WHAT'S WRONG WITH THE INTERNET ?
THE NETWORK MANAGEMENT OF UUM WIRELESS NETWORK SERVICES

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INTRODUCTION : THE "IT" PLAYERS

"This year in 2015 is a year that continues to challenge our integrity and dependability in performing the task to improve the delivery system and management system of the university", uttered by Mr. Kamarudin Abdullah as the Director of UUM Information Technology (IT) in his new year's speech to the staff. Mr. Kamarudin Abdullah is the Director of the newly rebranded computer centre in UUM, which is now called UUMIT.

He went on saying to his staff, "I want to share two recipes I've learned that need to be practised by all UUMIT citizens in order to improve our performance and at the same time transform our minds and bodies to survive in this very challenging environment".

Mr. Kamarudin elaborated on his recipes. The first of the recipes is that UUMIT needs to increase efficiency per employee. "We need to complete certain tasks in a shorter period than before. We need to examine our weaknesses, create or join training courses appropriate to increase the competency and our efficiency", he said. Meanwhile for the second recipe, he elaborated that "we need to increase our capacity and ability in order to increase the output of our work. This ability is closely related to the method, manner or process of our work. We must always examine what we do every day and look for ways to increase the production of our centre".

UUMIT is responsible for managing and maintaining the whole network of the university that virtually covers all application systems and the IT Infrastructure. The campus-wide network links all 16 buildings and over 2000 computers in all offices, laboratories, tutorial rooms, and lecture halls. This high-speed ATM fibre optic network is the largest and fastest campus

network in the region. The academic community can access all computing resources in the University from the convenience of their workstations in their own offices and computer laboratories. The resources include a wide variety of software products, printers, library catalogues, and mini computers. In addition, the entire academic community can communicate electronically with one another.

UUM was the first higher education institution in Malaysia to have its own integrated and comprehensive campus network communication using fibre optics called Integrated Sintok Local Area Network (ISLAN). The networking system uses Gigabit Ethernet technology, which was developed in 2000. This Gigabit Ethernet technology uses the Lucent/Avaya Cajun P880, Cajun P882, Cajun P550, and Cajun P580 as the network backbone. The connection to the workstation is done by using Lucent/Avaya P330 with 10/100 Mbs speed.

UUM community received another boost with the link up to Internet, a world-wide information and communications network. The Internet offers electronic mail and file-transfer facilities, and provides access to electronic discussion groups, resource and data archives, databases, bulletin boards, library catalogues, and news articles stored in computers all over the world.

Right now, schools, colleges, and universities throughout the world are implementing powerful network infrastructure solutions to create better learning opportunities, raise learning standards, reduce costs, and improve security. Maximising the performance of their networks, not just individual PCs, these institutions are investing in their network infrastructures from top to bottom, deploying ever-faster, higher-capacity connections for simultaneous voice, video, and data access.

UUM provides 24/7 Internet access for over 28,000 students and 6,000 staff members in every university offices, academic buildings, student residential halls, and almost 90% of campus area is provided with WIFI connections. Moreover, the campus is linked to the Internet through the Internet Service Provider. Every college in UUM is incorporated with distributed multilayer switches which connect to a couple of core switches in UUMIT. UUMIT comprises varying high efficiency network devices including servers, firewall, controllers, multilayer switches, and routers. In addition, the availability of numerous wireless hotspots throughout the campus is another aspect of the fast-paced ICT development

which UUM has embraced. All registered students of UUM are provided with a personal email account.

One of the main issues faced by the UUMIT is basically related to network management problems. This is due to the challenge of providing quality wireless services to the students and staff. Going back to history, apart from ISLAN being the backbone of UUMIT, it had also setup a wireless network infrastructure called the UUMZone. To date, UUM have upgraded its wireless network infrastructure from UUMZone to UUMWiFi however this case will only concentrate on the issues related to the deployment of UUMZone.

The functions of UUMZone were to provide wireless services and hot spots throughout the UUM campus area, especially for accessing emails and e-learning applications such as LearningZone. As time went by, the demand on UUMZone was overwhelming to UUMIT. They did not expect such a high demand and usage of the wi-fi services. As a provider of IT services, UUMIT kept updating its Internet services. However, Web 2.0 applications are growing rapidly. In addition, the extensive usage of these applications consumes high bandwidth, leading to network congestion and performance degradation. Of course, educational institutions and IT departments are always expected to do more with less—that is a given. Fewer people to manage more equipment with tighter timelines and lower budgets—these are all serious challenges to the effective operation of a network infrastructure.

