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# THE SIMULATION OF PATH CONTROL AND ROUTE REDISTRIBUTION TECHNIQUES ON THE INTEGRATION OF WANs WITH DIFFERENT ROUTING PROTOCOLS

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## Abstract
*There are several other techniques that could be used to control paths in the integration of Wide Area Networks (WANs) with diverse routing protocols such as frame relay, enhanced interior gateway routing protocol (EIGRP), etc. In this paper, the concept of route redistribution was considered to integrate Wide Area Networks with different routing protocols. A simulation of networks with different routing protocols integrated as a single network to aid communication between them was developed with the help of a simulation package known as Cisco Packet Tracer. This simulation approach enables various users of the said network to distribute files, communicate and navigate across the entire network thereby managing and controlling paths. In conclusion, the use of route redistribution in the integration of WANs with different routing protocols had helped reduced some of the problems that aroused as a result of the integration of network with different routing protocols.*

**Keywords:** Routing, Route Redistribution, Internet Protocol, Routing Protocols

## Introduction
Pathing otherwise known as path control basically refers to tools and protocols used by layer 3 devices to learn, forward, manipulate and use IP routes in a WAN network. Path control has to do with controlling the path traffic follows in a network communication, some networks only have one path for traffic to follow but most networks have redundant links, path control specifies which path the network administrator wants traffic to follow. This is normally used in storage networks. The choice of path to be taken is affected by the routing protocols used in the network, for example, different administrative distances, metrics, and convergence times may result in different paths being selected (Key, Aveue & Massoulie 2006).

When we have different networks running on different routing protocols, getting the two networks to communicate becomes a problem, route redistribution allows routing protocols from one different network to be advertised into another network with a different routing protocol at least one redistribution point needs to exist between the two routing domains. This device will actually run both routing protocols. Recent studies have shown that enterprise networks are more difficult to manage due to that their routing structures usually consist of routing instances and multiple domains (Han Shakkotai, Srillkant & Towsley 2006). Routing instances are caused by network administrative policies to filter route, other causes of routing instances occur in case of company mergers and equipments of different vendors are used. The potential need for route redistribution exists when a route learned through one source of routing information, most typically one routing protocol, needs to be distributed into a second routing protocol domain (routing instance). For example, two companies might merge, with one company using Enhanced Interior Gateway Routing Protocol (EIGRP) and the other using Open Shortest Path First (OSPF). The engineers could choose to immediately migrate away from OSPF to instead use EIGRP exclusively, but that migration would take time and potentially cause outages. Route redistribution allows those engineers to connect a couple of routers to both routing domains, and exchange routes between the two routing domains, with a minimal amount of configuration and with little disruption to the existing networks. (A routing protocol will be run on one routing instance i.e. OSPF will be run on one routing instance of one company, department etc and EIGRP will be run on the other).

**Related Works**

Balchunas (2007) revealed that, it is preferable to employ a single routing protocol in an internetwork environment, for simplicity and ease of management. Unfortunately, this is not always possible, making multi-protocol environments common. Route redistribution allows routes from one routing protocol to be advertised into another routing protocol.

According to Internetworking Technology Overview (1999) routing involves two basic activities: determination of optimal routing paths and the transport of packets through an internetwork. The transport of packets through an internetwork is relatively straightforward. Path determination, on the other hand, can be very complex. One protocol that addresses the task of path determination in today’s networks is the Border Gateway Protocol (BGP). The BGP is an inter autonomous system routing protocol.

Key et al (2006) worked on flexible routing schemes mitigating some of the problems associated with uncertain traffic patterns and workloads by making the exact location of capacity less important: if there is available capacity, the routing scheme will find it. In this paper a combined multipath routing and congestion control architecture that can provide performance improvements to the end user and simplifies network dimensioning for operators is proposed. A flow-level model was described, which was able to handle streaming and file transfer traffic, with stochastic arrivals, and look at a fluid limit. A congestion controller and path selection algorithm that automatically balances traffic across the lowest cost paths was also described, and a suggestion to ways in which just two paths may be used, with a random selection policy. A notable feature of a multipath congestion controller is that it cannot be tuned to a single Round-Trip Time (RTT), hence it differs from standard TCP with respect to RTT bias. Also this work showed that under certain conditions the allocation of flows to paths is optimal and independent of the flow control algorithm used. Scalability of the architecture results from implementing the algorithms at end-systems (Le, Xie & Zhang 2007).

