# FOCUS

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# Technology Information System, Emerging Network Technologies

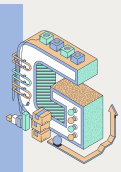
# APPLICATION OF 5G IN SMART CAMPUS

## 5G IN SMART CAMPUS

5G technology's high capacity, high speed, and low latency enable a slew of new services across a variety of locations, including smart airports, smart ports, smart stadiums, and university campuses. Edge computing and a private 5G network, also known as 5G network slicing, allow specific apps and experiences to run at their best.

## SMART CAMPUS CONCEPT

Many studies have been undertaken on Smart Campus implementations or concepts, with many of them concentrating on technology frameworks and architectures in specific use cases. The goal is to separate the campus network into virtual networks depending on the different categories of users who have different service requirements. The IoT system framework and the education cloud system framework are used to build A Smart Campus, which is built on IoT networks and cloud computing. Following that, a three-tier Smart Campus concept with portal architecture, management, service and decision support layer, smart learning and management layer, and infrastructure layer is provided. To accomplish Smart Campus service, different wireless technologies such as WiFi, Bluetooth, and ZigBee are compared. Platforms, architecture, and services have been the primary emphasis of Smart Campus concepts, which are unquestionably the cornerstones of any intelligent environment development.



## SMART CAMPUS

1. Traditional campus network pain points and smart campus development trends
2. Smart Campus Typical Application Scenarios
3. Smart Campus Solution Architecture, Features, and Values Case Studies on Smart Campuses

## SMART CAMPUS IN PRESENT TIME

According their profile, a Smart Campus can provide advanced services and personalized information to students, teachers, researchers, and visitors. In addition, the students want to understand how to work in a digital environment. This is a problem that a number of Smart Campus projects are attempting to address. Students nowadays have great expectations for their schooling. Listening, writing, exercising, and exhibiting in a classroom are no longer the exclusive methods of teaching. In educational settings, technological advancement has been obviously noticeable. There is very little study on 5G network deployments and architecture descriptions in university campus use cases, according to extant literature on Smart Campuses. There is also little research on the operational elements of Smart Campuses. According to the existing research on Smart Campuses, there is relatively little research on 5G network deployments and architecture descriptions in university campus use cases. In addition, little research has been done on the operational aspects of Smart Campuses.

## IMPACT IN FUTURE

5G increases computing and processing capability at the network edge, it will spur innovation at the edge. Ultra-fast speeds and data transfer will be available not just to devices, but also at the network's edge. According to Blackard, 5G and edge computing will bring a slew of new use cases to life behind the scenes, particularly in the IoT and connected devices arena for companies and the home. He went on to say that today's 4G networks can't manage this need for edge computing


## REFLECTION

5G increases computing and processing capability at the network edge, it will increase creativity at the edge. Ultra-fast speeds and data transfer will be available not just to devices, but also at the network's edge. According to Blackard, 5G and edge computing will bring a slew of new use cases to life behind the scenes, particularly in the IoT and connected devices arena for companies and the home. 5G's core functional drivers will open up a slew of possibilities, including improved service delivery, decision-making, and end-user experience. By 2035, this will have generated $13.2 trillion in global economic value, with 22.3 million employment created in the 5G global value chain alone.

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# "EMERGING TECHNOLOGY ON NETWORK INFRASTRUCTURE" (COMMSCOPE MALAYSIA)

**In the pandemic, it not only gives our life big change also increase the acceleration to the IT world, COVID-19 has affected employees working remotely, the increased use of cloud and mobile computing, the acceleration of digital transformation and more. This is because the pandemic puts pressure on performance to improve asset utilization, reduce energy and utility costs, improve guest service, and provide a safe environment away from COVID-19. This leads to the deployment of billions of IoT devices every month.**

## TECHNOLOGY HIGHLIGHTS

Over the past decade, we've been living more and more online, and the wireless Internet has helped us make that transition. The latest version of the technology is Wi-Fi 6, also known as 802.11ax. Wireless access points and routers incorporating the technology are becoming more common. Many new smartphones, tablets, laptops, and other connected devices are certified with Wifi 6 to take full advantage of its capabilities. The advantage is peak throughput increase, enhanced Wi-Fi coexistence, extend battery life of devices, increase the network capability.

