Performance Evaluation of OSPF-Based Data Network

Okezie C.C, Uzoh F.I, Onubogu J.O, Azubogu A.C.O

Abstract- The implementation of the Open Shortest Path First (OSPF) Routing Protocol for data network has became imperative as the size of the internet growing at an alarming rate and data network needs to employ Routing Protocol to route data faster so as to prevent network congestion and high IP drop across a data network. The Open-Shortest Path First (OSPF) protocol, due to its use of route cost as its metric provides better scalability than rival protocols and a reasonable convergence time. We investigate the performance of OSPF routing protocol in a WLAN. This is done with the help of OPNET IT GURU 9.1, in which six scenarios were simulated for the throughput, delay and IP Traffic dropped for both OSPF and RIP. The result showed that network performance was enhanced by a 50-150% range when the OSPF routing protocol was used instead of Routing Information Protocol (RIP).

Keywords: Wireless LAN, OSPF, Throughput, Delay, IP Traffic Dropped, RIP

I. INTRODUCTION

Wireless Local Area Network is a computer network system that uses radio air interface for data transmission. Nowadays, several standards for WLAN air interface for various frequency bands exist. IEEE 802.11b is the most successful standard for WLANs in 2.45 ISM (Industrial, Scientific & Medical) bands [1]. For planning of indoor Wireless LAN systems working in the ISM band, the signal propagation prediction is needed. Indoor scenarios are usually very complicated and due to moving people rapidly changing environment. Since the WLAN systems use wideband transmission, QoS (Quality of Service) is highly dependent not only on average signal strength in specific location, but also on fading statistics.

Many of today's applications are performance-driven and demand everything that the network can provide. Unfortunately, data networks in use today are built upon routing protocols that were developed one or more decades ago. While technologies march forward, many of these protocols have remained stagnant, which can be the cause of performance issues within networks today. We now stand at a critical turning point in the use of technology to extend and empower our human network. The globalization of the internet has succeeded faster than anyone could have imagined.

This research work became imperative as the size of the internet grew at an alarming rate, data network needed to employ Routing Protocol to route data faster so as to prevent network congestion and High IP drop across a data network. A **Routing Protocol** is a program or algorithm that dynamically updates the routing table of a router. This was developed as a solution to the cumbersome and time-consuming process of manually updating the routing table of a large network by an administrator. The main objectives of a routing protocol are to determine the network topology and the best route to a destination. The method that a routing protocol uses to determine the best route to a destination network is called a **routing algorithm** [2] [4].

This research is aimed at showing how OSPF can be used to improve the performance metrics of a data network due to its use of Djisktra Algorithm to find the smallest route cost (Shortest path) to a destination network. The material lays the groundwork for exploring how to make a data network function at its best or most effective performance with the same network parameters. This work can't be timelier than now because of the tremendous growth of data traffic presently experienced today. It will help optimize the network in various aspects which include throughput, reliability, IP traffic carried, Convergence time, Delay.

II. DYNAMIC ROUTING ALGORITHM

Dynamic routing algorithms can be supplemented with static routes where appropriate. A router of last resort (a router to which all unroutable packets are sent), for example, can be designated to act as a repository for all unroutable packets, ensuring that all messages are at least handled in some way. Dynamic routing protocols are usually used in larger networks to ease the administrative and operational overhead of using only static routes. Typically, a network uses a combination of both a dynamic routing protocol and static routes. In most networks, a single dynamic routing protocol is used; however there are cases where different parts of the network may use different routing protocols [3].

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***Correspondence Author(s)**
Dr. Christiana C. Okezie, Electronic & Computer Engineering, Nnamdi Azikiwe University, Awka, Nigeria.
Engr. Ikenna F. Uzoh, , Enterprise Resource Planning (ERP)/ ICT Outsourcing, C2G Consulting Limited, University, Lagos, Nigeria..
Engr. Okechukwu J. Onubogu, Electronic & Computer Engineering, Nnamdi Azikiwe University, Awka, Nigeria.
Dr. Austin C. Azubogu, Electronic & Computer Engineering, Nnamdi Azikiwe University, Awka, Nigeria.

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The Table 2.1 effectively compares the features of Static and Dynamic routing in such a way that could be easily deciphered. For example, it shows that the configuration complexity for dynamic routing is independent of network size, while that of Static increases with the size of the network [1].

