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"A Proof-of-Concept Study of Tuleva Cube System as a Solution for rural area coverage system"

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Introduction

Ookla's data reveals that the median mobile internet connection speed in Malaysia increased by 11.79 Mbps (+48.0 percent) in the twelve months to the start of 2023. Meanwhile, Ookla's data shows that fixed internet connection speeds in Malaysia increased by 16.66 Mbps (+22.3 percent) during the same period.[1]. But there is still a sizable discrepancy in rural internet access that needs serious improvement. This disparity highlights the significant variations among urban, suburban, and rural areas in terms of accessibility and caliber of Internet connectivity. Many people who live in rural areas have trouble getting high-speed broadband internet, which makes it difficult for them to do remote work or take distance education courses. It might not be financially feasible to build communication towers in sparsely populated areas. The challenges of delivering internet connectivity in rural locations are caused by several variables. First, because they frequently have lower population densities than cities, rural areas make it harder and more expensive to build and maintain the infrastructure needed for high-speed internet, such as Fiber-optic cables or cell towers. Infrastructure development and upkeep are further complicated by the characteristics of rural areas, which include rugged terrain and dispersed population centers.

Keywords: *multi-carrier, convergence, internet, data, voice, cellular communication*

Abstract

The revolutionary Tuleva Cube (TC) is presented by the Grass2Route (G2R) initiative and is proudly produced in Malaysia by G2R. This innovative multi-carrier convergent system, which boasts quicker deployment times and better cost-effectiveness, presents a tempting alternative to conventional telco tower construction.

By enabling data transmission over one communication channel while utilizing several carrier frequencies, the Tuleva Cube marks a paradigm change in telecom technology. Numerous applications, such as wireless communication, digital television transmission, and broadband internet access are made possible by this multi-carrier convergent method.

Organizations can avoid the time-consuming and expensive process of building new telecom towers by implementing the Tuleva Cube. Due to the system's quick implementation capabilities, lead times and expenses associated with conventional infrastructure development are drastically decreased. This innovative approach removes the conventional constraints of expensive costs and protracted delays, allowing for enhanced connectivity and telecommunication services.

To summarise, the Tuleva Cube from Grass2Route Sdn. Bhd. is a game-changing advancement in communication technology. Its multi-carrier convergent system's unparalleled cost and efficiency enable rapid adoption and a wide range of data transmission applications. Organizations that use this innovative technology may revolutionize their connectivity landscape and create new chances for improved communication offerings.

Background: *This section provides context for the study by reviewing relevant literature and prior research related to the concept or technology being assessed.*

Tuleva Cube System (TC)

Grass2Route (G2R) proposed the Tuleva Cube (Made in Malaysia by G2R), a multi-carrier convergent system that is faster to deploy and more affordable than building a new telco tower.

A multi-carrier convergent system is a type of telecommunication that transmits data over a single communication channel while utilizing various carrier frequencies. Broadband internet access, digital television broadcasting, and wireless communication are only a few examples of the uses of this kind of technology.

Wireless and optical convergent technologies might enable mobile network systems to meet the wireless system's needs, such as high throughput, latency, coverage, and geographical positioning. For example, eMBB can benefit from the available wide bandwidth from optical communication followed by millimeter waves (mmWaves) and terahertz (THz) communications [2].

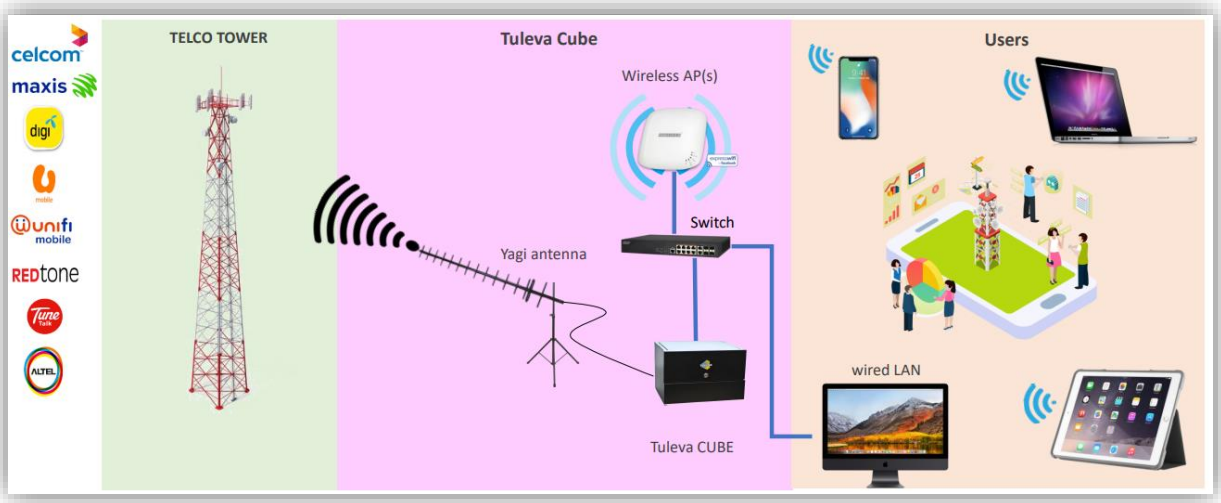


Figure 1 shows how does Tuleva Cube system works.

A multi-carrier convergent system works by dividing the available communication bandwidth into a few sub-channels or sub-carriers, each of which is capable of simultaneously transmitting data. A multi-carrier convergent system can use the available bandwidth more effectively and produce better data speeds than a single-carrier system by utilizing numerous sub-carriers.

