COS10025 Technology in an Indigenous Context

Semester 2 2022

Research Report

Project Title:

Innovation Concept

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Table of Contents

Project Overview

In these concept designs, our key **objective** is seek to use our telecommunication infrastructures uniquely designed based on Borroloola's specific contexts to solve the 3 identified issues in the area which are education, telehealth, and income. In the previous papers, research reports, the already mentioned **main goals** are as follows.

1. Telecommunication infrastructure specifically designed to fit Borroloola's contexts analysis and needs
2. Telecommunication infrastructure development
3. Telecommunication deployment for public usage

In the previous paper we explained how our key goals can be achieved through 3 main steps.

1. Research report/literature review - to develop sufficient understanding of the community's background and technical knowledge to create solutions.
2. Project demonstration/presentation - to design the details of solutions including prototyping and operation flows.
3. Innovation concept - to go deeper into development plans including required resources and budgeting.

This paper will focus on our designed innovation concepts and the processes and materials required for the concepted to be achieved.

Project Requirements

To solve the identified issues, the requirements to achieve each solution will be explained in this section starting from education, telehealth, and income respectively.

Education's Project Requirement

As a final result, we aim to see students in Borroloola gain their access to learning without the barrier of time, location, and finance. This will be achieved when the requirements listed below are met.

1. As network providers, local technicians have sufficient knowledge to install and maintain the infrastructure, thus, to keep the operation going.
2. As users, students can connect to the free public wifi anywhere and anytime within the Borroloola area.
3. As users, students can use the portal website to sign up, log in, edit my profile information, and update my password.
4. As users, students can use the portal website to log into my account before utilizing the internet.
5. As network administrators, the school and the library staff can use the workspace to monitor and configure usage and manage security control.

Telehealth's Project Requirement

We aim to see residents of Borroloola get easy and hassle-free access to medical services. This will be done by:

1. Network providers, who will stage the infrastructure and run it while it is operating.
2. Stable internet connection within Borroloola area which will allow patients to reach out to doctors.
3. A web portal for doctors that will give them access to database including patients' details and information and keep track of records.
4. An online queue so that patients will be able to book their appointments online before their arrival to the healthcare center to reduce waiting times.
5. Nurses and admin staff can update patients' records easier just by using the portal, instead of having to update it manually. Backups of the records can also be created so if the physical copy gets misplaced, the patients' care can still be administered.

Income's Project Requirement

We aim to see the people of Borroloola have the equal opportunity to increase their income without being constrained by lack of digital communication technology, the needs of their town and their towns accredited education institutes and programs. This will be achieved when the following requirements are met:

1. Have a network provider install the digital communication infrastructure.
2. Have a technician who can also serve as staff and admin of the computing site and network, assisting with the maintenance of the hardware, software and user concerns.
3. Have an established in person and online computer session booking and account creating method for users.
4. Develop a website to assist users in using the computer, avoiding viruses and providing them with a clear path to receiving an online job online they would desire and the digital accessible qualifications required for the job if necessary.

Design idea/concept 1: Education Issue

Brief Introduction to the Education Issue

Since Borroloola already provides free WIFI for everyone at its library and one for students only at the school ("About Borroloola | Roper Gulf Regional Council", 2022). This means that residents already have access to network connection. However, evidence shows that Borroloola is suffering from transportation affordability to commute back and forth from home to school and/or to library("Yellow Shirts helping kids get to school", 2022). Another barrier to network connection is lack of unaffordability since evidence shows that the residents are very low income ("2021 Borroloola, Census Community Profiles | Australian Bureau of Statistics", 2022).

As the free network access is only available at the two locations combined with the limitations of transportation and affordability, those students with transportation and affordability limitations do not have access to the internet at home, missing out opportunities to explore online learning materials, and the opportunities to learn consequently. As mentioned by Abulencia (2022),

education is every child's right by law and is the root to better well-being in many aspects. This design concept aims to improve education equality via connectivity infrastructure.

To overcome the education issue impacted by transportation barriers to connectivity, the proposed solution in this design concept is to extend the range of network connection across the Borroloola using the wireless Mesh network infrastructure.

Design outline

Unlike a traditional network which devices connect to one single hub before they can communicate to each other, a mesh network allows all devices to connect and forwards data to each other across the network then to the destination host devices. These forwarding nodes make decisions in route prediction based on the topology and forwarding the data. This network infrastructure uses radio nodes to forward the data in a wide distance. Using radio waves eliminates cost of cables and their installation while enabling a wide range of extension, making the mesh network a **cost-efficient infrastructure** (How Mesh Networks Work, 2022).

Characteristics of Mesh Networks

Mesh networks are widely being implemented both in large cities and developing worlds because of their main known qualities.