TABLE I: FEATURES OF STATIC AND DYNAMIC ROUTING PROTOCOL

	Dynamic routing	Static routing
Configuration Complexity	Independent of network size	Increase with network size
Required administrator knowledge	Advanced knowledge required	No extra knowledge required
Topology changes	Automatically adapt to topology change	Administrator intervention required
Scaling	Suitable for complex and simple topology	Suitable for simple topology
Security	Less secure	More secure
Resource usage	Uses CPU, memory and link bandwidth	No extra resources needed
Predictability	Route depends on current topology	Route to destination is always the same

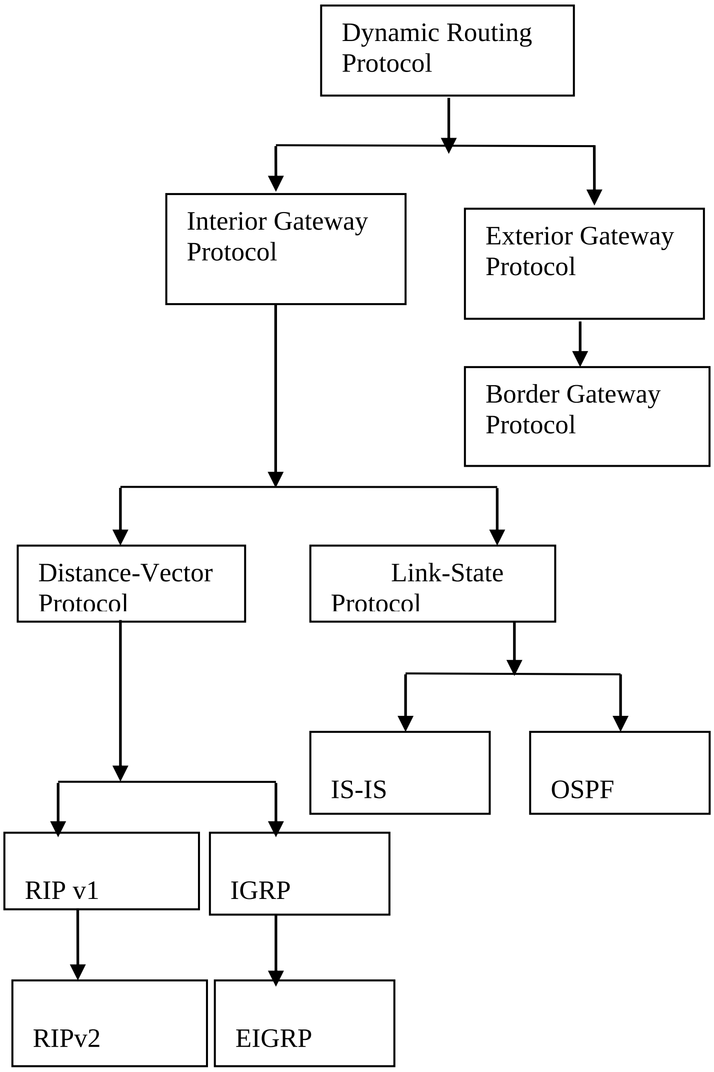

Fig 1. DYNAMIC ROUTING PROTOCOL HIERARCHY

Fig 1 shows how dynamic routing protocols is divided into Interior and exterior Gateway protocol. They are further sub-divided into their composite components. Routers use routing protocols to dynamically manage information received from their own interfaces and from other routers.

III PRACTICAL ALGORITHM

Dijkstra's algorithm, shown in figure 2, is commonly referred to as the shortest path first (SPF) algorithm. This algorithm accumulates costs along each path, from source to destination. Although, Dijkstra's algorithm is known as the shortest path first algorithm, this is in fact the purpose of every routing algorithm.