Data is typically modulated into each sub-carrier in a multi-carrier convergent system using a method like Orthogonal Frequency Division Multiplexing (OFDM) or its variations. Even when they are sent simultaneously over the same channel, these modulation algorithms make sure that the sub-carriers are orthogonal to one another and do not interfere with one another.

Long-Term Evolution (LTE), a wireless broadband communication standard that uses OFDM to transmit data over many sub-carriers, is one example of a multi-carrier convergent system [3]. Another illustration is Digital Video Broadcasting - Terrestrial (DVB-T), a digital television broadcasting standard that also employs OFDM to transfer data over several sub-carriers.

The hybrid Tuleva CUBE device combines and amplifies numerous wired and wireless internet gateways for both uplink and downlink traffic. Up to five wired and wireless service provider inputs can be combined using Tuleva CUBE's configuration options.

The Tuleva CUBE wireless AP utilizes TWO (2) frequencies:

Radio	**2.4GHz**	**5.0GHz**
Operating frequency (MHz)	2400-2500	5150 - 5350
Wireless protocol	802.11 n	802.11 ac

Wired LAN cables can also be used to connect to a Tuleva CUBE. For crucial services like those provided by the government, banks, and security, Tuleva CUBE meets the Service Level Agreement (SLA) to the tune of 99.9%. The contract includes an SLA that details, among other things [4]:

a. The kind of service that a service provider offers,
b. The quality of the service, and
c. What happens if the service provider does not meet the requirements?

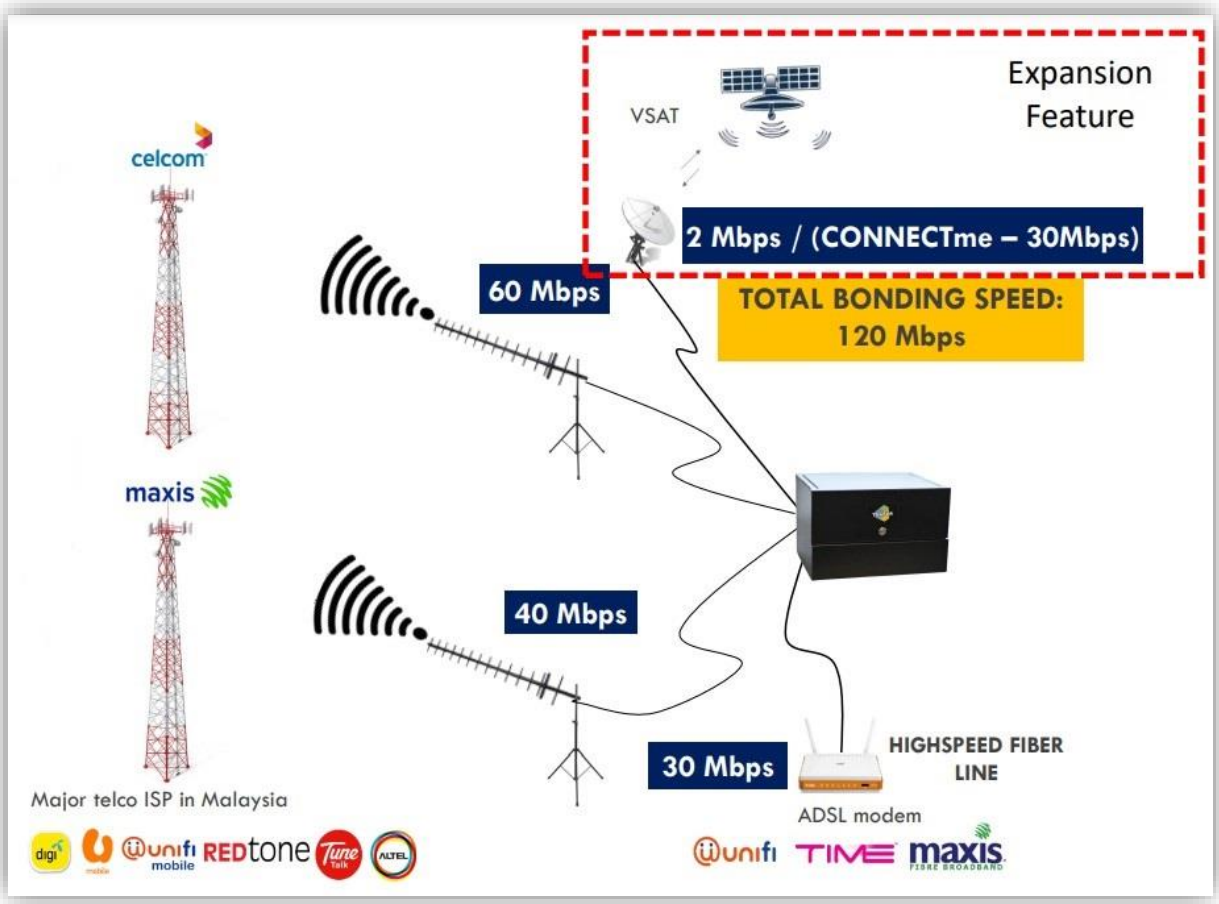


Figure 2 shows the connections between the telco tower and the TC system.

Networking devices known as wired and wireless internet gateways connect a local area network (LAN) to the internet.

An Ethernet cable is often used to connect a wired internet gateway to the local area network (LAN) and to offer access to the internet via a modem or broadband service. The gateway may also have further functions like a router that allows several LAN devices to share an internet connection and a firewall that protects data by preventing unauthorized access to the LAN.

On the other hand, a wireless internet gateway offers communication to the LAN and the internet via wireless signals as opposed to a physical cable. A wireless router that enables numerous devices to connect to the internet through Wi-Fi is often included with this kind of gateway, along with a modem or broadband service to give the connection to the internet.

