute	Value
Application	FTP
Operation Mode	Serial (Random)
Start Time (sec)	Uniform (100,110)
Duration (sec)	End of simulation
Inter-repetition Time (sec)	Constant (300)
Number of Repetitions	Constant (0)
Repetition Pattern	Serial

Table I. Traffic for Simulation

4. ANALYSIS OF INVESTIGATIONS

Simulation performed for both the conventional RIP and proposed integration of RIP and OSPF protocol are presented in figure 4 to 12.The network contains the statistics on average throughput and delay time of network through which traffic can flow in and out. Figure 4 and 5 shows the simulation run-times corresponding to the average Download and Upload response time experienced while transferring the files between networks under conventional and proposed scenarios. We can see that the download response time is much lower in case of modified protocol, it has reduced from 11.3 to 7.3sec and in case of upload response time both the protocols present approximately same time which is 11.29sec.

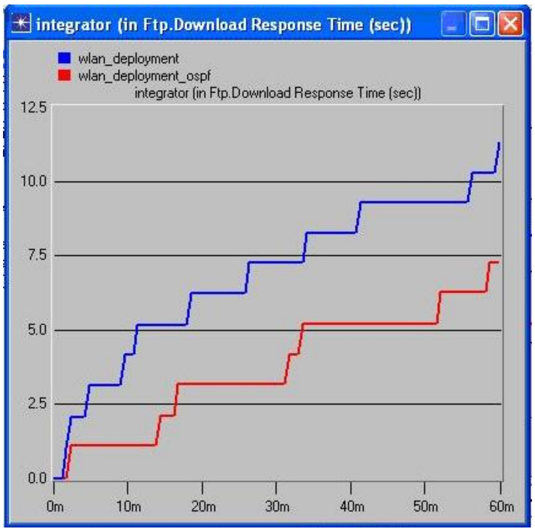


Figure 4: FTP Download Response Time (sec)

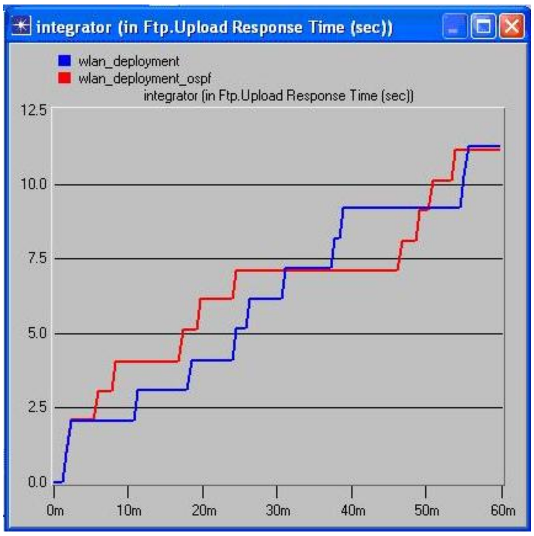


Figure 5: FTP Upload Response Time (sec)

Figures 6 and 7 illustrate the load (bits) and throughput (packets/sec) with both the scenarios. Initially both the protocols give same load and throughput and it increases as simulation progress. Figure 8 and 9 presents the point-to-point utilization and throughput of link. The simulation result shows that the utilization has increased from 122% to 133% and point-to-point throughput has increased from 1547packets/sec to 1703packets/sec.

