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## THEME

### Simulation And Comparison Between OSPF & RIP Routing Protocols

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# *Dedications*





*I dedicate my work to my dear parents who have always been there for me through all my schooling years since 1st grade.*

*To my whole family especially my two brothers Chamsou and Amine and my best friend Makhlouf Grien.*

*To my supervisor who supported me throughout this project Mrs. Belalta Ramla.*

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## Abstract

In a network topology various protocols are used for forwarding the packets. A routing table is maintained by routers for successful delivery of the packets from the source node to the correct destined node. The extent of information stored by a router about the network depends on the algorithm it follows. Most of the popular routing algorithms used are RIP, OSPF. in our project, we are evaluating the performance of RIP, OSPF for the parameters: convergence, throughput, queuing delay, utilization through simulation which has been attempted using OPNET as simulating tool. We are trying to find out which protocol suits the best for the network.

**key words:** RIP, OSPF, OPNET, Simulation, Protocol.

## Résumé

Dans une topologie de réseau, divers protocoles sont utilisés pour transmettre les paquets. Une table de routage est maintenue par les routeurs pour une livraison réussie des paquets du nœud source au nœud destinataire correct. L'étendue des informations stockées par un routeur sur le réseau dépend de l'algorithme qu'il suit. La plupart des algorithmes de routage populaires utilisés sont RIP, OSPF. Dans notre projet, nous évaluons la performance de RIP, OSPF pour les paramètres : convergence, débit, délai de mise en file d'attente, utilisation par la simulation qui a été tentée en utilisant OPNET comme outil de simulation. Nous essayons de découvrir quel protocole convient le mieux au réseau.

**Mots clés :** RIP, OSPF, OPNET, Simulation, Protocole.

## المخلص

في طوبولوجيا الشبكة، تُستخدم بروتوكولات مختلفة لإعادة توجيه الحزم. تحتفظ أجهزة التوجيه بجدول التوجيه من أجل التسليم الناجح للحزم من الجهة المصدر إلى الجهة الموجهة الصحيحة. يعتمد مدى المعلومات المخزنة بواسطة جهاز التوجيه حول الشبكة على RIP و OSPF. في مشروعنا، نقوم بتقييم أداء OSPF و RIP الخوارزمية التي يتبعها. معظم خوارزميات التوجيه الشائعة المستخدمة هي كأداة محاكاة. من OPNET للمعاملات: التقارب، والإنتاجية، وتأخير الانتظار، والاستخدام من خلال المحاكاة التي تمت تجربتها باستخدام أجل هذا نحاول معرفة البروتوكول الذي يناسب الشبكة.

الكلمات المفتاحية: البروتوكول، المحاكاة.



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## Abbreviation list:

**RIP:** Routing Information Protocol.

**OSPF:** Open Shortest Path First.

**EIGRP:** Enhanced Interior Gateway Routing Protocol.

**Integrated IS-IS:** Integrated Intermediate System to Intermediate System.

**PAN:** personal area network.

**WAN:** wide area network.

**LAN:** local area network.

**MAN:** Metropolitan Area Network.

**SAN:** Storage Area Network.

**BGP:** Border Gateway Protocol.

**IGP:** Internal Gateway Protocol.

**LSA:** Link-State Advertisements.

**LSDB:** Link-State Database.

**ASBR:** Autonomous System Border Router.

**BDR:** backup designated router.

**DR:** designated router .

**ABR :** Area Border Router.

**ASBR :** Autonomous System Border Router .

**UDP :** the User Datagram Protocol .

**GWINFO :** Gateway Information Protocol .

**XNS :** Xerox Network Systems .

**RTMP :** Routing Table Maintenance Protocol .

VLSM : variable length subnet masks.

CIDR :Classless Inter-Domain Routing.

**ADSL :Asymmetric Digital Subscriber Line.**

Vdsl” Very High Digital Subscriber Line .

http: hyper text transfer protocol.

Tcp: transmission control protocol .



# *general introduction*



# General Introduction

Nowadays the world has known a massive evolution in the communication field between people all over the world and we all can see the huge difference between the past and the present and all of this is possible because the invention of networks.

A network consists of two or more machines that are linked in order to share resources (such as printers and CDs), exchange files, or allow electronic communications. The machines on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams.

There are a lot of rules and methods that allows the machines to interconnect and recognize each other and transfer messages in the network ,and we call these rules and methods “protocols”.

There are two types of protocols which are:

Interior gateway protocols such as : OSPF,RIP,ISIS, EIGRP

Exterior gateway protocol : EGP

Our research evolve around the simulation and comparison between 2 interior gateway protocols which are OSPF & RIP. the main questions that we are going to answer are :

First we need to know theoretically What is a network then we dive a little bit deeper to understand protocols, after that we need to learn both RIP & OSPF protocols and the uses of each one of them, how each one works and How we can simulate each protocol. so for that we chose this subject because of it's importance especially after it became necessary in a lot of communication fields. And the goal of our research is to simulate the behavior of OSPF & RIP routing Protocols and present a comparative study between them while demonstrating which protocol is suitable for which kind of networks.

Our contribution with this project is to help the readers understand the routing protocols (RIP & OSPF) and the differences between them and be able to choose which protocol suits them best. To be able to achieve the best results for our project we worked with a desktop computer which characterized: intel processor i3 7<sup>th</sup> generation ,8gb ram and PC of intel processor i5 3<sup>rd</sup> generation.

For writing of the rapport, we used Microsoft word office 2016.

And for simulation: OpNet modular 14.5.

We divided our project to 3 chapters to elaborate the many parts of our work. we accomplished this by following the producers outlined in the following chapters:

For the sake of evaluation, the study is divided into chapters. The structure of thesis, chapter by chapter is shown below:

The first chapter we are going to demonstrate the RIP and OSPF routing protocols and give a detailed explanation of them.

In the second chapter we are going to choose the best method to resolve our problem which is the simulation of the two protocols.

In the third chapter we are going to simulate both protocols using the simulation environment: OpNet.

To obtain some results and do an analysis and a comparison between the results to determine which protocol is suitable for which kind of networks.



# CHAPTER 1

Demonstration of networks and  
routing protocols (OSPF & RIP)





# CHAPTER 1: Demonstration of networks and routing protocols (OSPF & RIP)

## 1.1 introduction

In this chapter we will talk all the basics of networks,

Starting with the definition of network then the deferent divisions of networks geographically and functionally.

And not forgetting the mention of deferent categories of networks.

Because our project is about routing protocols, we have to explain what is routing and what is a protocol, then the definition of

both of the routing protocols OSPF & RIP

## 1.2 network

A computer network is a set of equipment linked together to exchange information. By analogy with a net, we call node the end of a connection, which can be an intersection of several connections (a computer, a router, a hub, a switch).