1. The implementation of wireless mesh networks is **cost-efficient** due to its small requirements in terms of required equipment and installation manpower compared to the range of radio coverage and network quality (Köbel et al., 2013)
2. They are known to be **self-healing**. This means if one node is down, the network will automatically find another path by linking to the closest reliable node and continue forwarding data across the network (Pollette & Roos, 2021).
3. They are also **self-configuring**. The network automatically connects to the new node without requiring configuration by the network administrator (Pollette & Roos, 2021).

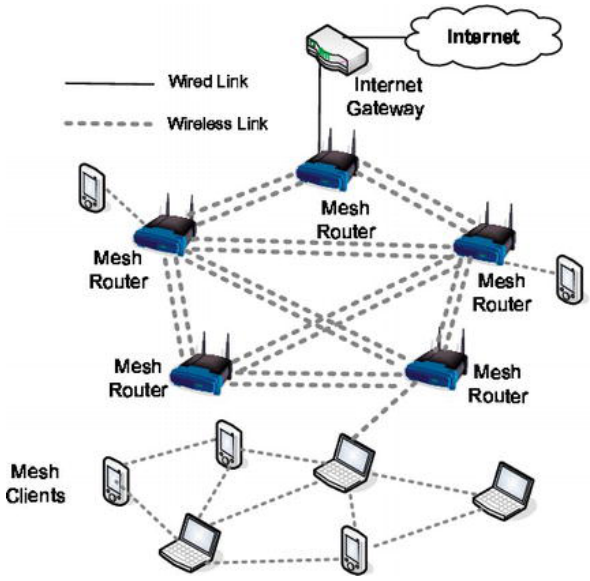

Figure 1: Mesh network topology (How Mesh Networks Work, 2022)

Mesh Network Use Cases

Because of its effective characteristics mentioned in the previous section, many developing countries have implemented mesh networks to improve their well-being. Here are some successful use cases.

Macha, a remote town in Zambia with low income residents, established the "Macha mesh Network" to overcome the financial challenge in establishing network infrastructure for their habitats. This network was built up of 56 nodes using low-cost routers. Only 1 node was required as a gateway to connect to the satellite receiver with the rest of nodes working as forwarding nodes to provide internet access to 100 - 150 users across the area. The successful launch of Macha helped set up a program for digital health records of patients at a mission hospital and made access to university courses possible for the local students, allowing them to connect to the world and get standardized education. Farmers in the area also gained more knowledge about crop diversity by learning through the internet. (Köbel et al., 2013)

Pollette and Roos (2021) gave an example in their writing that mesh networks had been making public wifi available to citizens in a great number of downtowns. In some foreign areas, mesh

networks are funded by the U.S. State Department to allow dissidents to avoid their government's surveillance in their communication.

Mesh Network Implementation Plan in Borroloola

As mentioned in the brief introduction, Borroloola already provides 2 free internet locations: the school and the library. In this case design concept, the mesh network will be implemented to extend the range of the existing networks through the following steps.

1. Use the routers at the library and the school as the internet gateway routers.
2. Install the internet forwarding routers, within the range of the ones closer to the gateways.
3. Develop a website portal to let users, students, login before using the internet.
4. Develop a management web application to manage access, control content, and monitor usage for the network administrators and the library and the school to use.
5. Distribute standard quality laptops to registered students to equalize the access to the network connection and learning materials.

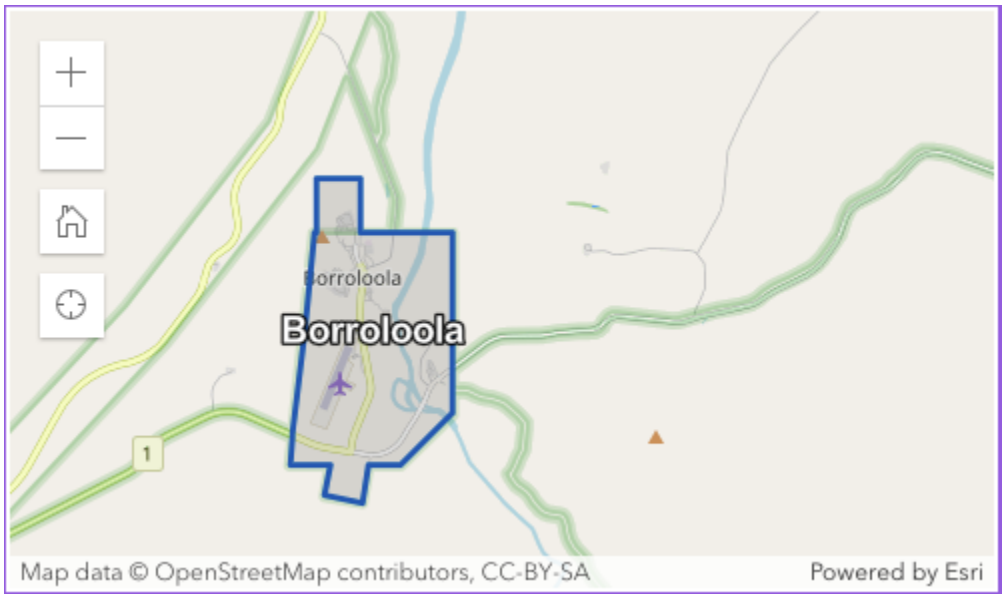

Figure 2: Map of Borroloola covering approximately 12.6 square kilometers. ("2021 Borroloola, Census Community Profiles | Australian Bureau of Statistics", 2022)

