International Journal of Computing Academic Research (IJCAR)
ISSN 2305-9184 Volume 1, Number 1 (October 2012), pp. 25-35

http://www.meacse.org/ijcar

Impact of Information Technology on Nigeria Banking Industry: a case Study of Skye Bank

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Abstract
As Information Technology is vital in banking today, it becomes imperative for banks to realize its impact on operational performance in order to justify capital investments. The objective of this work is to examine how the adoption of Information Technology affects the operations of commercial banks in terms of effectiveness, efficiency, competitiveness, customer base and globalization of the bank. The research methodology involved reviewing the existing network design of the investigating bank and comparing it with the proposed network design solution. The design and simulation results of work revealed that Information Technology led to increase customer satisfaction, improved operational efficiency, reduced transaction time, better competitive edge, reduced the running cost and ushered in swift response in service delivery.

Keywords- VLAN, VPN, Tunnel, WAN, LAN

I. INTRODUCTION

Case studies have shown that effective and efficient use of Information Technology (IT) helps to distinguish between business equivalents. For example, IT was an important distinction between banks that were doing well in the mid-1980s as compared to those that was less profitable [1]. Hence the need to survive, for global relevance, to maintain existing market share and sustainable development has called for the exploitation of IT and its many advantages. In the banking industry, a list of IT products that have been adopted range from teller printers, Automated Teller Machines (ATMs), smart cards, Magnetic Ink Character Reader (MICR). A list of IT services also includes internet banking, mail, telephone banking, and mobile banking. Accounting for a greater percentage of what could be regarded as IT in banks is its internetworking. This internetworking refers to the internet, extranet and intranet and interbank networking. Intranet exists in branches such that transactions taking place in a branch is only accessible in that branch alone. For example, a branch has a VPN of 10.108.108.0 and another has a VPN of 10.103.103.0. A transaction taking place at 108 networks is exclusively for that network, it cannot be seen from the 103 network. Extranet exists such that a customer is not restricted to the branch he opened his account. He could bank anywhere since such information is made securely available within the bank regardless of its network. Internet is the unsecured channel wherein both the secured intranet and extranet exists. Here, every other information aimed for the public is made available since they are not confidential.

This research work aims at providing Nigerian banks with a better IT solution with respect to its network design, architecture and deployment; to examine how IT affects the operations of banks regarding their effectiveness, efficiency, competitiveness, performance, customer base and globalization; to review the bank’s existing network and provide a workable solutions to the existing network.

2. LITERATURE REVIEW

Researchers have evolved from mere reports to more empirically based reports. These include the extensive works [2] and [3]. For instance, a study of selected stores in a fast food industry showed that stores with the technology and large breakfast sales performed significantly better in terms of cutting materials cost [4]. However, it was realized that firms that extensively relied on computers had either a very strong or a weak financial performance [5]. The first stage of information technology in banks started with an attempt to automate the banking process through mechanization. It was by the use of note counters and accounting calculators to speed up basic transactions. Another stage of information technology was in the storage and retrieval of information. Then in the late 1950s and 1960s, business data processing was through punched card equipment. The 1970s saw the introduction of Information Technology Management System (MIS) and Decision Support System (DSS). The 1980s saw the fusion of telecommunications and networking technologies for business deployment. It also saw to the emergence of data processing, Office Information System (OIS) and personal computers.

The financial sector has been an interesting case for service innovation as it moves towards using the web for commercial purpose through internet banking and IT. The impact of price clarity and consumer empowerment afforded by information technology eventually led to product and price competition. IT has made banks not just being profit-centric but also customer-centric banks [6]. The web based banking operations has made it possible to accommodate functions and processes in other sectors like in government (vehicle license registration) and education (payment of fees). With the aid of information technology, banks are closer to their customers to find out what they really need and deliver such needs. Information technology has made it possible for customers to gain access to their account balance, buy recharge cards and pay bills using their mobile phones anytime from anywhere. Online banking allows customers to get their current account balance at any time. Information technology leads to a reduction in cash transactions which leads to reduction in crime [7].