Regardless of the underlying technology, there is usually a matrix view of what a network is. Horizontally, a network is a stratum of three layers: infrastructures, control and command functions, services provided to the user. Vertically, a geographical division is often used: local network, access network and interconnection network. [1]

### 1.2.1 Geographical division

Computer networks are classified according to their scope:

the personal area network (PAN) connects personal electronic devices;  
the local area network (LAN) connects computers or telephones located in the same room or in the same building;

the metropolitan network (MAN) is a city-wide network;

wide area network (WAN) is a large-scale network that connects multiple sites or computers around the world [1]

### 1.2.2 functional division

A network can be classified according to its usage and the services it offers. This division also overlaps with the notion of scale. Thus, for networks using Internet technologies (family of TCP / IP protocols), the nomenclature is as follows:

Intranet: the internal network of an organizational entity

Extranet: the external network of an organizational entity

Internet: the network of interconnected networks on a global scale [1]

### 1.2.3 Computer network categories

There are several ways to categorize a computer network.

Computer networks can be categorized in terms of extent:

- Personal Area Network (PAN): Personal network
- Wireless PAN: Wireless personal network
- Local Area Network (LAN): Local area network
- Wireless LAN: Wireless local area network
- Metropolitan Area Network (MAN): Metropolitan network
- Wide Area Network (WAN): Wide Area Network
- Storage Area Network (SAN): Storage network [1]

Computer networks can also be categorized by functional relationship between components:

- Client server
- Multi-tier architecture
- Peer-to-peer (P2P or peer-to-peer)

They can also be categorized by network topology:

- Star network
- Bus network

- Ring network
- Grid network
- Toroidal or hypercube network
- Tree network [1]

### 1.3.1 Protocol

Communication protocols are used to define in a standardized way the way in which information is exchanged between network devices: these are procedures that control the flow of information between two devices. Specific software that manages these protocols is installed on interconnection equipment such as network switches, routers, telephone switches, GSM antennas, etc. Control functions can be provided by signaling protocols or routing tables. [2]

### 1.3.2 routing

In computer science, the term routing designates the mechanism by which the data of a sending equipment is routed to its destination by examining the information located at level 3 of the OSI model (IP for example), even if neither of the two knows the full path that the data should follow. Having an efficient routing procedure is especially important for decentralized networks.

There are two types of network nodes:

- hosts who can only be the sender or recipient of a message
- routers which transmit messages between at least two networks or subnetworks of the same authority. When such a routing element is used between two networks depending on different authorities (for example between a local network and the Internet), a more advanced element is then used: a gateway. [3]

### 1.3.3 routing table

The routing table is made up of the list of known networks, each of these networks is associated with one or more neighboring routers which will route the packets to this destination.

There are three types of routes in the routing table:

- the routes corresponding to directly connected networks: for these networks, the router can route the packet directly to the final destination using the level 2 protocol (Ethernet for example).
- static routes: hard-configured on the router by the network administrator,
- dynamic routes, learned from a dynamic routing protocol whose role is to disseminate information about the available networks.

A routing table can be reduced to its simplest expression by including only the list of directly connected networks as well as a default route, i.e., all the packets that do not correspond to a known network in the table routing will be directed to a specific router (the default router). The default route can be static or learned dynamically.

Conversely, a router which does not have a default route must know all of the possible destinations. This is the case of routers participating in the Internet backbone, we say that they have a complete routing table (which currently represents more than 240,000 individual networks) or that they belong to the default-free Internet zone. [3]

### **1.3.4 Routing protocols**

Since the maintenance of the routing tables of the routers cannot reasonably be carried out manually beyond a certain size of the network, protocols have been defined allowing routing information to be exchanged between the routers.

Conversely, a router which does not have a default route must know all of the possible destinations. This is the case of routers participating in the Internet backbone, we say that they have a complete routing table (which currently represents more than 240,000 individual networks ) or that they belong to the default-free Internet zone.

#### **1.3.4.1 Internal routing protocols**

IGPs are protocols that operate within an autonomous system.

These internal routing protocols work in different ways:

- called link states, they transmit all the routing information to all participating routers and establish direct neighbor tables, this is the case with OSPF or IS-IS.
- so-called distance vector, which only broadcast their best routes on their interfaces, such as RIP or IGRP or a hybrid of the first two, like EIGRP

Examples of internal routing protocols:

- Routing Information Protocol (RIP)
- Open Shortest Path First (OSPF)
- Enhanced Interior Gateway Routing Protocol (EIGRP)
- Integrated Intermediate System to Intermediate System (Integrated IS-IS)

#### **1.3.4.2 External routing protocols**

These are the protocols that exchange routing information between autonomous systems.

Example of an external routing protocol:

Border Gateway Protocol (BGP) [3]

### **1.3.5 OSPF protocol**

Open Shortest Path First (OSPF) is an internal IP routing protocol of the link-state protocol type.

#### **1.3.5.1 General operation**

In OSPF, each router establishes adjacency relationships with its immediate neighbors by sending hello messages at regular intervals. Each router then communicates the list of networks to which it is directly connected by LSA (Link-State Advertisements) messages propagated step by step to all the routers of the network. The set of LSAs forms the Link-State Database (LSDB), which is identical for all participating routers. Each router then uses Dijkstra's algorithm, Shortest Path First, to determine the shortest route to each of the known networks in the LSDB.

The proper functioning of OSPF therefore requires complete consistency in the SPF calculation, so for example it is not possible to filter routes or to summarize them within an area.

In the event of a change in topology, new LSAs are propagated step by step, and the SPF algorithm is executed again on each router.

OSPF is able to distribute the load over multiple links, as long as the metric is exactly the same for each destination. [4]

#### **1.3.5.2 metric**

OSPF uses a simple numeric metric, based on an additive cost. The default value for a link cost is  $10^8$  / link bandwidth in bit / s. For example, a 10 Mbit / s link will have a cost of 10. To take account of very high-speed connections (1 Gbit / s and more), you can manually set the cost of each link, or you can set a bandwidth of reference greater than the default. [4]

### 1.3.5.3 Adjacency on a broadcast network

An adjacency relationship is required for OSPF routers to share routing information. In an Ethernet network if each router were to establish an adjacency with each other router and exchange link state information the load would be excessive, the number of adjacencies being  $\frac{n(n-1)}{2}$ , or in  $O(n^2)$ . To overcome this problem, we choose a DR (designated router) which will receive all the information on the state of the links and retransmit them to the other routers. As this becomes a critical point of the network, a BDR (backup designated router) is also designated. The adjacency number is therefore in  $O(n)$ . [4]

OSPF only uses multicast to chat with the following two addresses:

224.0.0.5 used by the designated router (DR) to send link state information to all other routers in the segment.

224.0.0.6 used by all routers to send link state information to designated routers (DR and BDR)

### 1.3.5.4 Concept of area

In order to avoid propagating the entire database of links and to limit the negative impact of flapping (rapid alternation in the availability of a physical link), all the routers are segmented into related groups called areas, at the border of which summaries can be made. The area border routers are called Area Border Router (ABR).

There is always a backbone area 'or area 0 to which all areas must be directly connected.

A router that injects routes from another routing protocol or static routes into OSPF is called an Autonomous System Border Router (ASBR), these routes will be marked as external in OSPF. [4]

### 1.3.6 RIP protocol

The **Routing Information Protocol (RIP)** is one of the oldest distance-vector routing protocols which employs the hop count as a routing metric. RIP prevents routing loops by implementing a limit on the number of hops allowed in a path from source to destination. The largest number of hops allowed for RIP is 15, which limits the size of networks that RIP can support.

