IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

PERFORMANCE ANALYSIS OF BORDER GATEWAY PROTOCOL (BGP) IN MULTI-AUTONOMOUS SYSTEM NETWORK WITH OPNET SIMULATOR: A CASE STUDY

[1]Dr.D.Devi Aruna,[2]Mr.V.Yuvaraj,[3]Mr.P.Dinesh Kumar,

[1]Associate Professor,[2]Assistant Professor & Research Scholar,[3]Assistant Professor(SG)
Department of Computer Applications,
[1]Dr.N.G.P. Arts and Science College,Coimbatore,Tamilnadu,India
[2]Dr.N.G.P. Arts and Science College,Coimbatore,Tamilnadu,India&Rathnavel Subramaniam (RVS) College of Arts and Science,Sulur,Coimbatore, India
[3]Dr.N.G.P. Arts and Science College,Coimbatore,Tamilnadu,India

*Abstract:*Enterprise network is a network group or single network with one administrative control in an enterprise. An autonomous system (AS) is a network collection or single with administrative domain in an internet. An autonomous system contain a global different number called Autonomous system number (ASN). ASN is a unique number assigned to each AS which provides identifier for the system. Within an autonomous system, nodes communicate with one other using protocol called Interior gateway protocol(IGP).An autonomous system share and communicate route with another autonomous system using Border Gateway Protocol(BGP).BGP is an inter autonomous system routing protocol nodes in one autonomous system connect with other autonomous system.BGP is a path based protocol for routing to find efficient route from source to destination and it take routing decision based on the routing procedure and policies. From the autonomous system one router acts as border router communication information of route and create routing table using TCP connection. The border router advertises path and information of routing to its neighbor autonomous system. This research paper contains autonomous system and detail review of BGP protocol and analyzes the two different scenario contains two autonomous system with BGP protocol enabled configuration. The simulation study is conducted using OPNET simulator. Two different case studies have been created with varying parameter. For the first scenario, six BGP enabled router and links are used with various BGP parameter and specifically local preference attribute used for traffic tuning to find the network operation. For the second scenario, Eight BGP enabled router and links are used with various BGP configuration to find the result. It is strongly recommended that BGP protocol provides optimal route to a destination in an enterprise network.

Index Terms **- Border Gateway Protocol, Multi-Autonomous System Network, OPNET Simulator**

I. INTRODUCTION

An autonomous system (AS) is a networks collection or a single network which is restricted by a one single administrative control which could be a very large enterprise organization. An autonomous system is allocated a distinctive number called Autonomous System Number(ASN).The number is used for sharing the routing information and to identify the AS .Nodes communicate with each other within the autonomous system using the protocol called interior gateway protocol (Dipra Mitra, S. S. 2017).The autonomous system exchange the information of route with other autonomous system using the protocol called Border Gateway Protocol (BGP).BGP creates routing decision depends on the policies of network so it is called path vector based routing protocol. One router act as a border router for the whole autonomous system. The border router shares routing information and form routing table using the connection of Transmission control protocol (TCP) (Emami, M. 2012).The border router communicates and advertises routing path and information to its neighbor system. This paper reviews the different types of autonomous system and Border gateway protocol route information management .This paper contains BGP attributes and local preference attribute is used for simulation. For the simulation study, two different scenarios are created using OPNET simulator for finding the result. The experiment is conducted for Border Gateway protocol with two different paths with different configuration is used to evaluate and find the routing path to the destination (Joy Na Wang, J. V. 2019).

II. Review of Literature

2.1 Autonomous System

An autonomous system (AS) is a large network or single network which is organized by one organization. An AS is a various set of network owned by a very large enterprise. An AS has different types of small networks with procedure of route and routing logic of information (Uhlig, B. Q. 2005).

2.2. Different types of Autonomous Systems

Autonomous Systems are classified into three different types.

- A multi-homed AS retains internet connection when any one AS fails. More AS is communicate with each other.
- A stub AS have private connections only one other AS is connected.
- A transit AS communicate with two or more AS allows passing data.