3. CHALLENGES OF IT APPLICATION IN NIGERIAN BANKS

Nigeria's poor infrastructures have been identified as the first major challenge in banks. Reports have it that in Nigeria, there are only one computer and four main telephone lines per thousand people. Also, electricity supply is sporadic and inefficient. Most importantly, Nigeria has very low internet penetration with less than one internet service provider per thousand people [8]. Highlighted was the ineffective implementation of information technology [9]. The challenges being faced by Nigerian banks in their attempt to ensure a smooth exchange of electronic data and information are [10]:

a) The need to build a better infrastructure that will serve as backbone for communication within the banks
b) The need to collaborate in sourcing for new technological equipment that will provide common standard
c) The need to get better at information technology system development and operation by bank management
d) The need to impress by improving the present telecommunications infrastructure

To combat these challenges, the following were proffered [10]:

a) There should be government and public awareness to attract long term investments in the telecommunication industry.
b) Emphasis should be set on the importance of maintaining existing infrastructure and equipment.

4. NETWORK DESIGN

Network design is a critical process to network architecture and administration. This section seeks to deliver a comprehensive network design based on two models; the existing network model and a proposed network solution for the bank. The design was broken down into 4 categories: The existing WAN, proposed WAN, existing LAN and, proposed LAN.

4.1 Research Methodology

We obtained the existing network design with emphasis on its topology, link speed, LAN/WAN technology. The existing bank network designs are reviewed. We measured the performance characteristics being offered by the existing network. Then propose network design solution that will give better network performance results and characteristics.

4.2 Existing Bank WAN

Basically, the bank leases a circuit (a particular amount of bandwidth) from a service provider. The service provider would take care of providing and maintaining the complete circuit from one location to other location(s) which includes owning and operating all the passive and active components required in maintaining the Wide Area Network. The leased lines cost more with increasing distance between locations. And in case of multiple branches, each branch needs to take a separate leased circuit to every other location to maintain communications between them.

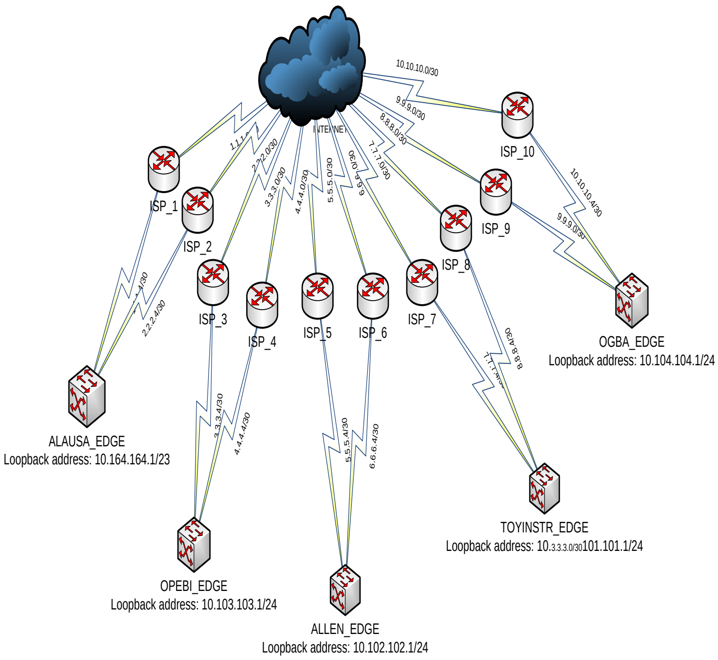


Figure 1: Existing Bank WAN

Leased lines have been traditionally a popular mode of connectivity between two branches or multiple branches in different locations. Leased lines are private, secure, scalable and quite sufficient for basic data connectivity between different branches. Basically, the bank leases a circuit from a service provider via multiple interfaces including Optic fiber etc.