RIP implements the split horizon, route poisoning, and hold down mechanisms to prevent incorrect routing information from being propagated.

In RIPv1 routers broadcast updates with their routing table every 30 seconds. In the early deployments, routing tables were small enough that the traffic was not significant. As networks grew in size, however, it became evident there could be a massive traffic burst every 30 seconds, even if the routers had been initialized at random times.

In most networking environments, RIP is not the preferred choice of routing protocol, as its time to converge and scalability are poor compared to EIGRP, OSPF, or IS-IS. However, it is easy to configure, because RIP does not require any parameters, unlike other protocols.

RIP uses the User Datagram Protocol (UDP) as its transport protocol, and is assigned the reserved port number 520. [5]

### 1.3.6.1 Development of distance-vector routing

Based on the Bellman–Ford algorithm and the Ford–Fulkerson algorithm, Distance-vector routing protocols started to be implemented from 1969 onwards in data networks such as the ARPANET and CYCLADES. The predecessor of RIP was the Gateway Information Protocol (GWINFO) which was developed by Xerox in the mid-1970s to route its experimental network. As part of the Xerox Network Systems (XNS) protocol suite GWINFO transformed into the XNS Routing Information Protocol. This XNS RIP in turn became the basis for early routing protocols, such as Novell's IPX RIP, AppleTalk's Routing Table Maintenance Protocol (RTMP), and the IP RIP. The 1982 Berkley Software Distribution of the UNIX operating system implemented RIP in the *routed* daemon. The 4.2BSD release proved popular and became the basis for subsequent UNIX versions, which implemented RIP in the *routed* or *gated* daemon. Ultimately RIP had been extensively deployed before the standard written by Charles Hedrick was passed as RIPv1 in 1988. [5]

### 1.3.6.2 Versions

There are three standardized versions of the Routing Information Protocol: *RIPv1* and *RIPv2* for IPv4, and *RIPng* for IPv6.



### 1.3.6.2.1 RIP version 1

The original specification of RIP, defined in RFC 1058, was published in 1988. When starting up, and every 30 seconds thereafter, a router with RIPv1 implementation broadcasts to 255.255.255.255 a request message through every RIPv1 enabled interface. Neighboring routers receiving the request message respond with a RIPv1 segment, containing their routing table. The requesting router updates its own routing table, with the reachable IP network address, hop count and next hop, that is the router interface IP address from which the RIPv1 response was sent. As the requesting router receives updates from different neighboring routers it will only update the reachable networks in its routing table, if it receives information about a reachable network, it has not yet in its routing table or information that a network it has in its routing table is reachable with a lower hop count. Therefore, a RIPv1 router will in most cases only have one entry for a reachable network, the one with the lowest hop count. If a router receives information from two different neighboring router that the same network is reachable with the same hop count but via two different routes, the network will be entered into the routing table two times with different next hop routers. The RIPv1 enabled router will then perform what is known as equal-cost load balancing for IP packets.

RIPv1 enabled routers not only request the routing tables of other routers every 30 seconds, they also listen to incoming requests from neighboring routers and send their own routing table in turn. RIPv1 routing tables are therefore updated every 25 to 35 seconds. The RIPv1 protocol adds a small random time variable to the update time, to avoid routing tables synchronizing across a LAN. It was thought, as a result of random initialization, the routing updates would spread out in time, but this was not true in practice. Sally Floyd and Van Jacobson showed in 1994 that, without slight randomization of the update timer, the timers synchronized over time.

RIPv1 can be configured into silent mode, so that a router requests and processes neighboring routing tables, and keeps its routing table and hop count for reachable networks up to date, but does not needlessly send its own routing table into the network. Silent mode is commonly implemented to hosts.

RIPv1 uses classful routing. The periodic routing updates do not carry subnet information, lacking support for variable length subnet masks (VLSM). This limitation makes it impossible to have different-sized subnets inside of the same network class. In other words, all subnets in a network class must have the same size. There is also no support for router authentication, making RIP vulnerable to various attacks. [5]

### 1.3.6.2.2 RIP version 2

Due to the deficiencies of the original RIP specification, RIP version 2 (RIPv2) was developed in 1993, published as RFC 1723 in 1994, and declared Internet Standard 56 in 1998. It included the ability to carry subnet information, thus supporting Classless Inter-Domain Routing (CIDR). To maintain backward compatibility, the hop count limit of 15 remained. RIPv2 has facilities to fully interoperate with the earlier specification if all *Must Be Zero* protocol fields in the RIPv1 messages are properly specified. In addition, a *compatibility switch* feature allows fine-grained interoperability adjustments.

In an effort to avoid unnecessary load on hosts that do not participate in routing, RIPv2 *multicasts* the entire routing table to all adjacent routers at the address 224.0.0.9, as opposed to RIPv1 which uses broadcast. Unicast addressing is still allowed for special applications. (MD5) authentication for RIP was introduced in 1997.

Route tags were also added in RIP version 2. This functionality allows a distinction between routes learned from the RIP protocol and routes learned from other protocols.

### 1.3.6.2.3 RIPv2

RIPv2 (RIP next generation), defined in RFC 2080, is an extension of RIPv2 for support of IPv6, the next generation Internet Protocol. The main differences between RIPv2 and RIPv2 are:

- Support of IPv6 networking.
- While RIPv2 supports RIPv1 updates authentication, RIPv2 does not. IPv6 routers were, at the time, supposed to use IPsec for authentication.
- RIPv2 encodes the next-hop into each route entry, RIPv2 requires specific encoding of the next hop for a set of route entries.

RIPv2 sends updates on UDP port 521 using the multicast group `ff02::9`. [5]

### 1.3.6.3 RIP messages between routers

RIP messages use the User Datagram Protocol on port 520 and all RIP messages exchanged between routers are encapsulated in a UDP segment.

### 1.3.6.4 Timers

The routing information protocol uses the following timers as part of its operation:

#### Update Timer

Controls the interval between two gratuitous Response Messages. By default the value is 30 seconds. The response message is broadcast to all its RIP enabled interface.

#### Invalid Timer

The invalid timer specifies how long a routing entry can be in the routing table without being updated. This is also called as expiration Timer. By default, the value is 180 seconds. After the timer expires the hop count of the routing entry will be set to 16, marking the destination as unreachable.

#### Flush Timer

The flush timer controls the time between the route is invalidated or marked as unreachable and removal of entry from the routing table. By default the value is 240 seconds. This is 60 seconds longer than Invalid timer. So for 60 seconds the router will be advertising about this unreachable route to all its neighbors. This timer must be set to a higher value than the *invalid timer*.

