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Design and Implementation of MikroTik Router-Operating System Introduction

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ABSTRACT: This paper presents the design, configuration, and implementation of a MikroTik Router-OS system aimed at alleviating challenges faced by students during their academic research activities at the Nigerian Institute of Leather and Science Technology (NILEST) in Samaru Zaria. The proposed solution incorporates an administrator portal, NILEST.com, enabling login access for students and staff. The implementation of this system facilitates seamless online research for students throughout the campus, fostering an improved learning experience. Upon investigating the current research methods at NILEST, it was evident that the existing approaches were inadequate and outdated in today's rapidly evolving information technology landscape. By adopting the MikroTik Router-OS system, NILEST stands to benefit significantly in terms of streamlined research processes and enhanced connectivity for students and staff. However, to maximize the potential of this system, it is crucial to ensure its proper implementation and continuous improvement. Through these efforts, NILEST can effectively leverage modern information technology solutions to promote a more efficient and engaging academic research environment.

Keywords: MikroTik Router-OS, NILEST, information technology, campus connectivity
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INTRODUCTION

MikroTik, known internationally as MikroTik, is a Latvian manufacturer of computer networking equipment. It sells wireless products and routers (Fathurohman *et al.,* 2022). The company was founded in 1996 to sell in the emerging wireless technology market. As of 2015, the company has more than 160 employees. The company's products are known for being low-priced alternatives to expensive routers and Ethernet radio relay lines (Hadi, 2022).

The main product of MikroTik is an operating system based on the Linux kernel, known as the MikroTik RouterOS. Installed on the company's proprietary hardware (Routerboard series) (Muc *et al.,* 2020) or standard x86-based computers, it turns a computer into a network router. It implements various additional features, such as firewalling, virtual private network (VPN) service and client, bandwidth shaping and quality of service, wireless access point functions and other commonly used features when interconnecting networks (Slamet et al., 2021). The system can also serve as a captive-portal-based hotspot system (Herlina, 2022). Department of Defense (DoD) unclassified networks, and they suggested that over 64% of the attacks were successful. Since most client computers do not include the ability to provide a firewall facility in the client remote or residential computer, the chances of being attacked when Connected to public high-speed networks is extremely good as well as having a high potential for success (Ari, 2022). A 1996 US General Accounting Office report showed over 240,000 attempts at attacking the US (Darmianto, 2022). It is well known that the DOD takes security very seriously (Zamros and Bahari, 2022). So, what will happen to the potential millions of telecommuters who connect to their office facilities with no network security facilities and who leave their home-based systems on all day while at the office and also while connected to the high-speed network provided by the cable television vendor? Free-lance attacks will be

the norm and easily accomplished (Danang and Setiawan, 2022).

The operating system is licensed to increasing service levels, each releasing more of the available Router-OS features (Syaputra and Stiadi, 2020)). A Microsoft Windows (MS) application called Winbox provides a graphical user interface for the Router-OS configuration and monitoring. Still, Router-OS also allows access via file transmission protocol (FTP), telnet, and secure shell (SSH) (Irfan and Heryanto, 2020). An application programming interface is available for direct access from applications for management and monitoring (Rahman *et al.,* 2020).

Lack of internet connection is a setback in an institution like NILEST. Internet contributes heavily to research which is still lagging in this system and is the immediate up necessity of this design (Doni, 2019). However, we seek to address the problem of internet creation in an institute like NILEST. Looking around the country, information and communication technology dominate, requiring each unit to be functional, active and easy to access. NILEST is found to lag, and then we came up with this low-cost network-OS, which comes with the capacity to connect us without much stress like others such as Cisco etc. The aim is to address the problem of internet access in NILEST. This design is the Design and Implementation of MikroTik Router-OS. It covers the significant advantages of using the system and describes its flexibility, ease of management and maintenance. Indeed, it addresses the internet limitation of the institution, staff, and students access to the network.

METHODOLOGY

This part of the design tried to see the different ways this design's specific objective was achieved. In the course of this design, due to error, inefficiency and problem associated with access to the Internet at the Nigerian Institute of Leather and Science Technology (NILEST). The affordable sources of the network were discussed, such as how it can be setup, the essential maintenance and routing.