Han et al (2006) considered the problem of congestion-aware multi-path routing in the internet. Currently, Internet routing protocols select only a single path between a source and a destination. However, due to many policy routing decisions, single-path routing may limit the achievable throughput. In this paper, we envision a scenario where multi-path routing is enabled in the Internet to take advantage of path diversity. Using minimal congestion feedback signals from the routers, a class of algorithms is presented that can be implemented at the sources to stably and optimally split the flow between each source-destination pair. Then shows that the connection-level throughput region of such multi-path routing/congestion control algorithms that can be larger than that of single-path congestion control scheme.

Radunovic, Gkantidis, Gheorghiu & Rodriquez (2007), Designing high throughput wireless mesh networks is a challenge, and involves solving interrelated scheduling, routing, and interference problems. In this paper, we exploit the fundamental properties of broadcast medium and path diversity in wireless meshes to implement multipath routing between a source and destination pair.

Network coding was used for a given unicast source-destination flow to ease the scheduling problem, exploit diversity, and deal with unreliable transmissions. It was described that multipath-forwarding algorithms, show their performance benefits over existing proposals, using simulation, analysis, and a prototype implementation on a small test bed. Proposition of a rate scheduling protocol that relies on network coding was done, which gives over 30 % performance improvements for a realistic topology and can double the throughput in certain cases.

The internet is a best effort network, which means that packets are neither guaranteed to arrive at the intended destination at all, nor guaranteed to arrive at the destination in the order that they were sent (Le, 2007). This fundamental design feature of the internet has allowed it to scale well, because reliability is implemented at the end-hosts and not within the network. To provide applications with a guaranteed, in-order, data delivery service, a reliable transport protocol must operate over this unreliable network. Many of the most popular Internet applications, such as the web, file transfer, electronic mail, and remote terminals, rely on end-to-end reliability between hosts. Almost all of this traffic uses one dominant transport protocol; named the Transmission Control Protocol (TCP).

## Materials and Method

The paths which a message takes from host or source to destination can be as simple as using a single cable to connect one computer to another or it could be as complex as a network that literally spans the globe. The physical elements or hardware of the network are devices and media are. Hardware is the visible components of the network such as a router, a switch, laptop, a PC, or the cabling used to connect the devices. Some components may not be so visible. In the case of wireless media, messages are transmitted through the air using invisible radio frequency or infrared waves.

## Network Design

Network planning and design is an iterative process, encompassing topological design, network-synthesis, and network-realization, and is aimed at ensuring that a new network or service meets the needs of the subscriber and operator. This study is to design two separate networks with each running a routing protocol different from that of the other. One network will be running on OSPF while the other runs on EIGRP. Figure 1 below depicts the process involved in the design of this work.