#### Hold-down Timer

The hold-down timer is started per route entry, when the hop count is changing from lower value to higher value. This allows the route to get stabilized. During this time no update can be done to that

routing entry. This is not part of the RFC 1058. This is Cisco's implementation. The default value of this timer is 180 seconds. [5]

### 1.3.6.5 Limitations

- The hop count cannot exceed 15, or routes will be dropped.
- Variable Length Subnet Masks are not supported by RIP version 1 (which is obsolete).
- RIP has slow convergence and count to infinity problems. [5]

### 1.3.6.6 Implementations

- Cisco IOS, software used in Cisco routers (supports version 1, version 2 and RIPng)
- Cisco NX-OS software used in Cisco Nexus data center switches (supports RIPv2 only<sup>[15]</sup>)
- Junos software used in Juniper routers, switches, and firewalls (supports RIPv1 and RIPv2)
- Routing and Remote Access, a Windows Server feature, contains RIP support
- Quagga, a free open source software routing suite based on GNU Zebra
- BIRD, a free open source software routing suite
- Zeroshell, a free open source software routing suite
- A RIP implementation first introduced in 4.2BSD, routed, survives in several of its descendants, including FreeBSD<sup>[16]</sup> and NetBSD.<sup>[17]</sup>
- OpenBSD introduced a new implementation, rripd, in version 4.1 and retired routed in version 4.4.
- Netgear routers commonly offer a choice of two implementations of RIPv2;<sup>[19]</sup> these are labelled RIP\_2M and RIP\_2B. RIP\_2M is the standard RIPv2 implementation using multicasting - which requires all routers on the network to support RIPv2 and multicasting, whereas RIP\_2B sends RIPv2 packets using subnet broadcasting - making it more compatible with routers that do not support multicasting, including RIPv1 routers.
- Huawei HG633 ADSL/VDSL routers support passive and active routing with RIP v1 & v2 on the LAN and WAN side. [5]

## 1.4 conclusion

Sharing routing tables between routers is the main idea to let data transferring in network, to achieve this goal, we needed to use routing protocols.

The RIP & OSPF routing protocols are two of the most known protocols in networking, we know these protocols theoretically, so we need to learn more about them by simulating their behavior in different type of networks.



# CHAPTER 2

## *Research Methodology*



# Chapter 2: Research Methodology

## 2.1 introduction

The various key points involved in the research work are discussed in this section. Various methods are compared with each other and the justification of chosen method is given in this section. Three methods are available for performance evaluation of protocols in a network which include mathematical or analytical analysis, direct measurement and computer simulation. After taking all the constraints and parameters under consideration mathematical and computer simulation are suitable for our research. There are various advantages of mathematical analysis like cost, time and the ability of providing best predictive results. The direct measurement as a choice of method could be expensive but an alternative to simulation. In direct measurement the analysis is to be done on an operational network which can lead to disruptive situation and an operation network could be very expensive in terms of configuration complexity. The advantage of direct measurement is fairly accurate results. There are various simulators like NS-2, NS-3, Qualnet, Telnet, Omnet++, OPNET etc. In order to do simulation work, the simulator was to be chosen suitably. The suitable choice after keeping many considerations was OPNET simulator introduced by the OPNET Technologies inc.

## 2.2 OPNET Modeler 14.5

OPNET Modeler 14.5 is an impressive high-level event-based network level simulation tool. It can be used as a research tool or as a network design or analysis tool. You can work with various different types of programs for communication network creation, protocol compiling and application programming.

OPNET Modeler 14.5 has got a wide variety of tools for designing, analyzing as well as creating models of various different types of networks and their performance. This application accelerates the R&D process for analyzing and designing communication networks, protocols, devices and applications. It incorporates a wide range of protocols and technologies. It also includes a development environment to enable modeling of all network types and technologies. Users can easily analyze simulated networks to compare the impact of various different technology designs on end-to-end behavior. All in all, OPNET Modeler 14.5 is a very imposing and handy high-level event-based network level simulation tool which can be used as a research tool or as a network design and analysis tool. [6]

### 2.2.1 Features of OPNET Modeler 14.5

- An impressive high-level event-based network level simulation tool.
- Can be used as a research tool or as a network design or analysis tool.

- Can work with various different types of programs for communication network creation, protocol compiling and application programming.
- Got a wide variety of tools for designing, analyzing as well as creating models of various different types of networks and their performance.
- Accelerates the R&D process for analyzing and designing communication networks, protocols, devices and applications. [6]

### 2.3 Network Model and Implementation Tool

This section discusses various components used in building the networks and their functions. The following are the components suggested in network models running on OPNET.

**Application Config:** it is a node which is used to set the application through the network and also used for specifications like Ace Tier Information, application specifications e.g web browsing (heavy http), voice encoder scheme.

**Profile Config:** it is a node which is used to define applications and manage them. These user profiles created on this node are used on different nodes in network to generate application layer traffic. Profile Config is also used to define the traffic patterns followed by the applications.

**CS\_7000\_6s\_a\_e6\_fe2\_fr4\_slr4\_tr4:** this model represents a specific configuration of an IP based router gateway model. Its specifications are Ethernet\_wkstn: it is a node model which represents a workstation with clientserver applications running over TCP/IP and UDP/IP. The workstation supports one underlying Ethernet connection of 10mbps, 100mbps and 1000mbps.

**PPP\_DS3:** It is a full duplex link which connect the two IP nodes 100BaseT: 100BaseT full duplex links are used to represent the Ethernet connections. This links can connect any combination of the nodes such as Station, Hub, Bridge, Switch and LAN nodes.

**Failure Recovery:** this controller node is used to model the failure-recover scenarios. For providing the time and status of the objects in the model it provides the attributes.