System analysis

This chapter focuses on the analysis of the operation of the system and its implementation that will enable potential students and staff to carry out their research works and be kept up-to-date in the World of information and communication technology, which we are in today. Analysis can be seen as the methodological study of a system, its current and future requirements, objectives and procedure to form a basis for the system and design (*Candra et al., 2022*). System analysis is the detailed study of the various operations performed by the system and their relationships within and without the system.

System analysis is concerned with becoming aware of the problem, identifying and synthesizing the various factors and determining an optional or at least a satisfactory solution (Candra *et al*., 2022). System analysis is a problem-solving technique that decomposes (breaks) a system into its parts and interacts to accomplish the purpose and objectives of the plan (Candra *et al., 2022*). The work of system analysis is to go into a system, study the system, understand the system, and draw out a goal and objectives of such system management. The effectiveness and efficiency of the wok of an analyst can go a long way in affecting the system in such a way as speed, operation, testing and reliance (Abdullahi, 2009). In every system development, close to 50% of faults oriented comes from a lack of shortcoming system analysis.

Feasibility analysis

The feasibility of a system involves a thorough assessment of the operation (needed) and the financial and technical aspects of the system. The feasibility study is the study of the proposed system made to identify whether the user need may be satisfied using the system will be cost-effective from a business point of view (Candra *et al*., 2022). Feasibility analysis is defined as the activity by which feasibility or the potential outcome of the design is measured and accessed, while feasibility measures how healthy the development of an information system would be to an organization or society (*Candra et al., 2022*). The following feasibility tests were carried out to determine whether the design is feasible or not:

Operational feasibility tests

This analysis involves how the system will work when installed and the assessment and the political and managerial environment in which it is implemented. It measures how well the solution will work in the given locality and how users feel about it. Operationally, the design will be feasible because it has been analyzed that both students and staff using the system will work effectively both for the user and the organization. The measure of feasibility of any design is determined by the acronym: PIECES. The meaning is given below: Performance: Does the system provide an adequate response to time? This system would be designed to provide sound output and time response.

Information: Does the system provide administrators and end users with accurate, practical, and timely information? This system would be designed to give administrators, officers and users accurate, useful and timely information always to use.

Economy: Does the system offer an adequate service level and capacity to reduce the business's cost or increase the company's profit? Yes, this system would be designed to provide good services like lowering the cost

and increasing profit by being the source of revenue for the institute or organization. Control: Does the system offer adequate authority to protect against fraud and guarantee data and information accuracy and security? Yes, it is the primary target of the new system. Efficiency: Does the system make maximum use of the available resources? Time and provide an answer to their problem maximally? Yes, the new system would minimize dalliance in its data processing through optimization speed. Service: Does the system provide desirable and reliable services to those who need them? Yes, it is flexible and interactive; the new system would provide a service with a good measure of flexibility and expandability.

Technical feasibility test

The technical feasibility measure must be based on an outline design of system requirements regarding input, output, files, programs and procedures. It measures the technicality of a specific technical solution and the availability of technical resources and experts and technical resources needed are available in society. Therefore, technological solutions are provided to resolve the problem.

Schedule feasibility test

This measures how reasonable the design timetable will be. The design is feasible because the time frame to develop the newly proposed system is sufficient.

Economic feasibility test

This measures the cost of effectiveness of a design or solution. This design is economically feasible because even if it involves hosting, it may be annually or bi-annually, as the case may be affordable. Considering and analyzing the four major feasibility tests mentioned above for the proposed design, we can now conclude that the design is feasible.

System design

A design system can be defined as applying various technologies and tools principles to determine a device, a process ora system in sufficient detail or permit a new system. System design is a complementary problem-solving technique that resembles a system component process back into a complete system, hopefully, an improved system (Figure 1). This may involve adding and removing some details (*Candra et al., 2022*).