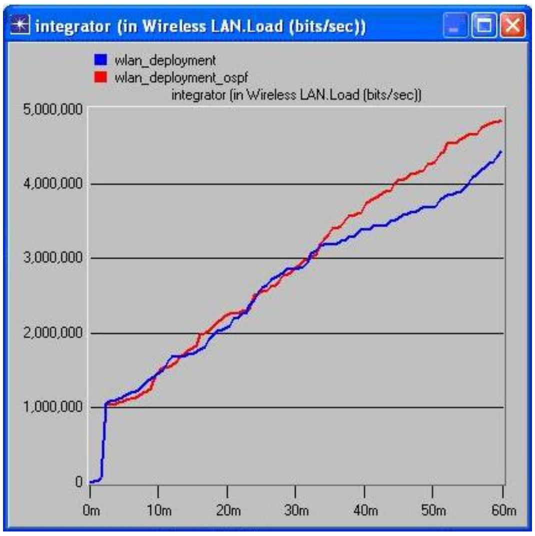


Figure 6: Wireless LAN Load(bits/sec)

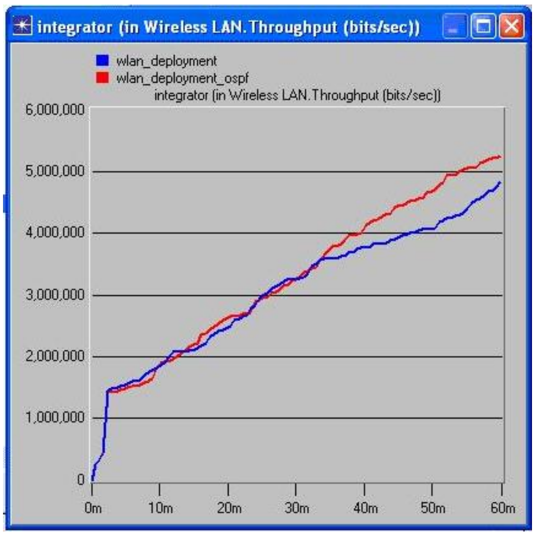


Figure 7: Wireless LAN Throughput(bits/sec)

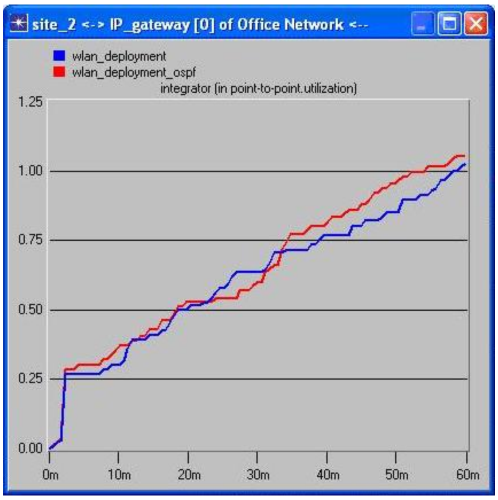


Figure 8:Point-to-Point Utilization of Link(%)

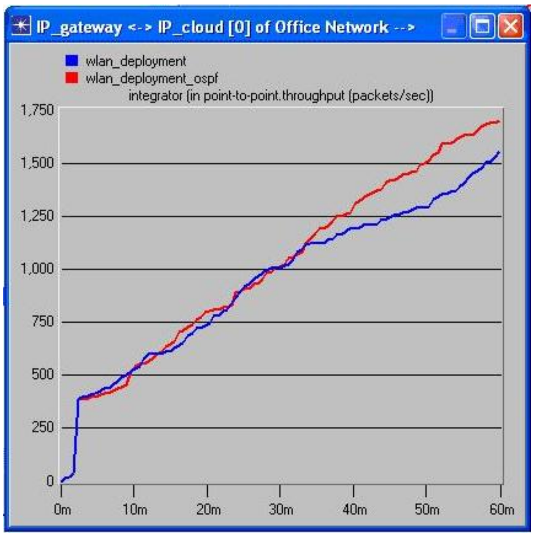


Figure 9:Point-to-Point Throughput(packets/sec)

Figure 10 to 12 presents the average delay, media access delay and queuing delay. It is observed that for both the dynamic routing protocols the delay is approximately same for Wireless LAN delay, wireless LAN media access delay and point-to-point queuing delay which is 0.00128 sec, 0.00098sec and 0.00127sec respectively.

