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UNIVERSITI TEKNOLOGI MALAYSIA

**SCHOOL OF COMPUTING**  
Faculty of Engineering

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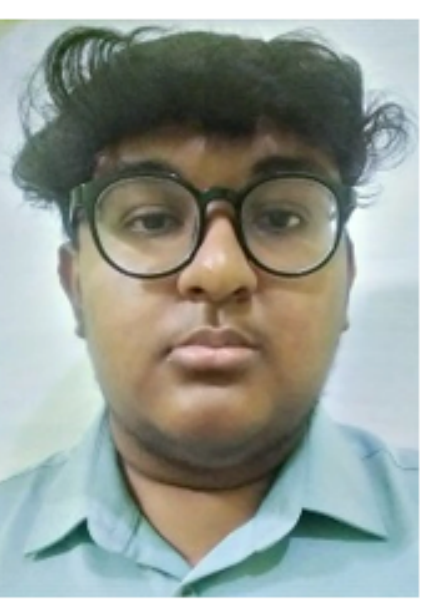
TECHNOLOGY & INFORMATION SYSTEM

**ASSIGNMENT 3: Application of 5g in Smart Campus,  
Industry Talk 5 & 6 Magazine**

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# THE NEW ERA : SMART CAMPUS, 5G AND WIFI6

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10 Dec 2021 | Edition 2

What's in?

APPLICATION OF 5G IN  
SMART CAMPUS

INDUSTRIAL TALK 5: SMART  
CAMPUS: THE JOURNEY STARTS  
HERE (COMMScope MALAYSIA)

INDUSTRIAL TALK 6 : 5G, WIFI6 AND  
EMERGING NETWORK TECHNOLOGIES  
(HUAWEI)



HUAWEI

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# APPLICATION OF 5G IN SMART CAMPUS

## SUMMARY : WHAT IS SMART CAMPUS

A smart campus is a campus that uses advance network infrastructure and devices that use internet to provide supportive and engaging experiences. Smart campus also can be defined as a a physical and digital environment where human and technology interact to give more automated experiences to the students.



5G Campus

smart buildings and city infrastructure,

## APPLICATION OF 5G IN SMART CAMPUS

### Switching campus into smarter campus :

When a campus provided with 5G, it means the campus already extending their campus private networks which means they can already deploy IoT to improve the services inside the campus.

One of the examples is 5G-connected autonomous buses or shuttles or any delivery vehicles will have to report their boarding time, arrival time and the locations of the vehicles.

Second example is extending the connectivity to every corner of the campus. When 5G internet provided in the campus, it will give every students in the campus the connectivity of fast internet to attend classes and do some works. 5G also will allow new applications and connections to smart devices around the campus.



## CONTENTS

### EXAMPLE OF SMART CAMPUS TECHNOLOGIES

- Direct visitors to open parking spaces and provide campus mapping technologies.
- Detect water leaks or faulty appliances to address operational deficiencies proactively.
- Refine security systems by adding gunshot sensors, facial recognition, and location intelligence.
- Use data to identify opportunities for inclusive activities or shift employees into meaningful roles.
- Add value to classroom instruction by offering engagement platforms and self-service technologies.
- Monitor attendance and resource use at recreational facilities, stadiums, dining, housing, and classrooms.
- Automate student and faculty processes to support efficiency while maintaining a human-centric approach.

## REFLECTION

5G will bring a lot of benefits to the smart campus. Firstly, 5G will give a further technology network leap for the future. It will make the network be more powerful than ever before. This is important for the smart campus to deploy to IoT system where everything be ease for the students, lecturer and everyone. It will also give more safety for the people in the campus as example students who want to take the buses or shuttle will have the safety and the buses will sent report automatically of the locations, boarding and arrival time.

Secondly, 5G will give the fastest internet network for everyone in the campus and ease everyone in every matter in campus. When the 5G provided, every students will have a fast connection and will easily attend the classes and all assessment without any doubt. The lecturers also can easily make the class or activity without any problems in the digital world.



