University of Dhaka

Department of Computer Science and Engineering

CSE 3111 – Computer Networking Laboratory Credits: 1.5 Batch: 26/3rd Year 1st Sem 2022

Instructors: Prof. Dr. Md. Abdur Razzaque (AR), Mr. Md. Mahmudur Rahman (MRR), Mr. Md. Ashraful Islam (MAI) and Mr. Md. Fahim Arefin (FA)

Lab Experiment # 9

Name of the Experiment: Implementation of BGP Protocol

Objectives: In this lab, you will be exploring the BGP Protocol as the objective is to understand the routing mechanism, path selection, and message exchange between autonomous systems (ASes) in the Internet. It will also help you understand its basic concepts, such as autonomous systems, path vector routing, BGP messages (OPEN, UPDATE, KEEPALIVE, and NOTIFICATION), and BGP attributes (AS-PATH, NEXT-HOP, LOCAL_PREF, MED, etc.).

Theoretical Concepts:

Autonomous Systems (ASes):
An Autonomous System (AS) is a group of IP networks and routers under the control of a single organization that presents a common routing policy to the Internet. Each AS is identified by a unique number called the Autonomous System Number (ASN).

Path Vector Routing:
BGP is a path vector routing protocol, which means that it maintains a list of ASes that a route traverses instead of computing the shortest path like distance-vector or link-state routing protocols. This approach helps prevent routing loops and allows for more flexible policy-based routing.

BGP Message Types:
There are four types of BGP messages that routers exchange with each other:

a. OPEN: This message is used to establish a BGP session between two routers.
b. UPDATE: This message is used to exchange routing information between routers. It contains the new routing information (prefixes and attributes) and withdrawn routes.
c. KEEPALIVE: This message is used to maintain the BGP session and to confirm that the connection is still alive.
d. NOTIFICATION: This message is used to signal an error or to close a BGP session due to an error.

BGP Attributes:
BGP attributes are pieces of information that describe specific characteristics of a route. They are carried in UPDATE messages and are used in the BGP path selection process. Some common BGP attributes are:

a. AS-PATH: This attribute represents the sequence of ASes that a route traverses.
b. NEXT-HOP: This attribute specifies the IP address of the next router in the path to reach the destination.
c. LOCAL_PREF: This attribute is used to indicate the preference of a particular route within an AS. Higher is better
d. MULTI_EXIT_DISC (MED): This attribute is used to convey the preference of an entry point into an AS.

Procedure:

1. **Design the network topology :** Design a simple network topology with multiple autonomous systems. Each AS will have **at least one router** (preferably more), and these routers will exchange BGP messages to establish connections and exchange routing information. Example topology:

AS1 – AS2 – AS3
| |
AS4 – AS5 – AS6

2. **Implement the main components :** Implement the main components required for the BGP simulation, including:
    a. Router: A class representing a router in the network.
    b. Autonomous System: A class representing an autonomous system in the network.
    c. BGPMessage: A class representing a generic BGP message, with subclasses for OPEN, UPDATE, KEEPALIVE, and NOTIFICATION messages.
3. **Implement BGP session establishment :** Implement the BGP session establishment mechanism using the OPEN and KEEPALIVE messages. Routers will exchange these messages to establish a connection with their neighbors.
4. **Implement BGP UPDATE message exchange :** Implement the exchange of UPDATE messages between routers to share routing information, such as the AS-PATH, NEXT-HOP, LOCAL_PREF, and MED attributes. Routers will update their routing tables based on the received information.
    a. If you learned the route from eBGP, advertise to all peers (eBGP and iBGP)
    b. If you learned the route from iBGP, advertise to eBGP peers only
    c. Add to AS_PATH when the route leaves your AS
5. **Implement BGP path selection :** Implement the BGP path selection algorithm, which selects the best path based on the BGP attributes. The algorithm should follow the standard BGP decision process.
    a. LOCAL_PREF [Higher is better, 100 default]
    b. Prefer shortest AS_PATH attribute
    c. Prefer lowest MED (only between same AS)
    d. You can assume LOCAL_PREF and MED attribute values as you prefer

The input will be “Host A of Router X” and “Host B of Router Y” and output will show the path which will be taken for the packet delivery.

BGP route decision example 1:

10.33.12.0/24 Origin IGP AS_PATH (65534 65212 65419) Next hop 10.1.4.4	10.33.12.0/24 Origin IGP AS_PATH (65412 65112) Next hop 10.1.4.4

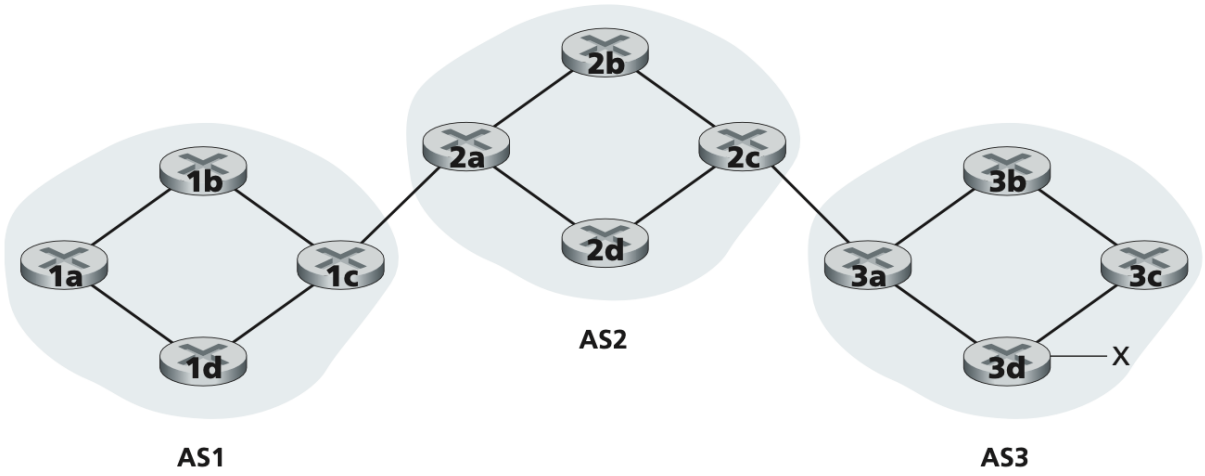
The one on the right is better because it has shorter AS_PATH, as LOCAL_PREF = 100 by default for both

BGP route decision example 2:

10.33.12.0/24 Origin IGP AS_PATH (65534 65212 65419) Next hop 10.1.4.4 LOCAL_PREF 110	10.33.12.0/24 Origin IGP AS_PATH (65412 65112) Next hop 10.1.4.4

The one on the left is better because it has higher LOCAL_PREF

Example Network for simulation :



Points to note :

- policy based routing needs to be implemented,
- For testing, source and destination hosts will be chosen from different ASes and from the same,
- The minimum Autonomous Systems to consider is 4.
- iBGP needs to be implemented at least in a few ASes.

Deliverables:

1. Source code for the application
2. A report that documents the design and implementation of the algorithms.

References :

1. **https://www.cloudflare.com/learning/security/glossary/what-is-bgp/**
2. **https://www.techtarget.com/searchnetworking/feature/BGP-tutorial-The-routing-protocol-that-makes-the-Internet-work**
3. **Theory : https://www.youtube.com/watch?v=ZucnfoJiFr8**