Additionally, wireless internet gateways may offer features like parental controls, which let users limit access to websites or categories of content, and guest access, which enables network guests to connect to the internet without using the private LAN.

To provide internet access and allow networked devices to communicate with one another and the internet, both wired and wireless internet gateways are frequently used in homes and companies. The decision between a wired and wireless gateway is frequently

influenced by the design of the building, the quantity and distribution of network-connected devices, and the speed and dependability of the internet connection.

Methods: *This section describes the design and construction of the prototype or model, as well as the testing methodology and any relevant instrumentation or data collection techniques*

The Cellular Convergence Concept for Improving Internet Connectivity

Cellular convergence applies to the integration of diverse cellular network architectures and communication technologies to provide customers with a seamless communication experience. It intends to provide seamless network switching and access to phone, data, and multimedia services across several networks, including 2G, 3G, 4G, and 5G. The use of a common network infrastructure to support multiple cellular technologies is a vital component of cellular convergence, as many cellular network providers are introducing 4G and 5G networks that share a basic network architecture, allowing consumers to switch between the two without having to reconnect or change the settings on their device.

Cellular convergence is the integration of different wireless communication technologies, such as Wi-Fi and cellular, to produce a unified communication experience. Smartphones and other mobile devices can switch between Wi-Fi and cellular networks based on which network provides the best connection.

Cellular convergence seeks to deliver a consistent user experience across different types of cellular networks and technologies, allowing users to get services regardless of their location or network resources. As cellular networks evolve and new technologies are introduced, it is a critical area of interest for network operators and technology providers.

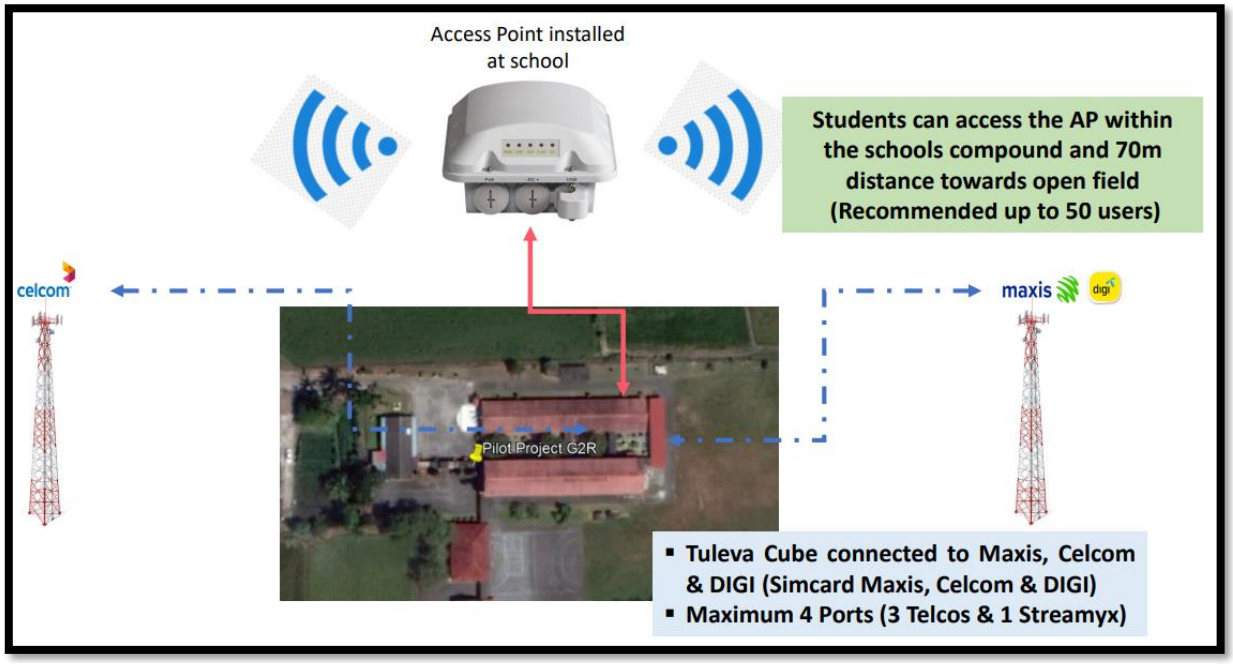


Figure 3 shows the location of the Access Point (AP) placed in the school and how the AP spreads the coverage signal.