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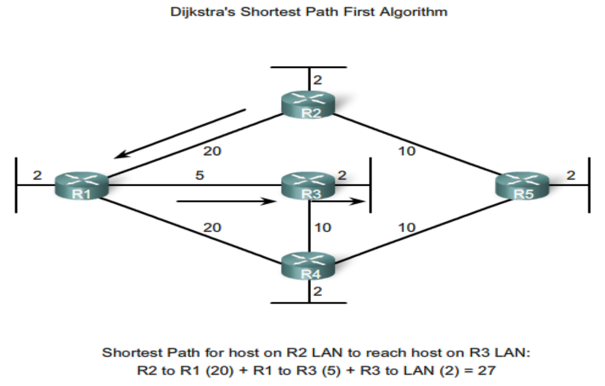

Fig. 2: DIJSTRA'S SHORTEST PATH ALGORITHM

IV OSPF ALGORITHM

Open Shortest Path First (OSPF) is a link-state routing protocol that was developed as a replacement for the distance vector routing protocol RIP. RIP was an acceptable routing protocol in the early days of networking and the Internet, but its reliance on hop count as the only measure for choosing the best route quickly became unacceptable in larger networks that needed a more robust routing solution. OSPF is a classless routing protocol that uses the concept of areas for scalability. RFC 2328 defines the OSPF metric as an arbitrary value called cost. The Cisco IOS uses bandwidth as the OSPF cost metric. OSPF's major advantages over RIP are its fast convergence and its scalability to much larger network implementations.

Each OSPF router maintains a link-state database containing the LSAs received from all other routers. Once a router has received all of LSAs and built its local link-state database, OSPF uses Dijkstra's shortest path first (SPF) algorithm to create an SPF tree. The SPF tree is then used to populate the IP routing table with the best paths to each network.

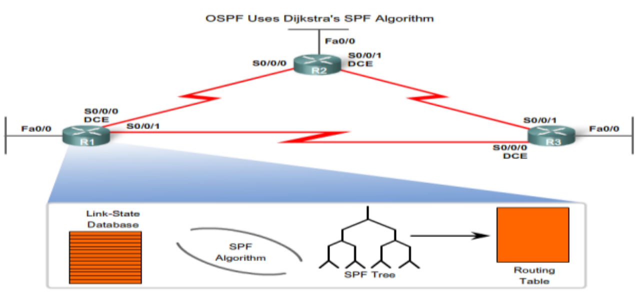

Fig. 3 HOW THE DIJKSTRA'S ALGORITHM UPDATES THE ROUTING TABLE.

Table II: INTERFACE AND ROUTE COST

Interface Type	10^8/ bps = Cost
Fast Ethernet and faster	10^8/ 100,000,000 bps = 1
Ethernet	10^8/ 10,000,000 bps = 10
E1	10^8/ 2,048,000 bps = 48
T1	10^8/ 1,544,000 bps = 64
128 kbps	10^8/ 128,000 bps = 781
64 kbps	10^8/ 64,000 bps = 1562
56 kbps	10^8/ 56,000 bps = 1785

At each router, the cost for an interface is calculated as 10 to the 8th power divided by bandwidth in bps. This is known as the reference bandwidth. Dividing 10 to the 8th power by the interface bandwidth is done so that interfaces with the higher bandwidth values will have a lower calculated cost.

Route Cost (RC) = RB / IB

Where RB = Reference Bandwidth (100Mbps)

IB = Interface Bandwidth

The interface type and Route Cost profile is shown in TableII.

V. ADVANTAGES OF OSPF OVER RIP

Hop Count: RIP uses hop count as metric for determining the best path to a network destination which is further limited to 15hops while OSPF can accommodate more than 224 hops and uses route cost as metrics.

Builds a Topological Map: OSPF create a topological map, or SPF tree of the network topology. RIP do not have a topological map of the network.

Fast Convergence: When receiving a Link-state Packet (LSP), OSPF immediately flood the LSP out all interfaces except for the interface from which the LSP was received, unlike RIP.

Event-driven Updates: After the initial flooding of LSPs, OSPF only send out an LSP when there is a change in the topology. Unlike RIP, OSPF do not send periodic updates.

Hierarchical Design: Link-state routing protocols such as OSPF and IS-IS using the concept of areas, help in the isolation of faults.\

