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# Design A VLAN-Based Branch Network: College of Political Sciences as a Case Study

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**Abstract**
Network performance is influenced by user satisfaction, which is directly related to the network services provided. Fault tolerance, scalability, Quality of Service (QoS), and security are four basic characteristics that need to be addressed in terms of network architectures to meet user satisfaction. Diverse engineering and architectural aspects should be leveraged in modern converged enterprise campus networks from a design standpoint. In this study, existing network architecture of the political sciences college at the University of Kufa is identified and analyzed for any issues that could affect user satisfaction. The final phase will be to propose a new network design that meets user satisfaction without high costs. To achieve the proposed design and network criteria, packet tracer software is used to design and test the new network architecture.

**Keywords:** Switched Network**;** VLAN; Packet Tracer; Network infrastructure.

## 1. Introduction

The Faculty of Political Science is one of the faculties of the University of Kufa located outside the main campus of University of Kufa, and it was an annex building and it did not belong to the University of Kufa's network campus [1]. The existing network suffers from weak signal and incorrect distribution of access point network devices[2]. Next to the college's main building is the Kufa Studies Center that also suffers from the same issues. Therefore, a new network design is needed to deliver satisfactory services to staff, teachers and students[3]. The network shall have at least the following four basic features that network architectures need to address to meet user satisfaction: fault tolerance, scalability, service quality (QOS), and security [4] [5].
In 2009, Choi et al., proposed a network infrastructure that enables firms and organizations to adapt changing business needs rapidly, addressing needs that had never been met before [6]. Also in 2017, Vadivelu and Malathy showed that the aggregation and linking are done via Virtual Local Area Network (VLAN), Dynamic control of redundant traffic occurring in VLAN environments is discussed and the effect of redundancy in actual networks is measured and through experiments, the effects on transmission of a routing point migration mechanism using HSRP are shown. It is clearly understood that the mechanism improves performance and is feasible with real network devices. Experiments on larger-scale networks that include more complex topologies are subject to future work [7]. Nathaniel et al. in 2017, describe how the tool can be used to develop a simulation model of the LAN for the College of Engineering of the University of Agriculture, Makurdi, Nigeria, a Local Area Network (LAN) that used both wired and wireless topology has been implemented with some important concepts such as DHCP, DNS, Email, and VLANs in a single network using Cisco Packet Tracer. VLANs have been used to logically group clients on the network, and with the aid of a router and switch configuration, data packets were routed from one device to another. It is also noteworthy that, the configuration and specifications are for the initial prototype and can be further developed, and additional functionality can be added to increase support and coverage. The procedures provide a valuable approach for the design of LANs for end-to-end IP network connectivity for Next Generation Network (NGN) architecture implementations [8]. Abdulkareem et al. In 2018 examined the current network architecture and characteristics of the campus network at the University of Kufa and proposed recommendations to develop a high-performance network on campus that is fully scalable, more secure and effectively utilized [2]. In [1], authors tried to select an optimal location for APs at Department of Electrical Engineering within the Faculty of Engineering at the University of Kufa by using the combination of the received signal levels (RSL) and the effective service coverage area. In this study, the objectives are to design integrated infrastructure local area network for Political Sciences College and Kufa Studies Center, to identify the obstacles of the current network, analyze these constraints, including the weak signal and incorrect

distribution of access points, from which the network suffers, propose a new integrated design that meets user requirements, implement it in Packet Tracer software, and test its network specifications.

## 2. Methodology

This research comprises of four phases:

*2.1 Phase 1: Existing network analyzing*

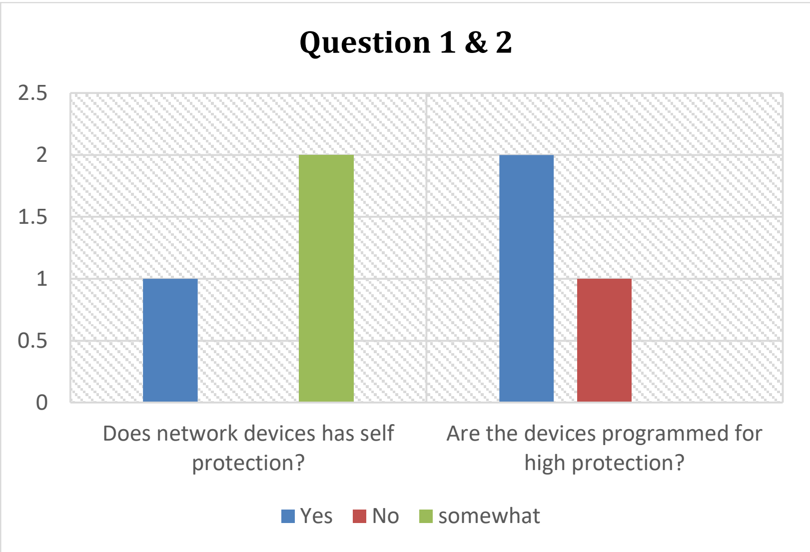
A detailed analysis was conducted on the existing buildings (the college, the dean's building, and the Kufa Studies Center). The analysis covers all floors, rooms, and classrooms, where the number of electronic devices was counted. In Figure 1, the design of one floor shows the details of the rooms. The signal in the three buildings was measured by a program used to measure signal strength and quality. In Figure 2, one of the signal cases is shown on the second floor of the college. Due to the type of access points and their faulty locations, the analysis revealed that some areas have little to no signal, resulting in dead Wi-Fi spots. A questionnaire was administered to four groups (employees, staff, teachers, and students) to assess the current network status, the services it provides, and their expectations for an ideal network designed according to international standards. Specific questions targeted employees to clarify the status of security, scalability, and existing network services. Questions for staff and teachers investigated whether the network provides continuous coverage, as well as the services currently available and those they hope will be available.