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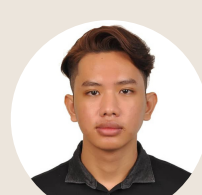
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# SMART CAMPUS : THE JOURNEY STARTS HERE (COMMSCOPE MALAYSIA)

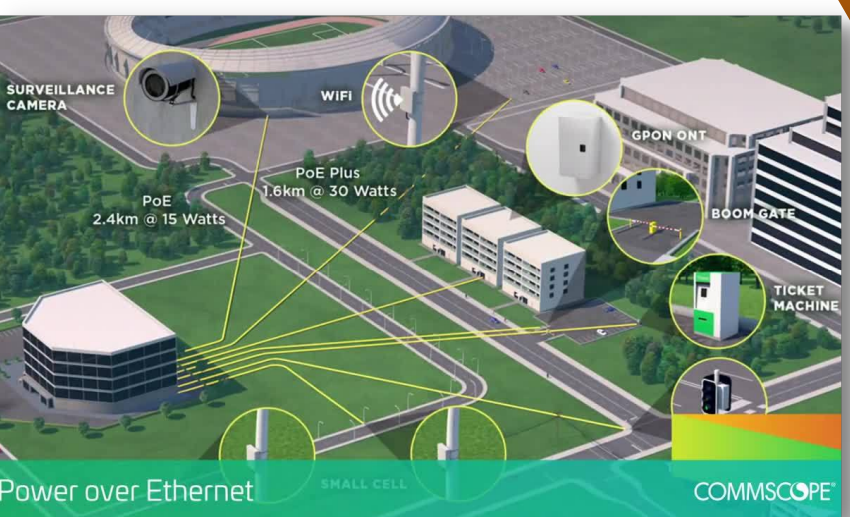


MR. GOH BIH DER  
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## DESCRIPTION OF THE INFRASTRUCTURE

IBM At the end of 2019, the world was shaken by the existence of a new virus, covid 19. During this pandemic people started to realise the importance of IT and many organisations started to invent and invest in the IT sector. The most significant after-effect of the pandemic on the IT sector is the Internet speed and coverage. In Malaysia, we use wifi 6 that offers up to 9.6 Gbps which is 30% improvement from the previous versions but in 2022 the Malaysian Communication and Multimedia Commission ( MCMC ) has plans to introduce the latest technology, wifi 6e and they are still deciding whether Malaysia is prepared enough for this tech. For your information, wifi 6 is not only about speed but it also includes the capacity aspect that is very important for huge network infrastructure to maintain its connectivity if there are multiple users at the same time. Since physical contact is very forbidden during the pandemic, many small medium enterprises ( SME ) are now focusing on improving their online system. One of the most important things is the customer services system because it can help the business to build trust, improve brand awareness and attract new customers. The thing that needs to be highlighted while improving the system is it must always be customer friendly and it must deliver 100% satisfaction both online and offline experiences for the customer. Another thing that needs to be focused is network security. Besides, other new feature in Wi-Fi 6 is the ability for devices to plan out their communications with a router, lowering the amount of time they must keep their system to run, turned on to transmit and search for transmissions. This implies less energy consumption and will result in longer battery longevity. All of that is made possible by a technology called Target Wake Time, which allows routers to improve its functionality.



In the smart campus, the demand for internet connectivity is increasing because the space requires internet connections and it needs to run multiple access points which will lead to internal problems in the core network when transferring the data simultaneously. This can frequently happen in smart buildings where technologies are applied at every edge of the building. In certain cases, wifi speeds will decrease when there are multiple wifi devices that operate at the same time. This will be a serious problem if the campus uses wifi 5 or below that has certain limitations. In addition, cloud applications and video streaming will drain most of the internet connectivity and cause lagging for other devices. This problem can be solved by updating wifi 5 into wifi 6, the latest version of wifi can increase the efficiency of the system because wifi 6 can increase the connectivity of the system. To apply wifi 6 in the environment, we are advised to change our router with a new version to prevent bottlenecks from occurring in the system. By keeping the router up to date, it can prevent inefficiencies such as delays and higher production costs. The feature that comes with wifi 6 is the MU-MIMO technology ( Multi user - Multiple input and Multiple output ). Although this feature is already present on a vast number of existing routers, it will be implemented across the board on all Wifi 6 routers. Instead of sending data one after another, It now permits data to be transferred to multiple devices at once. Furthermore, by embedding this technology into wifi 6 it helps to connect with four devices at once and be able to support up to eight devices simultaneously. Beside of that, wifi 6 also use OFDMA technologies (Orthogonal Frequency Division Multiple Access) that can boost the data transferring rate while reducing the wifi latency. This technique helps data to be sent to multiple devices at the same time while maximising the size of every data transmission



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# SMART CAMPUS : THE JOURNEY STARTS HERE (COMMSCOPE MALAYSIA)



## DEVICES USED BY COMMSCOPE

In order to support the future of Smart Campus, CommScope Ruckus provides many different types of Wireless Access Points, both indoor and outdoor, depending on the budget of the school. There are 2 different series of Wireless Access Point that can be used for indoor, which are R-series and H-series. The Wireless Access Point offered indoor are Ruckus H550 which can serve up to 512 clients per AP, Ruckus R550 which can serve up to 512 clients per AP, Ruckus R650 which can serve up to 512 clients per AP with 5GHz connection and provides 2.5 GbE, Ruckus R750 which can serve up to 1024 clients per AP and also Ruckus R820 which can serve up to 1024 clients per AP and provides 2.5GbE/5GbE. On the other hand, the series that is used as an outdoor Wireless Access Point is the T-series. Some example of the T series are Ruckus T350c which can serve up to 512 clients per AP, Ruckus T350d which can serve up to 512 clients per AP, IoT ready, contains USB port and also DC-powered, Ruckus T750 which can serve up to 1024 clients per AP, IoT ready, contains USB port and also AC-powered.