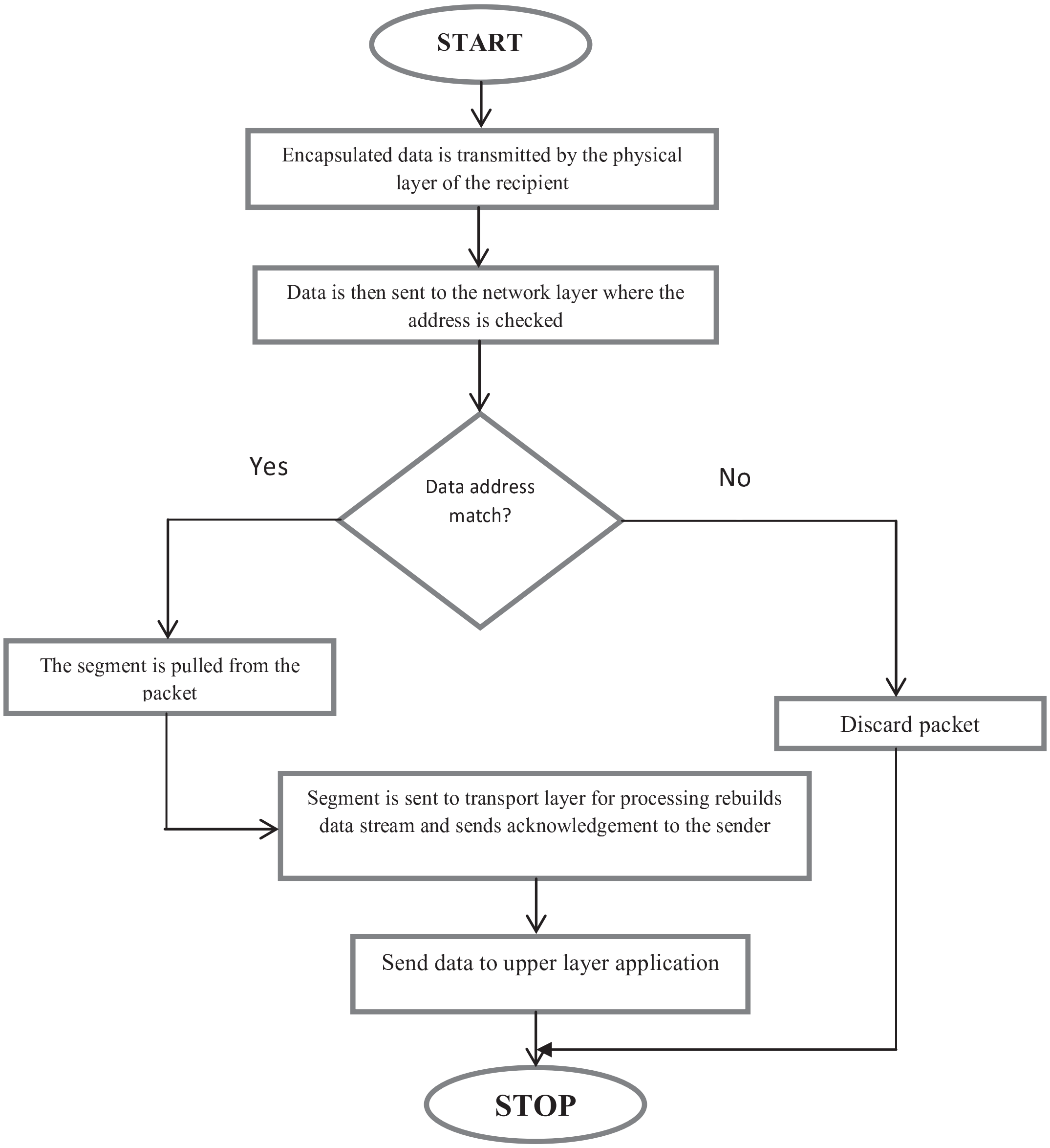


**Figure 1: Flow chart representing data flow across a network**

**Open Shortest Path First (OSPF**

Is a routing protocol developed for Internet Protocol (IP) networks by the interior gateway protocol (IGP) working group of the Internet Engineering Task Force (IETF). OSPF is a link-state routing protocol that operates by sending of link-state advertisements (LSAs) to all other routers within the same routing instance. Information on attached interfaces, metrics used, and other variables are included in OSPF LSAs. As OSPF routers know and store link-state information, they use the SPF algorithm to calculate the shortest path to each node. The largest entity within the hierarchy is the autonomous system (AS), which is a collection of networks under a common administration that share a common routing strategy.

## Enhanced Interior Gateway Routing Protocol (EIGRP)

According to Jumomo (2011), Enhanced Interior Gateway Routing Protocol (EIGRP) is an interior gateway protocol suited for many different topologies and media. In a well-designed network, EIGRP scales well and provides extremely quick convergence times with minimal network traffic. EIGRP is a Cisco proprietary routing protocol. EIGRP is a hybrid protocol as it incorporates features of a Distance Vector routing protocol and features of a Link State routing protocol. EIGRP is often used in Cisco-based networks running multiple network-layer protocols. EIGRP only advertises its entire routing table when it discovers a new neighbor and has formed an adjacency with it through the exchange of Hello packets. EIGRP routers will only advertise their routing tables to their neighbours.

## Route Redistribution

Route Redistribution allows routes from one routing protocol to be advertised into another routing protocol. The routing protocol receiving these redistributed routes usually marks the routes as external. External routes are usually less preferred than locally-originated routes. At least a redistribution point is needed between the two routing domains. This redistribution point will actually run both protocols running on the interacting routes. Thus, to perform redistribution in the following example, the router at the middle would require at least one interface in both the EIGRP and the OSPF routing domains (Shafi'i M. A., Victor O. W. & Laminu I.' 2011)

## Simulation

The Cisco Packet Tracer is a powerful network simulation program that allows one to experiment with network behavior. Packet Tracer provides simulation, visualization, authoring, assessment, and collaboration capabilities and facilitates the teaching and learning of complex technology concepts.