P2P Connectivity and P2P Capability

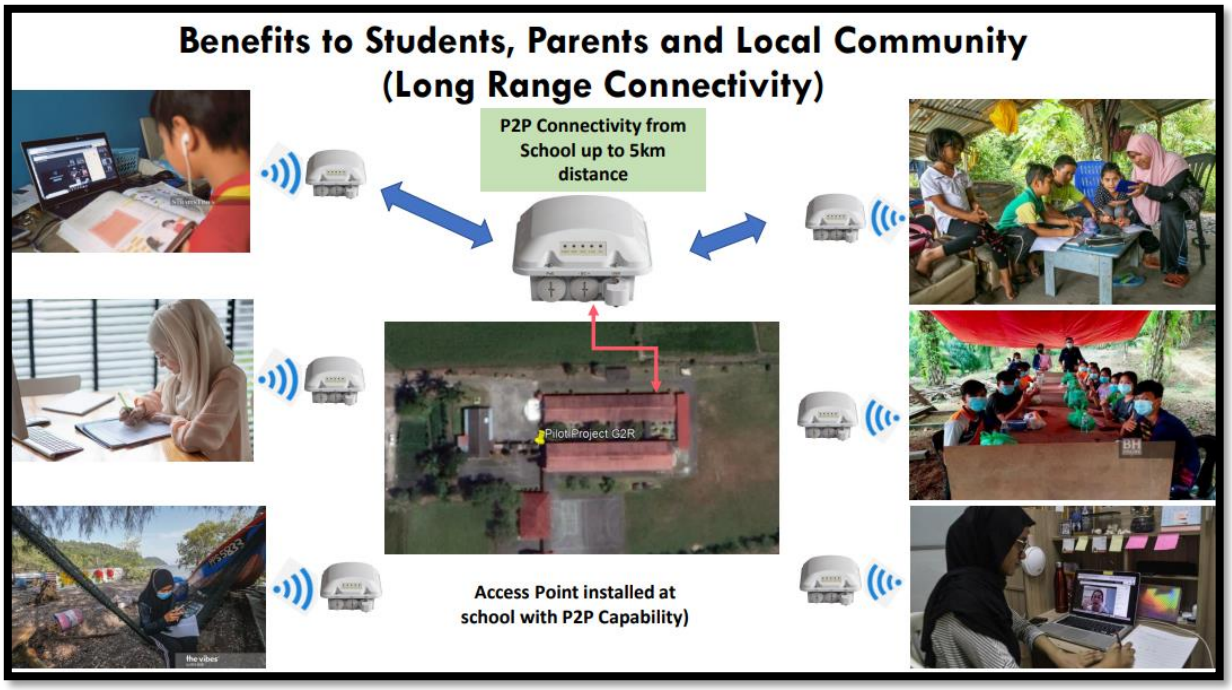


Figure 4 shows the P2P connectivity from the school to the area.

Peer-to-peer (P2P) communication is a type of connection in which two or more devices or nodes connect to a network and interact directly with one another without the use of a central server or other intermediaries. This type of connection is known as peer-to-peer (P2P) communication because it allows users to share files over the internet without the necessity of a central file server. P2P file sharing is an example of a P2P connection since it allows users to share files with one another over the internet without the need for a central file server.

Another example of a P2P connection is peer-to-peer messaging software, which allows users to connect directly with one another rather than through a central messaging server. When the benefits of a decentralized network exceed the problems and complexity of the deployment, P2P networking is frequently used in applications.

Figure 5 Among another project that involves G2R.

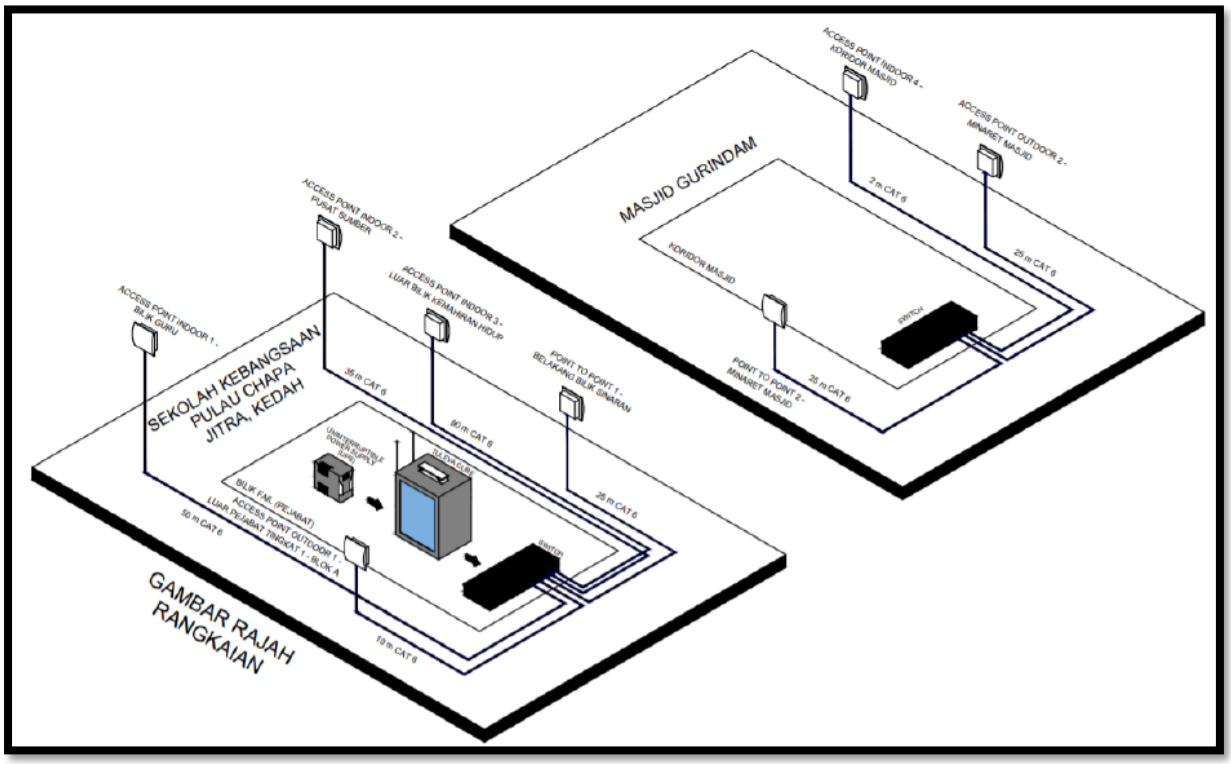


Figure 6 shows the Network Block Diagram of the TC system.

Figure 7 shows the installation of Hardware devices at the school.