System requirement

An advanced 4th generation (core frequency 100MHz or more), 5th generation (Intel Pentium, Cyrix 6X86, AMD K5 or comparable) or newer Intel IA–32 (i386) compatible motherboard and processor; from 32MB to 1GB RAM (from 48MB suggested); 30MB or more PRIMARY MASTER IDE HDD or IDE flash drive. Note: The hard disk will be entirely reformatted during the installation, and all data will be lost! A network adapter (NE2000 compatible PCI, ISA Ethernet card, or any other supported NIC).

Software requirement

The software required for configuration includes:

Operating system window 7 (32bit)
MikroTik Router
Winbox

The operating system increases service levels, each releasing more of the available Router-OS features. A Microsoft Windows (MS) application called Winbox provides a graphical user interface for the Router-OS configuration and monitoring. Still, Router-OS also allows access via file transmission protocol (FTP), telnet, and secure shell (SSH). An application programming interface is available for direct access from applications for management and monitoring so that the next chapter would install the network operating system with its features.

RESULTS AND DISCUSSION

System configuration and implementation

Configuration

The system configuration is the default setting life cycle or software configuration process in network engineering, is the process of creating or altering ordered information system, and the models and methodologies that people use to configure these systems (http://en .m.wikpedia.org/wiki/system development life cycle" accessed 2013)

System implementation

System implementation realizes a technical algorithm specification as a program, software component, or another computer system through programming and configuration. Many implementations may exist for a given specification or standard. For example, Networking contains internet protocols (IP) that address performance of sever recommended specification tools and implementation settings of programming (Wikipedia, 2013).

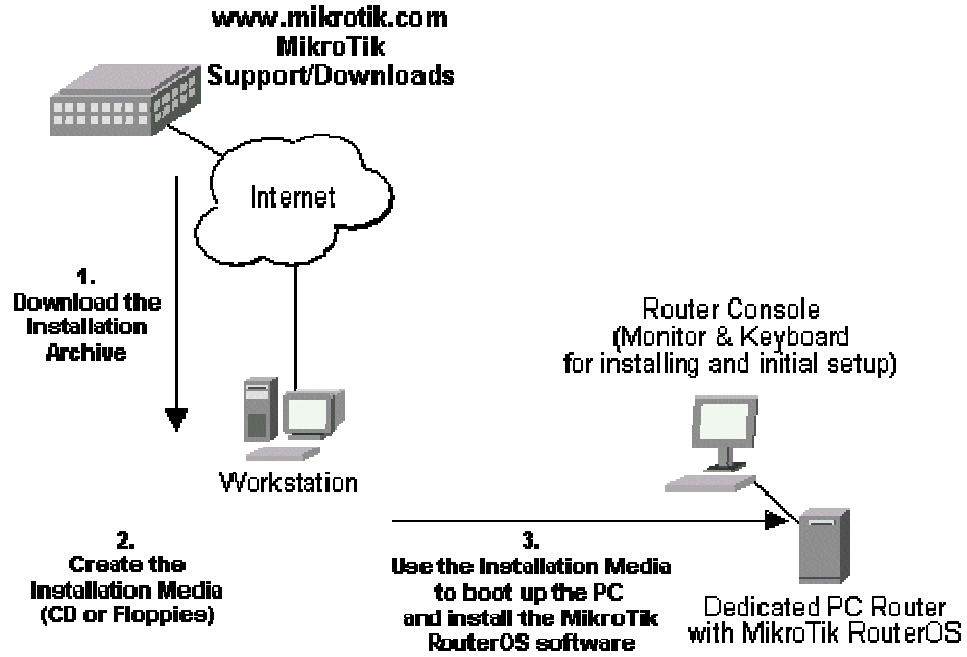

Figure 1: system architecture

System documentation

As explained by Paul *et al.,* (2002), it is the creation of an artefact, namely, a document, which may be electronic files, web pages or paper.