Regardless of the real cause of poor application performance, the first thing a network manager hears is “the network is slow.” That is certainly the default assumption of end users. The only thing that really matters is managing the network and the impact on the users. Regardless of how sophisticated a network resource is, if the user community finds it slow or unreliable, then no amount of technical arguments will be able to counter this complaint.
Therefore, the Director of UUMIT, Mr. Kamarudin assigned the network team headed by Mr. Khalil to begin investigating the issues related to UUMZone. Mr Khalil and his network administrators have the task to search for the solutions in order for its wireless network services to perform to its optimal peak performance.

THE NEW FACE: FROM COMPUTER CENTRE TO UUMIT

Universiti Utara Malaysia was established on 16 February 1984 under the Universiti Utara Malaysia 1984 Order (Statutory). The university was corporatised on 23 April 1998. The university is located in Sintok, Kedah and was established with the specific mission of providing a leadership role for management education in the country. Thus, the university is also known as a management university. Part of the managements' vision is to have the best computer centre in the region.

The UUM Computer Centre, now known as UUMIT, was officially established on 1 March 1988, as a result of the university computing programme that began simultaneously with the establishment of UUM. UUMIT provides a comprehensive computer and network infrastructure to support teaching, learning, and research activities at the university. It also supports the university's administration, which was developed and managed the university's information system. UUMIT is also a catalyst for the development of information technology on campus and in the northern region of Malaysia. Its main component is a campus-wide network connecting all schools, administrative buildings, and centres, as well as providing microcomputers to the campus.

UUMIT is a dedicated group of information technology professionals working collaboratively with the campus community to advance the university's mission. It is located in the UUM main campus (Sintok) with facilities and support staff distributed all over the campus. Its motto is to "We Make IT Better" by delivering information technology services that are safe and secure to support research, learning, teaching, administration, and student life. UUMIT delivers IT as a service and integrates superior information technology infrastructure across all applications, data, network, and devices 24 hours a day, 365 days a year. Addressing the technology needs of today's campus community is becoming increasingly challenging, as users expect to have wireless access to all resources, anytime and anywhere, from any device. These challenges require new IT strategies and UUMIT is continuously working together with the campus community to advance the university's mission via IT innovation.

Vision of UUMIT

To make UUM the best campus in Information Technology.

Mission of UUMIT

To provide innovative IT services to enhance performance of students, faculty and staffs of UUM.

Objectives of UUMIT

The objectives result from the appreciation of the vision and mission of UUMIT, which are to:

- Make UUM a leading and top organization in this region in ICT management in a creative and innovative way.
- Place UUM to a level of excellence and competitive with other organizations within and outside the country
- Create a complete and conducive ICT environment for facilities:
    - Teaching, learning, research and administration, and
    - Cooperation, smart partnerships, consulting, services and dissemination of information.
- Making ICT as a catalyst for improving the quality, effectiveness and productivity through excellent ICT management

Services (Teaching and Learning) of UUMIT

Below are the different types of services provided to the students and staff members. The services are given free of charge and maintained by the administrators from UUMIT. The services that are provided by UUMIT are as follows:

1. **Learning Zone**
   Learning Zone is UUM's learning management system (LMS) based on Moodle, which was developed from a learning-centric perspective rather than a technical administrative

perspective. Learning Zone enables lecturers to enhance their students' learning by providing an online environment to distribute materials and encourage collaboration and interaction both within and outside the classroom. It provides a range of functionalities to allow for content creation and delivery, communication, collaboration, and assessment.

2. **MyLab**

   "On Demand" access to applications via the Internet.

3. **MyBox - Web-based File Storage System**

   This is a web-based file storage system available to academic staff which allows users to upload, store, access, retrieve, and share files via the Internet using only a web browser.

4. **Video Conferencing**

   Video conferencing allows the connection of one or more people at separate locations via a sound and video link. It can be used both for one-to-one discussions or larger group meetings. Video conferencing is suitable for small meetings and presentations, lectures, and seminars. It can offer large savings in time and travel costs, and allows people to be connected to other in remote locations. Video conferencing can help in managing students' and colleague's times more efficiently by not being restricted by a person's location.

