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Design and Simulate an OSPF Routing Protocol based Network on Packet Tracer

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ABSTRACT: The aim of this paper is to explore a practical laboratory implementations in terms of structure, content and overall educational effectiveness. Furthermore, it aims to present the development of a virtual laboratory model that addresses some of the limitations of current solutions through the provision of a high-realistic virtualization environment. With the recent advancements of Internet protocol-based services, packet traffic is becoming the mainstream of data traffic. This has increased the demand for transport network technology that can efficiently accommodate the large capacity of both packet-based and circuit-based traffic while achieving high reliability, sufficient operation, and maintenance capability comparable to that of traditional transport networks such as synchronous digital hierarchy or optical transport networks. In this paper also, a survey has been carried out on previous work dealt with MPLS, SDN networks and different routing algorithms and simulation tools. Also research and design of an OSPF routing based network on packet tracer has been implemented in which trace out packets flow through the routers.

KEYWORDS: Multipath Label Switching (MPLS), Software Defined Network (SDN), Open System Interconnection (OSI), Routing Protocols, Cisco Packet Tracer.

I. INTRODUCTION

Routing plays a vital role in transfer of data from source to destination which takes place in the network layer of OSI model. It is divided into two parts i.e. static routing and dynamic routing. In static routing, the transmission of data takes place manually whereas; in dynamic routing it is done using various routing protocols. In this paper, a literature survey has been done which compared different routing protocols and their advantages, such as Routing Information Protocol (RIP), Enhanced Interior gateway routing Protocol (EIGRP), Open Shortest Path First (OSPF) and Rapid Spanning Tree protocols. Furthermore, outlines of various networks such as, MPLS, MPLS TP and SDN DWDM have also been reviewed. At the time being the computer networks give us the possibility to communicate and interact in real time. Now we use the networks at maximum capacity in order to use a great variety of applications as the ones following: web applications, video conferences, e-commerce applications, IP protocol telephones, conference calls, education process development, media access applications, online newspapers applications and so on[3]. Routing protocols should be very well planned and dimensioned for each type of network. They are used according to the choices of the network administrator. The advantage of the routing protocols consists of the fact that they converge very quickly, even though the main route disappears, meaning that these protocols are auto adaptive [1]. In order to optimize the routing protocols, the solution should be very carefully chosen in order not to overload the low performance hardware. The dynamic routing protocols are divided in two distinct categories: interior routing protocols and exterior routing protocols.