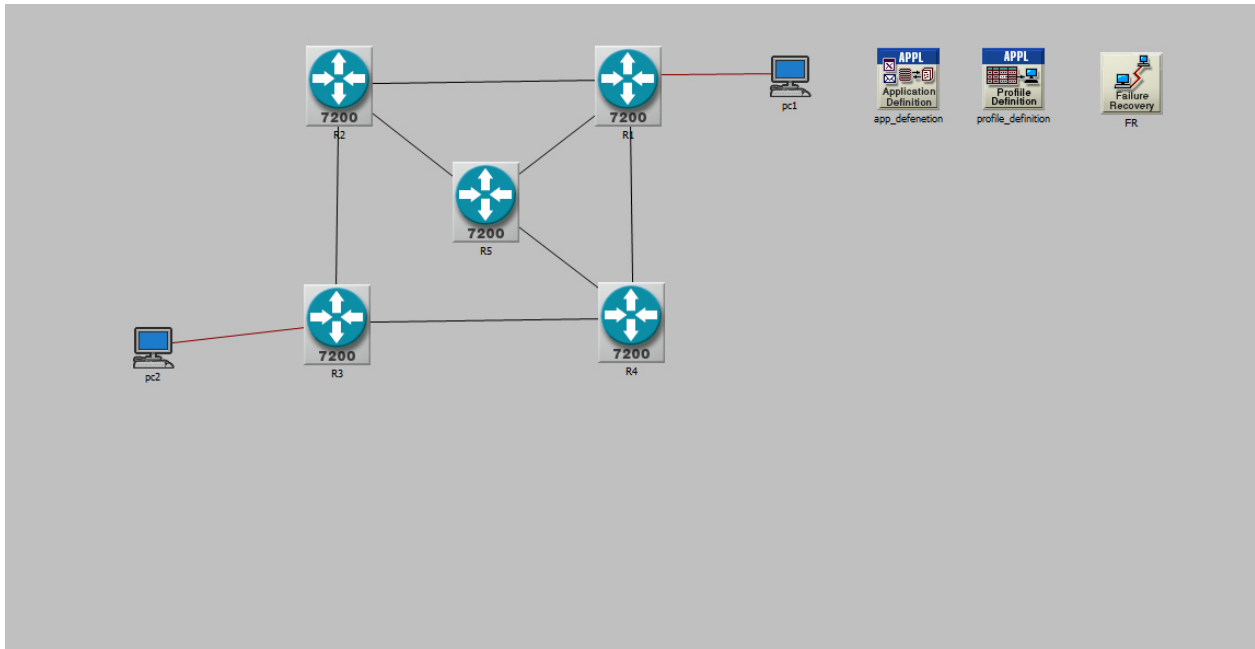
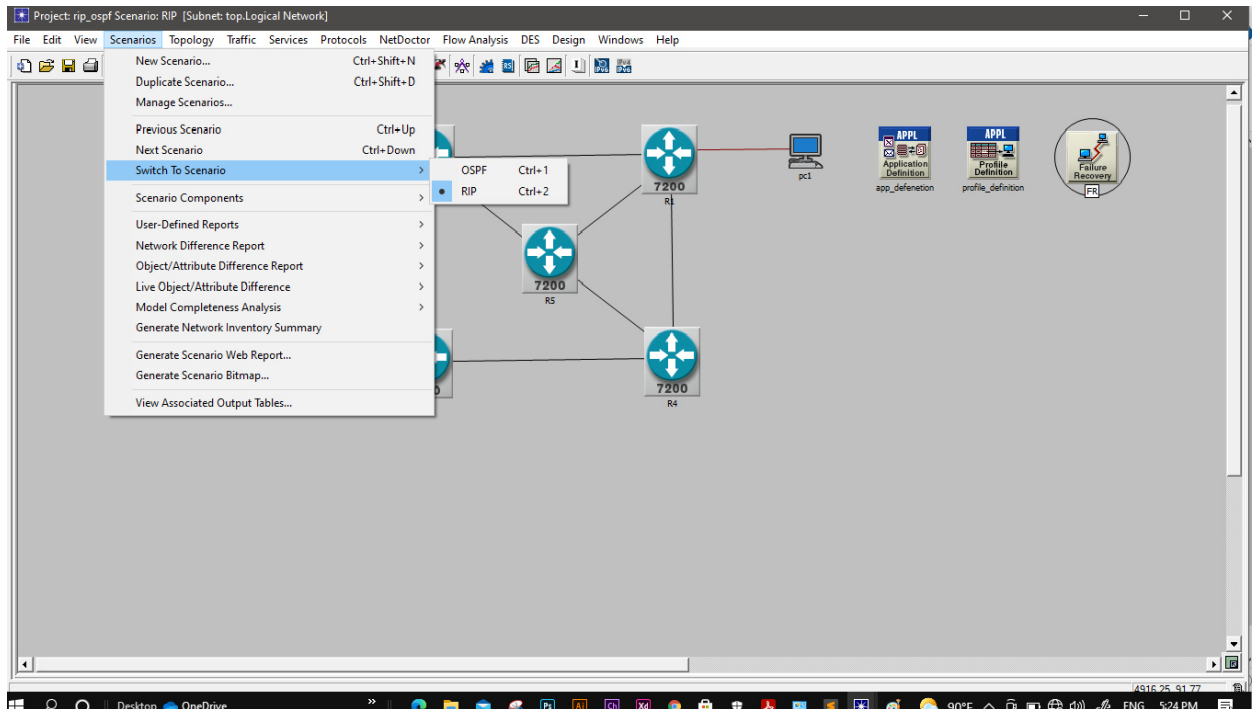


Figure 1. network topology

## 2.4 Simulation Scenarios

OPNET Modeler 14.5 has been used for the simulation analysis. This section describes the architecture of the network and how the two protocols are implemented on this network model. Two network scenarios have been designed as follows, which will be elaborately demonstrated in the upcoming sections. Scenario 1 is modeled as a Baseline scenario for OSPF protocol. Scenario 2 is modeled as a Baseline scenario for RIP protocol.

In order to study the results from other scenarios (1,2), a baseline network model comprising of five Cisco 7000 routers connected with each other via ppp\_ds3 links and two Ethernet work stations. The two PCs in our network are the video conferencing workstations. The four different network models configured for the analysis of protocols namely RIP, OSPF.



2Figure 2. scenarios

## 2.5 Simulation Setup

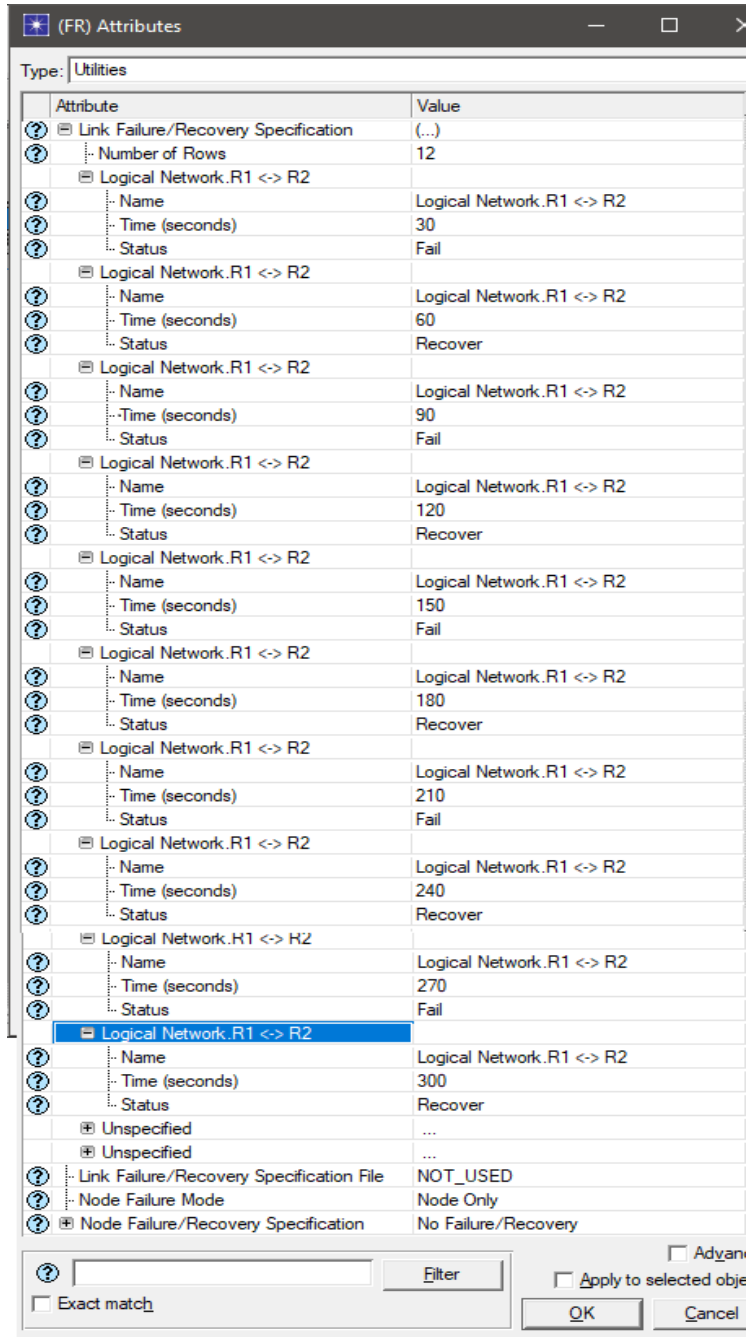
### 2.5.1 Simulation Setup for Failure/Recovery Configuration

the setup for failure/Recovery Configuration. The simulation is set to be 15 minutes, and the times for failure and recovery are shown in figure 6