Cisco Packet Tracer have two (2) workspaces; logical and physical workspace. The logical workspace allows users to build logical network topologies by placing, connecting, and clustering virtual network devices. The physical workspace provides a graphical physical dimension of the logical network, giving a sense of scale and placement in how network devices such as routers, switches, and hosts would look in a real environment. The physical view also provides geographic representations of networks, including multiple cities, buildings, and wiring closets.

The simulation of an effective path control network integrating wide area networks (WAN) running on different routing protocols was designed to be user friendly and easy to navigate using the Cisco packet tracer. The simulation was designed based on a topology known as the extended star topology. However, the components of the network were configured in other to ease transportation of packets from one end to another end successfully. The entire network was furthermore segmented into branch networks, having two branches or wide area networks (WAN's) being merged together by a merging router using the concept of route redistribution as discussed earlier. The first branch of the network had a router connecting to a mini-large local area network (LAN) which had switches and different end devices, and the router connecting the local area network on this branch was routing using EIGRP while the second branch is almost a duplicate of the other branch, only that the router connecting the local area network (LAN) is running on a different protocol OSPF. Finally the merging router came to play, using the concept of route redistribution to learn paths through which the two (2) branches will communicate across the network. A router was introduced named the merging router; this router connected the branches together to have a free flow of packets from different end of a branch to another, by configuring route redistribution on the router thereby enabling connectivity between the branches as shown in Figure 2 below, the branch network with yellow background is the branch running with EIGRP while the green background is running with OSPF protocols.

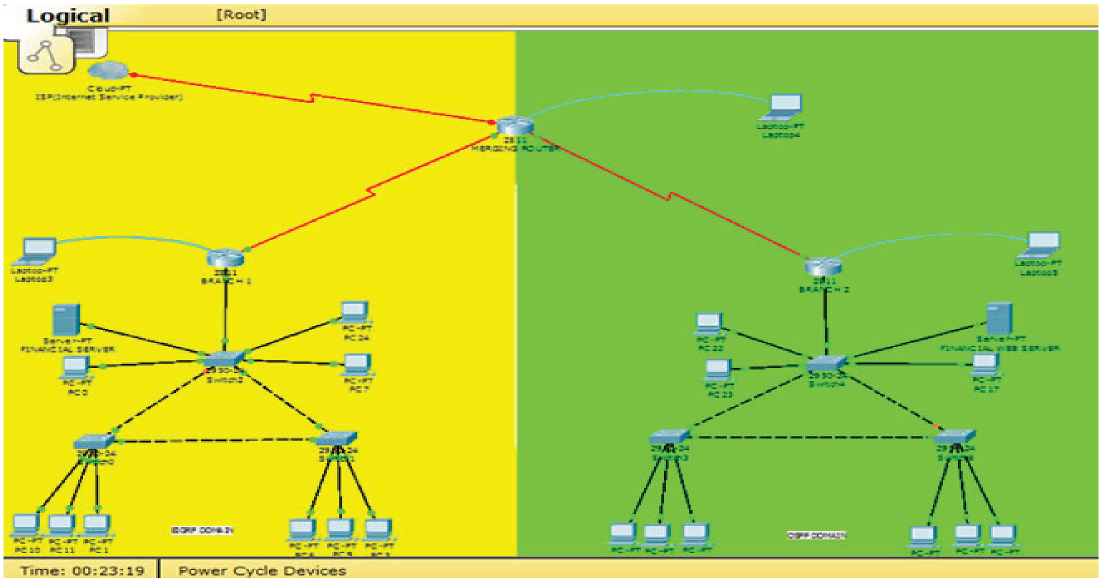


**Figure 2: Screen shots showing entire network architecture using cisco packet tracer**

**System Testing**

In order to examine the efficiency or how well the network was designed, tests are carried out using the ping packets to verify connectivity between the different segments of the network. Since the network has been segmented into two (2) branches with the merging router as a connector between the two (2) branches, then the connectivity test is carried out stage by stage.