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II. LITERATURE SURVEY

Recent advancements in technology have led to increment in the networks using shortest path first algorithms (SPF). As a result, network traffic gets unevenly distributed which leads to more congestion on some links in the network. So to deal with this issue, SDN using dynamic routing were used. There are various pros and cons of decoupling control and data planes in a Software- Defined Network (SDN). After a failure, simultaneous recovery of all switch-controller communication paths (control paths) was not possible, and multiple recovery stages were required. This in turn affected the data-path recovery performance. Hence, an algorithm was proposed for recovery-aware switch-controller assignment and routing (RASCAR), which enabled fast data-path recovery after a set of failures (e.g., single point of failures and disasters). The problem was formulated as an Integer Linear Program (ILP) and an efficient heuristic algorithm to solve large problem instances was proposed. The numerical studies showed that RASCAR significantly reduced the data-path restoration times after any failure with a minor increase in resource consumption of control paths. Moreover; it was observed that RASCAR improved the performance by using less number of controllers [5]. Furthermore, the success of novel multimedia services such as Video-on-Demand (VoD) was leading to a tremendous growth of Internet traffic. So an evaluation of energy-efficient VoD content caching and distribution under static and dynamic traffic in converged networks as well as in non-converged networks was performed. Also, an energy-efficient content caching and VoD-request routing heuristic algorithm was proposed. The results showed that deploying caches in the access and metro network segments reduced the overall energy consumption of the network. Moreover, results showed that the evolution towards a Fixed-Mobile Converged metro access network, where fixed and mobile users can share caches, can reduce the energy consumed for VoD content delivery. The results confirmed that the proposed strategy, both in static and dynamic traffic scenarios, saved energy in comparison to the cases where all the caches are always powered-on or all the contents were retrieved from a centralized video-server location[4]. In addition to this, a method was proposed to enhance OSPF network system survivability to Link State Advertisement (LSA) falsification attacks by implementing redundant routing protocol architecture. The experimental results proved that protocol redundancy increased the survivability of an OSPF network system, assuming the network topology was similar to that of the network system tested. The main motive of this proposal was to maintain host-to-host connectivity in the presence of an OSPF LSA falsification attack [3]. A survey has also been done on the Design and Implementation of a Stateful PCE-Based Unified Control and Management Framework for Carrier-Grade MPLS-TP Networks. An experimental approach was implemented to identify the performance of 30 students grouped into two. Each group was assigned a simulation tool but were given the same topology and network requirements. Correlation analysis was applied in processing the data from students' scores. Results showed evidence on the transfer of skills from two environments and identified GNS3 as getting a higher percentage of knowledge transfer [2]. Also, the security issues in Internet of things (IoT) environment were studied. For this, a Probe Route based Defence Sinkhole Attack (PRDSA) scheme was proposed to resist Sinkhole attack. The PRDSA scheme proposed a routing mechanism which combined the far-sink reverse routing, equal-hop routing, and minimum hop routing, scheme required the nodes and the sink node to return the signature of the information (e.g., IDs, etc.), to determine the location of the sinkhole. It proved that this scheme was much better than the existing ones [6]. The emerging technologies have increased the demand of using Software Defined Networks (SDN) but on the other side, there are many cons of these networks. It can be vulnerable to dynamic change of flow control rules, which causes transmission disruption and packet loss in SDN hardware switches. In order to overcome this problem, a novel robust flow control mechanism referred to as Priority-based Flow Control (PFC) was proposed. It was proved by the results that PFC was able to successfully prevent transmission disruption and packet loss events caused by traffic path changes, thus offering dynamic and lossless traffic control for SDN switches [7].

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Table1 IMPORTANT PARAMETERS OF RIP, OSPF, AND EIGRP PROTOCOLS

Protocol	RIP	OSPF	EIGRP
Convergence Time	Slow	Fast	Fast
VSLM	No	Yes	Yes
Bandwidth Usage	High	Low	Low
Resources Usage	Low	High	Low
Multiple path Support	No	Yes	Yes
Scalability	No	Yes	Yes
Patented	No	No	Yes
Non-IP Protocol	No	No	Yes

III. DESIGN & IMPLEMENTATION

Routing protocols should be very well planned and dimensioned for each type of network. They are used according to the choices of the network administrator. The advantage of the routing protocols consists of the fact that they converge very quickly, even though the main route disappears, meaning that these protocols are auto adaptive. Table 2 is showing types & quantities of devices requirement for develop a network model. In this network we are considering three routers with different area & hostname. Branch1 hostname has been assigned to router 1 & Head Office has been assigned to the router 2 & Branch2 is assigned Router 3. Branch 1 & 2 have one engineer with PC, Eng1 assigned in branch1 & Wng2 assigned in branch2. Each component of network requires 32-bit IP address so that it can communicate with other devices. In below table it has been assigned IP to each device.



Figure 1: Network model configuration diagram implemented with Packet Tracer Simulation software

Table2 Device Requirements

Device	Quantity	Model
PC	2	Generic
Routers	3	Cisco 2620XM
Cable-Serial DTE	2	Serial DTE
Cable-Straight-through and cross-over CAT 5e	2	Straight-through and cross-over CAT 5e

Table 3 IP Table of our network

Device /Interface	IP address /Network Address	Subnet Mask	Default Gateway	Host Name
Fa0/0	10.0.0.1	255.0.0.0	--	Branch1
Se0/1	20.0.0.1	255.0.0.0		Branch1
Se0/1	20.0.0.2	255.0.0.0		Head Office
Se0/0	30.0.0.1	255.0.0.0	---	Head Office
Se0/1	30.0.0.2	255.0.0.0	---	Branch2
Fa0/0	40.0.0.1	255.0.0.0		Branch2
Fa0	10.0.0.10	255.0.0.0	10.0.0.1	PC-Eng1
Fa0	40.0.0.10	255.0.0.0	40.0.0.1	PC-Eng2

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IV. CONFIGURATION OF COMPONENT