4.3 Proposed Bank WAN Solution

The central office is the headquarters that connects to smaller central offices (regional headquarters) by fibre links.

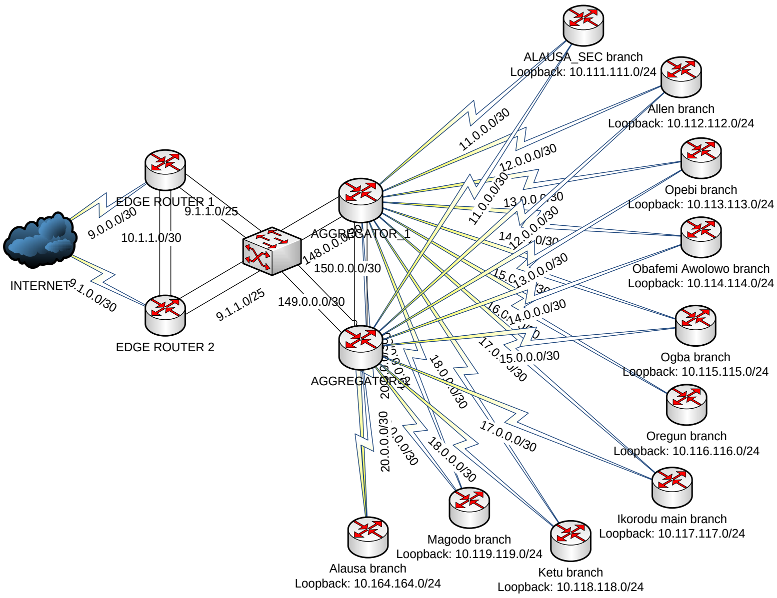


Figure 2: Proposed Bank WAN

At the hubs, point-to-multipoint links are being used while at the spokes, point-to-point links are being used. The star topology reduces the probability of network failure by connecting all of the spokes to a hub. The failure of a link between any spoke and the hub will only result in the isolation of that spoke from all others, but the remaining will be unaffected. An advantage of the star topology is the simplicity of adding extra spokes. It is such that even in any case of expansion, additional branches do not affect the existing branches network.

4.4 Existing Bank LAN

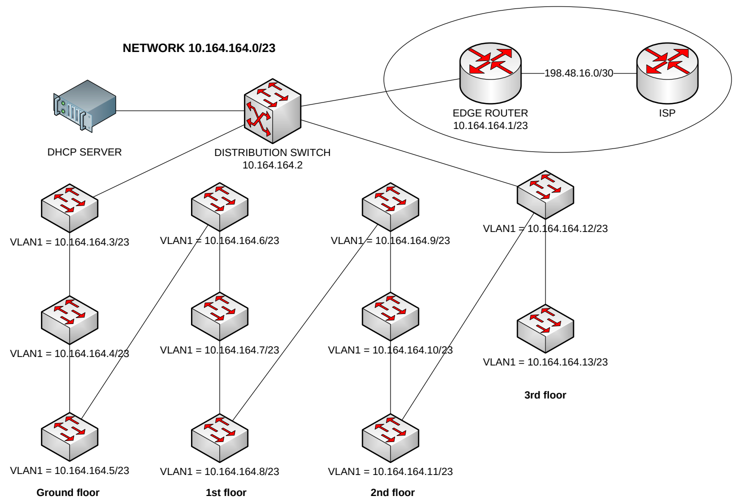


Figure 3: Existing *Bank* LAN

Each of these central offices act as hubs to several other branches (spokes) within their geographical area. In general, the topology used is physical star and logical bus. Here, each access layer switch acts as a node while the endpoints are the branches. A typical access layer switch acts as a hub to a maximum of about 24 branches. The failure of one switch port or link results only in the failure of that branch while every other branch remains active. Likewise, between the distribution switch and the access layer switches, redundancy is achieved because in star topology, failure of a link/node does not result in the failure of the network.