Attribute	Value
Failure/Recovery Modeling	Enabled
Link Failure/Recovery Specification	(...)
Number of Rows	10
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	240
Status	Fail
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	420
Status	Recover
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	520
Status	Fail
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	580
Status	Recover
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	610
Status	Fail
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	620
Status	Recover
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	625
Status	Fail
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	626
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	726
Status	Fail
Logical Network.R1 <-> R2	
Name	Logical Network.R1 <-> R2
Time (seconds)	826
Status	Recover
Link Failure/Recovery Specification File	NOT_USED
Node Failure Mode	Node Only
Node Failure/Recovery Specification	No Failure/Recovery

3 Figure 3. fail/recovery attributes case 1

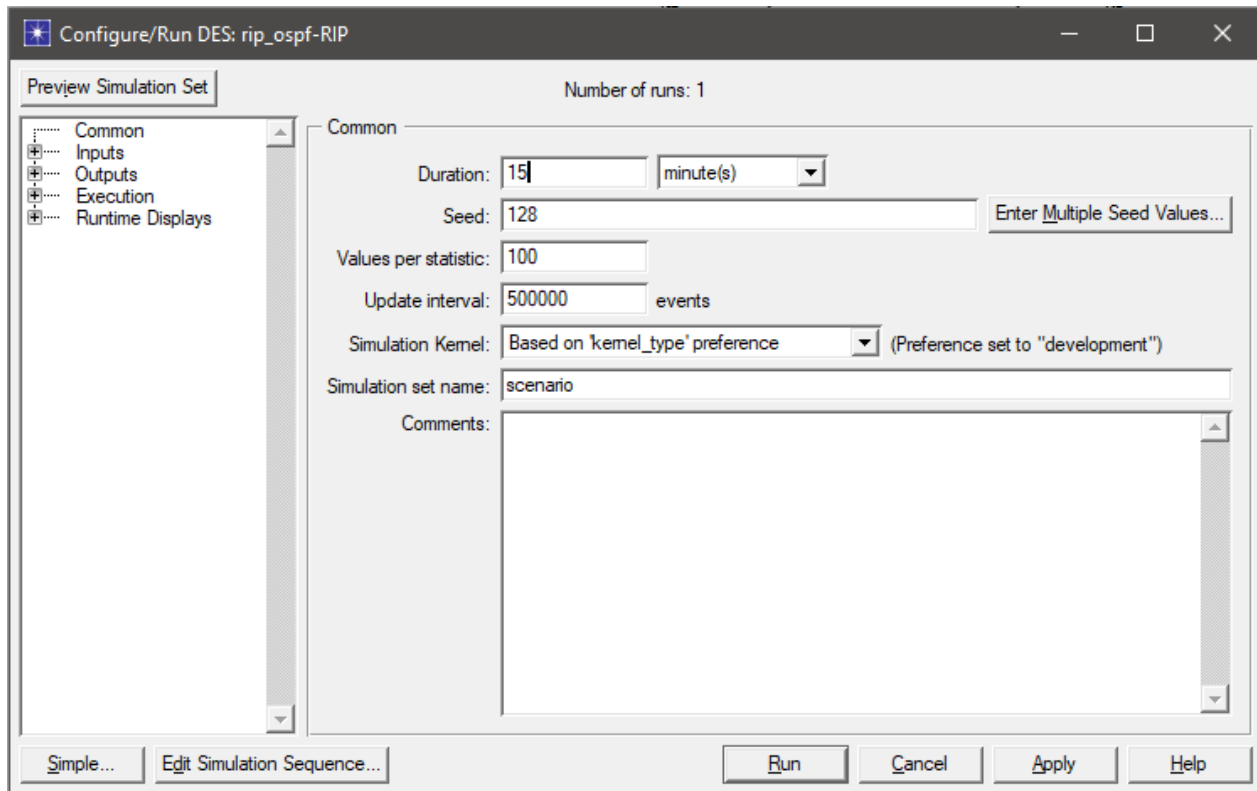
the setup for failure/Recovery Configuration. The simulation is set to be 6 minutes, and the times for failure and recovery are shown in figure 7



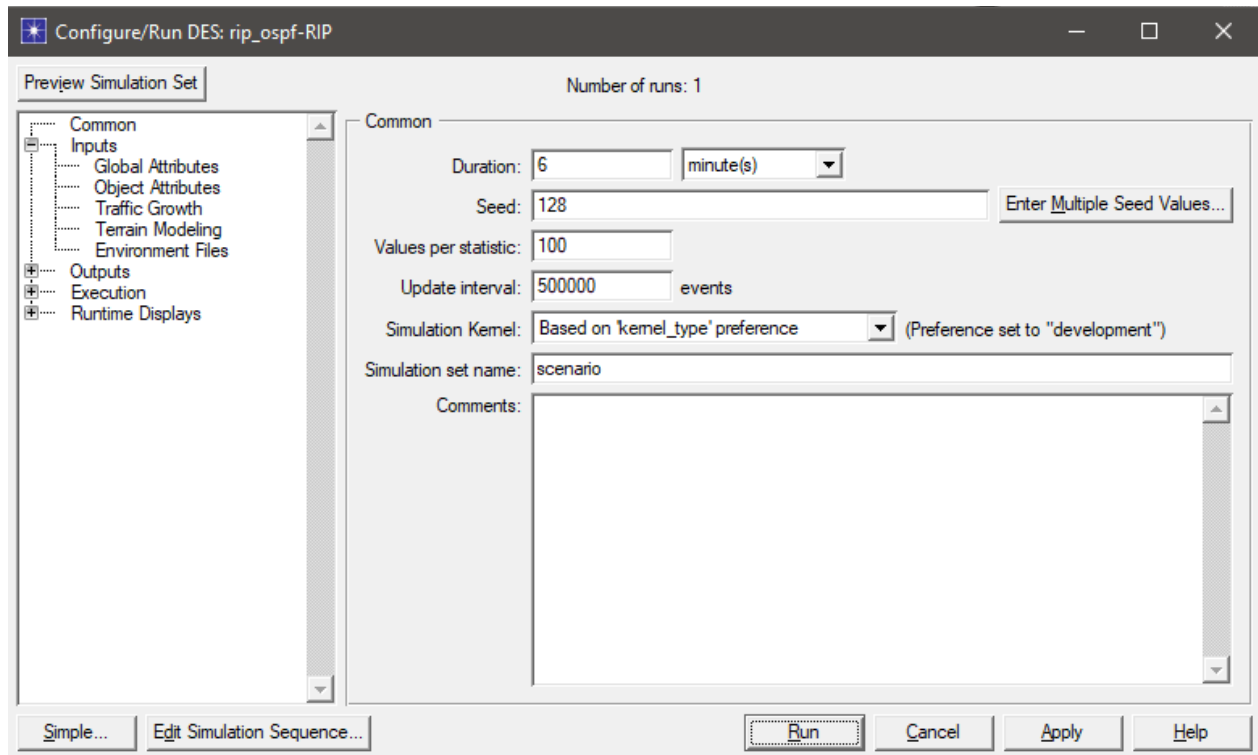
4 Figure 4. fail/recovery attributes case 2

### 2.5.2 Simulation Setup for Simulation Global Attributes

IP dynamic Routing Protocol is set to be RIP, OSPF respectively. And it exports routing table once the simulation is completed. Simulation efficiency for two protocols are disabled and stop time has been set to longer than the simulation time, it guarantees the protocols continue throughput until the end of the simulation.