Routing is used to trace the path for the network and in this paper we implemented the virtual network model using Cisco packet tracer. As per referring IP from Table3 it has been configured to each device.

```

Branch1>
Branch1>
Branch1>enable
Branch1#
Branch1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Branch1(config)#
Branch1(config)#interface fa0/0
Branch1(config-if)#ip address 10.0.0.1 255.0.0.0
Branch1(config-if)#no shutdown

HeadOffice>
HeadOffice>
HeadOffice>enable
HeadOffice#conf t
Enter configuration commands, one per line. End with CNTL/Z.
HeadOffice(config)#
HeadOffice(config)#interface serial 0/1
HeadOffice(config-if)#ip address 20.0.0.2 255.0.0.0
HeadOffice(config-if)#encapsulation ppp
HeadOffice(config-if)#no shutdown

HeadOffice(config-if)#
%LINK-5-CHANGED: Interface Serial0/1, changed state to up

HeadOffice(config-if)#exit
HeadOffice(config)#
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up
Branch2 (config) #
Branch2 (config) #
Branch2 (config) #interface fa0/0
Branch2 (config-if)#ip address 40.0.0.1 255.0.0.0
Branch2 (config-if)#no shutdown

Branch2 (config-if) #
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up

Branch2 (config-if) #exit
Branch2 (config) #

Branch2 (config-if) #
%LINK-5-CHANGED: Interface FastEthernet0/0, changed state to up
exit
Branch1 (config) #
Branch1 (config) #
Branch1 (config) #interface serial 0/1
Branch1 (config-if)#ip address 20.0.0.1 255.0.0.0
Branch1 (config-if)#encapsulation ppp

Branch2>
Branch2>enable
Branch2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Branch2 (config) #interface serial 0/1
Branch2 (config-if)#ip address 30.0.0.2 255.0.0.0
Branch2 (config-if)#no shutdown

Branch2 (config-if) #
%LINK-5-CHANGED: Interface Serial0/1, changed state to up

Branch2 (config-if) #encapsulation ppp
Branch2 (config-if) #
%LINEPROTO-5-UPDOWN: Line protocol on Interface Serial0/1, changed state to up

Branch2 (config-if) #exit
Branch2 (config) #

HeadOffice (config) #
HeadOffice (config) #interface serial 0/0
HeadOffice (config-if)#ip address 30.0.0.1 255.0.0.0
HeadOffice (config-if)#encapsulation ppp
HeadOffice (config-if)#no shutdown

%LINK-5-CHANGED: Interface Serial0/0, changed state to down
HeadOffice (config-if) #exit
HeadOffice (config) #

```

Figure 2 Step by Step description of each command configured on routers

In above Figure 2 Shown configurations IP have been configured on interface of routers. In Router R1 interface fastethernet 2/0, address 10.0.0.1 255.0.0.0 configured, same practice has been done at all interface of routers according to assigned IPs.

Configure OSPF routing protocol

OSPF (Open Shortest Path First) is a link state routing protocol that is used to distribute information within a single Autonomous System [5]. Its principle is that each router determines the state of its connections (links) with the neighboring routers; it diffuses its information to all the routers belonging to the same zone. This information forms a database, which must be identical to all routers in the same zone. Knowing that a stand-alone system (AS) consists of several zones, all of these databases represent the topology of the AS. Now enable IP routing by configuring ospf routing protocol in all routers, it has to configure router id when we configure ospf. It is used to identify the router. Here, R2 knows Area 0. Network 20.0.0.0 connected to R2 from R1, so R1 learns networks through this network. R3 (config)# router ospf 1, here, 1 is Process ID, it can be 1-65535. It initializes ospf process. There must be one interface up to keep ospf process up. So it is better to configure loopback address to routers. It is a virtual interface which never goes down once we configured.