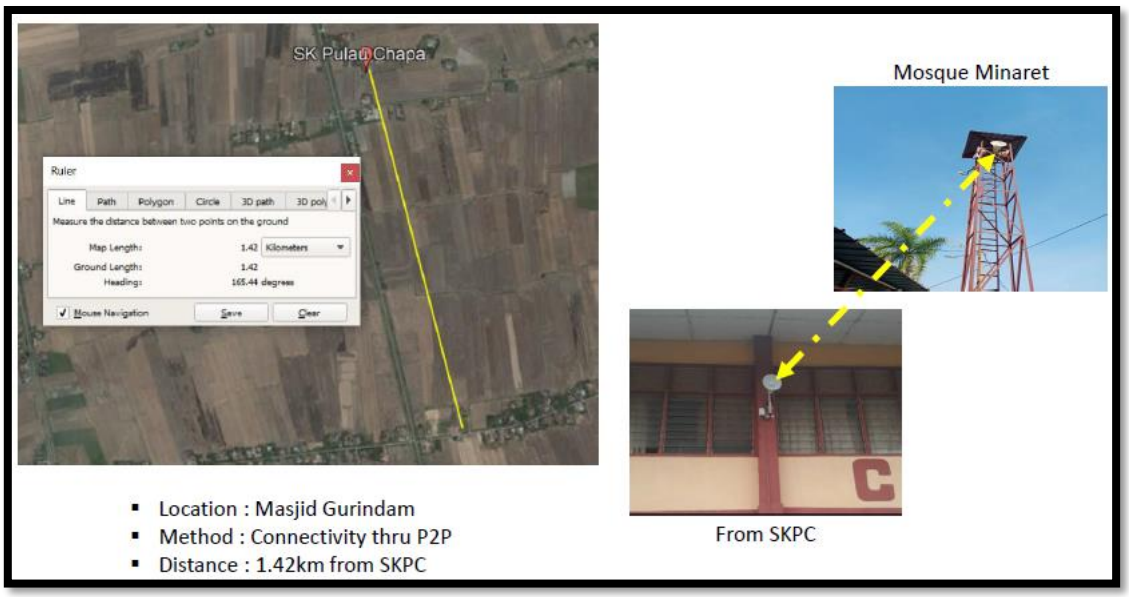
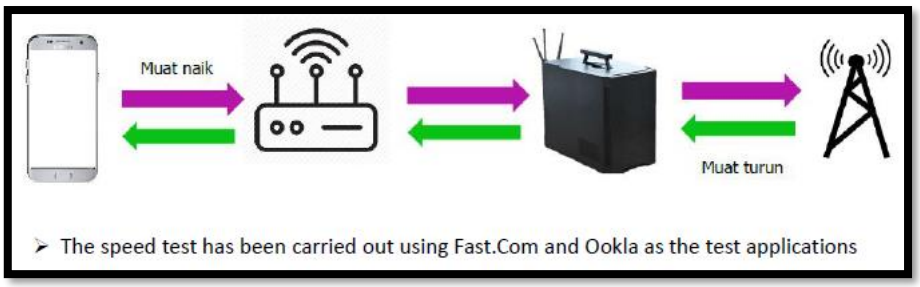


Figure 8 shows the connectivity link between SK Pulau Chapa and Masjid Gurindam

Internet Speed Tests

One of these quick and simple methods to assess the speed of the internet is to run a speed test. It offers the ideal means of determining whether the internet is operating more slowly than it ought to or whether there are any other underlying problems on the other end. When performing a speed test, two elements are considered. You have a lot of alternatives when it comes to what performance element to assess for free, like the Okla speed test. When running your internet speed test, the download and upload speeds are undoubtedly the ones you need to look at first. How quickly you can download content from a specific internet server to your device is measured by download speeds [5].



The network speed test serves a vital purpose that extends beyond a mere evaluation of network speed. Its primary objective is to delve into the intricate dynamics of upload and download times, offering valuable insights into the sustained performance of each network. In this rigorous assessment, we specifically focus on the performance of two prominent telco providers, namely Maxis and Celcom, putting their capabilities to the test under real-world conditions.

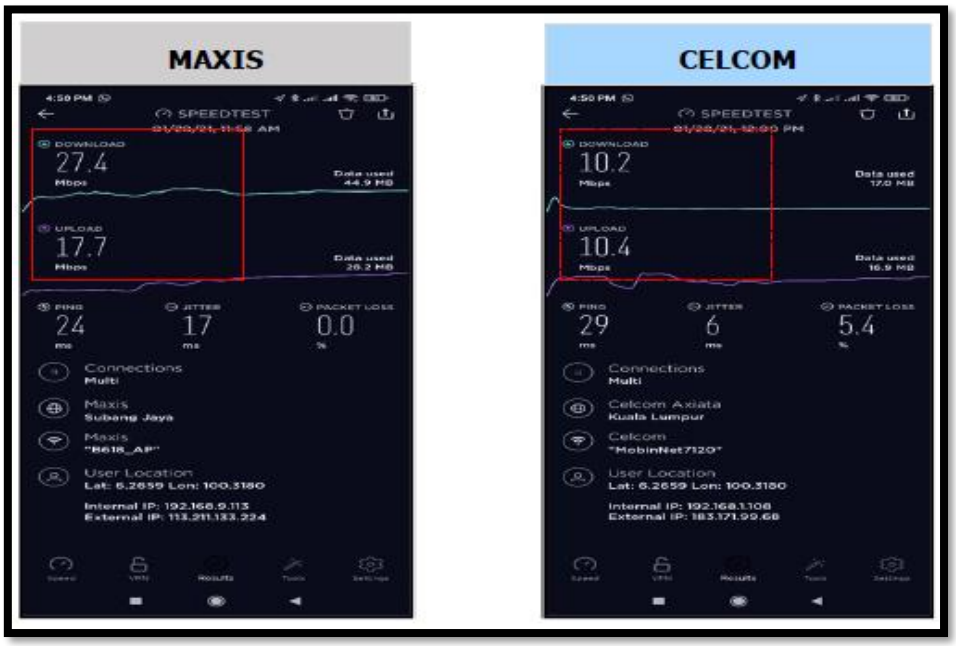


Figure 9 shows the Speed test at the SKPC (Smartphone test result)

By subjecting these networks to a comprehensive examination (Figure 9), we gain a comprehensive understanding of their resilience and stability. Beyond mere speed measurements, we uncover the ability of each network to consistently deliver optimal upload and download speeds over an extended period. This meticulous evaluation equips us with the knowledge needed to make informed decisions regarding network selection, enabling us to navigate the digital landscape with confidence and reliability.