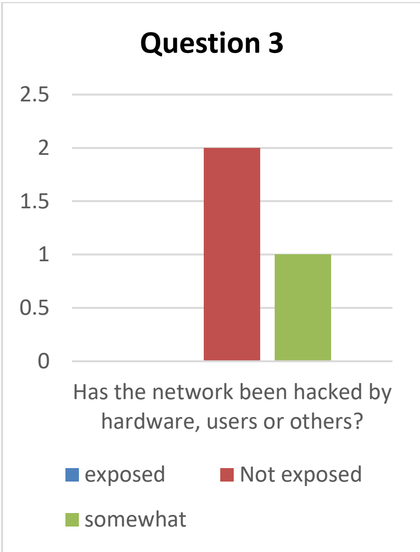
*2.2 Phase 2: Identify factors and limitations of the existing network*

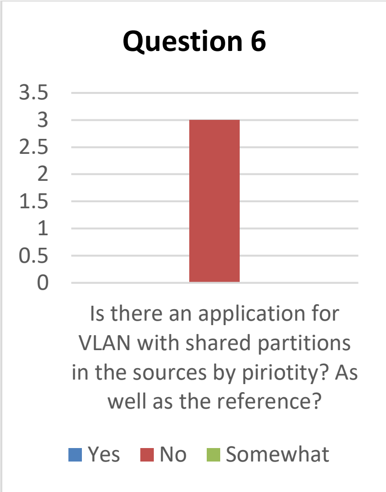
Using the network coverage illustration program, a diagram showing the signal status on each floor can be seen in Figure 3. Through the questionnaire, the standards provided by the current network have been made very clear in comparison to the standards we aspire to provide in the proposed network, as detailed in Tables 1, 2, 3, and 4.

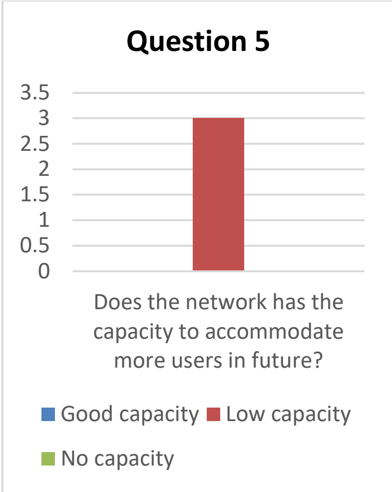
The following bar charts show our questionnaire results divided into four groups: Admins, Employees, Academics, and Students.