Information Systems of UUMIT

There are many different types of information systems that are developed to accommodate the collection, organisation, storage, and communication of information in the university. The information systems are aimed to support operations, management, and decision making in relation to the university's missions and visions. There are two types of information systems in UUM, which are:

1. University Management Information System (UMIS)

- PERSIS (Personnel Information System)
- IFAS (Integrated Financial and Accounting System)
- GAIS (Graduate Academic Information System)
- CLIMAS (Clinic Management System)
- SAIS (Student Affair Information System)
- PBU (University Continuous Learning System)
- eQUIP (Library Information System)

2. Other Support Systems

- MyIdea (UUM Community Idea System)
- LeCas (Lecture Attendance System)
- Ecevas (Electronic Course Evaluation System)
- Enomination (Academic Post Nomination System)
- IPMO (Institutional Project Management Office)
- ePOST (In Out Letter System)
- SECURIS (Security Department System)

Organisational Chart

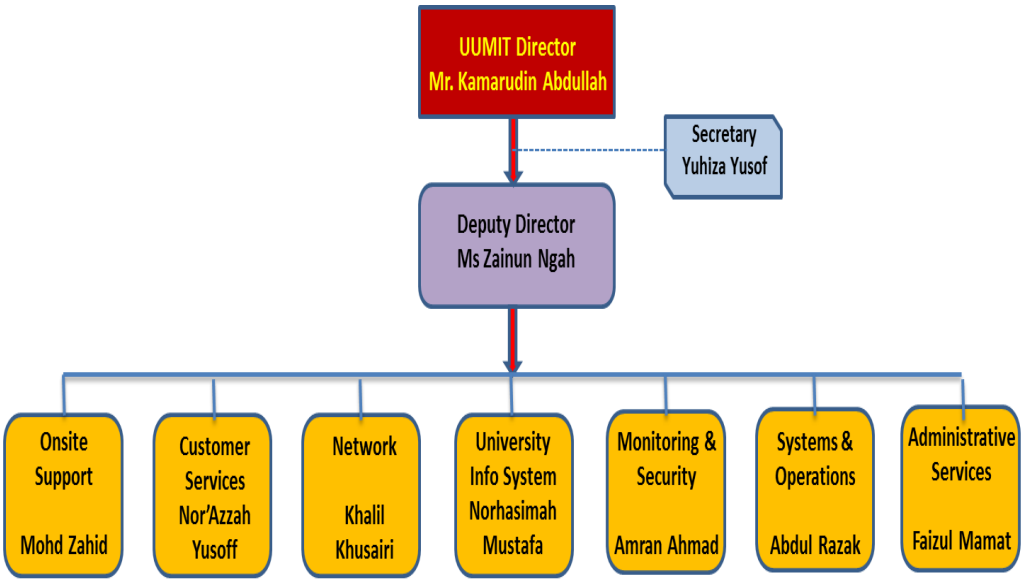

Figure 1.0: UUMIT organisational chart.

DEPLOYING HIGH DENSITY WI-FI TO RESIDENTIAL HALLS: "IT" FOR YOU

As a fully residential university, Universiti Utara Malaysia provides accommodation for over 28,000 students placed within 15 on-campus residential halls. This includes a residential hall for student with families. Many of these halls were named after multinational companies. The student residential halls (known as DPP) are: DPP Malaysian Airlines (MAS), DPP Tradewinds, DPP Tenaga Nasional Berhad (TNB), DPP PROTON, DPP EON, DPP Telekom Malaysia (TM), DPP Petronas, DPP Malaysia International Shipping Corporation (MISC), DPP Bank Simpanan Nasional (BSN), DPP Sime Darby, DPP Bank Muamalat, DPP Yayasan Al-Bukhari (YAB), DPP SME Bank, DPP Bank Rakyat, and DPP Maybank (for students with families), plus Taman Siswa located off-campus in Jitra for students with families.

These DPPs are placed accordingly into four zones in UUM known as Route A, B, C, and D. The table below shows the position of DPPs in these zones.