**Stage One**

This stage comprises of the connectivity testing from one end device in a branch network to the router in the same branch, using the ping packets to ascertain whether or not connectivity exists in the network.

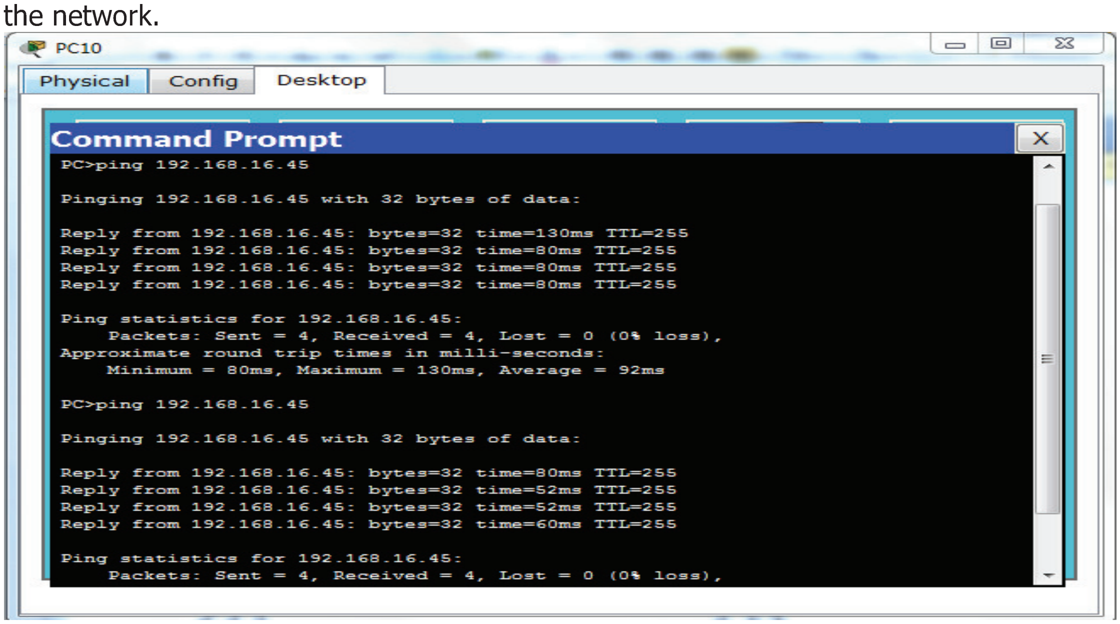


**Figure 3: Screenshot Showing Connectivity Test from an End Device to a Router in**

**Branch 1 Network**

From the figure 3 above, ping statistics for router with ip address (192.168.16.45)**;**
Packets: sent = 4, received = 4, loss = 0. Therefore since sent packets are received and there is no high percentage of packet loss, we conclude that connectivity exists in the LAN of the branch 1 network and exists even outside the LAN.

*Stage two*
At this stage of testing, test for connectivity between the router (router running on the EIGRP) of the branch1 network and the redistributed router (Merging router) i.e. the router that connects the two branches by learning the paths and routes. Using the ping packets to determine whether connectivity exists or not as shown in Figure 4.