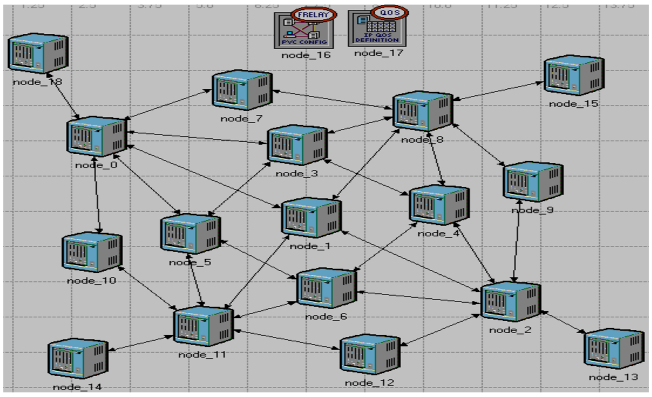

Fig. 4: TOPOLOGY OF SAMPLE NETWORK ON OPNET GUI

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The scenarios 1a, 2a and 3a correspond to the simulations under the adaptive routing strategy (OSPF) while the scenarios 1c, 2c and 3c correspond to the simulations under the conventional routing strategy (RIP) submitted to the packet mean sizes defined in Tables 3, 4 and 5 respectively.

Table III: PACKET MEAN SIZES – SMALL TRAFFIC CONDITION (1A, 1C)

Source Router	Packet Mean Size(bytes)	Destination Router
node_0	250	node_13
node_11	200	node_15

Table IV: Packet Mean Sizes –Medium Traffic Condition (2a, 2c)

Source Router	Packet Mean Size (bytes)	Destination Router
node_0	250	node_13
node_11	250	node_15

Table V: PACKET MEAN SIZES – LARGE TRAFFIC CONDITION (3A, 3C)

Source Router	Packet Mean Size(bytes)	Destination Router
node_0	300	node_13
node_11	280	node_15

Figures 5, 6 and 7 shows the results for the six scenarios above described. In terms of network throughput (Figure 5), we can evaluate the network traffic distribution through the network. Routing strategies that better distribute traffic through the network offer higher network throughput. More specifically for the scenarios above described, Figure 5 shows better network throughput achieved by using the adaptive strategy; that is, Scenarios 1a, 2a and 3a (the adaptive routing) present better throughput than scenarios 1c, 2c and 3c (the conventional routing) respectively. These results can be explained by the fact that the adaptive routing strategy is able to select best routes that change (or oscillate) occasioning in better link utilizations and therefore, better average throughput.