Table 1.0: Names of Residential Halls Based on Routes

Route	**Student Residential Halls (DPPs)**
A	MAS
	TNB
	Tradewinds
	PROTON
B	Petronas
	EON
	Sime Darby
	TM
	BSN
	MISC
C (Aseania)	Bank Muamalat
	YAB
D (Bukit Kachi)	Bank Rakyat
	SME Bank

Each DPPs in Routes A and B have between six and eight blocks and can accommodate a total of between 700 to 1000 students. DPPs Bank Muamalat and YAB in route C each have two blocks where each block can accommodate up to 1500 students. The latest two DPPs located at Bukit Kachi are DPPs Bank Rakyat and SME Bank, both of which have eight blocks each with a capacity of 2216 students for each DPP.

The management of the wireless network for the DPPs are given to two parties, which are R&D SerindIT and UUMIT. R&D SerindIT which is a UUM subsidiary IT company located in Napoh, is given the task to manage the DPPs in Route A (Tradewinds, TNB, PROTON,

and MAS) and Route B (Petronas, EON, Sime Darby, TM, MISC, and BSN), while DPPs in Route C and D are under the management service of UUMIT which uses UUMZone.
R&D SerindIT has a mission to provide the blanket wi-fi coverage to UUM, with the motto of "mobile Internet for everyone". The company provides superior wi-fi performance within the coverage zone despite providing a much wider coverage area to the DPPs. Every day, more than 10,000 students enjoy the wi-fi facility. In order to cater to the traffic on the wireless network infrastructure, R&D SerindIT uses equipment and technologies such as Altai A2N WiFi AP, Altai A3 WiFi AP, Altai A8 Super WiFi Base Station, Wireless Controller, and Altai AWMS for its management system.

R&D SerindIT utilises outdoor wireless APs which had issues with buildings that had a closed structure, compared to open space building design. This caused users to have issues with the wi-fi signal.

Despite the access to the Internet via a wireless network being available to students all the time, students often complain about how difficult it was for them to use these facilities.

UUM IT: WE MAKE "IT" BETTER

Mr. Kamarudin as the Director of UUMIT knew that the time had come. All the warning signs for a network upgrade were glaringly apparent. "Data transfers were slow, and as students, faculty, and staff brought more wireless devices to campus, the 10-year-old network and UUMZone lacked the coverage the stakeholders needed", Kamarudin said.

The complaints piled up. Kamarudin added, "students and the faculty continued to ask why the Internet and network is slow, and they had trouble streaming video … we also had more demands for increased network performance from the administrative side".

As the Head of Network in UUMIT, Mr. Khalil admitted that as IT staff watched the technology rapidly evolve, it became clear that the network serving UUM's over 28,000 students and 6,000 staff members would need an upgrade. "Technology is pervasive in everything we do," Khalil said, and added that "it is an enabler of teaching, learning and research, and with all the mobile devices people use today, we knew we had to ensure that the network was sufficiently robust".

Wireless Network Login

One of the complaints made by students and staff of UUM was that everyone is required to login using the web or captive portal with the Service Set Identifier (SSID) of UUMZone. SSID is referred to as a "network name", which allows users to connect to the desired network when multiple independent networks operate in the same physical area. Ironically, a captive portal is a one-to-one connection between devices to access points. A captive portal is a special login web page that is shown before using the Internet. So every time a user moves from one location to another, they are required to re-login again to the wi-fi system.

A captive portal is designed to authenticate students before they can access the web over a wi-fi connection. When a user connects to the wireless network, they do not have access to the Internet, even though their device thinks is does. Every webpage request is redirected to a login page, which alerts the user that the security certificate is not trusted, and only after a user logs into this system would they have access to the Internet. This happens every time, day, and for every device, when students enter every building, forcing a username and password to be entered multiple times per day. If the student or staff member saves the password in a browser, it is only saved for one building, because the login page URL is specific to each building. Because of this, applications such as email are unable to work continuously throughout the day. Many students and staff opt to disable their cell phone wi-fi when on campus so that they do not have to login every time. While some of them are able to buy mobile data plans, others see this as a financial hardship.

Furthermore, one of the drawbacks of a captive portal is that it disturbs the user's experience when a web browser must be loaded every time before the Internet can be used, because each device has to be authenticated to use the services. Since the authentication is web based, the users need to have a web browser on their devices. While requiring a web browser on clients' devices is a disadvantage of captive portals, for some of them it is necessary for web browser to be run in the background all the time to keep the connection alive, since they rely on the scripts to keep track of the connection. This creates difficulties to keep the connection alive on some platforms, e.g., Portable Digital Assistants (PDAs).