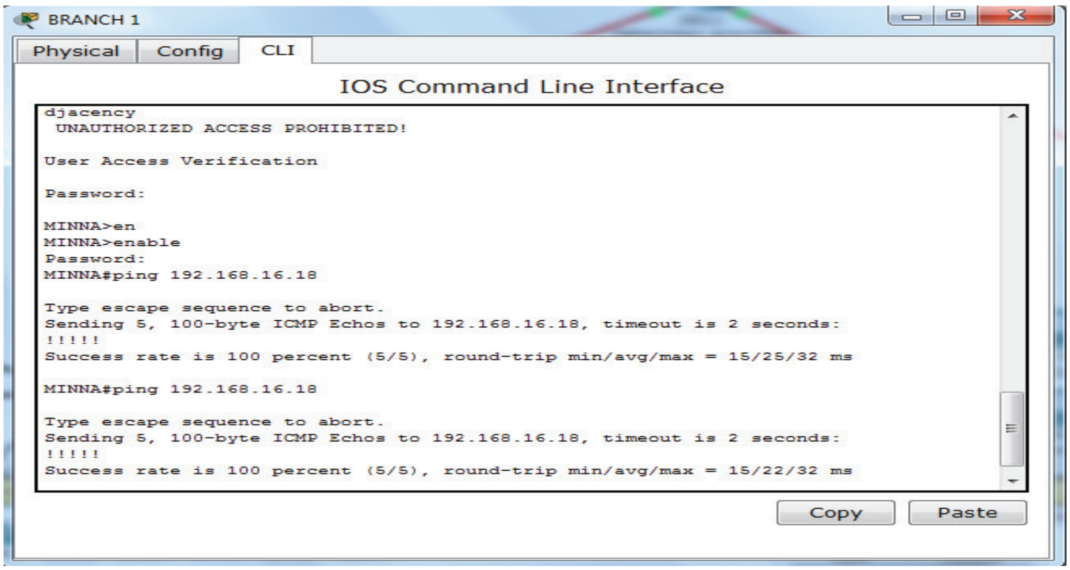

**Figure 4: screenshot showing connectivity from branch1 router to merging router**

**ROUTER CONFIGURATIONS**
Router(config)#hostname Minna
Minna(config)#banner motd x Unauthorized access prohibited! x
Minna(config)# line console 0
Minna (config-line)# password cisco
Minna(config-line)#login
Minna(config)#line vty 0 4
Minna(config-line)#password cisco
Minna(config-line)#login
Minna(config)#enable password cisco
Minna(config)#enable secret cisco
Minna(config)#int fastethernet 0/0
Minna(config-if)#ip address 192.168.16.45 255.255.255.240
Minna(config-if)#no shut
Minna(config)#int serialethernet 1/0
Minna(config-if)#ip address 192.168.16.17 255.255.255.240
Minna(config-if)#clock rate 64000
Minna(config-if)#no shut
Minna(config)#router eigrp 100
Minna(config-router)#network 192.168.16.16
Minna(config-router)#network 192.168.16.32
Minna(config-router)#no auto summary

The configurations above are the routers in figure 4 above, we can conclude that connectivity exists between the two routers, since there is a success rate of about 100% when packets are sent out of the router and are all received by the other router.

*Stage Three*
This testing stage was between the redistributed router (Merging router) and the router (router running on OSPF) of the branch two (2) network, test for connectivity was performed by using ping packets. The success rate is 100% thereby showing that the ping packets sent by the router were successfully received without loss in packets at a very good speed. Hence connectivity exists from the branch2 router to the merging router.

*Stage Four*
This stage of testing consists of the test for connectivity from the router (router running on OSPF) of branch2 to the end device in the LAN of the branch2 network, using the ping packets to verify and confirmed connectivity. The success rate is 100% which simply means the packets sent from the router was received successfully without loss in the packet, thereby proving that connectivity exists between the router and end devices in the LAN of branch2.

*Stage Five*
This stage comprises of the connectivity testing from one of the end devices in the branch1 network to an end device in the branch2 network, thereby trying to proof that the redistributed router has learnt all the paths/routes in the entire network.