4.5 Proposed LAN Solution

The proposed network design guarantees both security and availability, in other words, it guarantees segmentation and redundancy. It employs a physical star and logical bus topology. With the use of

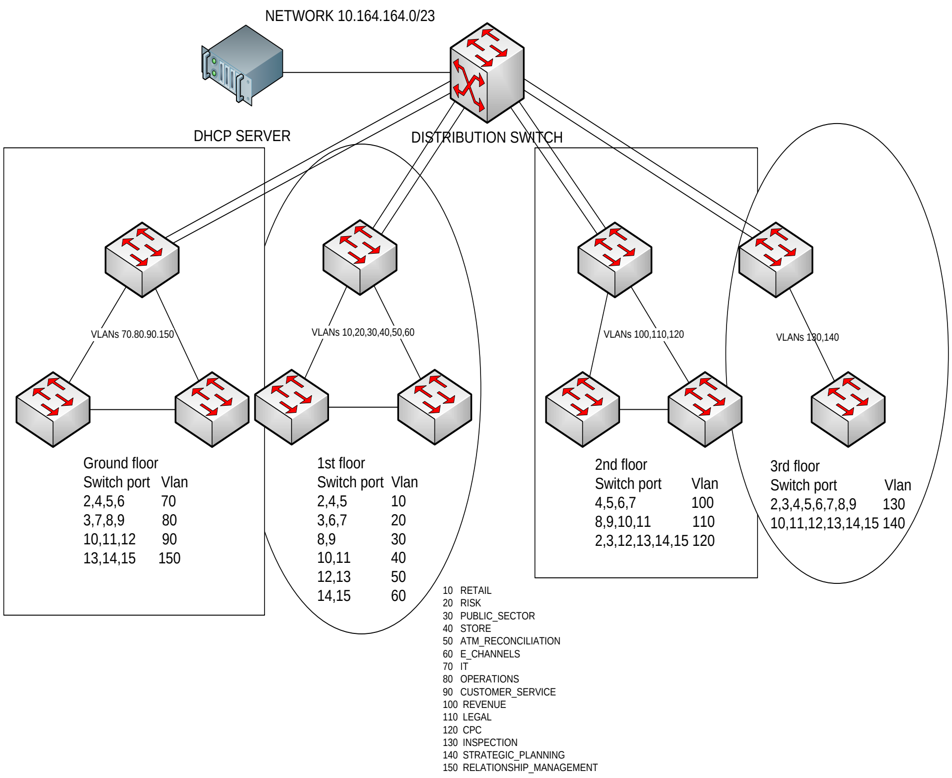


Figure 4: Proposed Bank LAN

Virtual Local Area Networks (VLANs), an access switch could segment a network (even without the network being geographically separated), and as such reduces bandwidth wastage as well as providing some degree of confidentiality. Due to the proper network segmentation, troubleshooting is made easier and faster than in a network that is not segmented. In addition, bandwidth allocation and optimization is highly achieved by the use of VLANs.

4. 6 Benefits of Proposed Solution

The proposed network solution offers the bank significant positive benefits which include cost, security, delay, jitter, latency and maintenance.

Cost: More cost is incurred when intra-bank transactions are done through the internet. More so, each branch being provided with internet access directly from an ISP results in more overhead cost. Therefore, routing intra-branch transactions without the use of direct internet leads to lower overhead. Moreover, workers are restricted from browsing during work hours (i.e., 9am - 5pm), which implies money spent not gained.

Security: The existing network is such that packet traffic is routed through the internet while in the proposed network, inter-branch traffic is routed within its own private network. Although intra-bank connections using tunnels offer some degree of security, it cannot be as secure as connections that do not go through the internet (public network) at all.

Delay/latency: Latency means any delay or waiting that increases real or perceived response time beyond the response time desired. Causes of latency include mismatches in data speed between the microprocessor and input/output devices and inadequate data buffers. The more security features available in a single connection, the more the delay. Intra-branch transactions were through VPNs which implies more security features, and as such more delay than in a network with less security features.