The risk of performance bottlenecks from wired networks increases enough to spur the development of gigabit technology, which allows you to achieve 1 to 10Gbps bandwidth over traditional Cat 5E cables. This essentially enables you to extend the life cycle of your current wired infrastructure.

Besides, unified network management manages wired and wireless networks through a single interface such as access point and switch all in one network controller.

The Internet of Things (IoT) market is growing rapidly across industries. Growing opportunity on internet of thing have bring some benefits of implement IoT solution such as cost reduction, enhance customer experiences, increase efficiency & productivity, and increase business opportunity. But there are challenges when deploy IoT solution is connectivity, security, and compatibility. Internet of Things (loT) also help in school and education like environment air monitoring, IP video, staff alert tags and so on.

Cloud analytics refers to the use of cloud computing to analyze large amounts of data. Therefore, we need cloud analytics because large amounts of data are too complex for normal humans to manage. Example, 42% of network professionals spend too much time troubleshooting, 38% of network professionals cannot proactively identify network performance issues, and number one ranking of wireless as the top network challenge.

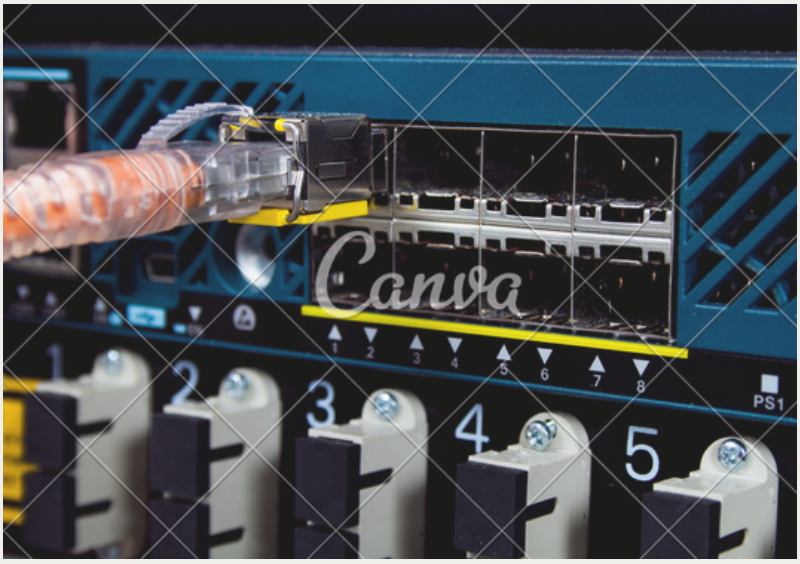
## What is Smart Campus?

Smart campus is a term used to describe an educational institution that seamlessly integrates the next generation of technologies in a well-structured infrastructure. This enables Digital Connected institutions to enhance the campus experience, improve operational efficiency and provide education in a way that is accessible to all. There are some benefits of smart campus is smart living, smart learning, smart security. Digital educational content for e-learning, mapped to school curricula and boards. Manage school activities online, from online registration, enrollment, and fees to generating reports will make the students easier. Besides, through the installation of CCTV cameras and other monitoring systems, to achieve intelligent and safe digital classrooms on campus.

### Devices Used

Network infrastructure devices are the network components that transport the communications needed for data, applications, services, and multimedia. The device include:

- routers
- firewalls
- load balanced
- intrusion detection system
- domain name system
- storage area network



# EXAMPLE OF A DOMAIN

The network Infrastructure Domain defines the roles, policies, standards, and technologies that provide and manage the communications networks and computing platforms for the State's IT environment. This domain includes the hardware and software used to send, receive, manage, store and process data. Like LAN Domain.