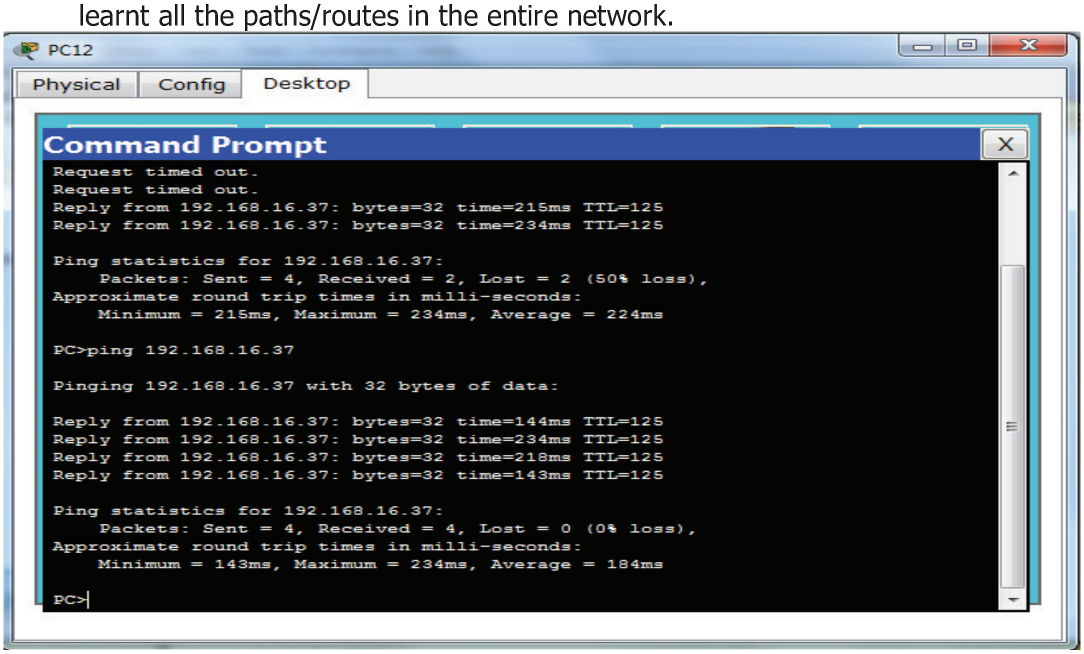


**Figure 5: Screenshot Showing Connectivity from an End Device in Branch1 Network to an End Device in Branch2**

From figure 5 above, ping statistics shows packets: sent = 4, received = 4, lost = 0 (0% loss), since there are no packet loss and packets were received, thereby showing that connectivity exists. Therefore it simply means that the redistributed router has learnt all the necessary route/paths in the entire network that is essential for connectivity across the entire network.

*Stage Six*

Finally the last testing stage is more like a security test, simply showing that authorized access cannot be granted to any other individual aside the network administrator to make effects on the routers or switches using the line console password and the enable secret password.

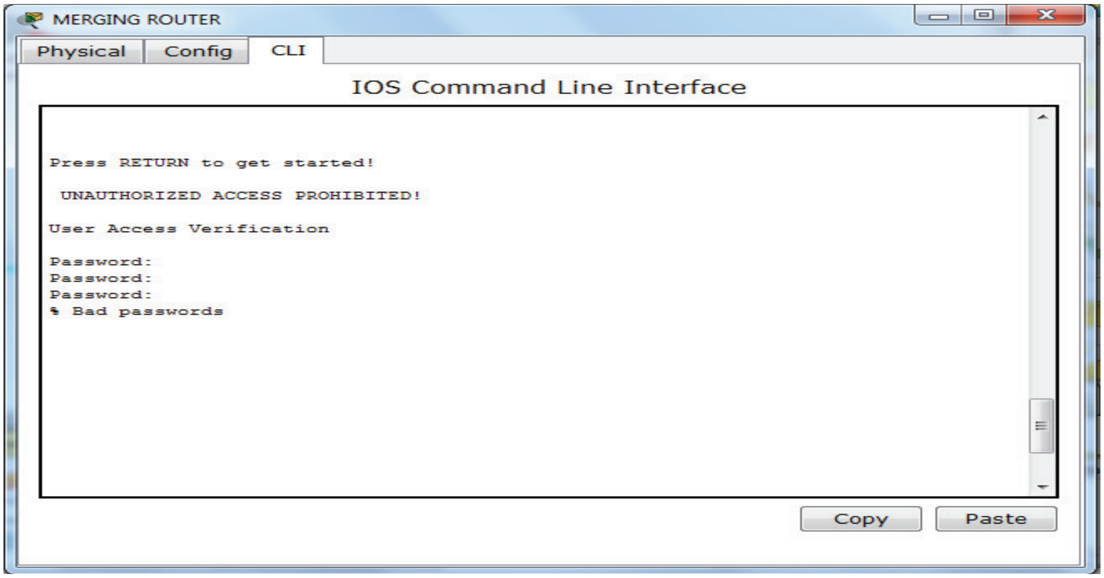


**Figure 6: Screenshot showing the security of a router via the passwords**

From figure 6 above, we discovered that the router is secured and cannot allow telnet i.e. remote access into the router or switches to alter configuration to sooth the individual. So without the console or telnet password unauthorized access is prohibited.

**Discussion of Result**

We were able to attain a great level of success in achieving the sole aim of this project work which is to simulate an integration of wide area networks routing on different routing protocols and also to efficiently manage and organize the paths or routes which packets or frames take to communicate across a wide area network.