Jitter: Jitter is a direct offshoot of delay. Since, the existing network has been studied to give a higher delay than the proposed network; the jitter also is higher for the existing network than for the proposed network. A relatively high delay implies a high jitter.
Maintenance: By implementing VLANs on the proposed network, the network is more segmented than the existing network that is not at all segmented. Troubleshooting is greatly easier and faster in a segmented network since every office, link, node can be identified with a unique VLAN or otherwise segment.

5. NETWORK IMPLEMENTATION AND TESTING

Virtual Local Area Networks are used to logically segment users. VLANs are created in an enterprise to differentiate jobs done and people using specific networks. Every switch has a default VLAN of 1. By default, VLAN 1 has all switch ports pre-assigned to it. Figure 5 below shows the configured VLANs on DISTR_SW using "show VLAN-switch"

```
ACC_SW1#sh vlan-s

VLAN Name                             Status    Ports
---- -------------------------------- --------- -------------------------------
1    default                          active
10   IT                               active    Fa1/4, Fa1/5, Fa1/6
20   OPERATIONS                       active    Fa1/7, Fa1/8, Fa1/9
30   RELATIONSHIP_MANAGEMENT          active    Fa1/10, Fa1/11, Fa1/12
40   CUSTOMER_SERVICE                 active    Fa1/13, Fa1/14, Fa1/15
1002 fddi-default                     act/unsup
1003 token-ring-default               act/unsup
1004 fddinet-default                  act/unsup
1005 trnet-default                    act/unsup
```

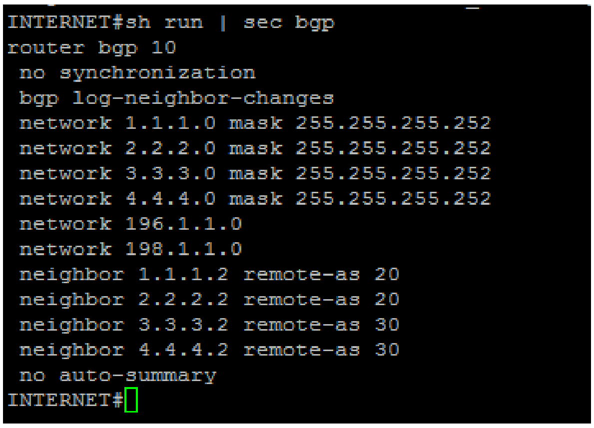
Figure 5: Assigning switch ports to configured VLANs

Dynamic Host Configuration Protocol (DHCP) as the name implies is a protocol used in auto-assigning IP addresses hosts within a network. As the network becomes larger, its impact is better felt. However, unless configured otherwise, DHCP leases out every IP address within the allowed network range including "network and broadcast addresses."

```
ip dhcp pool POOL
   network 10.164.164.0 255.255.254.0
!
!
no ip domain lookup
ip dhcp-server 10.164.165.2
```

Figure 6: Configuring DHCP

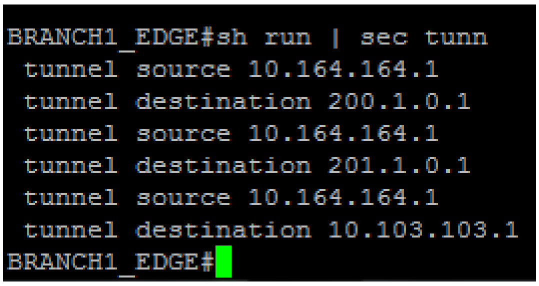
Communication at the network layer (layer 3) is only possible using routing protocols. BGP routing protocol was used since the network consists of both internet and extranet. Figure 7 shows BGP configurations on a router.



```
INTERNET#sh run | sec bgp
router bgp 10
 no synchronization
 bgp log-neighbor-changes
 network 1.1.1.0 mask 255.255.255.252
 network 2.2.2.0 mask 255.255.255.252
 network 3.3.3.0 mask 255.255.255.252
 network 4.4.4.0 mask 255.255.255.252
 network 196.1.1.0
 network 198.1.1.0
 neighbor 1.1.1.2 remote-as 20
 neighbor 2.2.2.2 remote-as 20
 neighbor 3.3.3.2 remote-as 30
 neighbor 4.4.4.2 remote-as 30
 no auto-summary
INTERNET#
```