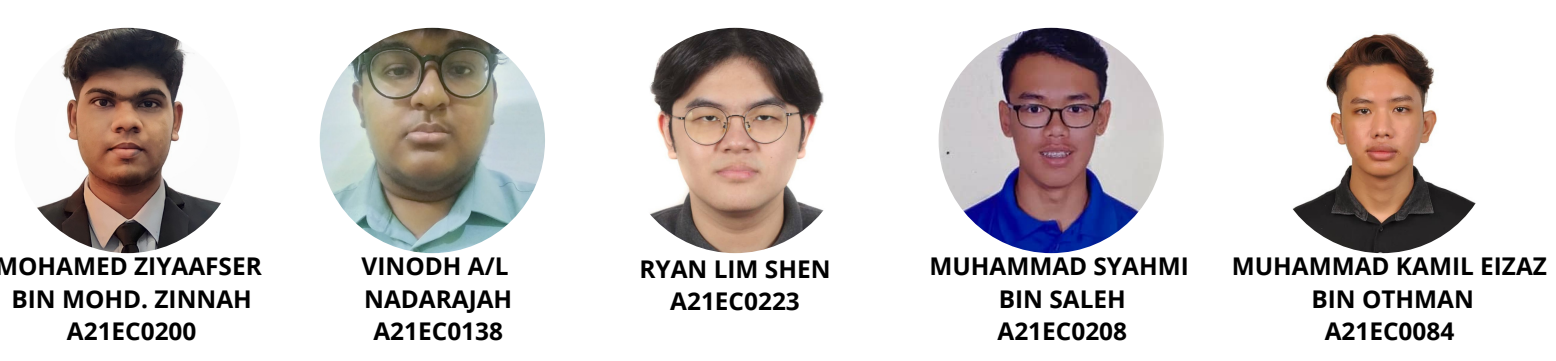
CommScope also provides switches to support the future of Smart Campus. There are 3 types of switches that CommScope offers. Firstly, CommScope provided access switches that enable seamless interoperability with Ruckus wireless products, providing integrated, wired and wireless network access. Secondly, CommScope offered aggregation switches which are used to connect with core switches. Lastly, CommScope offered core switch, which serve as a gateway to a wide area network (WAN) or even the Internet. Some of the switches that CommScope provides are ICX 7150 which is an entry-level access switch, ICX 7520 which is an access switch, ICX 7550 which is an access-aggregation hybrid switch, ICX 7650 which is a premium access-aggregation hybrid switch, ICX 7750 which is an aggregation-core hybrid switch and also ICX 7850 which is an aggregation-core data center.

## DOMAIN USED BY COMMSCOPE

CommScope uses a Multi-Domain Service Orchestration system that can aid service providers in many ways. For example, with dynamic service creation, CommScope can help its customers quickly initiate new revenues. Other than that, CommScope domain can help service providers to be able to implement new services quickly. CommScope can also provide customization to its customers while keeping it at a competitive price. Lastly, CommScope agility of service provides a better customer experience making it appealing to the customers, which results in gaining more customers in the future.

## REFLECTION

From the talk, we can adapt and understand that CommScope is putting a lot effort in order to develop into the new technological era. The covid-19 has impacted in many aspects and from this, we must know that a lot pressure is being implemented by many companies to retain back their performance. From the talk, we gained a lot of information regarding smart campus and those devices that can be used in. Few knowledges about the IOT were ablet gain as well in the aspect opportunities, market complexity and more. The separation of 3 aspect for the smart campus was also able to be learned, which are the smart living, smart learning, and smart security. We also got to know that CommScope uses many devices to adapt and make it easier for the new era such as the indoor wireless access point and outdoor wireless access points.