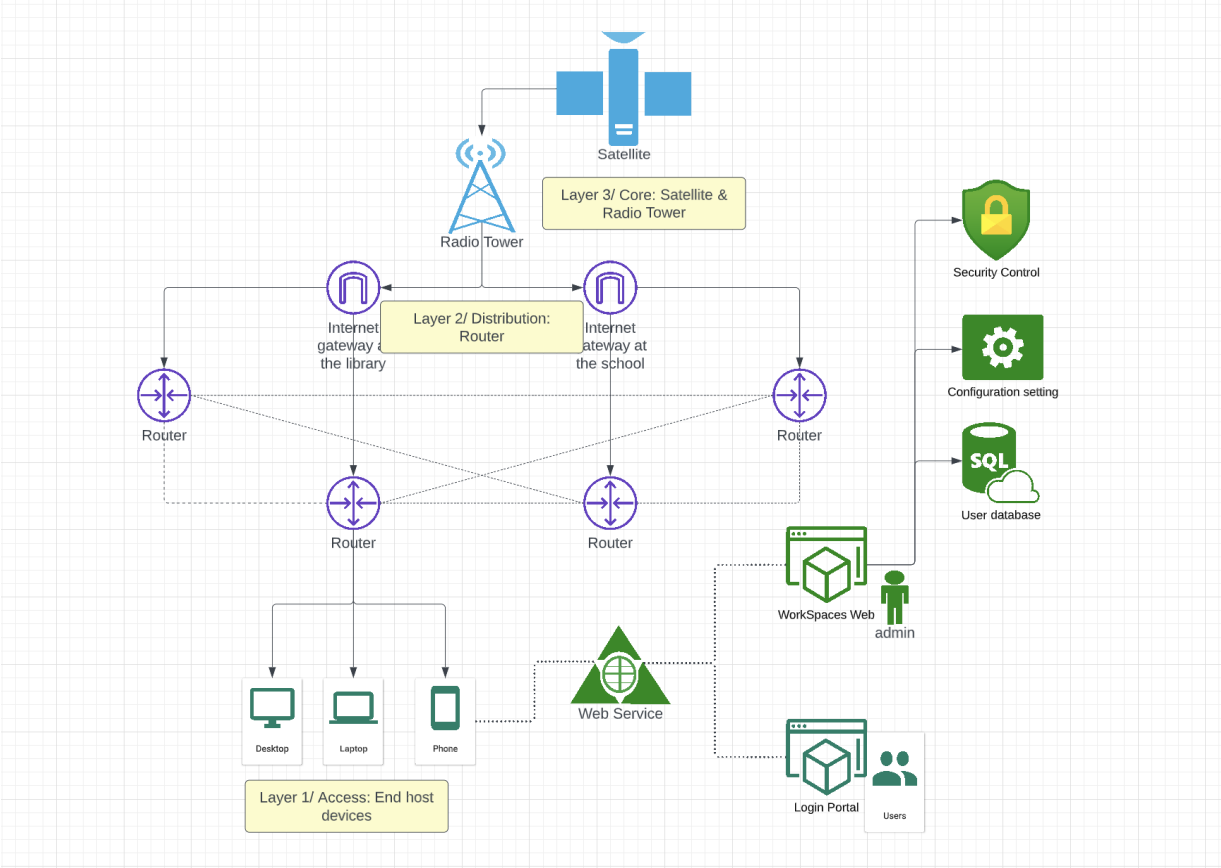

Figure 3: Mesh network design for Borroloola

Design Specifications

Covering the entire Borroloola's residential area of approximately 12.6 square kilometers can be achieved using a few high gain directional antennas. To complete the infrastructure, required hardware and software are listed below.

1. **Routers** - WA512GM-IP67 model routers (x 6)
    a. Gateway nodes (x 2)
    b. Extending/forwarding nodes (x 4)
        - Outdoor Mesh WiFi router and access point
        - Dual-band wireless LAN supporting 2.4 & 5 GHz rardios
        - Cover up to 10 kilometers from the central access point (CAP)
2. **Portal login website** for users (x 1)
    a. Sign up
    b. Login

    c. Password change
    d. Users profile update
3. **Backend management dashboard** for administrators (x 1)
    a. Usage monitoring
    b. Configuration
    c. Security control
4. **Standard-quality laptops** that support internet connection (x 150) for all students registered at the school ("2021 Borroloola, Census Aboriginal and/or Torres Strait Islander people QuickStats | Australian Bureau of Statistics", 2022)
    a. Primary students (x 83)
    b. Secondary students (x 45)
    c. Tertiary - Vocational education (x 3)
    d. Tertiary - University or higher education (x 3)
    e. Spares / Replacements (x 16)