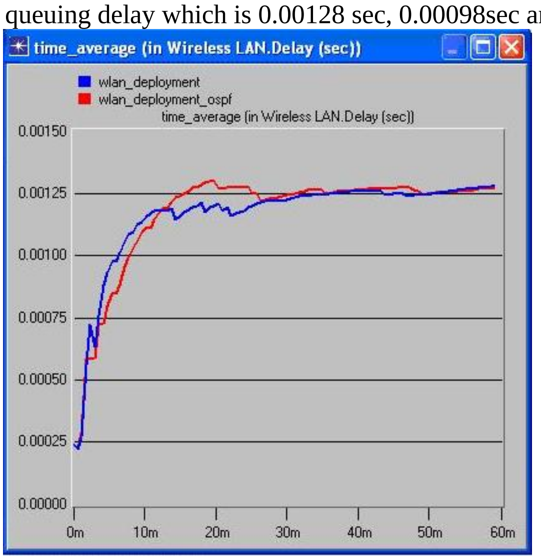


Figure 10:Wireless LAN Delay(sec)

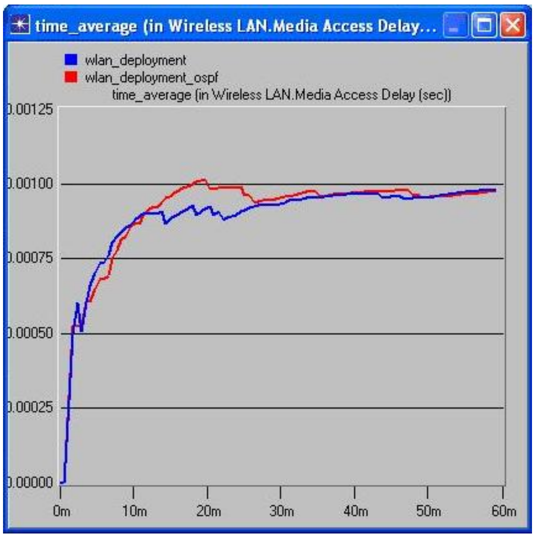


Figure 11:Wireless LAN Media Access Delay (sec)

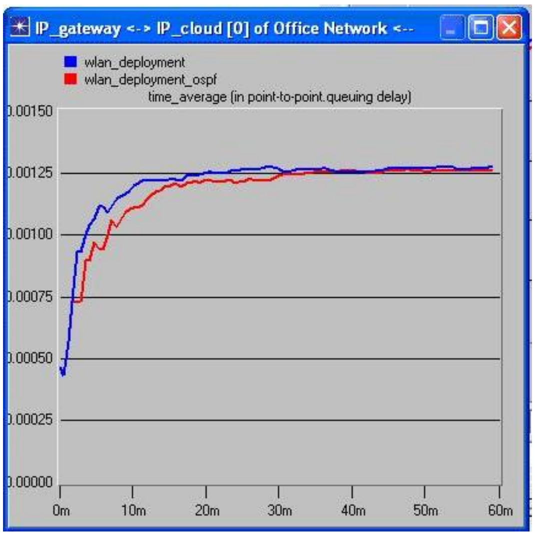


Figure 12:Point-to-Point Queuing Delay

5. CONCLUSIONS AND FUTURE WORK

This paper presents the network for verifying traffic for different routing protocols using OPNET^{TM}. The comparative investigations have been reported for RIP and RIP with OSPF. The simulations were evaluated with respect to the download/upload response time for FTP traffic, delay time when the data is exchanged between the nodes in network.

There is significant improvement in the FTP download response time which is reduced by the order of 3sec. The performance metrics like: point-to-point link utilization has increased from 122% to 133% and throughput has increased from 1547 to 1703packets/sec without significant change in queuing delay for both the protocols.

It can thus be concluded that the overall throughput and load of network has increased with approximately same delay time. Moreover, the download response time for FTP traffic is much lower with the modified version of dynamic routing protocol.

The work can be further extended by evaluating this integrated protocol for different types of network traffic over Wide Area Network.

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