Interface form

Address (IP)
Bridge
Gateway
Routing
The domain name (DNS)
Internet Server protocol (ISP)
Wireless access
Hotspot
Administrator
Login

Advantages

The "simplest and cheapest network operating system ever exists, MikroTik Router-OS",in hardware and software. It is affordable and quickly set up for small and large business enterprises. They are friendly network appliances that work with other networking devices' cooperate bodies. It is designed in such a friendly way.
You can do almost everything that a proprietary router does at a fraction of the cost of such a router and have flexibility in upgrading, ease management and maintenance. No Operating System is needed. The MikroTik Router-OS is a standalone Operating System. The OS is Linux kernel based and very stable.
Significant advantages of MikroTik Router-OS include:

Security: information technology defends digital information and IT assets against internal and external malicious and accidental threats. These defences include detection, prevention and response to threats using security policies, software tools and IT services (http://serchsecurity.techtarget.com/definition/security).
Since most client computers do not include the ability to provide a firewall facility in the client's remote or residential computer, the chances of being attacked when connected to public high-speed networks are extremely good, as well as having a high potential for success. A 1996 US General Accounting Office report showed over 240,000 attempts at attacking the US Department of Defense (DoD) unclassified networks, and they suggested that over 64% of the attacks were successful. It is well known that the DOD takes security very seriously. So, what will happen to the potential millions of telecommuters who connect to their office facilities with no network security facilities and who leave their home-based systems on all day while at the office and also while connected to the high-speed network provided by the cable television vendor? Free-lance attacks will be the norm and easily accomplished (Developing World); on June 15, 2015, Brian Krebs, an online reporter, reported that "recently, researchers at the Fujitsu Security Operations Center in Warrington, UK began tracking [the] Upatre [trojan software] being served from hundreds of compromised home routers, particularly routers powered

by MikroTik and Ubiquiti'sAir OS is very effective in security (Zach, 2014).

1. Portability: a portable thing like MikroTik-OS can easily be moved, used, and tested for quality and durability. It is movable such that it can embed all networking features in it, features a firewall, hardware support, installation, configuration, multiprotocol label switch etc. not only that, it comes with a free license trial for 24 hours of which is used if 3 hours each day, can use for three days, also, as software which can install on company proprietors and can take it captive and can turn it to network OS.

2. Less expensive: The cost factor comes into the picture. A Cisco router with MPLS support would cost a few thousand dollars; however, one can find MPLS support in MikroTik routers in the market for a few hundred dollars (Zach, 2014). So working with MikroTik is like spending a few hundred dollars to buy a MikroTik router and putting in brains worth thousand dollars. MikroTik also offers an API to send commands to the router, which allows users to customize MikroTik routers. Cisco offers no such API. MikroTik routers also offer hotspot profiles allowing admins to create customizable guest user authentication profiles. These types of integrations are common for wifi services in public places. Compared to Cisco's unified wireless solutions, this would cost only a fraction of what Cisco's wireless solution would cost. it is less expensive than other network operating systems in terms of cost and maintenance. The operating system is licensed in increasing service levels, each releasing more of the available Router-OS features. A Microsoft Windows (MS) application called Winbox provides a graphical user interface for the Router-OS configuration and monitoring. Still, Router-OS also allows access via file transmission protocol (FTP), telnet, and secure shell (SSH). An application programming interface is available for direct access from applications for management and monitoring.

3. Features: The great thing about MikroTik is that the part set out of the box is tremendous. I can do more of what a Cisco router can for about a quarter of the cost. But MikroTiks are not easy to learn. To figure it out, you need to be fairly advanced in your networking skills. Once you do, though, you will have a great weapon Router-OS supports many applications used by Internet service providers; for example, Open Shortest Path First (OSPF) is a routing protocol for Internet Protocol (IP) networks. It uses a link state routing (LSR) algorithm and falls into the group of interior routing protocols operating within a single autonomous system (AS). It is defined as OSPF Version 2 in RFC 2328 (1998) for IPv4.The updates for IPv6 are specified as OSPF Version 3 in the requirement for comment (RFC 5340) (Zach, 2014).