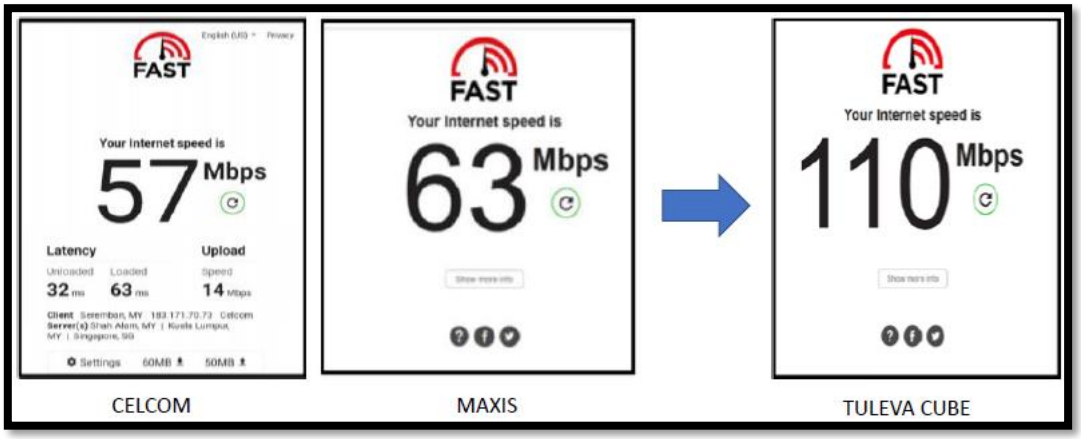


Figure 10 shows the Speed test at the SKPC ((Test Using Sim card Injector by TC)

The compelling graphic presented above (Figure 10) vividly portrays the remarkable result of G2R Company's ambitious pursuit of network convergence. Through the harmonious integration of numerous communication networks into a cohesive and unified infrastructure, G2R aims to revolutionize the way we connect. This convergence empowers a singular network capable of seamlessly catering to a myriad of services, encompassing not just traditional phone and data, but also video and multimedia applications.

The driving forces behind these transformative endeavors are multi-faceted and compelling. The demand for an unparalleled communication experience, fuelled by the ever-evolving technological landscape, necessitates a convergence of networks. By consolidating resources, leveraging innovative advancements, and maximizing network efficiency and utilization, G2R Company is poised to reshape the very fabric of communication, unlocking new possibilities and propelling us toward a more integrated and interconnected future.

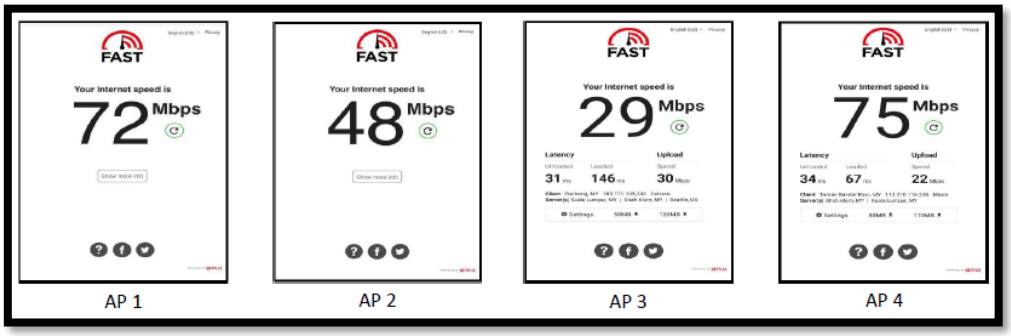


Figure 11 shows the signal output results for FOUR (4) APs installed at SKPC.

By analysing the signal output results obtained from the FOUR (4) access points (APs) meticulously deployed at SKPC and TWO (2) at Masjid Gurindam, it becomes evident that this meticulously engineered system possesses the remarkable ability to deliver uninterrupted

internet services to remote regions that were once challenging to reach. These results provide compelling evidence of the system's efficacy in ensuring a consistently stable and reliable internet connection, even in the most inaccessible areas.

NETWORK MANAGEMENT SYSTEM (NMS)

A network management system, or NMS, is a program or collection of programs that perform a few important tasks and enables network engineers to manage a network-independent component inside of a larger network management framework.

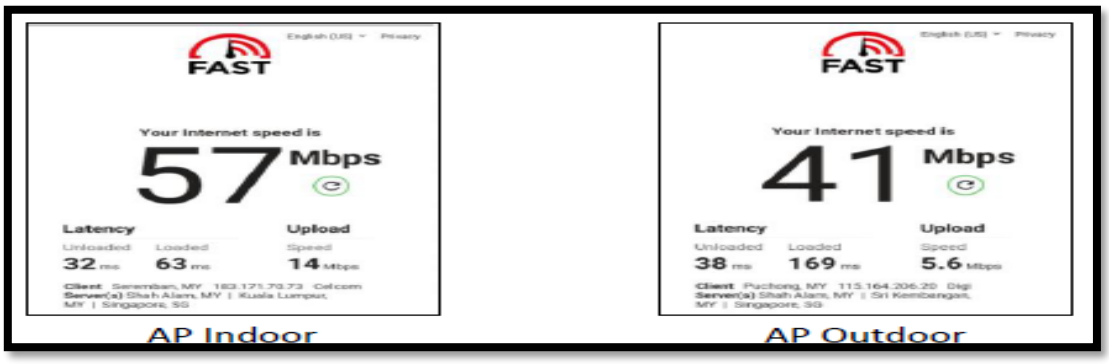


Figure 12 shows the signal output results for TWO (2) APs installed at Masjid Gurindam

An enterprise network's wired and wireless network devices are identified, set up, monitored, updated, and troubleshooting by an NMS. The performance data gathered from each network component is then shown in a system management control application, which enables network engineers to make the necessary changes.