5Figure 5. DES setup in case 1



6Figure 6. DES setup in case 2

## 2.6 conclusion

we choose the simulation as a method to release our objective, and to get the best results we chose OPNET modeler, Simulation is the best method to approve the behavior of OSPF & RIP letting us understand them practically, and giving us real results leading to getting full comparison between the two protocols.



# CHAPTER 3

## *results analysis*





### Chapter 3: results analysis

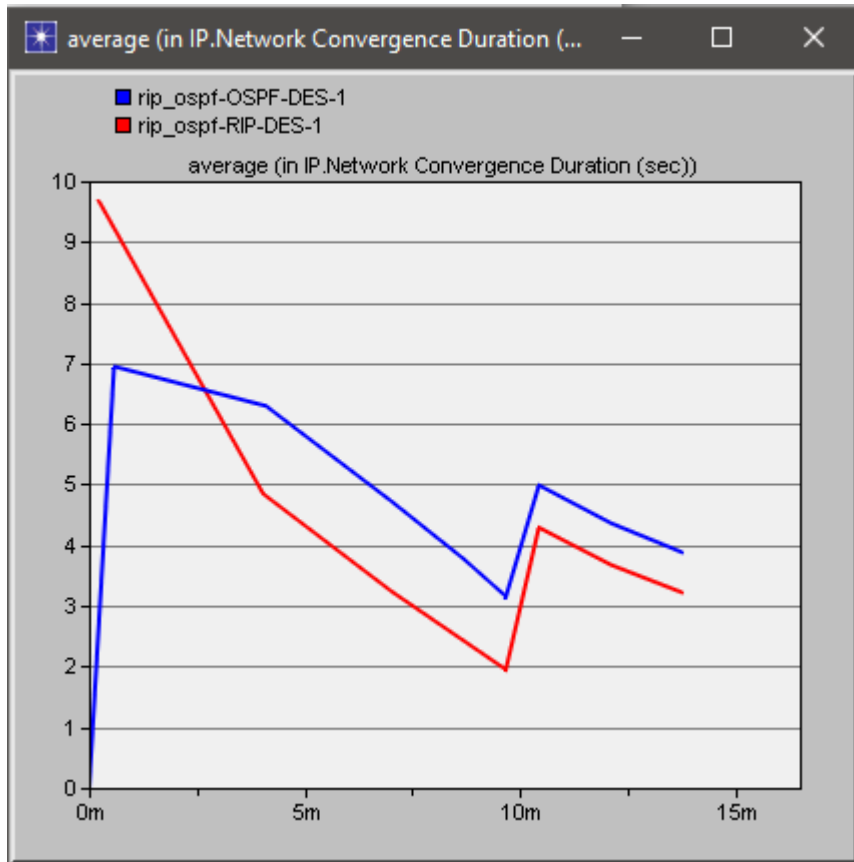
#### 3.1 introduction

The Simulation give practical results which help us to analyze the behavior of the two protocols (OSPF & RIP) in various situations.

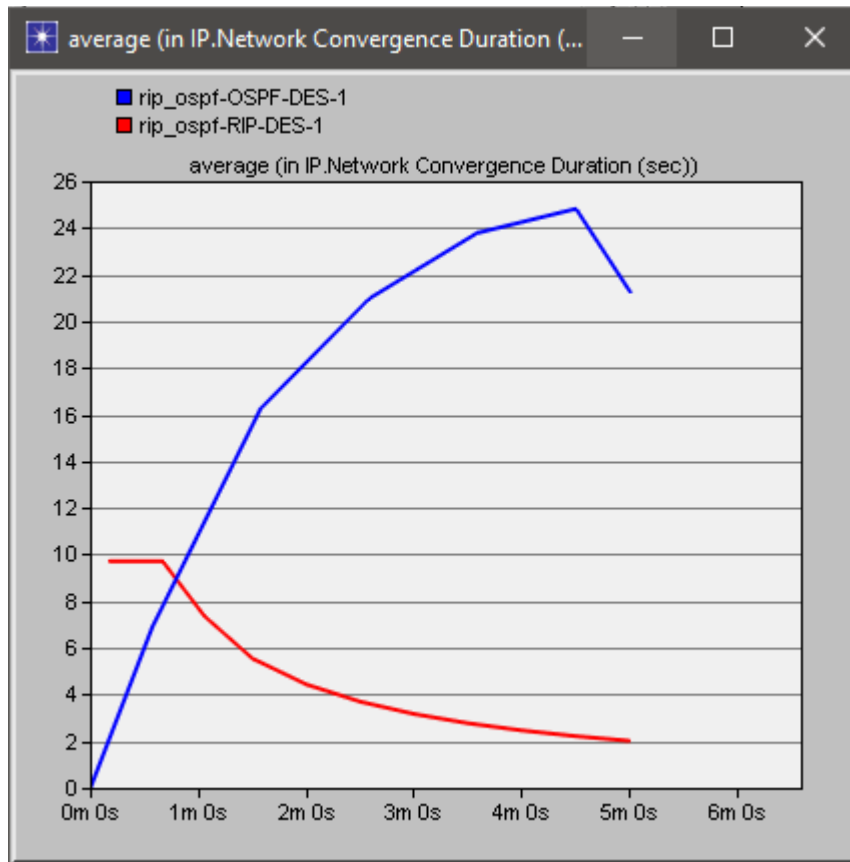
in this chapter we will analyze the results of the previous chapter that are about convergence, throughput, link utilization and queuing delay, and eventually we will demonstrate which one is suitable for which kind of networks.

#### 3.2 results

We have analyzed the performance of protocols namely RIP, OSPF respectively over a network with different situations and on simulating the network for 15 minutes in case of situation 1 and for 6 minutes in case of situation 2, we have analyzed the performance in terms of convergence of RIP and OSPF respectively. When the network was tested under these two situations, the result for convergence in case of RIP, OSPF respectively is shown in Fig7 and 8.