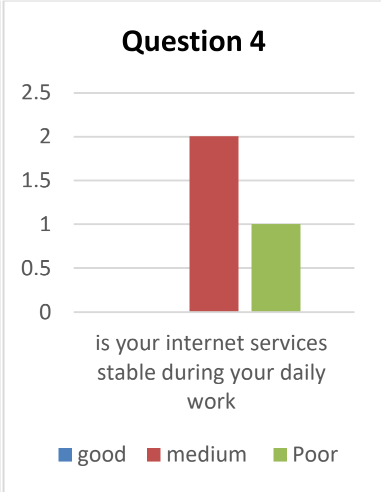
1-*Questions for the network Admin*

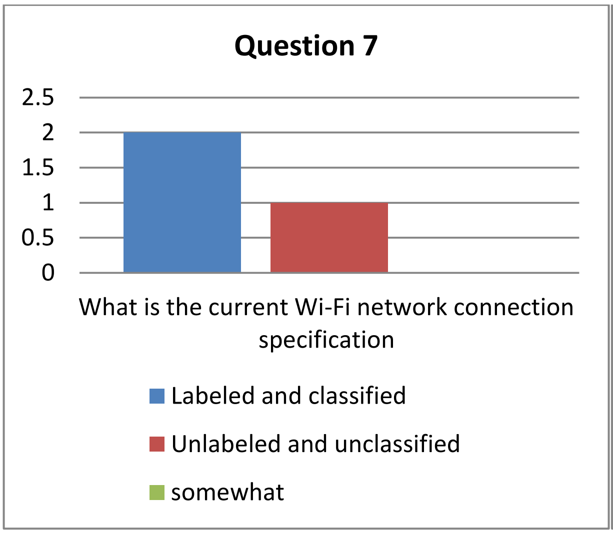


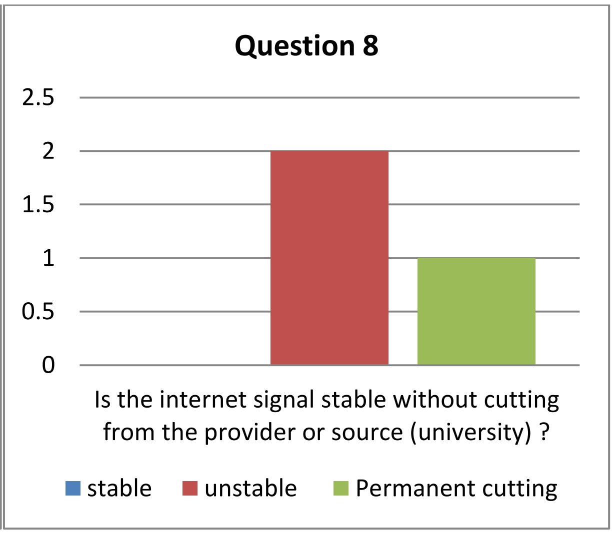



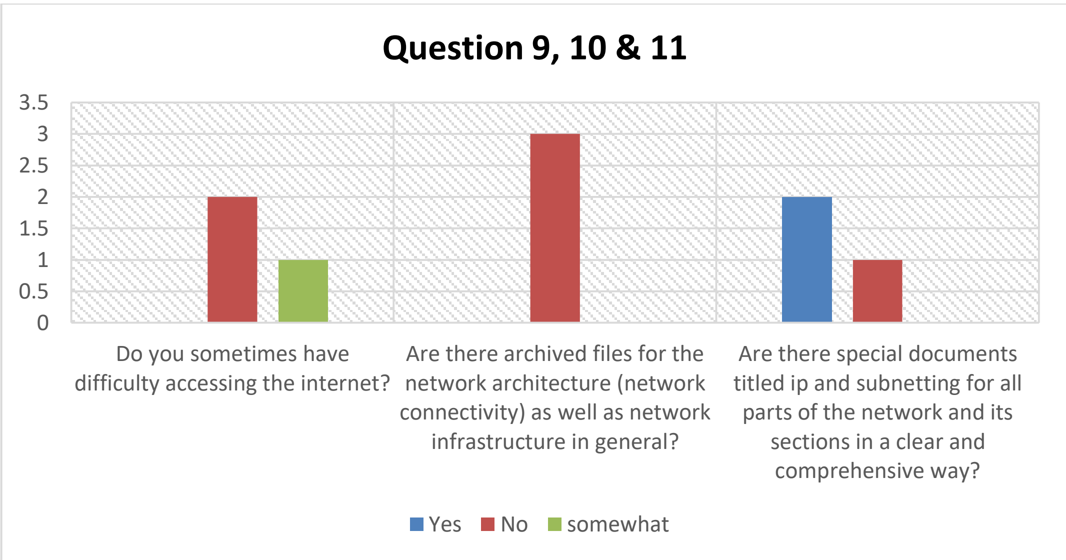


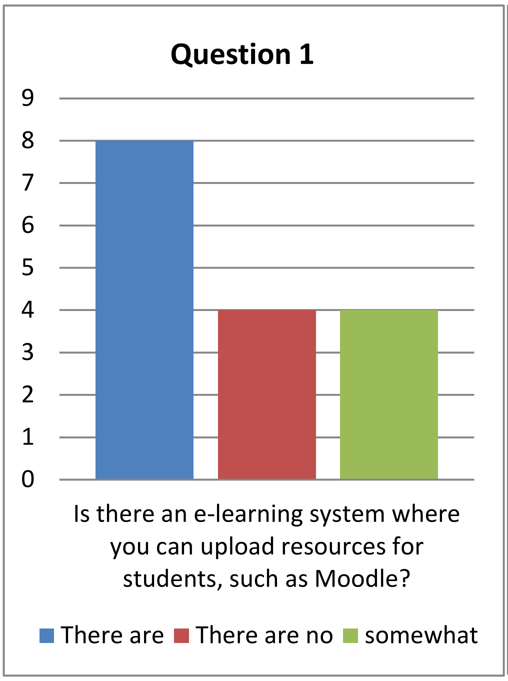



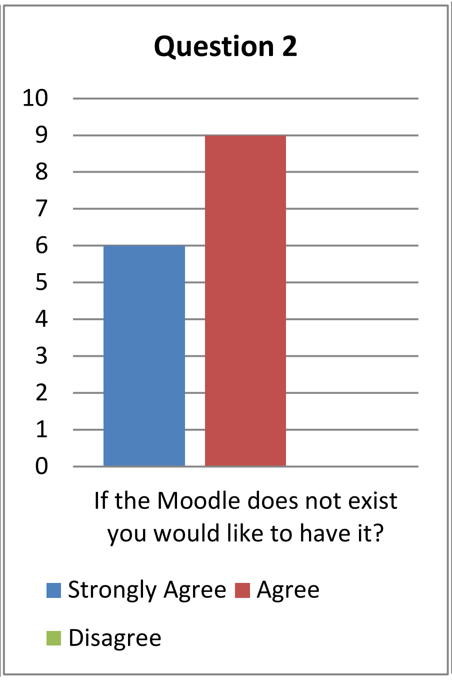



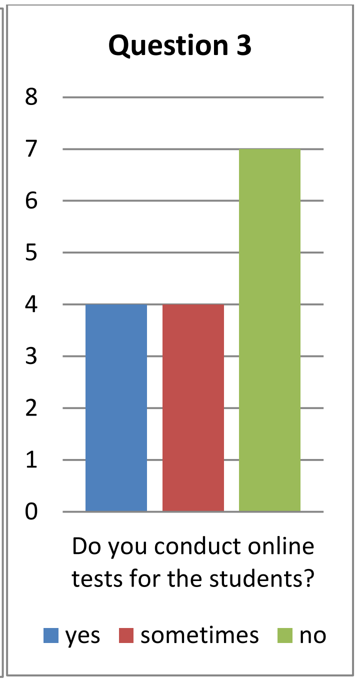



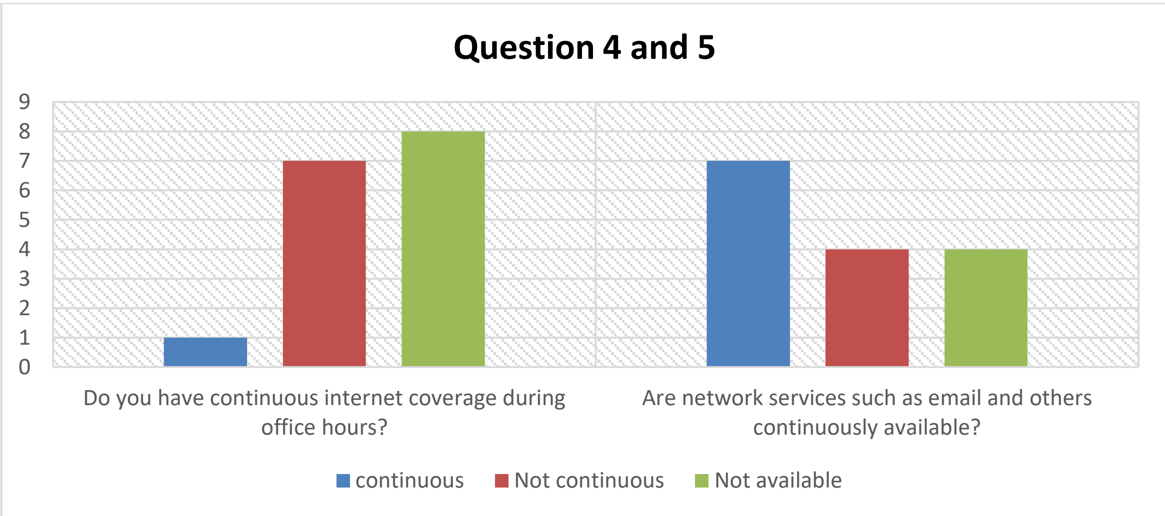




*2-Questions for the Teaching Staff*

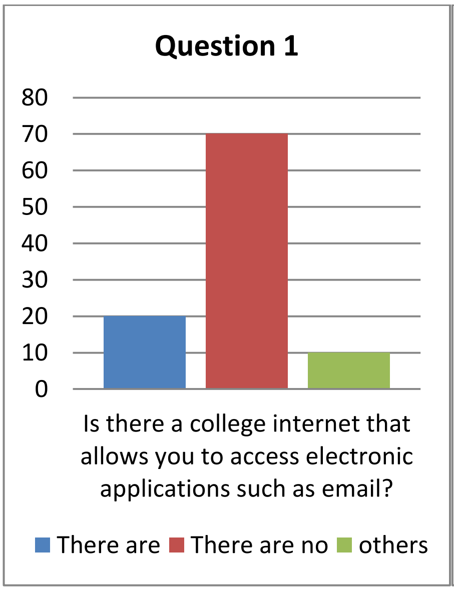


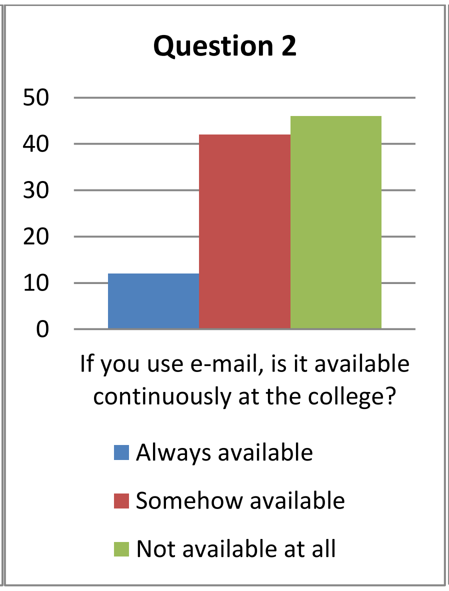



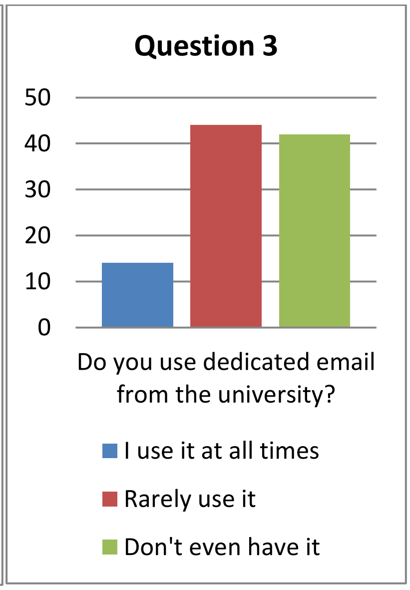



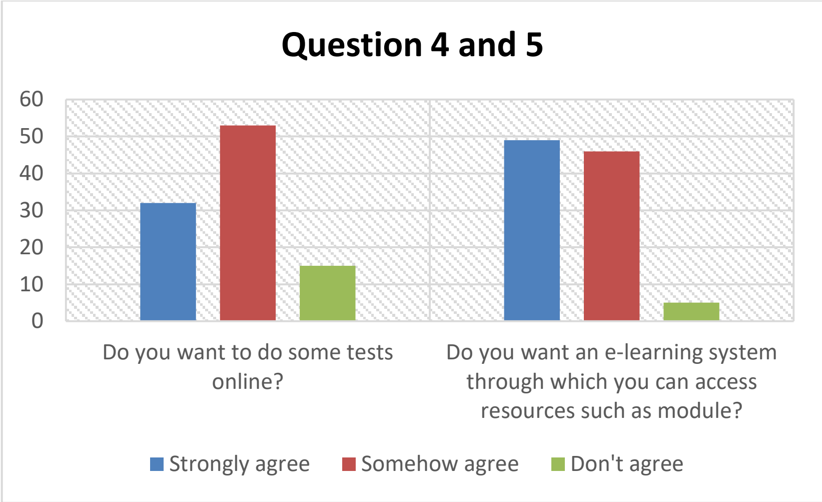




*3- Questions for Students*

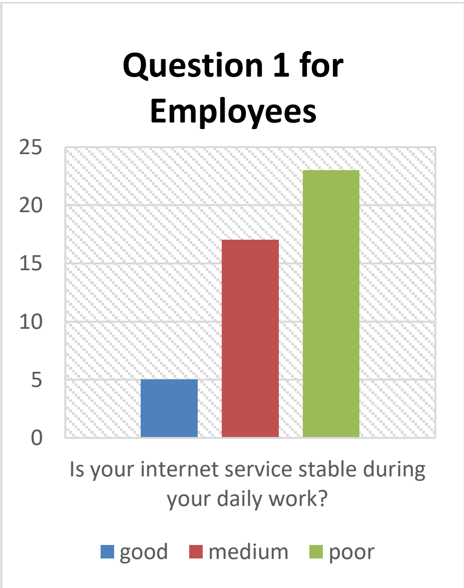


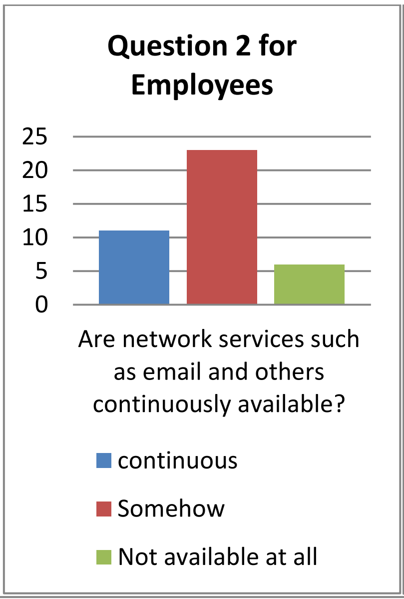



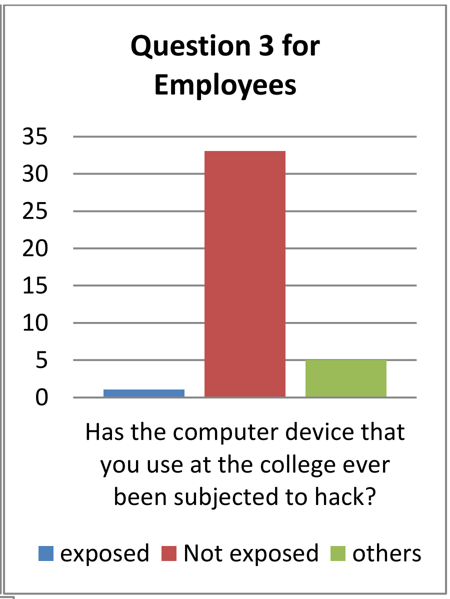



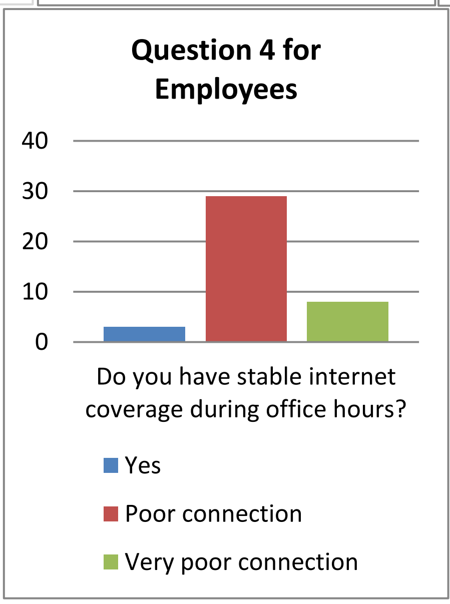



*3- Questions for Employees*