Hardware Type	Quantity	Manufacturer	Model	Notes	Cost (per unit)	Cost (total)
Laptop	150	Lenovo	Thinkpad L13 Gen2	i5-1135G7 8GB - 3200MHz DDR4 512GB NVMe Drive	$800	$120,000
Router	6	WoMaster	WA512GM-IP67	2x Gateway Nodes 4x Forwarding Nodes	$400	$2,400
Total						$122,400
						Thomas Horsley

Figure 4: Education project specification and costs by Thomas Horsley

Design Benefits

Once the designed infrastructure is deployed, it can be aimed that education issues due to the lack of connectivity will be resolved or eased in a significant level. The main aimed results are listed below:

1. **Limitless access to education** - Students can continue their learning anytime and anywhere regardless of the transportation and financial barriers.
2. **Diversity of knowledge and skills** - Students can attend online learning courses that are not provided by their schools. They can also opt to learn from free courses that provide specific course training along with making connections to the world.

3. **Better well-being -** The side-benefit of gaining more access to education is an improved well-being in many aspects i.g. connection to the world, employment opportunity, and affordability respectively.

Design Constraints

Mesh networks, despite their characteristics and massive adoption, have a few challenges in general application and in the case of Borroloola.

Security Weakness

Parvin (2019) shared in her article that the networks have weak security due to the lack of centralized authority for security management. This can be resolved by establishing a website portal for users to login before access to the internet and a connected backend workspace for administrators to monitor usage and manage security.

Lack of End Network Devices

Providing network connection alone will not solve the identified issue if the target users do not have devices to utilize it. It is indicated in "2021 Borroloola, Census Aboriginal and/or Torres Strait Islander people QuickStats | Australian Bureau of Statistics" (2022) that the residents are very low income and only 65.4% of households have at least 1 person with internet access. This can be interpreted that network devices such as laptop, mobile phone, and ipad are unaffordable for them. This can be overcome by running a program with a similar model like One-Laptop-Per-Child (OLPC) with a mesh network (McMahon, 2022). The mesh networks allowed learners in remote areas access to education via mobile applications including long-distance video chatting ("How Mesh Networks Work", 2012).

Stability of the Network

Köbel et al., (2013) reported in his study that low-cost hardware could malfunction and obstruct the stability of the connection. This issue could be resolved by training the local technician to maintain the hardware and, thus, the operation system.

Design idea/concept 2 : Telehealth

Brief Introduction to the Telehealth Issue

Borroloola's population of 750 people share one healthcare center, 'Borroloola Primary Health Care', which has only 12 practitioners. The healthcare center has two emergency beds and five treatment rooms. The lack of public transport and the remote location of the healthcare center makes it difficult for residents to seek medical help easily. The solution to this problem is telehealth. Telehealth is a collection of means or methods for enhancing health care, public health, and health education delivery and support using telecommunications technologies. However, the introduction of telehealth to Borroloola faces another problem. The lack of internet services. The only accessible free Wi-Fi is available in the school and the library (Roper Gulf Regional Council, 2022) but the residents are unable to digitally connect with the main telehealth services. To mitigate this issue, a WLAN (Wireless Local Area Network) could be set up, enabling the residents to get their online consultations with medical specialists easier and faster.

Design outline: plan 1- Ruffin Remad

A wireless local area network will be set up within the clinic to allow doctors to interact with patients via network. WLAN operates with a 2.4 GHz (802.11b) or 5 GHz bandwidth (802.11 a). An access point (AP) is used to connect to the internet. The linked devices receive and send frequency signals from the AP.

A high data transfer rate is provided via WLAN. It makes use of a star in which all nodes communicate with one another via access points. In homes and offices, it functions better. No additional cables are needed, particularly in offices, and organizing a meeting is very simple. It has a 1–10 Mbps knowledge transmission rate. WEP or WPZ are used for wireless LAN security. If necessary, it also employs infrared technologies.

Design outline: **plan-2 (Nur E Siam)**

As, aforementioned, in Borroloola healthcare there are only few rooms for treatment and emergency, we will allocate one small room with ten computers which will be connected to the newly setup network administration room(Design 1) in the health care, from that network administration room, 2 Lan connection will come out one will get connected to Health care's Wi-Fi line so everybody in the health care can have free accessible Wi-Fi and other one will get connected to the router-hub room where the main Hub will be located for all the desktops. From there all ten computers will be connected with each other with two different client server networks, 1st client server network for 5 computers and 2nd client server network for the rest of the computers. However, every single computer will have the same default gateway system.

This network system is easy to work with, because if someone needs to use only one computer, all the computers will stay shut down unless nobody is using it. Also, the server maintenance will be easy to handle.