LAN refers to the domain of a local area network. A domain is a subnetwork that consists of a collection of clients and servers that are all controlled by a single security database. Ethernet and Wi-Fi are the two most common technologies for local area networks. The LAN allows us to keep data on any central computer and share it with the rest of the organization. Because backup data are stored on a single server, file transmission and recovery are simple in a LAN network. As a result, it's most commonly employed in the following scenarios:

- Home and office networking
- Networking in the classroom, laboratory, and on the university campus.
- Setting up a network between two computers.

# REFLECTION

Network infrastructure is typically part of the IT infrastructure found in most enterprise IT environments. The entire network infrastructure is interconnected, and can be used for internal communications, external communications or both. Emerging technology on network infrastructure bring many benefits in our life. Day by day it brings new technologies. These technologies change our education systems. The new network infrastructure able to give us a better learning experience. In future this will make our student more productive and they can contribute in many better changes. New infrastructure like IOT. IT can synchronize our smart devices. It centralized management control so that we can save our more time. So that people will more productive than pervious. In this Way network infrastructure will lead our future

# 5G, WIFI6 AND EMERGING NETWORK TECHNOLOGIES (HUAWEI)

**The advancement of technology and information system has make the process of sharing and acquiring information become more efficient and easy, as most information are widely available around the globe. Other than that, it also has make various of careers and jobs to evolve and relied more on technology such as internet, where it required strong connection for it to have excellent performance. Which bring us to a technologies that exist to improve the performance of internet connectivity and that technologies are 5G, Wifi6, and Network Technologies.**

## 5G

5G is the fifth generation of wireless technology system. This technology is new and more advanced than previous generation as it has speed faster than any of it's predecessor, plus comparable via fiber-optic cables. The speed of 5G on early testing shows real-world 700-3025 Mbps. For better understanding, by using 5G, it will only take seconds to download files that took minutes to download with 4G.

5G devices are lower latency, where it enabling faster transmission of larger data streams. The devices are also more reliable since it enabling better transmission of data in extreme conditions. Other than that, 5G is more flexible than Wi-Fi and can support a wider range of devices, sensors, and wearable.

## USE CASE EXAMPLES

- Augmented Reality
- Virtual Reality
- Driver information
- Entertainment in vehicle
- Automation in the vehicle
- Smart Grid
- Delivery Drone


## 5G REQUIREMENT IN VR

While AR/VR technology has existed for a couple of years, adoption at scale needs 5G and edge computing. The ultra-low latency and high bandwidth that 5G brings is crucial in enabling the use cases. Today's VR solutions have to deal with a significant time lag between a response and request. 5G can reduce latency by around 10 times, while improving data transmission rates. This will reduce the " VR sickness" issue that users experienced because of lag between the movements of their body and the response of the VR machine.

## OPPORTUNITIES AND BENEFITS BY 5G

5G installation is important to humanity as it come up with plenty opportunities and benefit. These benefits are related to our modern lifestyle and technology usage that being part of our daily life.

One of the benefits is enhancing tourism experience. For example, tourist will be able to live-stream their experience anytime and anywhere through 5G network. Also, it can improve tourist-guide mobile app that can provide the tourist a guidance about the places they will going.

Next, the advance 5G industrial Park will encourage Hi-tech industry establishment and will attract lot of Hi-tech investor. Thus, a plenty of job opportunity will be created for the young generation.

Another is, 5G can enables AR/VR based Education, which provided students around the world with excellent resources inside and outside their country. For example, AR/VR can allowed the students to go through a learning process by having remote class, where they can still learning without physically attend to the class.

# WI-FI 6

Wi-Fi 6 is the next generation standard in Wi-Fi technology, also known as "AX WiFi" or "802.11ax WiFi" builds and improvement on the current 802.11ac WiFi standard. It come with 9.6Gbps as max rate and was originally built in response to the growing number of devices in the world. Wi-Fi 6 will be release for two time where the first one already release have spectrum of 2.4GHz and 5GHz, while for the upcoming second release have 2.GHz, 5GHz and 6Ghz.