# 5G, WIFI 6, EMERGING NETWORK TECHNOLOGIES



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## INTRODUCTION

We all known Huawei for their devices like smartphones, smartwatches and other things. But Huawei not only provide devices, they also provide intelligent automotive components, connectivity, computing and cloud and digital power. Huawei offers job to around 197,000 employees. They also well known around 170+ countries and 3rd place in Research and Development (R&D) ranking. In Malaysia, Huawei offers job to 2806 peoples, has 2000+ tech training per year and 300+ new hiring per year. Huawei has 11 global shared service centers, 1 customer solution innovation center and 1 global training center.

### WHAT IS 5G

Once 5G become widespread, the effect of these industries could be transformative for 3 main reasons. The first is 5G devices are lower latency, enabling faster transmission of larger data streams. Second is 5G devices are more reliable, enabling better transmission of data in extreme conditions. Last but not least, the third is 5G is more flexible than Wi-Fi and can support a wider range of devices, sensors and wearables. 5G has major application scenario defined by ITU, which are Enhanced Mobile Broadband (eMBB), Massive Machine Type Communications (mMTC) and Ultra-reliable and Low-latency Communications (uRLLC). In future 5G uses cases evaluation and prioritization. Example like augmented reality, virtual reality, driver information, entertainment in vehicle, automation in the vehicle, smart grid and delivery drone.

## DESCRIPTIONS

VR will be Killer Application of 5G was stated by Mark Zuckerberg is going to be true. Due to gradual formed industry chain like chipset (Qualcomm Snapdragon 820 with VR optimization), VR terminal (HTC Vive/Oculus Rift 2/Sony PSVR Gear VR/Huawei VR), content producer (Facebook (Meta) Surround 360/Google Jump/Nokia OZO) and broadcast platform (Facebook (Meta) VR Platform/YouTube VR Platform). Why VR need 5G? It is because 5G can support with high throughput for retina experience VR. For example, >5037X5707 resolution for retina experience per eye and 6 angles for full-view panoramic video mosaics. 5G also has low latency to avoid motion sickness like MTP (Motion-to-Photon) Delay which has less than 20ms and Network RTT which has less than 7ms. It offers new opportunities and benefits like next generation smart tourism requirements new technology applications, advance 5G industrial park encourage hi-tech industry establishment, create local job opportunities and 5G enables AR/VR based virtual education which helps students with excellent resources all over the country or world.

### WHAT IS Wi-Fi 6

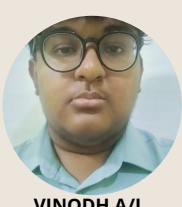
Wi-Fi 6 has been verified for more than 3 years by many companies like Huawei, Apple, Samsung, Asus and other more. The standard evolution for every Wi-Fi start from 802.11. On year 2014, 802.11n was found which is Wi-Fi 4. Then around year 2015 to 2019 802.11ac wave 1 and 802.11ac wave 2 found and everyone know it which is Wi-Fi 5. On the year range of 2020 to 2021 Wi-Fi 6 found which has 802.11ax standard. In October 2018, the Wi-Fi Alliance specified a new name for different Wi-Fi standards. 802.11ax was named Wi-Fi 6 which is a revolutionary new technology. The new Wi-Fi 6 (802.11ax) standard has large bandwidth, low latency, IoT-oriented energy saving and anti-interference. In other hand, Wi-Fi 6 supports gigabit broadband promotion. From 1 Gbit/s to mobile phones/pcs which allow an application to download faster or faster cloud backup experience. For example, with using a normal Wi-Fi 5 a game at least takes time up to 7 minutes with the speed of 30 Mbits/s but by using Wi-Fi 6 it only took around 20 seconds with the speed of 1000 Mbits/s. Second example is a 128 GB photo and video backup at least took 8 hours with normal Wi-Fi 5 but Wi-Fi 6 took only 20 minutes.

How Wi-Fi 6 improves bandwidth? There are 3 factors affecting its rate like spatial stream, sub-carrier quantity, symbol duration and coding mode. Wi-Fi 6 can improve its coverage by RF improvement or dedicated algorithm which penetrate one more wall. Wi-Fi 6 chip RD optimization, improving the TX power and sensitivity under the same signal quantity. Dedicated algorithm, improving performance and omnidirectional coverage when connecting to traditional Wi-Fi 5 STAs. Wi-Fi 6 is capable of giving coverage to a home with 120 square meters. With Wi-Fi 6, new video services like multi-screen IPTV, HD video teaching, cloud VR interaction and E-sports acceleration supports without any problem. Wi-Fi 6 also supports better multi-user experience by reducing terminal power consumption by 30% and enhance the positioning of gateways as the control center of smart home.