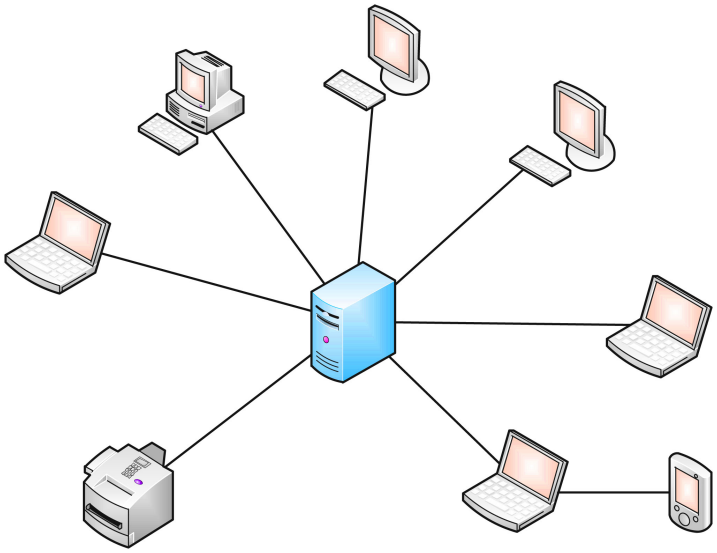

Figure 5: client server network (How it Client server network works)

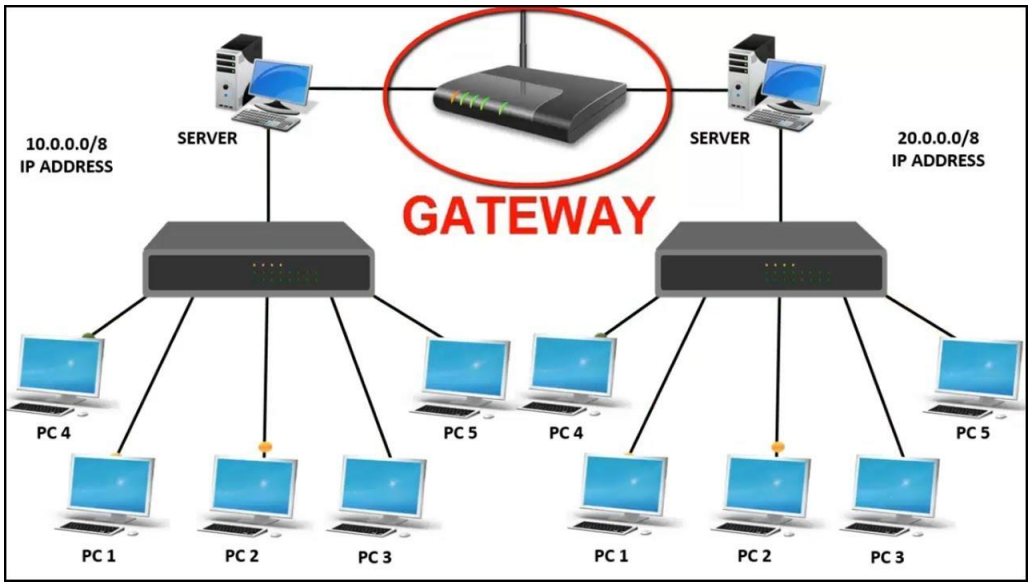

Figure 6: Gateway (How gateway and client server networks work)

Client Server Networks:

Client server networks:

A client-server network is the star-shaped topology medium through which clients access resources and services from a central computer, via either a local area network (LAN) or a wide-area network (WAN), such as the Internet. Client-server refers to a relationship between interdependent programs in an application, where clients request services and servers fulfil those requests. The client server relationship communicates in a request–response messaging pattern and must adhere to a common communications protocol. Client-server communication typically adheres to the TCP/IP protocol suite. TCP protocol keeps a connection open until the message exchange between the client and server is finished. The TCP protocol manages flow management and the retransmission of dropped or garbled packets. It also selects the optimal way to distribute application data into packets that networks can deliver.

Benefits of the client server networks:

1. The management of user permission and authentication is made simple by having one server hold all the necessary data in one location.
2. A client-server network can expand by adding network segments, servers, and PCs with minimal disruption.
3. Data can be accessed efficiently without requiring clients and the server to be in proximity.
4. The client-server design makes it simple to update, replace, and relocate the nodes because each node is independent and only requests data from the server.

Gateways

A gateway is a node (router) in a computer network, a key stopping point for data on its way to or from other networks. Thanks to gateways, we can communicate and send data back and forth. The Internet wouldn't be any use to us without gateways (as well as a lot of other hardware and software).