Figure 7: Configuring BGP

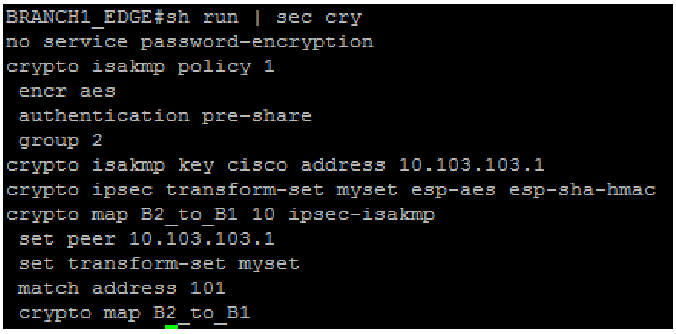
The security feature employed is the Generic Routing Encapsulation (GRE) over IPSEC tunnel which provides a secure connection between sites through an unsecure medium. Figure 8 shows tunnel configurations on a router



```
BRANCH1_EDGE#sh run | sec tunn
 tunnel source 10.164.164.1
 tunnel destination 200.1.0.1
 tunnel source 10.164.164.1
 tunnel destination 201.1.0.1
 tunnel source 10.164.164.1
 tunnel destination 10.103.103.1
BRANCH1_EDGE#
```

Figure 8: Creating tunnels

Figure 9 shows a Generic Routing Encapsulation (GRE) configuration on a router.



```
BRANCH1_EDGE#sh run | sec cry
no service password-encryption
crypto isakmp policy 1
 encr aes
 authentication pre-share
 group 2
crypto isakmp key cisco address 10.103.103.1
crypto ipsec transform-set myset esp-aes esp-sha-hmac
crypto map B2_to_B1 10 ipsec-isakmp
 set peer 10.103.103.1
 set transform-set myset
 match address 101
 crypto map B2_to_B1
```