*2.3 Phase 3: Proposed design network*

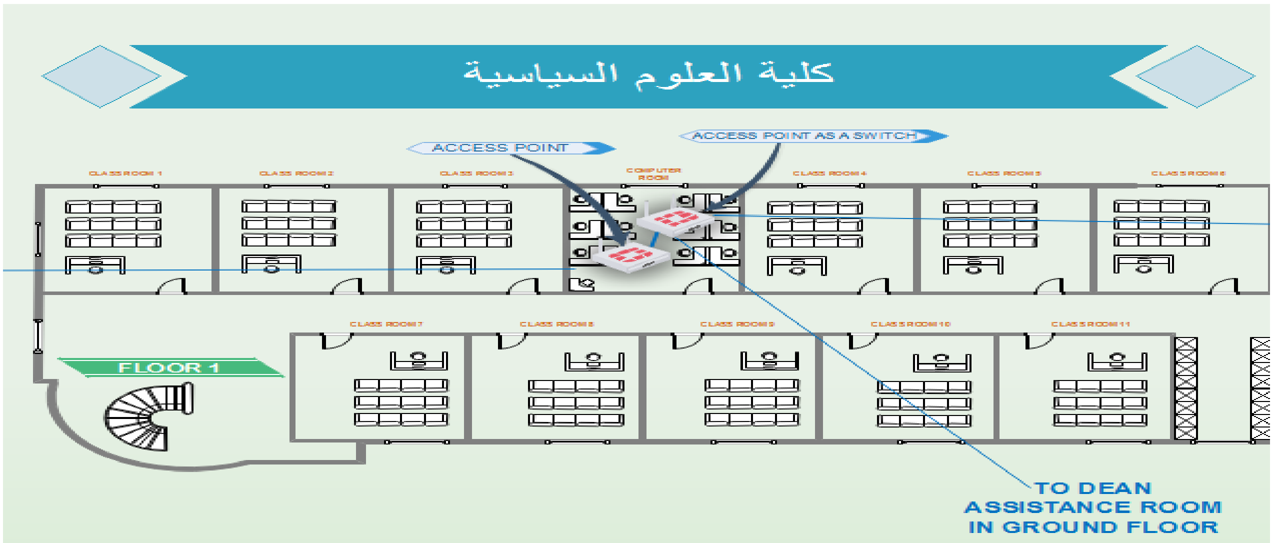
The 1200 series meets the needs of today's applications and protects future network infrastructure investments. The modular design of the 1200 series provides high performance.

In this study, Cisco features designed for small and medium enterprises were utilized. The three-level hierarchical design ensures network availability and allows for network assessment. A two-layer hierarchical design, where the core and distribution layers collapse into the same layer, is often more practical. A "collapsed core" occurs when the distribution layer and core layer functions are combined into the same unit. The primary motivation for the collapsed core design is to reduce network costs while maintaining most of the benefits of the three-level hierarchical model. Using the data obtained in