Advantages of Gateways

1. Connectivity: The connectivity that a gateway offers is its key advantage. A gateway can grow the network by joining machines with various operating systems. This will enable many computers to access the same type of information.
2. Security: Since they permit user authentication, gateways are known to have improved security. It is possible to apply security measures such as User ID and Password on the gateway to stop all unauthorized access. By doing this, you can make sure that only authorized individuals have access to important information in addition to protecting it.
3. Protocol conversion: A gateway can also modify data packets to suit the requirements of the final destination. It can also change the data format in accordance with the needs of the target network or architecture. It is also known as the Protocol Converter for this reason.

Telehealth Use-case

Because of cloud computing, access to telehealth became easier. For instance, in Brazil the majority of healthcare resources are concentrated in the largest cities, whereas the majority of communities lack adequate primary healthcare help and struggle to access specialists and diagnostic tests. The Telehealth Network of Minas Gerais (TNMG) was developed considering this. It is a public telehealth initiative that supports primary healthcare (PHC) by performing teleconsultation and telediagnosis, primarily for small and remote cities in the state of Minas Gerais, Brazil, to discuss the TNMG's successful experience over the course of its 10 years of operations. Methods: The TNMG was founded in 2005 as a research project that supported PHC in 82 cities before gradually expanding. The development of a methodology for installation, upkeep, and quality control. Currently, it supports 750 cities, or 88.0% of Minas Gerais state. (Milena Soriano Marcolino 1st November 2016) In addition to that, Bangladesh is also another country who introduce telehealth to the people who lives in remote places. Because of that during the pandemic covid-19, they were able to warn people and made them aware of the symptoms of corona. Also, with the help of telehealth the rural people had face to face conference with the doctors in the city and got professional advice and treatment from them. (Shastho Batayon 16263)

Project Implementation Plan:

The Borroloola Health Care is the only health clinic in the area, there should be two rooms dedicated to this design project. One room will be for the computers and the other for the network administrations room, where the routers and servers will be installed. A website portal will be set up for doctors' login to the server where they can access all the data including patients' information. A management team will be formed to provide technical assistance such as monitoring accessibility and controlling the security systems. For the conference room, it will a total of ten computers setup with two rows with 5 computes in each row. Also, there will be an assistant there to help the people to get into the conference with their doctors according to their schedule appointments.

Design specifications:

To ensure a stable accessible free internet throughout the healthcare there will be two rooms.

One room will be for the network administration room and the other one will be for the virtual conferences with the doctor in the computer room. The hardwares for the design project are listed below.

1. Routers and other hardware: There will be two routers (The Ubiquiti Networks EdgeRouterX ER-X-AU) which will cover the clinic area allowing the doctors access to the internet.
2. Ethernet Cables: approx 150m for the whole clinic
3. Website: A hub for the specialists who will have access to the server where they will be requested a booking for consultations. This will also allow doctors to keep track of patients' records in a database for future purposes.
4. Management controls: IT specialists will be employed to ensure security controls of the network.
5. Computers: Ten computers should be adequate for the clinic where doctors can set respective consultation times.

Hardware Type	Quantity	Manufacturer	Model	Notes	Cost (per unit)	Cost (total)
Desktop	10	CentreCom	Elite Pro Zen2	AMD 4700S, 16GB - 3200Mhz DDR4, 500GB SSD + 2TB HDD	$900	$9,000
Ethernet Cables	600 meters	Antsig	Cat6 Solid Core Ethernet Cables		$110 per 100m	$660
Modem	1	TP-Link	AC1200 Wireless MU-MIMO Gigabit Router	4 External Antennas + Multiple Gigabit Ports and One internal	$100	$100
Router	1	Ubiquiti Networks	EdgeRouterX ER-X-AU 5 Port Gigabit Router		$100	$100
Switch	1	TP-Link	JetStream 48 Port Gigabit L2 Managed switch - 4 SFP slots	Provides both centralized and static management	$650	$650
Total						**$10,510**
						Thomas Horsley

Figure 7: Telehealth issue specification and costs by Thomas Horsley

Design Benefits

1. Contact-free access to medical advice for patients: Patients do not need to travel to hospital which will cut down their transportation costs.
2. It will be time saving since everyone can have their own meetings with their respectable doctors with the fixed schedule.
3. It will be easily accessible to men, women, children and to the senior citizens even if they do not have any basic idea how computers work. Because there will be an expert who will help you to set up the meetings, all you need to do will be just to put on the headset and talk about your physical or mental problems with the doctor.
4. Having access to immediate online consultations will reduce the chances of patients' ailments worsening.