Figure 9: Encrypting a tunnel interface

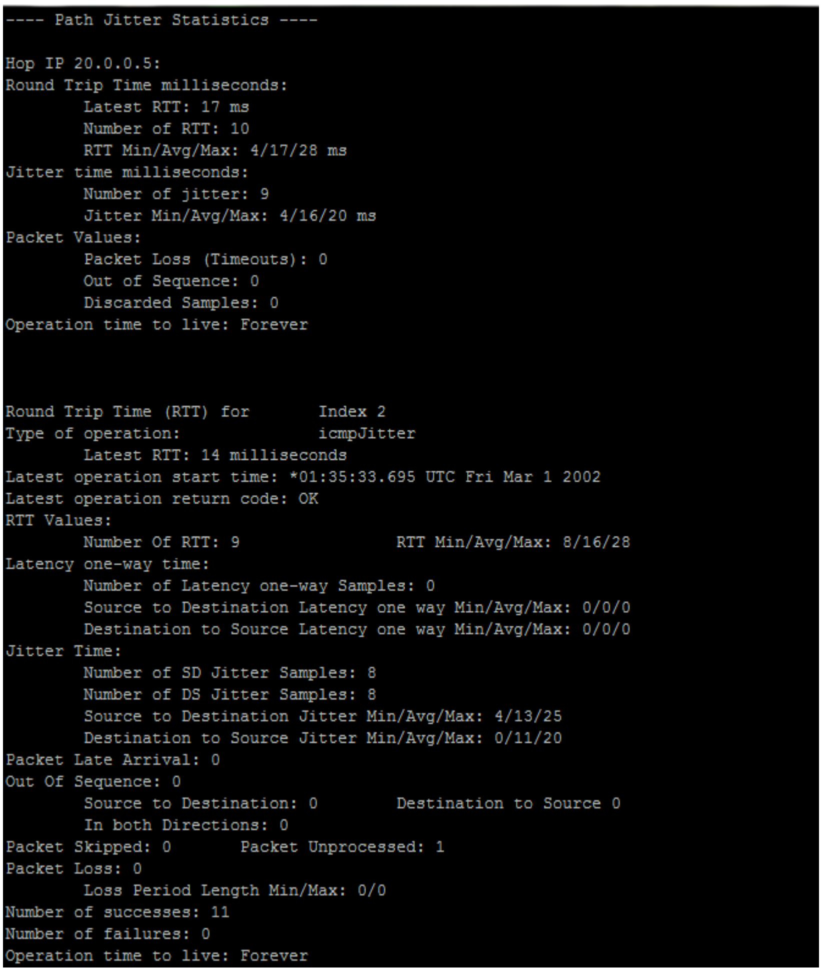
6. VERIFICATION

The verification shows successful connectivity between hops and appropriate neighbour. It further presents the delay and jitter encountered in branch to branch communication.

```
IPSLA operation id: 1
Type of operation: path-jitter
        Latest RTT: 87 milliseconds
Latest operation start time: *22:21:03.379 UTC Mon May 28 2012
Latest operation return code: OK

---- Path Jitter Statistics ----

Hop IP 1.1.1.5:
Round Trip Time milliseconds:
        Latest RTT: 18 ms
        Number of RTT: 10
        RTT Min/Avg/Max: 7/18/36 ms
Jitter time milliseconds:
        Number of jitter: 8
        Jitter Min/Avg/Max: 4/10/29 ms
Packet Values:
        Packet Loss (Timeouts): 0
        Out of Sequence: 0
        Discarded Samples: 0

Hop IP 1.1.1.1:
Round Trip Time milliseconds:
        Latest RTT: 39 ms
        Number of RTT: 10
        RTT Min/Avg/Max: 31/39/60 ms
Jitter time milliseconds:
        Number of jitter: 9
        Jitter Min/Avg/Max: 1/7/17 ms
Packet Values:
        Packet Loss (Timeouts): 0
        Out of Sequence: 0
        Discarded Samples: 0

Hop IP 4.4.4.2:
Round Trip Time milliseconds:
        Latest RTT: 66 ms
        Number of RTT: 10
        RTT Min/Avg/Max: 43/66/84 ms
Jitter time milliseconds:
        Number of jitter: 9
        Jitter Min/Avg/Max: 1/12/36 ms
Packet Values:
        Packet Loss (Timeouts): 0
```

Figure 10: RTT and Jitter for existing network

From the results shown in Figure 10, the time taken for a branch to communicate with another branch is determined by the sum of delay along each hop for the entire number of hops it takes to reach the destination from the source. Also, the Round Time Trip (RTT) is an increment at each hop = 87ms. The average jitter holds at 48ms (10 + 7 + 12 +19).



```
---- Path Jitter Statistics ----

Hop IP 20.0.0.5:
Round Trip Time milliseconds:
        Latest RTT: 17 ms
        Number of RTT: 10
        RTT Min/Avg/Max: 4/17/28 ms
Jitter time milliseconds:
        Number of jitter: 9
        Jitter Min/Avg/Max: 4/16/20 ms
Packet Values:
        Packet Loss (Timeouts): 0
        Out of Sequence: 0
        Discarded Samples: 0
Operation time to live: Forever



Round Trip Time (RTT) for       Index 2
Type of operation:              icmpJitter
        Latest RTT: 14 milliseconds
Latest operation start time: *01:35:33.695 UTC Fri Mar 1 2002
Latest operation return code: OK
RTT Values:
        Number Of RTT: 9                RTT Min/Avg/Max: 8/16/28
Latency one-way time:
        Number of Latency one-way Samples: 0
        Source to Destination Latency one way Min/Avg/Max: 0/0/0
        Destination to Source Latency one way Min/Avg/Max: 0/0/0
Jitter Time:
        Number of SD Jitter Samples: 8
        Number of DS Jitter Samples: 8
        Source to Destination Jitter Min/Avg/Max: 4/13/25
        Destination to Source Jitter Min/Avg/Max: 0/11/20
Packet Late Arrival: 0
Out Of Sequence: 0
        Source to Destination: 0        Destination to Source 0
        In both Directions: 0
Packet Skipped: 0       Packet Unprocessed: 1
Packet Loss: 0
        Loss Period Length Min/Max: 0/0
Number of successes: 11
Number of failures: 0
Operation time to live: Forever
```