2.3 Border Gateway Protocol (BGP)

The Border Gateway Protocol (BGP) it is an autonomous system routing protocol designed for large network.BGP maintains IP network prefixes for network reach ability between autonomous systems.BGP creates routing information and makes route decisions based on network procedures and policies. The main task of BGP autonomous system is to shares and communicate routing and information with other BGP system.The main aim of BGP is to establish routes among each autonomous system and each IP address packets transmit from one network to another. Using the BGP, the enterprise users creates connection with

the corporate network .enterprise user set up BGP router and reroute traffic information between ISPs for sharing the load (Kashif Ishaq, A. A. 2019).

2.4 BGP Functionality and Route Information Management

The Border Gateway Protocol is used to share and exchange information of route among BGP nodes. So every router can find routes to each network on an IP network. In a broader part, BGP peers have provides three functionality. The first peer function is acquisition and authentication. The second function is for sending network reach ability information. The third function is for verification and connection between peers and networks.

2.5 BGP functions of management of route information

The route information management has four main tasks:

- Storage of Route: Every BGP stores routing information in a database. It uses routing information in a database get from other devices.
- Update of Route: BGP device gets an update from peers that how to use information. This special method is applied to find and how to get information from peers for proper update of routes.
- Selection of Route: Every BGP get information from the route database for efficient routes to every network.
- Advertisement of Route: Every BGP speaker ask peers about networks and techniques by using BGP update messages (Khanafer, M. 2007).

2.6 BGP Attributes

BGP Attributes are linked with routes from BGP to find efficient route to the destination node.

The BGP attributes are used in selection of route are

- **Local Preference Attribute:** The local preference attribute is used for selection of exit point for particular routes from the autonomous system. The local preference attribute are used to broadcast all local AS.
- **AS path Attribute:** In an autonomous system, route advertisement passes over the network; Autonomous system number is added to a list of AS numbers when advertisement of route has travelled.
- **Next-Hop Attribute:** The next hop attribute is used for communication among the peers in the networks.
- **Weight Attribute:** The highest weight of the route will be given more preference. The router knows same destination with more than one route in the network (M.T. Moubarak, A. D.-H. 2015).

2.7 Path Selection of BGP

BGP chooses only one path as the efficient path. In the IP routing table BGP store selected route path and disseminates the path to its neighbors and it gets more advertisement for the same route (Syed Yasir Jalali, S. W. 2014).

BGP utilize the given condition for destination path selection.

- Largest weight of the path is preferred.
- It drops the update if next hop of the path is inaccessible.
- The largest local preference of the path is preferred if the weights are same.
- The shortest AS_Path is preferred, If route is not originated.
- Lowest IP address of the path is preferred, specified by BGP router ID.
- The path with IGP neighbor is preferred if the path is same.

III. Simulation Design

The Simulator Optimized Network Engineering Tools (OPNET) is used for simulation study to create the two autonomous systems with Border Gateway Protocol (BGP) and to analyze with various configurations. For the experimental analysis, Two different scenarios is created with various configuration like configuration of routing protocol, configuration of neighbor information, reachability of network layer configuration and redistribution of route configuration.

3.1 Design of Autonomous System with Border Gateway Protocol (BGP) Scenario 1:

For the first scenario with various simulation configurations, three routers are used to form one autonomous system and other three routers to form another autonomous system implemented for an enterprise. Six ethernet4_slip8_gtwy routers and two 100BaseT_LAN objects are used. Border Gateway Protocol (BGP) is configured in each router. Routers are connected using Bidirectional PPP_DS3 links .Router 1 connected with LAN_West and Router 6 connected with LAN_East using Bidirectional100BaseT link. Assigning autonomous system number 1000 to the router 1, router 2 and router 3.Assigning autonomous system number 2000 to the router 4, router 5 and router 6. Table 3.1 shows the simulation configuration of scenario 1.Figure 3.1 shows the autonomous system with BGP enabled scenario 1 (Refer Appendix).