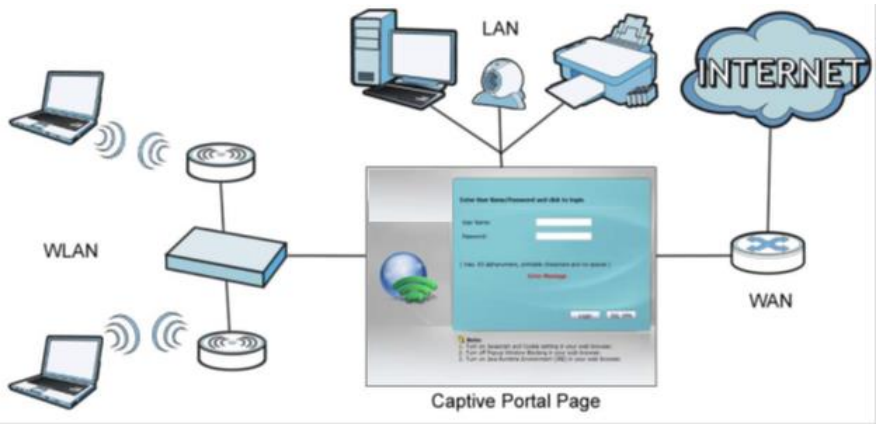

Figure 2.0. The wireless network architecture using captive portal.

Wireless Network Security

Nowadays, Internet access is very important to students and staff in order to carry out their tasks and to obtain any desired information from around the world. The Internet has developed rapidly from being as a tool to retrieve information to being a platform for social interactions. Many of the students and staff access their Internet through wireless access. A wireless access, such as UUMZone is one of the exact solutions being applied at the time. Network security is necessary to maintain the rights of the wireless access users, and security is one of the most important priorities in any network today. Security can be applied by the users or providers of the communication services themselves because the security vulnerability could originate from anywhere and at any time.

Moreover, many students and staff are being protected with a security mechanism every time they access the Internet. This security mechanism is very subjective and intangible in terms of its measurements. However, it can be seen by looking at what the security infrastructure mechanisms are put into place. It is an authorised system, which depends on how strong the user's password is. Authorisation is the function of specifying access rights to resources related to information security and computer security in general, and to access control in particular. As mentioned previously, the captive portal often presents a login page for authorisation purposes. This is done by intercepting most packets, regardless of address or port, until the user opens a browser and tries to access the web. After the users have been authorised, they will be redirected back to the last point they requested. If the AP has a problem, the connection to the next AP is not directly handed-over, so a new authorisation

process, i.e., the authorisation web page, must be opened and complied to in order to have renew the Internet connection.

Another issue in this security management is the encryption between user devices to AP, which is very critical in whatever transaction occurs between them. As mentioned above, the captive portal has a weak encryption mechanism, which is Wired Equivalent Privacy (WEP)—the first-generation security technique firstly used in wi-fi security. WEP is known to be very susceptible to guessing. At the same time, the captive portal is not secured by a secure socket layer, and this can lead to the worst case scenario where the username and password can easily be captured by hackers.

Moreover, the unsigned certificate used for the login page which prompts the user to trust a possibly fake certificate is a huge security flaw. Anyone could set up a fake wireless network called "UUMZone" and redirect users to a login page which would look identical to the official login page. This is called a "man in the middle" attack.

Wireless Network Performance

In the meantime, the performance of UUMZone is affected due to the increase of additional mobile and tablet devices in UUM, and this has led to slow wireless connections. Users often complain about the Internet being slow every time when they are accessing the Internet. "Oh … the Internet is crawling all the time … I wish they could increase the speed a bit" are often expressed by many frustrated users especially during the semester when assignments are due. Sometimes, many users are inconsiderate when they are only surfing the Internet, updating their social network, watching movies, and downloading huge files.

UUMZone wireless network allows everyone to experience the power of the Internet but during certain times, since the connections may be heavily used. When there is a lot of traffic on the UUM Network especially UUMZone, users temporarily will experience certain periods when Internet connection is denied or it is difficult to login. Typically, during the peak hours, the average usage reaches almost 18,500 devices. With the various types of devices connecting to the Internet, it is important to understand how various devices can promptly connect to the internet. Therefore, the UUMIT network team that provides the service needs to comprehensively manage the performance of the network and wireless

infrastructure. It is important that network administrators be aware of and has a handle on the different types of traffic that is traversing their networks.

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