An efficient monitoring process is essential to ensuring the smooth and trouble-free operation of all installed devices. **G2R** has advanced proactive system oversight by creating a cutting-edge Network Management System (NMS) in recognition of the importance of doing so. With the help of this cutting-edge system, any possible difficulties that might develop with the network infrastructure can be quickly identified and fixed.

The NMS keeps a close eye on the functionality and overall condition of the installed systems, acting as a watchful keeper to prevent any disturbances. It enables **G2R** to swiftly discover and address any anomalies or vulnerabilities by continuously gathering and analyzing crucial data points, maintaining optimal system performance at all times.

With the use of this state-of-the-art NMS, **G2R** demonstrates its dedication to providing flawless reliability and reducing downtime. The incorporation of such a potent monitoring system improves operational effectiveness while also bringing peace of mind, enabling proactive maintenance and prompt problem-solving, which eventually leads to a seamless and uninterrupted user experience.

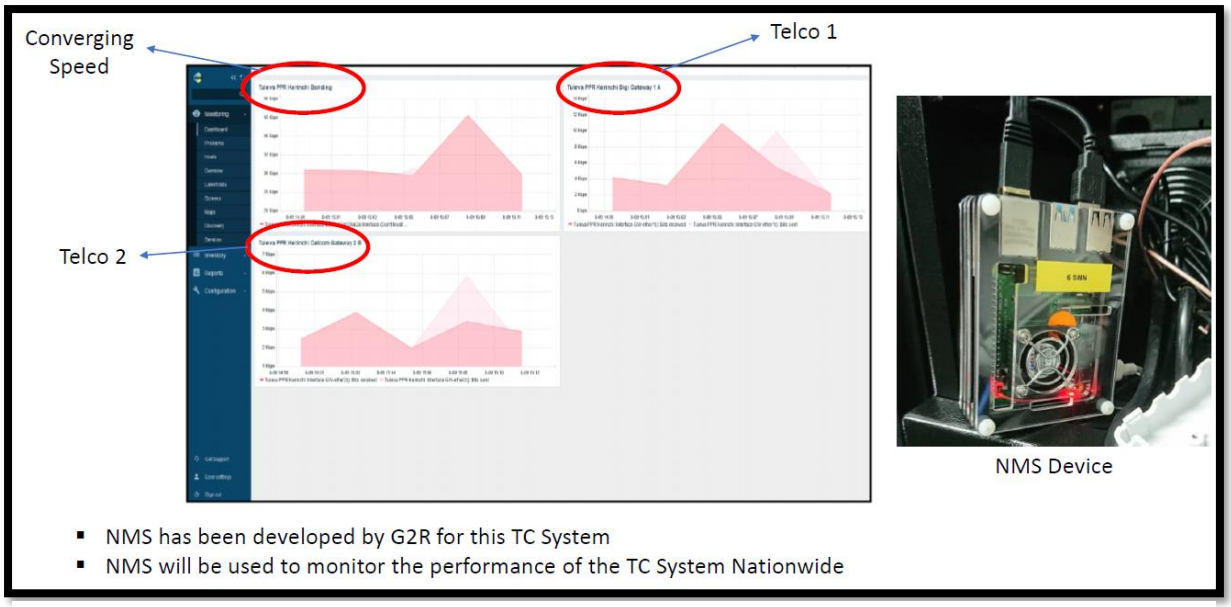

Converging Speed
Telco 1
Telco 2
NMS Device
NMS has been developed by G2R for this TC System
NMS will be used to monitor the performance of the TC System Nationwide

Figure 13

Summary

The Tuleva Cube, manufactured in Malaysia by Grass2Route, is a multi-carrier convergent system that offers shorter deployment timelines and lower costs as an alternative to traditional telco tower building. This novel method allows data transmission over a single channel and many carrier frequencies, enabling applications such as wireless communication, digital television, and broadband internet access. Organizations can cut lead times and costs associated with traditional infrastructure development by using the Tuleva Cube, leading to improved connection and telecommunication services.