Table 3.1: Simulation Configurations of scenario 1

S.No	Attribute	Values
1.	Network Scale	Enterprise
2.	Network Size	1000km × 1000km
3.	No of Router	6
4.	Router Model	ethernet4_slip8_gtwy
5.	Link Model	PPP-DS3
6.	IP address	Automatically assigned
7.	IP Routing Parameters	set Autonomous System Number 1000 and 2000
8.	BGP Parameter hierarchy	enabled
9.	Neighbours Parameter hierarchy	Row attribute enabled
10.	Route map configuration hierarchy	Set attribute Local preference

3.2 Design of Autonomous System with BGP Scenario 2:

For the second scenario with various simulation configurations, four routers are used to form one autonomous system and other four routers to form another autonomous system implemented for an enterprise. Eight ethernet4_slip8_gtwy routers and two 100BaseT_LAN objects are used. Border Gateway Protocol (BGP) is configured in each router. Routers are connected using Bidirectional PPP_DS3 links .Router 1 connected with LAN_West and Router 8 connected with LAN_East using Bidirectional100BaseT link. Assigning autonomous system number 3000 to the router 1, router 2, router 3 and router 4.Assigning autonomous system number 4000 to the router 5, router 6, router 7 and router 8.Table 3.2 shows scenario 2 simualation configuration. Figure 3.2 shows the autonomous system with BGP enabled scenario 2. Figure 3.3 shows BGP protocol with local reference attribute. (Refer Appendix)

Table 3.2: Simulation Configurations of scenario 2

S.No	Attribute	Values
1.	Network Scale	Enterprise
2.	Network Size	2000km × 2000km
3.	No of Router	8
4.	Router Model	ethernet4_slip8_gtwy
5.	Link Model	PPP-DS3
6.	IP address	Automatically assigned
7.	IP Routing Parameters	set the Autonomous System Number 3000 and 4000
8.	BGP Parameter hierarchy	enabled
9.	Neighbour Parameter hierarchy	Row attribute enabled
10.	Route map configuration hierarchy	Set attribute Local preference

IV. Simulation Configuration

Simulation configurations of autonomous system are

Configure routing protocols

BGP is an Inter-AS routing used for routing between router 1, 3, and 4 and BGP for router 1, 3 and 4 are enabled. Select the router for BGP configuration .with configures status.

Configure neighbor information of BGP

Configure BGP in each router it does not establish neighbors automatically. Router share information of route with neighbors has to be manually configured. For neighbor configuration, BGP parameter is configured and select IP address.

Network Layer Reach ability Information

To configure NLDI manually for router enabled BGP.BGP parameter is used to configure neighbor information.

Route redistribution

Tosend routing information from the router in one autonomous system to router in other autonomous system .Create border router to redistribute routing information between BGP protocols. To configure route distribution using BGP parameter.

V. Conclusion

This research paper reviews the different types of autonomous system and Border gateway protocol route information management . For the simulation study, two different scenarios have been created using OPNET simulator with particular concentration on two different route for two different autonomous system

with different configuration settings for finding the result. The experiment is conducted for Border Gateway protocol with two different paths with different configuration is used to evaluate and find the routing path to the destination. The performance analysis of border gateway protocol in two different scenario with various configuration such as neighbor information of BGP,network layer reachability information, route redistribution have been analyzed. During the experimental analysis of topology the BGP protocol is not failed to multi link or single link failure because BGP protocol is a efficient protocol to traffic reroute across links.BGP protocol is used in enterprise user establish reliable communication across enterprise network. Enterprise users create BGP routers reroute information traffic between two or more ISPs for sharing of load.BRP protocol uses aggregation for distribution NLRI between routers. This protocol uses path attribute for policies of route between the routers.