The results ascertained from the system testing carried out using ping packets in the previous chapter, proved that wide area networks operating or rather routing on different routing protocols could be integrated using the basic concept of route redistribution against many other concepts and also solve the problems that arises when networks are being merged, especially problems like packet loss and security. From the screen shots of the simulation work, we could also say that about 100% efficiency level was obtained because all packets sent from one end of the network to another were all received thereby having a 0% packet loss and solving the problems of packet loss and packet interception due to lack of security.

**Conclusion and Recommendations**

In conclusion, integrating of wide area networks routing on different protocols using route redistribution concept had helped to reduce all the problems that made the needs for integration arise. For instance, when an organization grows very large and needs to merge networks of its various branches together to promote a healthy communication between its branches. All what the network administrator need to do is to have a remote router connecting the branches and he/she manages and controls the network from their without having to visit the branch offices. This has also helped in the banking industry, such that wherever you are in the nation, your account details can be access without going to your particular branch and helped in so many areas that we didn't mention.

Network integration is essential in a large business environment, and ensures that the communication networks of an organization deliver the performance the business relies on. For effective communication of integrated networks, various concepts are applied to achieve a very high rate of success and a 0% packet loss. It's hereby recommended that:

- Emphasis should be made on the other concepts that could be used to achieve the integration of Wide Area Networks on different routing protocols.
- Route redistribution concept should be used as the most appropriate technique for the integration of Wide Area Networks on different protocols.
- The use of various routing protocols in a Wide Area Network should be supported, in other to enhance the security of the Network.

## References


Balchunas, A. (2007). *Route redistribution* v1.14. Available a www.**route**ralley.com/ra/docs/**redistribution**.pdf, date 18/12/2012, time 17:39

Cisco System Inc. (2006), *Building scalable cisco internetworks* 2(3) Available at http://fs1.bib.tiera.ru/content//DVD-021/_Building_Scalable_Cisco_Internetworks_(vol._2)._Student_Guide_(2006)(version_3.0)(en)(386s).pdf date 18/12/2012, time 17:40

Farley, M. (2001). Building storage networks

Han, H., Shakkotai, S., Hollot, C. V., Srilkant, R. & Towsley, D. (2006). Multi-path TCP: a joint congestion control and routing scheme to exploit path diversity on Internet. *Journal, IEEE/ACM Transaction on Networking, pp. 53.*

Internetworking Technology Overview (1999). Chapters 42 Pages 42-1 to 42-6(OSPF).

Isah, H. (2010). *Open System Interconnection Reference Model, with respect to Networking and data transfer.* Undergraduate project, FUT Minna, pp.23.

Jumomo, P. (2011). *CCNA lecture notes.* Chapters Six and Seven, pp. 45 & pp. 76-80.

Key. P., Aveue, J. T. & Massoulie, L. (2006). *Combining multi-path routing and congestion for robustness*, Citation

Laudon, K. & Laudon, J. (2001). *Management Information Systems.* http://www.routeralley.com/mis.html accessed 24/10/2012 time 12:23

Le, F., Xie, G. G. & Zhang, H. (2007). *Understanding route redistribution.* In Proceedings of ICNP'07, Beijing, China, pp. 21.

Odom, W. (2007). CCIE NO: 1624, CCNP ROUTE 642 – 902 Officially Certification Guide, http://www.routeralley.com accessed 24/10/2012 time 12:23

Postel, J. (1981). *Internet protocol,* RFC, 791available at www.rfcprotocol.com/791.htm accessed 16/11/2012, time 13:36

Radunovic, B., Gkantisdis, C., Key, P., Gheorghiu, S., Hu, W. & Rodriquez, P. (2007). *Multi-path code casting for wireless mesh network.* Citation.

Shafi'i, M. A., Victor, O. W. & Laminu, I. (2011), *The application of decidability theory in identifying similar computer networks.*, *The IUP Journal of Computational Mathematics, India. 4,(2), 1-1. Availableat:*http://www.iupindia.in/1106/Computational%20Mathematics/The_Application_of_Decidability.html

Todd, L. (2007). *Cisco certified network associate* (Study Guide) Sixth Edition.

What is (2012). www.whatis.techtarget.com/defimition/pathing-path-control accessed on the 15th March 2012.

Wikipedia (2012), www.google.com/en.wikipedia.org/wiki/Routing last accessed on 15th March 2012.



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