Design Constraints:

The servers and computers will occupy two rooms, however due to limited availability, there will not be enough space for the setup. Also, maintenance of the wiring will be a huge issue since there will be a lot of wire to connect the nod, hub, routers and switches to the server and then to the computers. A cooling system is also required to ensure that the network administrators do not overheat. Low-cost hardware may have problems and interfere with the connection's stability. Training the local technician to maintain the hardware and, consequently, the operating system, could alleviate this problem which was shown in a report by (Köbel et al., 2013)

Design idea/concept 3 : Income

Brief Introduction to the Income Issue

While the employment rate of Borroloola is similar to the national and state average, the township considerably lags behind in its income per an individual, family and household. The full and part time population percentage is 68.0%, 16.3% compared to the state average of the Northern Territory which is 67.1% and 19.5% (ABS, 2016). In contrast, the weekly individual, family and household income of Borroloola $424, $1050, $1289 which is relatively low

compared to the state's which is $871, $2105 and $1983 Therefore the average individual and family income of a Borroloola citizen is less than half than of the average Northern Territorian (ABS, 2016). Furthermore, Borroloola has slightly more professional workers, 23.2% compared to the state average of 20.1% (ABS, 2016). showing that there are less opportunities to earn state average money in the township. Furthermore, a report from Amsant states that long supply chains and poor road qualities to rural areas makes food in supermarkets 56% more expensive, meaning citizens of the rural town of Borroloola are more prone to struggle more to pay for household essentials (Amsant 2022).

In addition, only 65.4% of households had at least one user of the internet from dwelling compared to the state and national average of 79% and 83.2% (ABS, 2016). The town also has 4G Telstra internet (Telstra, 2022), however rural areas have slower internet.

Enhanced digital communication infrastructure would allow the people of Borroloola to use the internet to conveniently gain unique qualifications to earn a higher income online to become closer to the state average and improve their quality of life. Due to the recent coronavirus, working away from the office has become more socially acceptable for a variety of professions.

Design outline

1 designated computer room within the centre of the community, with computers which can be booked out and monitored would allow citizens of the township to access the internet to gain unique qualifications to earn a higher income online. This would encourage all townspeople to get involved, rather than giving certain people computers, as everyone has a fair chance. The computer room would be located in the centre of the town which would make it 1.5km from the furthest populated residential block. Furthermore, 30 computers would be provided, which would make 1 for 30 people in the township. A website may be built to walk the townspeople through on how to use computers and the internet, as well as recommended resources to use in order to enhance their efficiency at receiving an online job or the qualifications for one and then the job. Once the people receive a job they will have an entitled access to a computer, which would aligned with their working hours and their pay slips can be evaluated to determine the legitimacy of their time spent on the computer. Furthermore, there may be an admin in the computer room who could assist the towns people with any questions they have to smoothen their transition to

the using the technology. Staff may also use view the software on the computer which will monitor the usage of the computers by the townspeople.

Network design

A local area network (LAN) connects devices such as computers, printers and more in a shorter range. The 30 computers and a server will be all connected to a single switch via an ethernet cable. The switch will have 48 ports to accommodate all of the computers and be able to have the devices share information between each other (Cloudflare, 2022). The switch will connect to a router which will pass internet onto the connected devices and pass and receive information for and to the connected devices based on their IP addresses from the internet (Cloudflare, 2022). The router will be connected to the modem which is connected to the internet and translates the analog internet signal into a digital signal which the connected devices can interpret (Xfinity, 2022). This network design can be seen on Figure 1.

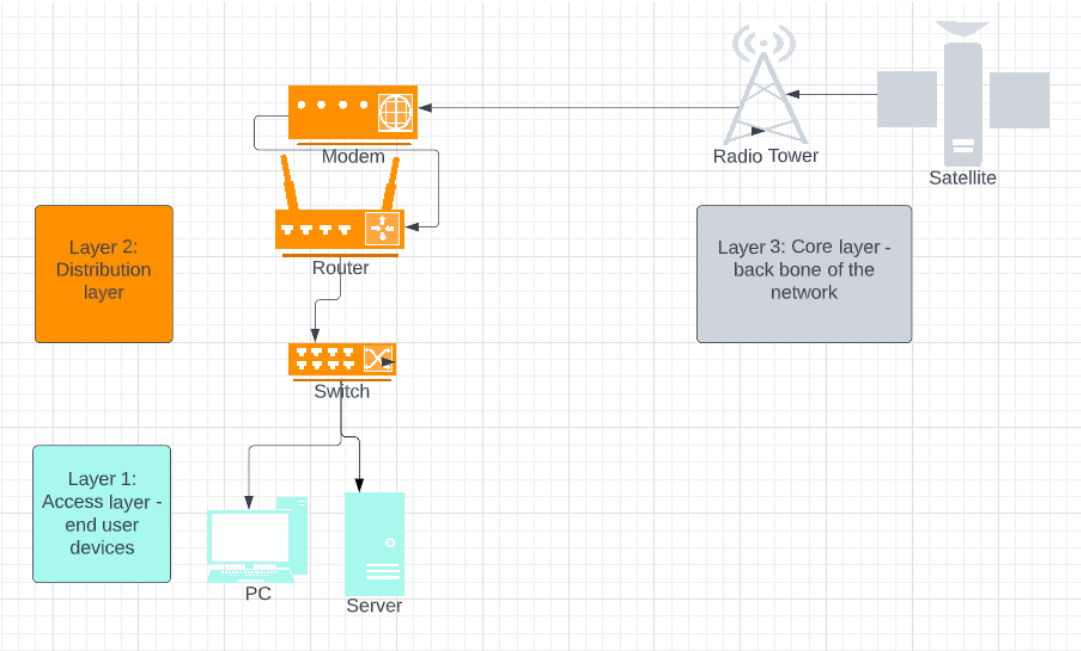

Figure 9: Public access computing facility network diagram

Characteristics of LAN network

1. Local area networks are cheaper, faster and easier to install and maintain than other network alternatives (Mishal, 2020).