## HUAWEI with Wi-Fi 6 Technologies

Huawei AirEngine Wi-Fi 6 technologies at a glance has highest performance with 16x16 MU-MIMO, most stable experience with using smart antenna, dynamic turbo, SmartRadio calibration algorithm. Huawei also has most compressive IoT apps with two built in slots for IoT module, IoT expansion through the USB port and also Huawei guarantee having most secure by having independent radio for scanning, hardware encryption and dual-signature boot. Huawei also ranked as world's first 10 Gbps Wi-Fi for their Huawei AirEngine Wi-Fi 6 with 10.75 Gbps performance speed. Also with their 5G technologies, smart antenna improves SNR expanding the coverage radius by 20%. It allows enables SmartRadio with 10ms ultra low latency and lossless roaming. With Dynamic Turbo, multi-QoS packet scheduling acceleration algorithm and high priority application latency less than 10ms. And also lossless roaming, device network synergy seamless mobile roaming experience and no packet loss during AGV Roaming.

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## DEVICES USED BY HUAWEI

Huawei provides a variety of Wireless Local Area Network, both indoor and outdoor access points in a variety of types of products. For example, the WLAN offered for indoors is the AirEngine 8760-XI-PRO that is known as the flagship among all the Wi-Fi 6 products with 16 spatial streams provided. Its feature include a built-in smart antenna, dual IoT slots, it can also support triple-radio mode and can achieve internet speed up to 10.75 Gbit/s. The product is designed for environments that require high bandwidth and high-quality network experience. The WLAN indoor access points also have other models like the AirEngine 6760-XI Access Point from the AirEngine 6700 series and the AirEngine 5760-5I Access Point from the AirEngine 5700 series. Meanwhile, the WLAN for outdoor access points offered is the AirEngine 5761R-II & AirEngine 5761R-II-E Access Points. It featured a high-speed internet rate up to 1.775 Gbit/s to 2.4 Gbit/s. These products with Wi-Fi 6 outdoor APs support more than 1000 users with excellent coverage. It also has features that withstand damage such as high waterproof and dustproof, this has made them ideal for environments like stadiums, public squares, pedestrian streets and amusement parks. It also offers other model like AirEngine 8760-XI and AirEngine 8760-XI E outdoor Access Points.

Huawei data center switches feature network scaling, automation, programmability, and real-life visibility for a wide range of network sizes. The switches provided are core/aggregation and access switches depending on what customer require. The switches offered for core/aggregation switches is the CloudEngine 16800 series data center switches. It's a data center switch that is very much suitable for this era of intelligence. The model is powered by a unique iLossless algorithm that learns and trains network-wide traffic as real-time passes by. It also achieves zero packet loss and E2E  $\mu$ s latency while maximizing throughput. Another model of the core/aggregation switches is the CloudEngine 12800 Series data center switches, that is design for data center network and high-end campus network. Other than that, the access switches offered the CloudEngine data center storage network switches which have a high-performance feature, high liability, low latency switches with simplified O&M. It has an advanced hardware structure with a high-density 10/25/50/100 GE downlink ports plus and etc. This specifically is designed for an all flash storage data center.

## DOMAIN FOR HUAWEI

Huawei has an NAS that performs domain-based user management. This means a user will use only AAA configuration information in the domain where the user belongs. The domain specializes in managing configuration information. This includes the AAA scheme, server template, and most importantly, authorization information in a codependent manner. The AAA scheme is divided into 3 parts, which are authentication, authorization and accounting schemes that are defined in this order specifically for the methods to take effect. Other than that, server templates configure the server for authentication, authorization and accounting. A configured server will make it easy to obtain authorization information from both server and domain. Local authentication would require a need to configure information related to the local user. Customer can also bind a service scheme and a user group to a domain. Authorization information includes the authorization of ACL and VLAN can also be configured in a user group.



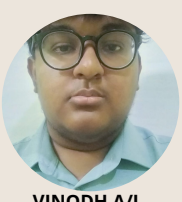
## REFLECTION



Technology has slowly advanced as time passes by, and it has been a vital part embedded in every individual's daily routine. Technology has made it undoubtedly easy to perform a task in any situation. For example, during an era of pandemic. This era specifically affects a lot of people ranging from children to adults in their daily routine, so technology had played a part in making sure people are connected with each other, being constantly updated on the news and most but importantly, allow people to do their work just at the tip of their fingertips. This has proven that technology has been a vital part of an individual's daily routine, which is why technology advancement will be very beneficial for the future. For example, the latest technology advancement offered is the Wifi-6 that has a lot of newest features like a wide internet radius for more coverage for a specific area. It can also achieve high internet speeds to support a variety of IoT devices. This will be beneficial for the development of IoT devices in the future. In conclusion, it has been proven that technology advancement has been very beneficial for mankind in a wide variety of sections, especially in the work section.



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