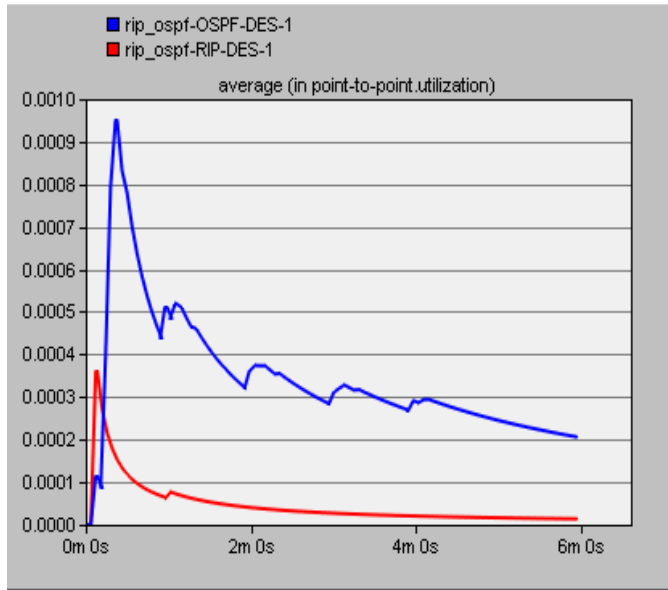


7Figure 7. Convergence in case of situation 1.

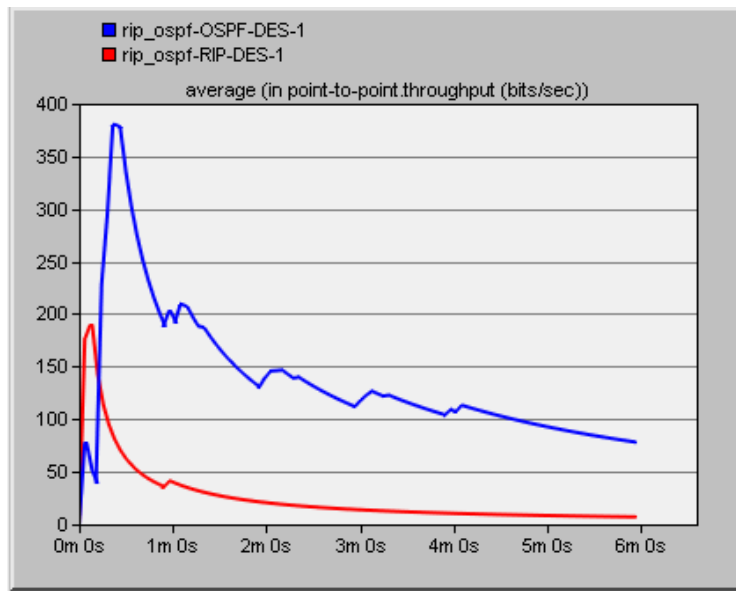


8Figure 8. Convergence in case of situation 2.

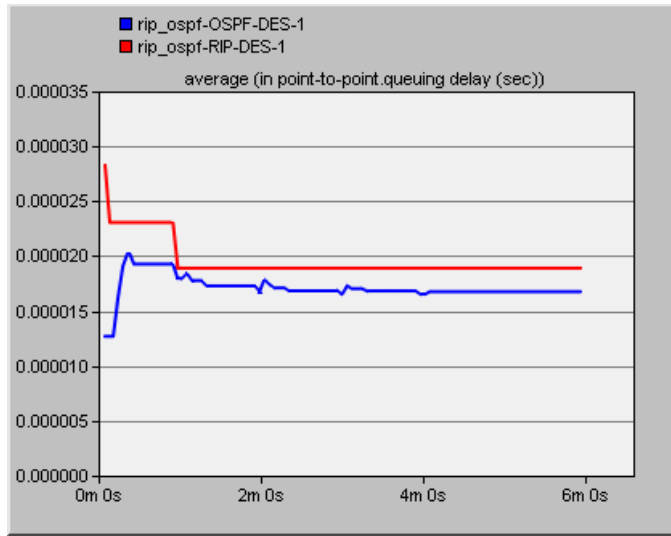
Distance vector protocol RIP is notoriously slow to converge, or adapt to network topology changes. After a change to the network, and before all the routers have converged, there is the probability of routing errors and lost data. Linkstate routing protocol, Open Shortest Path First (OSPF) is faster in convergence. Since OSPF advertises less frequently, it uses less bandwidth than RIP but converges much slower. Convergence with OSPF is faster Since each OSPF router has a copy of the topology database and routing table for its particular area, any route changes are detected faster than with distance vector protocols and alternate routes are determined. And on analyzing the parameters of performance like throughput, utilization and delay, as per results plotted OSPF has the maximum throughput followed by RIP shown in Fig.10; for the case of queuing delay OSPF has the least delay followed by rip, shown in Fig.11. and for the case of link utilization OSPF has the maximum link utilization followed by RIP as shown in Fig. 9.



9Figure 9. Point to point Utilization.



10Figure 10. Point to point throughput (bits/sec).



11Figure 11 . Point to point queuing delay (sec).

### 3.3 conclusion

On comparing the results of the simulation of protocols namely RIP, OSPF for convergence, throughput, link utilization and queuing delay, we can consider the performance of OSPF to be the best. Thus, we may conclude that when we consider the above scenarios, OSPF performs better but when the other criterion like least cost of transmission and lower router overhead are taken into consideration OSPF can be an alternate choice.



# General conclusion



## General conclusion

The goal of our research was to simulate the behavior of OSPF & RIP routing Protocols and present a comparative study between them while demonstrating which protocol is suitable for which kind of networks. Our contribution with this project was to help the readers understand the routing protocols (RIP & OSPF) and the differences between them and be able to choose which protocol suits them best. After the simulation of both RIP and OSPF and analyzing the results we concluded that OSPF is a better routing protocol than RIP in basically all the comparisons which were convergence, throughput, link utilization and queuing delay. So for us we can't say a protocol is not efficient but each one has its own features, and if we were to choose between these 2 routing protocols RIP and OSPF in a big scale network which contains more than 16 machines, we will definitively choose OSPF protocol, and for a small network which contains less than 16 machines RIP could be a better choice and it will cost less and be faster.

Noting that transferring data in networks does not depend only on these two protocols RIP & OSPF, and as we notice that OSPF is better than RIP but we notice that RIP is better in certain tasks like "in the initialization time and the cost", adding that OSPF is not the best routing protocol compared to other protocols such as the EIGRP which combines the two protocols "RIP & OSPF", so we want in the future to do other comparisons and simulations between these three protocols "RIP, OSPF and EIGRP" inshallah.

## Webography

[1] <https://fr.wikipedia.org/wiki/Network>

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17:45

[2] <https://fr.wikipedia.org/wiki/Protocol>

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[3] <https://en.wikipedia.org/wiki/Routing>

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[4] [https://fr.wikipedia.org/wiki/Open\\_Shortest\\_Path\\_First](https://fr.wikipedia.org/wiki/Open_Shortest_Path_First)

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[5] [https://fr.wikipedia.org/wiki/Routing\\_Information\\_Protocol](https://fr.wikipedia.org/wiki/Routing_Information_Protocol)

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[6] <https://opnetprojects.com/opnet-network-simulator>

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<https://www.youtube.com>

throughout the project