(RFC 5340) (OSPF is perhaps the most widely used interior gateway protocol (IGP) in large enterprise networks. Intermediate System to Intermediate System (IS-IS), another link-state dynamic routing protocol, is more common in large service provider networks. The most widely used exterior gateway protocol is the Border Gateway Protocol (BGP), the principal routing protocol between autonomous systems on the Internet), BGP, Multiprotocol Label Switching (VPLS/MPLS), OpenFlow. The product is supported by MikroTik through a forum and a wiki, providing various thematic examples of configurations. Router-OS supports Internet Protocol Version 4 (IPv4) as well as Internet Protocol Version 6 (IPv6).

4. Accuracy: A measurement system is considered valid if it is accurate and precise. Related terms include bias (non-random or directed effects caused by a factor or factors unrelated to the independent variable) and error (random variability). In numerical analysis, accuracy is also the nearness of a calculation to the actual value; At the same time, precision is the resolution of the representation, typically defined by the number of decimal or binary digits.

Setup using winbox version 2.2.16

1. Connect your Windows computer directly to the router with an Ethernet cable, or connect them through a switch.
2. Run the Winbox program, then click the button.
3. The Winbox tool should find your router and display its MAC address
4. Click on the MAC address part of the text in the scan window. This will load the MAC address into the connection to the text box.
5. Press Connect and the Winbox GUI interface will be loaded.
6. Configuring an IP address on the interface you are connected to is always advisable. Once you have a valid IP address on the router that is reachable by your PC, you should close down Winbox and reconnect by entering the IP address into the connect to box in the Winbox loader rather than the MAC address that you initially joined (Figures 2-6).

This is because communication is carried out via broadcast traffic when connected via the MAC layer. This is a very unreliable method and may cause an unexpected disconnect occasionally. When you click via an IP address, you will have a more stable TCP router connected to the router (Wikipedia).

Troubleshooting

If the router is not showing up when you click the button, the following may be why:

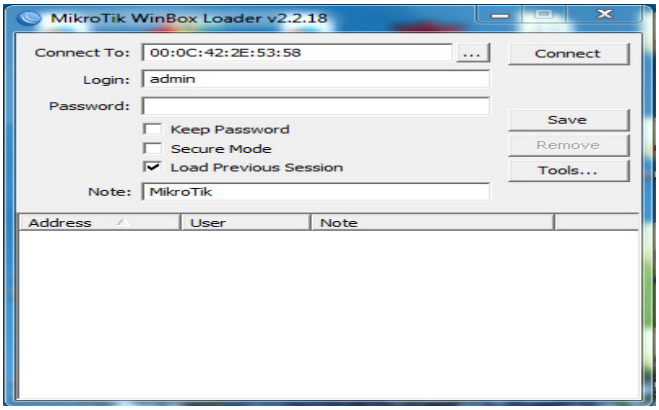

Figure 2: Interface 1

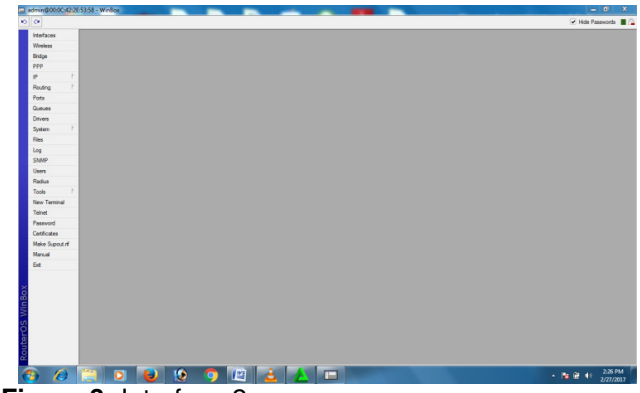

Figure 3: Interface 2

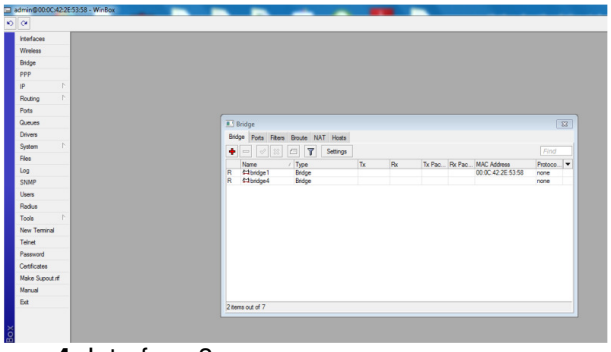

Figure 4: Interface 3

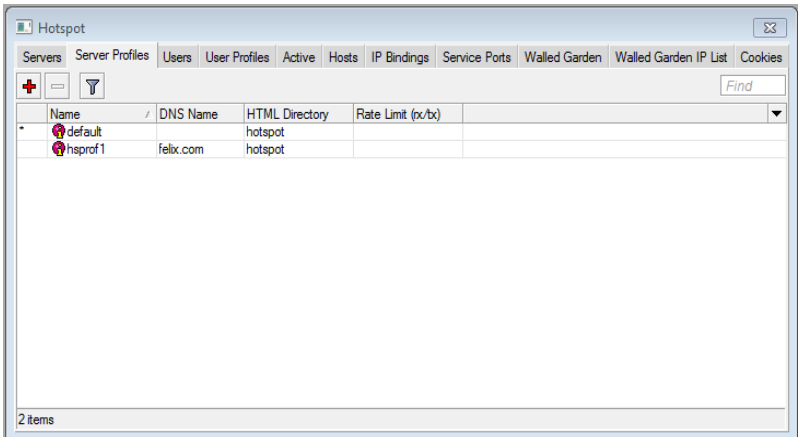

Figure 5: Interface 4

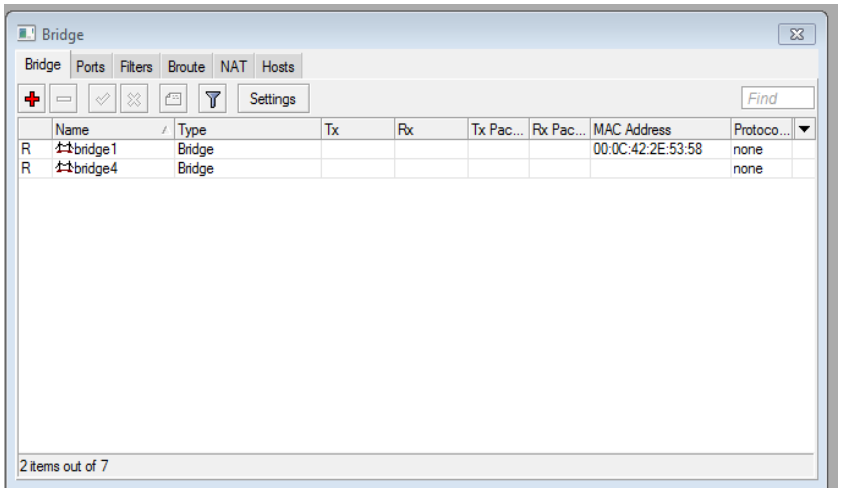

Figure 6: Interface 5

(I) Your Windows firewall may be blocking the Mac Broadcasting - Try turning off your firewall, both the Windows and any other commercial one that you may have installed, and or try adding Winbox to the exception list in your firewall.
(II) Another possible problem is that if you are connected through a managed switch with broadcast storm control features, it may be required to relax the broadcast threshold on the button as a switch may mistake a large amount of broadcast traffic as a misconfigured network start to block the traffic.

Conclusion

This design configuration and implementation of the Router Board system for Nigeria Institute of Leather and Science Technology Samaru Zaria has been tested and proven effective, reliable and secure. It can allow students to conduct online research anywhere in the school. During the investigation of this design, it was discovered that the present research method is neither idle nor the best for Nigeria Leather and Science Technology Samaru Zaria in this era where information technology has virtually taken over everything in the World. This system has much to offer if only implemented and improved upon. This design did not cover many aspects that, if carefully considered with enough time and resources, would have produced a better and more efficient system. The condition of network hackers in Nigeria is quite lamentable, in that since the advent of inter-network human secrecy is as take. To take care of this, MikroTik Router-OS should be used, which can track down unusual movements on the network and keep all the records of past and present.

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