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Appendix

Figure 3.1: Simulation experiment of Autonomous system with BGP Protocol scenario 1

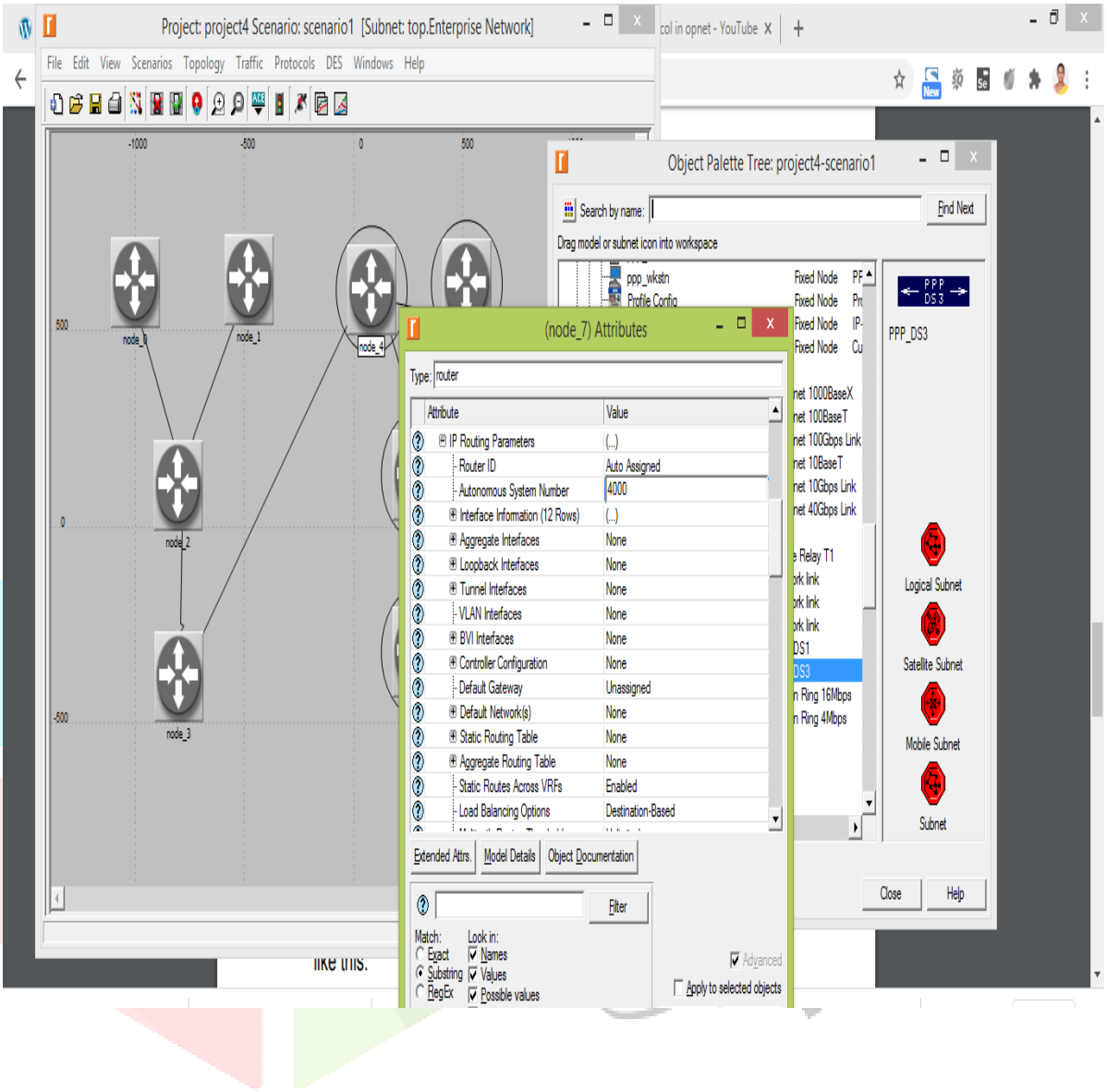

Figure 3.2: Simulation experiment of Autonomous system with BGP Protocol scenario 2