the first and second phases, a new design was proposed to address all existing problems, incorporate global standards appropriate for the college, and establish a new foundation for the network. The proposed design is shown in Figure 4, which details the layout of one floor's rooms, and Figure 5, which illustrates the full design. In the proposed network, high-quality devices were used to produce the best results:

1. The 48-port laboratory switch is a Cisco Catalyst 2960 (Figure 7a), Cisco Catalist 2960-S and 2960 Series switches are important layers of 2-cant switches, providing better operating experience, very secure business operations, better stability and improved scope. They are access switches for fixed configurations designed for business level, midmark and branch office networks.
2. The router used is a Cisco 2811 series (Figure 7b). The Cisco 2811 series provides significant additional values compared to the pre -generations of the Cisco router to the same pricing points. It provides five times improvement in performance, security and voice performance increased ten times, built -in service options and dramatic slot machines.
3. The seven access points used are Cisco Aironet 1200 Series models (Figure 7c). The Cisco Aironet 1200 Series Access Point Wireless LAN provides investment protection, versatility, and business-class features that customers have requested.

*2.4 Phase 4: implement the proposed design:*

In this phase, our proposed design was put in a test using a simulation program called Packet Tracer. A screenshot of our test can be seen in Figure (6).




Figure(1). Second floor of the Faculty of Political Science to illustrate part of the current network