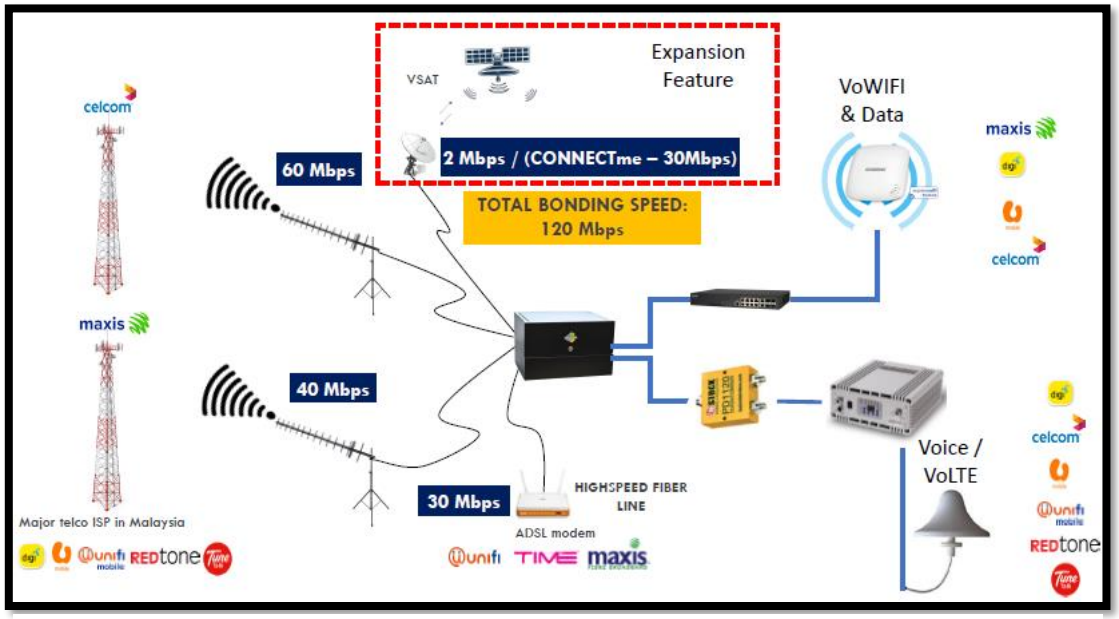


Figure 154 shows the Voice Call and Data for Advanced TC System

While G2R's ambitions of developing a 'Voice Call and Data for Advanced TC System' show their commitment to improving their capabilities, it is critical that they prioritize not only the technology itself but also the user experience and safety considerations. G2R can ensure that its innovative TC system genuinely revolutionizes transportation in a user-friendly and secure manner by focusing on seamless integration, intuitive interfaces, and solid security measures.

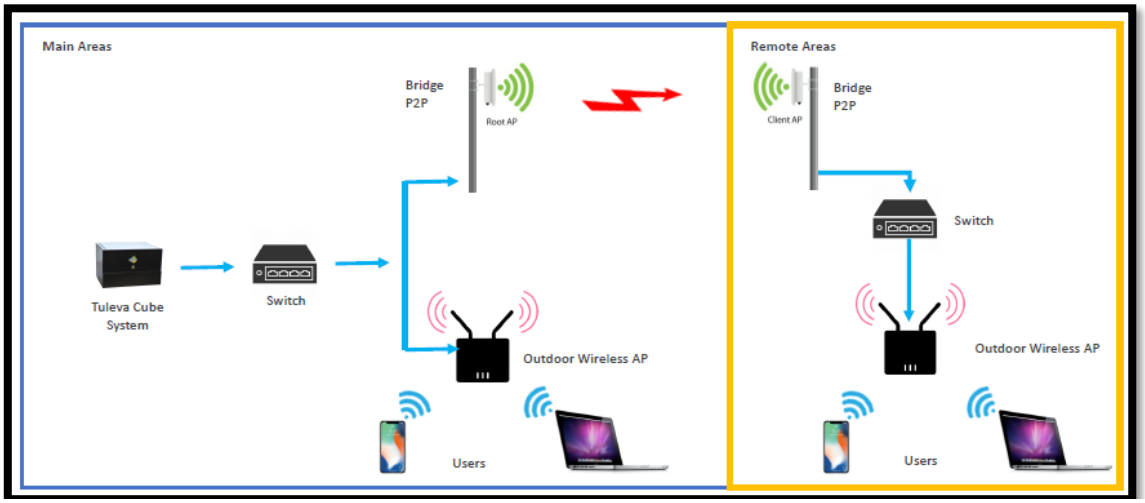


Figure 145 shows the Advanced TC System with Outdoor AP System

Characteristics	Tuleva Cube	Telco Tower
Deployment time	5 days	1 - 2 years
Site acquisition time	3 days	3 to 12 months
Cost variation	Minimal	Very high and depends on the steel market price
Cost impact for 2915 sites	RM 550mil (approximately)	RM 2.9bil (approximately)
Participation of Bumiputera Contractors	Can grow as many as sites awarded	Minimal. Only a few towers erectors in Malaysia
Creation of Job Opportunities	There are numerous opportunities. Only basic CME and IT installation skills are required.	Minimal because tower erection requires specialized knowledge.

Figure 16 shows the comparison between the Tuleva Cube and Telco Tower systems.

According to the table above, this TC system not only demonstrates the company's capacity to create a system that facilitates, but it is also capable of providing employment possibilities and lowering the cost of construction and installation. Furthermore, facilities for obtaining internet access are easily accessible, and individuals in rural areas can enjoy the same amenities as those in cities. This initiative is greatly appreciated, especially by Bumiputera businesses like G2R Sdn. Bhd.

References: *This section lists all the sources cited in the paper, using a standardized citation format.*

[1] https://www.slideshare.net/DataReportal/digital-2023-april-global-statshot-report-v01-april-2023

[2] G. Kalfas, C. Vagionas, A. Antonopoulos, E. Kartsakli, A. Mesodiakaki, S. Papaioannou, P. Maniotis, J. S. Vardakas, C. Verikoukis, and N. Pleros, "Next generation fiber-wireless fronthaul for 5G mmWave networks," IEEE Commun. Mag., vol. 57, no. 3, pp. 138–144, Mar. 2019.

[3] Hardeep Kaur; M.L. Singh; Department of Electronics Technology Guru Nanak Dev University Amritsar; "Evolution of OFDM Technology: A Review"; 2018 IJCRT Volume 6, Issue 2 April 2018; ISSN: 2320-2882

[4] https://fareezlaw.com/malaysia/service-level-agreement-sla/

[5] Internet Speed Tests and Why They Are Important; Jack Parker; 16 Aug 2021; https://dev.to/dailydevnews/internet-speed-tests-and-why-they-are-important-18b8