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```
Branch1>
Branch1>
Branch1>enable
Branch1#
Branch1#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Branch1(config)#
Branch1(config)#
Branch1(config)#router ospf 1
Branch1(config-router)#router-id 1.1.1.1
Branch1(config-router)#network 10.0.0.0 0.255.255.255 area 3
Branch1(config-router)#network 20.0.0.0 0.255.255.255 area 1
Branch1(config-router)#exit
Branch1(config)#
HeadOffice>
HeadOffice>
HeadOffice>
HeadOffice>enable
HeadOffice#conf t
Enter configuration commands, one per line. End with CNTL/Z.
HeadOffice(config)#router ospf 1
HeadOffice(config-router)#router-id 3.3.3.3
HeadOffice(config-router)#network 20.0.0.0 0.255.255.255 area 1
HeadOffice(config-router)#network 30.0.0.0 0.255.255.255 area 1
01:15:32: %OSPF-5-ADJCHG: Process 1, Nbr 1.1.1.1 on Serial0/1 from LOADING to FULL, Loading Done
HeadOffice(config-router)#network 30.0.0.0 0.255.255.255 area 0
HeadOffice(config-router)#exit
HeadOffice(config)#
HeadOffice(config)#
HeadOffice(config)#
Branch2>
Branch2>enable
Branch2#conf t
Enter configuration commands, one per line. End with CNTL/Z.
Branch2(config)#router ospf 1
Branch2(config-router)#router-id 3.3.3.3
Branch2(config-router)#network 30.0.0.0 0.255.255.255 area 0
Branch2(config-router)#network 30.0.0.0 0.255.255.255 area 0
01:18:52: %OSPF-5-ADJCHG: Process 1, Nbr 2.2.2.2 on Serial0/
Branch2(config-router)#
Branch2(config-router)#network 40.0.0.0 0.255.255.255 area 2
Branch2(config-router)#
Branch2(config-router)#exit
Branch2(config)#
Branch2(config)#
Branch1(config)#
Branch1(config)#
Branch1(config)#interface loopback 0
Branch1(config-if)#ip add 172.16.1.252 255.255.0.0
Branch1(config-if)#
Branch1(config-if)#no shutdown
Branch1(config-if)#
HeadOffice(config)#
HeadOffice(config)#interface loopback 0
HeadOffice(config-if)#ip add 172.16.1.253 255.255.0.0
HeadOffice(config-if)#no shutdown
HeadOffice(config-if)#

Branch1#sh ip route
Codes: C - connected, S - static, I - IGRP, R - RIP, M - mobile, B - BGP
       D - EIGRP, EX - EIGRP external, O - OSPF, IA - OSPF inter area
       N1 - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
       E1 - OSPF external type 1, E2 - OSPF external type 2, E - EGP
       i - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, I1 - IS-IS inter area
       * - candidate default, U - per-user static route, o - ODR
       P - periodic downloaded static route

Gateway of last resort is not set

C    0.0.0.0/0 is directly connected, Null0/0
C    10.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C    10.0.0.0/8 is directly connected, Serial0/1
C    10.0.0.1/32 is directly connected, Serial0/1
O IA 20.0.0.0/8 [110/111] via 20.0.0.1, 00:00:00, Serial0/1
C    20.0.0.0/14 is directly connected, Loopback0

Branch1#
*LINE5-CHANGED: Interface Loopback0, changed state to up
*LINE5DOWN-5-UPDOWN: Line protocol on Interface Loopback0, changed state to up
*V3-5-CONFIG_I: Configured from console by console
00:40:59: %OSPF-1-ADJCHG: Process 1, Nbr 1.1.1.1 on OSPF_VL0 from LOADING to FULL, Loading Done
```

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```

Head02f1ca31d IP route
Codes: C - connected, I - static, I - IGRP, B - BGP, H - mobile, S - SFP
        D - EIGRP, EX - EIGRP external, O - OSPF, EA - OSPF external area
        NL - OSPF NSSA external type 1, N2 - OSPF NSSA external type 2
        E1 - OSPF external type 1, E2 - OSPF external type 2, R - RIP
        I - IS-IS, L1 - IS-IS level-1, L2 - IS-IS level-2, IS - IS-IS inter area.
        * - candidate default, U - per-user static route, o - ODR
        P - periodic downloaded static route

Gateway of last resort is not set

 20.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C    20.0.0.0/8 is directly connected, Serial0/0
C    20.0.0.0/24 is directly connected, Serial0/0
 30.0.0.0/8 is variably subnetted, 2 subnets, 2 masks
C    30.0.0.0/8 is directly connected, Serial0/0
C    30.0.0.0/24 is directly connected, Serial0/0
C    172.14.0.0/24 is directly connected, Loopback0

Head022f1ca3
4218P-0-CHANGED: Interface Loopback0, changed state to up
4218P0T0-0-UPDOWN: Line protocol on Interface Loopback0, changed state to up
4218-0-CONFIG_I: Configured from console by console
01:22:30: 4218P-0-EXRND: Process 1, Mbr 2.1.1.1 on OSPF_PLS from LDRING to RWLL, Loading Done
  