Figure (2). The signal in existing network by using in SSIDer program

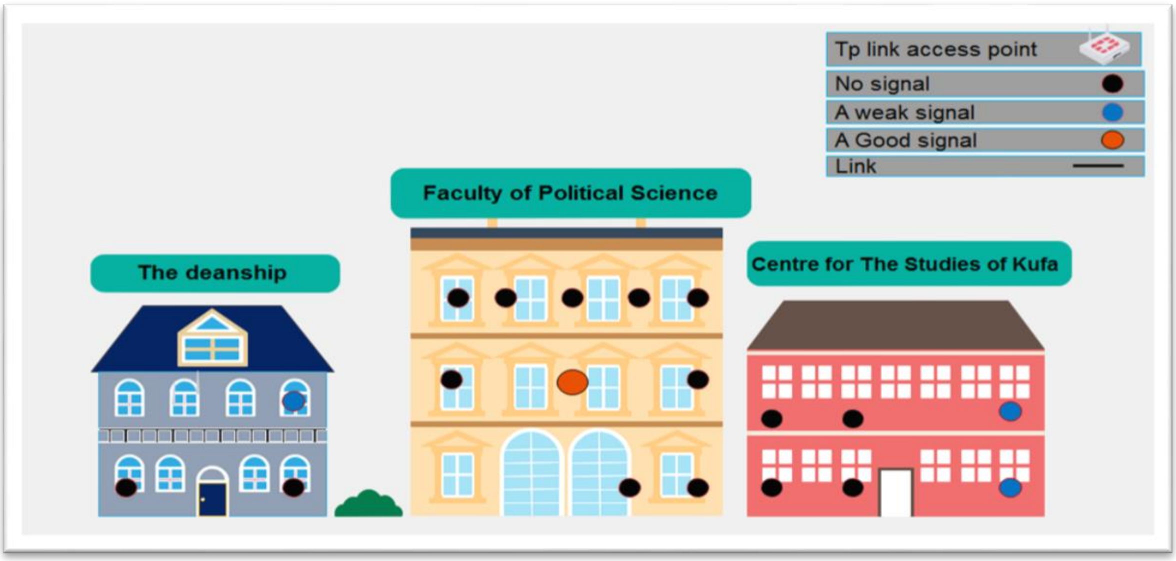



Figure (3). The signal in existing network by using EdrawMax program

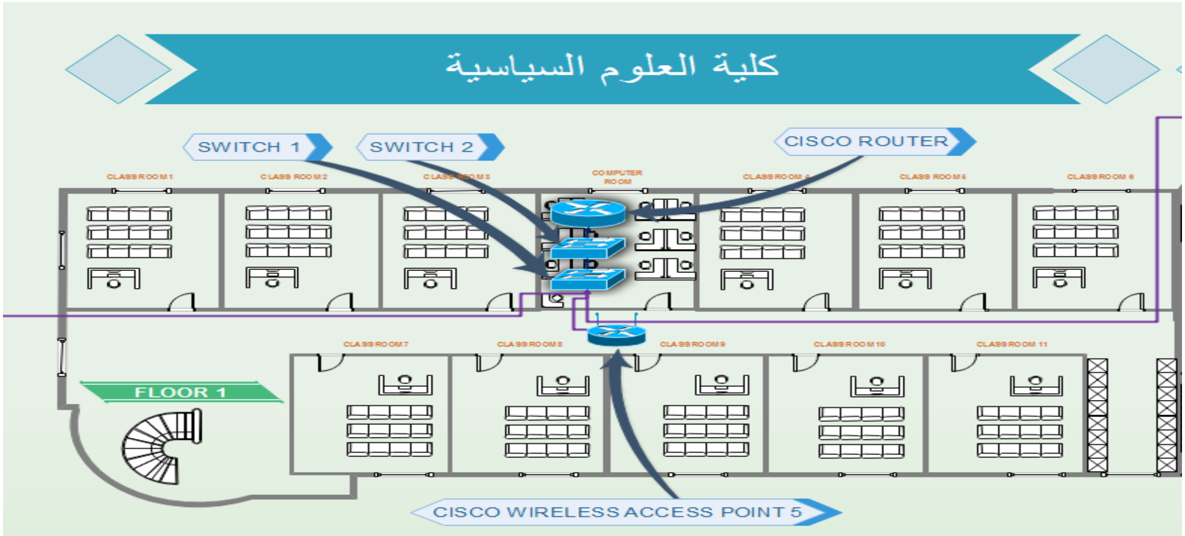



Figure (4) Second floor of the Faculty of Political Science to illustrate part of the proposed network