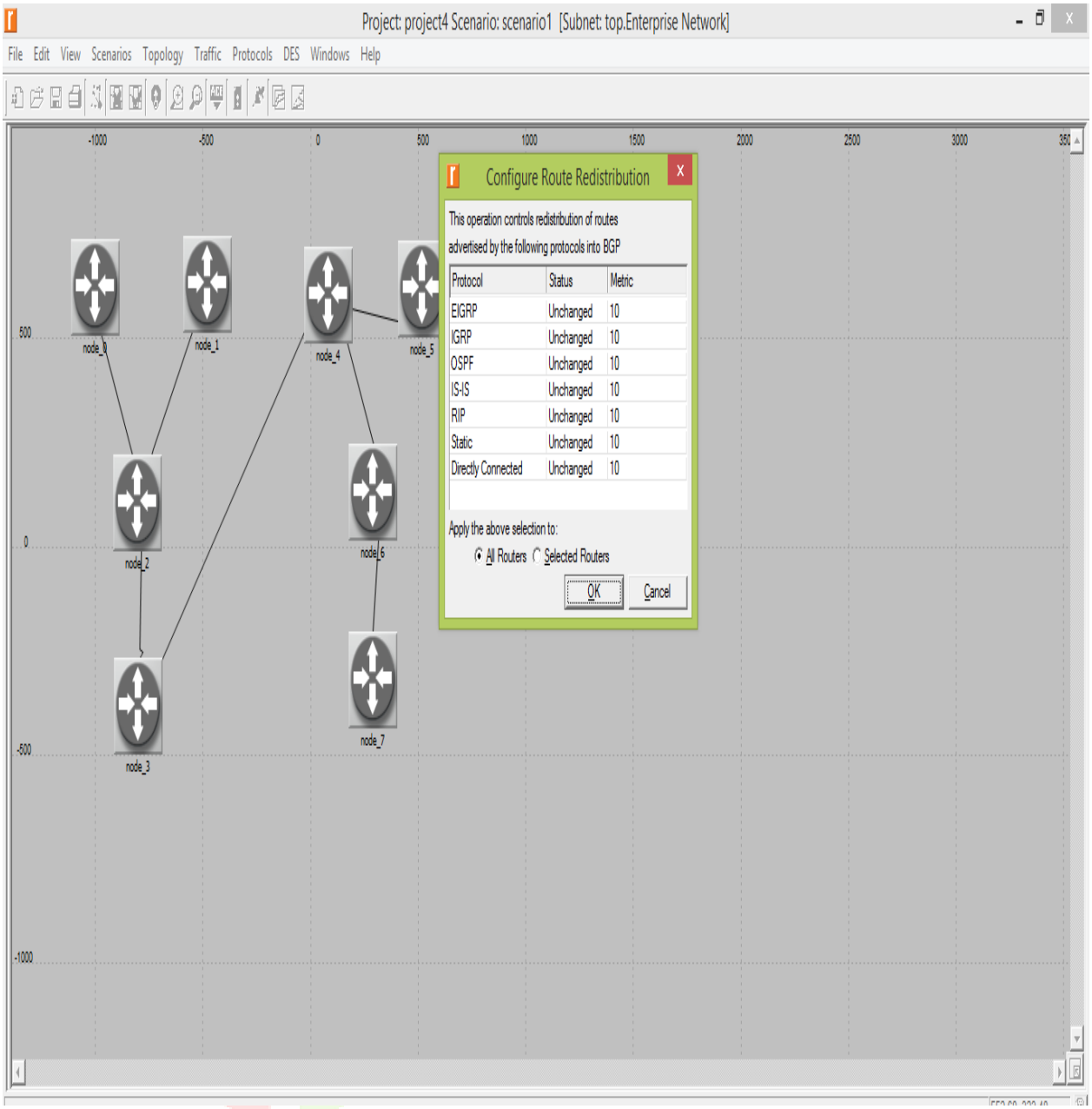

Figure 3.3: Simulation experiment of Autonomous system with BGP Protocol with route distribution configuration.