Figure 11: RTT and Jitter for proposed network

In the proposed network shown in Figure 11, the number of hops has been reduced to 2 between any 2 branches hence better results for RTT and jitter. In this case, RTT = 17ms and the average jitter holds at 16ms for the full connection between end-points.

Performance Measures comparison	**Existing network**	**Proposed Network**
Jitter	48ms	4ms
Round Trip Time	87ms	17ms
Delay	14ms	5ms

Table 1: Performance measures comparison

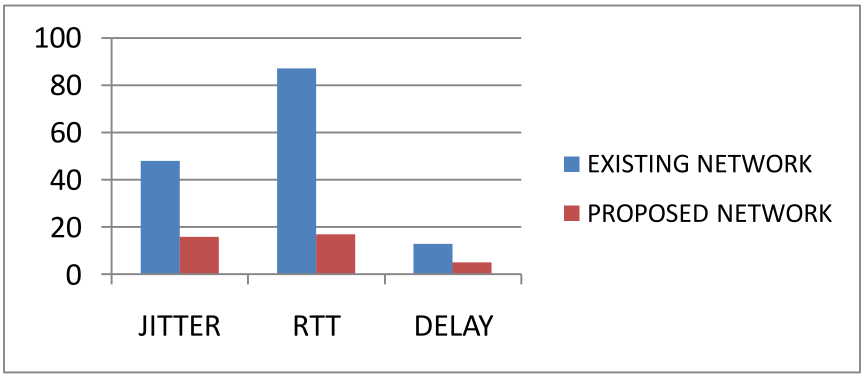


Figure 12: Comparative analysis between the existing and proposed bank networks

	Existing Bank Network	Proposed Bank Network
Cost	High cost since each branch leases internet link.	Less cost since internet connection is aggregated from central office to other branches.
Security	High security since each leased circuit is a private network even though inter-branch connectivity is through the internet using tunnels	Higher security since inter branch connectivity is purely within a private network
Delay	Moderate. More delay is due to distance between source branch and destination branch. Also, due to packet switching	Less delay. Average source-to-destination distance is 2 hops. Absence of packet switching WAN technology
Jitter	Moderate	Less
Maintenance	Not good	Good since every link or node, source has its source easily determinable

Table 2: Comparison of Significant Benefits

7. CONCLUSION

Banking operations have been made better through the adoption of Information Technology. Although, advances in technology bring its own shortcomings, its impact positively cannot be over-emphasized. Again, due to the ever evolving IT, security threats also constantly evolved, and as such, the need to adopt even better IT solutions. This work proposes a network design solution to accommodate for the lapses in the existing bank network. The banking institution is now greatly influenced by the strength of its Information Technology. Through networking, banking ceased to be only at the branch containing holder's information. A bank with branches nationwide seems like just in a building with internet banking, etc.

Though, the network design of any financial institution must satisfy- confidentiality, availability and redundancy which at present bank networks are in compliance with. This research has shown that advances in network design leads to reduced cost, improved security, less network delay and better

maintenance. From results obtained, the existing network design offers more delay between endpoints than the proposed network assuming constant bandwidth.
There exists opportunities in further enhancing this research work since Information Technology continually evolves. The ever-evolving IT also leads to an ever-evolving security threat. This implies advances into network design to eliminate any fear of future threats, and as such, the “security” aspect of the design should be researched.

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