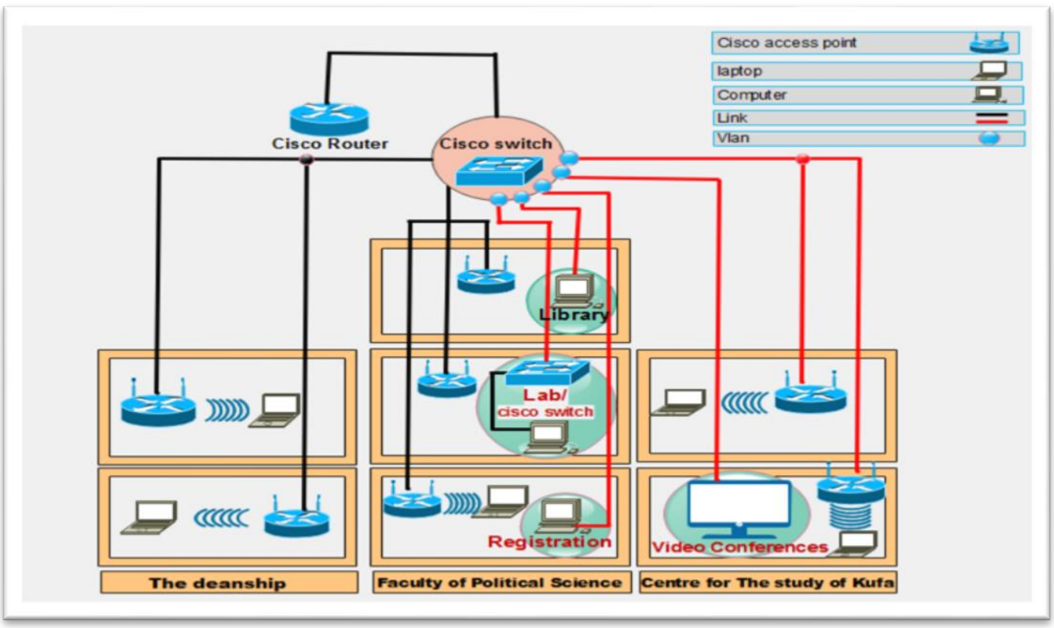



Figure (5). The proposed network

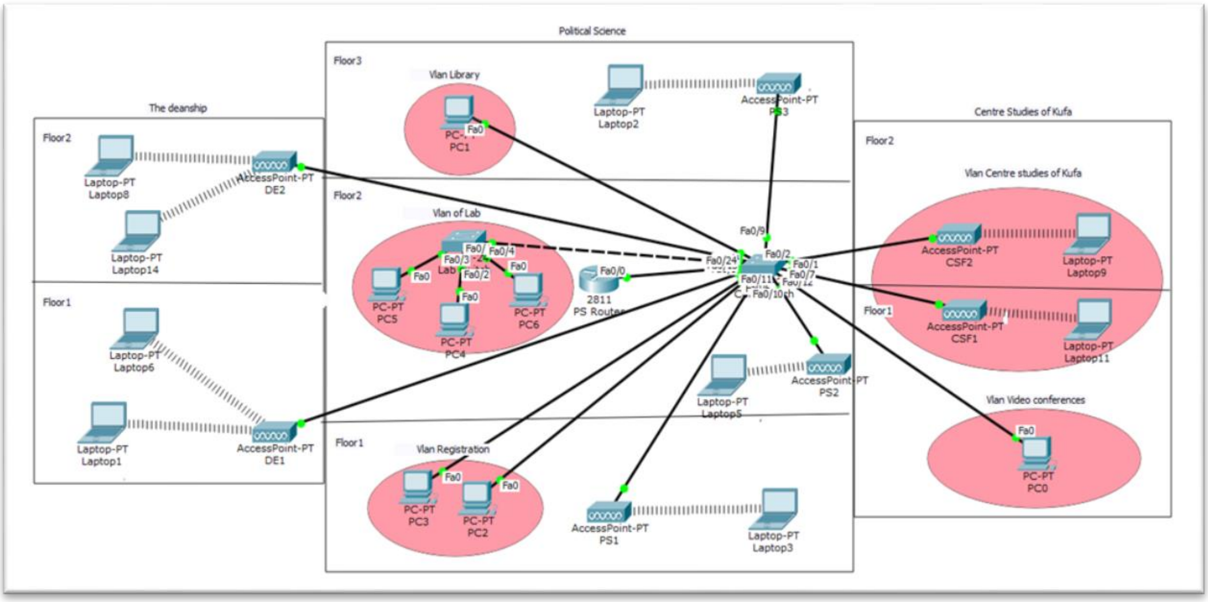



Figure (6). The proposed network in packet tracer program

|  |  |  |
|---|---|---|
| (a) Cisco Catalyst 2960-48TC-S Switch | (b) Cisco 2811 Router | (c) Cisco Aironet 1200 Series Access Point |

Figure (7). The devices in proposed design

ple of table show difference between previous and proposed network

| | Previous Network | Propose Network | Note |
|---|---|---|---|
| Security | X | √ | When using secure devices and by configuration of this devices |
| Manageability | X | √ | |
| Scalability | x | √ | |
| Cost | x | √ | When we using Vlan the cost is reduce from 29,056.25 To 6,376.25$ that is just in switch ,and when using one router the cost is reduce from 4,329.00$ To 2,164.50$ than two router |
| Application | x | √ | |

Table 2. Sample of table show security between previous and proposed network

| | Security | |
|---|---|---|
| Previous network | Hardware | Software |
| | X | x |
| Propose network | Hardware | Software |
| | Secure devices | More secure by configuration of router and configuration of Vlan |

Table 3. Table show difference in cost with and without VLAN

| Name | Cost With Valn | Cost Without VLAN |
|---|---|---|
| Library | 5,670.00$ | No cost |
| lab | 6,376.25$ | 6,376.25$ |
| Registration | 5,670.00$ | No cost |

| | | |
|---|---|---|
| Centre for The study of Kufa | 5,670.00$ | No cost |
| Video Conferences | 5,670.00$ | No cost |
| Total cost | 29,056.25 | 6,376.25$ |

Table 4. Table show difference in cost if used one or more router

| Cost with Two Router | Cost with One Router |
|---|---|
| 4,329.00$ | 2,164.50$ |

In current network VLANs are not used and it lacks scalable design. This has been proven by questionnaire results. In proposed design, VLAN was implemented to reduce costs and achieve better management to the network. Management is improved due to the ability to control VLAN groups and assign roles and capabilities to each group. Another benefit of using a management VLAN is improved network security. When all management traffic is on a separate VLAN, it is much harder for unauthorized users to make changes to your network or monitor network traffic. Another potential benefit is that a management VLAN can help you minimize the impact of a broadcast storm on other VLANs by giving you a separate path to access your network. It provides 100% scalability over a ten-year period.

## 5. Conclusion

In this study, a medium-sized network was designed and tested for the Faculty of Political Science and the Kufa Studies Center. The main obstacles in the current network were identified through a field survey and a questionnaire, which highlighted the most important problems and limitations concerning network coverage, security, administration, applications, and services. All issues were addressed, which helped in designing an improved network architecture that is more efficient, scalable, provides better management, and incorporates more security measures. Cisco network devices are recommended for the new proposed design due to their robust characteristics and better support in comparison to other competing vendors. Comprehensive IP management was designed and implemented based on a scalable hierarchical network design. The proposed design is tested using a simulation program called Packet Tracer.

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