Wi-Fi 6 has improved the experience of fast download and cloud backup. The peak performance for Wi-Fi 6 is 25% higher than Wi-Fi 5 and the transmission time is increased from 3.2 us/time to 12.8 us/time. In other word, Wi-Fi 6 change speed of download for files that take 7 minutes to download to 20 seconds.

Next, Wi-Fi 6 have improve coverage, where it can do a full-house (120 square meters) coverage of 5GHz signals, . This is because of Wi-Fi 6 chip RF optimization, enhancing TX power and sensitivity under the same signal quality. It also has dedicated algorithm, where there are improving performance and omnidirectional coverage when connecting to traditional Wi-Fi 5 STAs.

On the past years, Wi-Fi 5 Wave 2 debuted the use of downlink MU-MIMO ( Multi-user, multiple-input, multiple-output ), with transmitting and receiving antennas supporting up to four spatial streams per AP -- in a 4x4 configuration -- and enabling the AP to multitask by broadcasting to a different client on each channel .However, Wi-Fi 6 technology ups the ante even further enabling an 8x8 spatial stream variation that doubles the number of concurrent connections possible with Wi-Fi 5. In other words, what was once a two-lane highway becomes an eight-lane expressway.

Then, Wi-Fi 6 lowers latency compared to older Wi-Fi standards, using more advanced technology like OFDMA (orthogonal frequency-division multiple access). OFDMA is an advanced version of orthogonal frequency-division multiplexing and is already deployed in LTE networks. The feature, which complements MU-MIMO, enables an AP to intelligently and dynamically subdivide bandwidth into smaller resource units (RUs). The AP can then flexibly allocate those RUs across client nodes, thereby engaging with many devices simultaneously -- the precise number depends on which channel and how the AP intelligently divides it. Basically, it's better at packing data into a signal.

There is also a feature called Target Wake Time (TWT), a part of Wi-Fi 6 feature where the access points negotiate with attached devices to agree when they should wake up to transmit data. This pre-scheduling means devices can deep-sleep for extended periods, dramatically reducing current consumption and significantly increase battery life. It means that sensors could potentially be left usefully gathering data in the field for years at a time. Plus, the power consumption of terminals is reduced by 30%.

# 5G AND WI-FI 6

5G is a network technology that typically deployed at outdoor for internet access such as at commercial street, highway, scenic area and urban coverage. This is because for it's feature which are outdoor wide coverage and more flexible than Wi-Fi.

While for Wi-Fi 6, is typically deployed at places that indoor because of it's indoor ultra-high density. For example, Wi-Fi 6 are more suitable to be deploy at home, mall, classroom and even a stadium.

# REFLECTION

- The existing and advancement of technologies like 5G and Wi-Fi 6 are significantly important as it gave lot benefits to humanity. Some of the benefits is its create plenty new jobs opportunity for new generation, and make our daily life become better and easier. That is why, it is important for our government and us, the citizen of Malaysia to contribute on implementing 5G and Wi-Fi 6 in our country to enhance our network technology, and same goes for other countries. These technologies will become the stepping stones for humanity towards a bright and better future.

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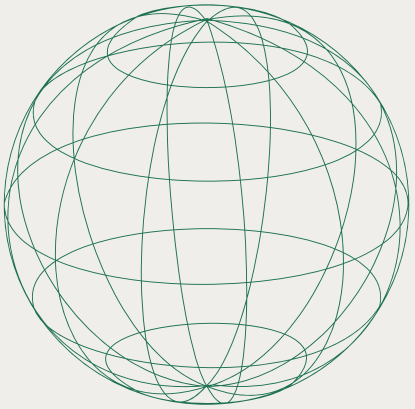

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