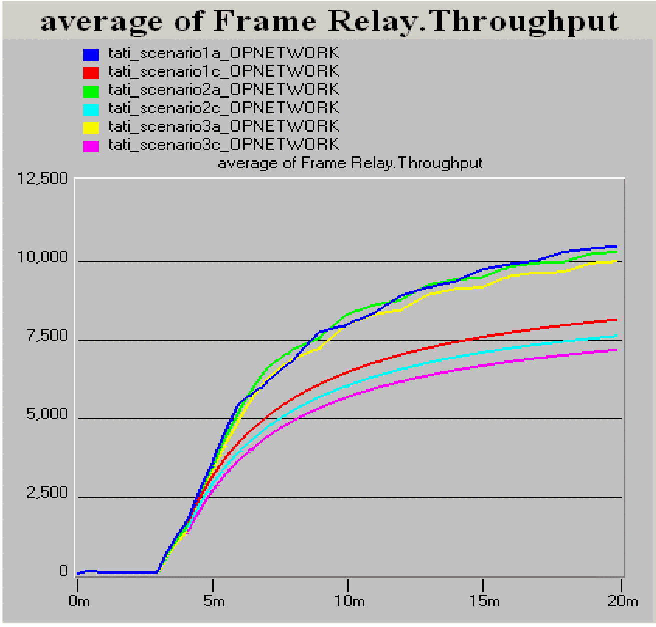

FIG 5: NETWORK THROUGHPUT (PACKET/SEC) IN FUNCTION OF TIME

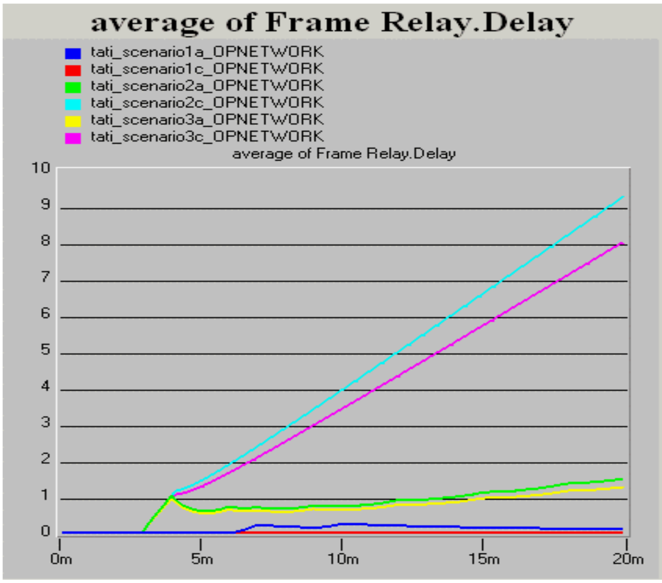

Fig 6: NETWORK DELAY (SEC) IN FUNCTION OF TIME

In particularly, we found that the adaptive routing strategy in scenarios 2a and 3a presented smaller transfer delays than scenarios 2c and 3c respectively. On the other hand, for the scenario 1a the adaptive routing strategy causes larger transfer delay than scenario 1c. These results can be explained by the fact that choosing the best routes according to the link conditions take advantage of forwarding packets through less loaded paths and therefore suffer less transmission delay measurements (like scenarios 2a and 3a).

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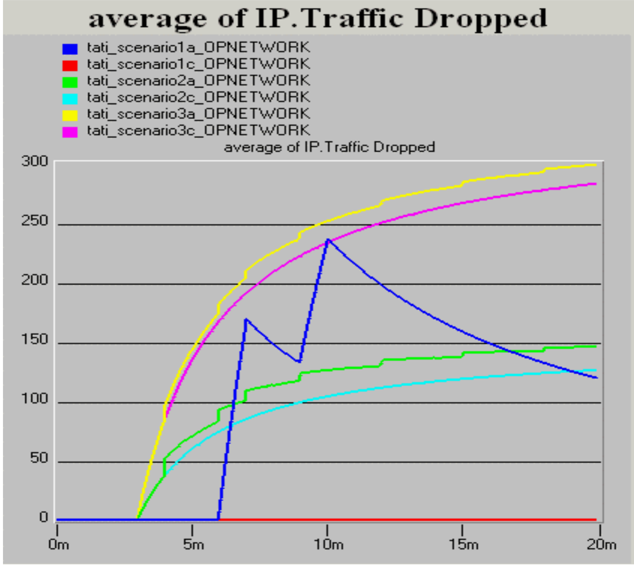

Fig 7: NETWORK TRAFFIC DROPPED (PACKETS/SEC) IN FUNCTION OF TIME.

Analyzing the results of scenarios 2a, 2c, 3a and 3c, we can observe that the traffic drop rates didn't present so much difference when comparing the adaptive and the conventional routing approaches. Most importantly, scenarios 2a and 3a presented good increase in network throughput and decrease in network delay when compared with scenarios 2c and 3c respectively.

6.0 CONCLUSION AND RECOMMENDATION

This research has shown that OSPF can be used to optimize the performance metrics (like throughput, delay and IP traffic dropped) of a data network due to its use of Djisktra Algorithm to find the smallest route cost (shortest path) to a destination network. The analysis from the OPNET graphs showed that enhancement of a data network to about 50-150% is possible if OSPF is used to configure a network instead of RIP. Considering the growth rate of internet users and also the importance of the networking to co-operate firms and organizations of international reputation, we recommend the use of the OSPF in Large data networks to ensure that the network meets specifications of greater throughput, shorter delay, lower convergence time, wider coverage and scalability due to the fact that it is an open-standard protocol that uses a shortest path first algorithm.

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Dr. Mrs. Christiana Chikodili Okezie
PhD in Computer Engineering
Data Communication
Senior lecturer
Nnamdi Azikiwe University, Awka
Associate Professor/ Reader
Professional Member IEEE

Engr. Ikenna Felix Uzoh
B.Eng , Telecommunication Engineering
Nnamdi Azikiwe University, Awka
Project Manager C2g Consulting Limited Lagos.
CCNA.

Engr. Okechukwu John Onubogu
B.Eng, Telecommunication Engineering (First-Class Honours)
Nnamdi Azikiwe University, Awka
Assistant Lecturer.
IEEE NAU SB Chair (2010)
Award of Outstanding leadership from IEEE (2010)
CCNA, OCA, OCP, MCP.

Dr. Austin Azubogu
PhD in Wireless Communication.
Senior lecturer
Nnamdi Azikiwe University, Awka
Professional Member IEEE
Sub- Dean of Faculty of Engineering

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