```

Figure 3 Step by Step description of each command configured on routers

Assigned Static IP to PC

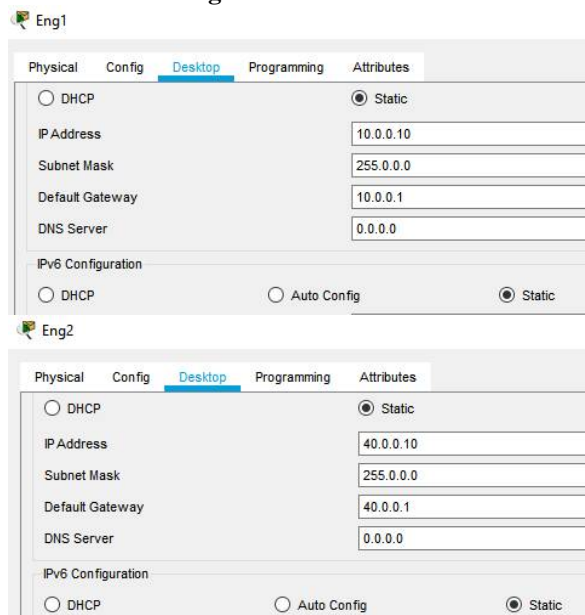


Figure 4 Static IP assigned to the Eng1 & Eng2 PC

With Static IP addressing, addresses are assigned manually so that each device has to its own address with no overlap. When you connect a new device, you would have to select “manual” configuration option and enter in the IP address, the subnet mask, the default gateway and the DNS server. In above figure 4 we have assigned IP address to Eng1 & Eng2 PC.10.0.0.10 & 40.0.0.10 to Eng1 & Eng2 respectively. Here, R3 doesn't know about the area 3 so we have to create virtual link between R1 and R2. After creating virtual link between R1, R2, a virtual link to connect area 3 to area 0 is also created. R2 and R3 get updates about Area 3. Now, check routing table of R3,

V. PARAMETRIC ANALYSIS OF PROPOSED

Check connectivity between hosts 10.0.0.10 to 40.0.0.10 the ping command first sends an echo request packet to an address, and then waits for a reply. The ping is successful only if: the echo request gets to the destination, and, the

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```
Command Prompt

Pinging 20.0.0.1 with 32 bytes of data:

Reply from 20.0.0.1: bytes=32 time=3ms TTL=253
Reply from 20.0.0.1: bytes=32 time=2ms TTL=253
Reply from 20.0.0.1: bytes=32 time=12ms TTL=253
Reply from 20.0.0.1: bytes=32 time=10ms TTL=253

Ping statistics for 20.0.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 12ms, Average = 6ms

C:\>ping 10.0.0.1

Pinging 10.0.0.1 with 32 bytes of data:

Reply from 10.0.0.1: bytes=32 time=3ms TTL=253
Reply from 10.0.0.1: bytes=32 time=9ms TTL=253
Reply from 10.0.0.1: bytes=32 time=10ms TTL=253
Reply from 10.0.0.1: bytes=32 time=2ms TTL=253

Ping statistics for 10.0.0.1:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 2ms, Maximum = 10ms, Average = 6ms

C:\>ping 10.0.0.10

Pinging 10.0.0.10 with 32 bytes of data:

Reply from 10.0.0.10: bytes=32 time=11ms TTL=125
Reply from 10.0.0.10: bytes=32 time=14ms TTL=125
Reply from 10.0.0.10: bytes=32 time=12ms TTL=125
Reply from 10.0.0.10: bytes=32 time=4ms TTL=125

Ping statistics for 10.0.0.10:
    Packets: Sent = 4, Received = 4, Lost = 0 (0% loss),
    Approximate round trip times in milli-seconds:
        Minimum = 4ms, Maximum = 14ms, Average = 10ms
```

Figure 8 Send & receive packets from Eng2 host to host Eng1

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