2. Local area networks tend to be faster than wireless network types such as the wide area network (WAN) (Mishal, 2020).
3. Sharing resources such as printers, hard drive disks and DVD drives is made easy with LAN (Mishal, 2020).
4. For LAN you can buy software for a single computer and share it with others in the network instead of buying the software for every computer (Mishal, 2020).
5. There is greater data protection on a LAN server than on other wireless networks such as the WAN (Mishal, 2020).

LAN network implementation plan in Borroloola

1. Connect the 30 computers and a server to a switch via a web of ethernet cables.
2. Connect the switch to the router via an ethernet cable (Geeksforgeeks, 2021).
3. Connect the router and the modem via an ethernet cable (Geeksforgeeks, 2021).
4. Ensure that all the devices are plugged into a power outlet (Geeksforgeeks, 2021).
5. Have the modem connected to the (only) radio tower (located at the police station) which is connected to the satellite.
6. Have all users receive login details which will be saved in the server to allow any user to receive their account information when they log into any computer connected in the LAN.
7. Develop or use a subscription based management application to view, control and manage viewed content and usage by the users.

Design specification

Hardware specifications

1. **Computers** (x 30). The computers will have ethernet cable ports in them and are for those who book sessions for their use.
2. **Switch** (x 1) . The switch will be a managed switch with 48 ports, which will be enough for a potential increase in computers and other connected devices. Though more expensive, a managed switch provides security features and key performance indicators of its and the network's performance (Rudy, 2021) . An example of this is

the TP-Link TL-SG3452 JetStream 48-Port Gigabit L2 Managed Switch with 4 SFP Slots.

3. **Router** (x 1). A wired router will be used with an ethernet cable port. Routers generally handle up to 250 devices. An appropriate model would be Ubiquiti Networks EdgeRouterX ER-X-AU 5 Port Gigabit Router.
4. **Modem** (x 1). A wired modem will be used with an ethernet cable port. An appropriate model would be ARCHERA6 TP-LINK Ac1200 Mu-Mimo Giga Router Dual Band 4 External Antennas and One Internal Antenna AC1200 MU-MIMO GIGA ROUTER.
5. **Ethernet cables**. Cat 6 ethernet cables will be used because it is versatile and supports high bandwidth which LAN's provide.

Hardware Type	Quantity	Manufacturer	Model	Notes	Cost (per unit)	Cost (total)
Desktop	30	CentreCom	Elite Pro Zen2	AMD 4700S, 16GB - 3200Mhz DDR4, 500GB SSD + 2TB HDD	$900	$27,000
Ethernet Cables	600 meters	Antsig	Cat6 Solid Core Ethernet Cables		$110 per 100m	$660
Modem	1	TP-Link	AC1200 Wireless MU-MIMO Gigabit Router	4 External Antennas + Multiple Gigabit Ports and One internal	$100	$100
Router	1	Ubiquiti Networks	EdgeRouterX ER-X-AU 5 Port Gigabit Router		$100	$100
Switch	1	TP-Link	JetStream 48 Port Gigabit L2 Managed switch - 4 SFP slots	Provides both centralized and static management	$650	$650
Microsoft Windows 10 Licenses (monthly)	30	Microsoft	Home		$225	$6,750
Total						**$35,260**
						Thomas Horsley

Figure 10: Income project specification and costs by Thomas Horsley

Software specifications

1. Login for users
    a. Signup or receive details from staff
    b. login
2. Backend Management
    a. Usage monitoring
    b. Connection monitoring
    c. Securing control and administration.

3. Operating System - The computer operating system will come from the chosen computer. An appropriate operating system would be the windows operating system (rather than macOS) because it has more available programs, than the other popular alternative macOS, that will aid the townspeople in completing work (Computer noobs, 2022).

Design benefits

User design benefits

Once the digital communication infrastructure is implemented it would provide the townspeople with the listed perks:

1. Ability to receive a greater income – Townspeople will be able to become part of a vast global job market which demands a variety of different skills they can acquire online, allowing them to receive a greater income.
2. Ability to learn work related skills – Access and guidance to the internet will provide the townspeople with an opportunity to learn a variety of different skills that could be utilized online or even physically in Borroloola, if they would like to change their career path.
3. Improved well-being and life quality – The townspeople will have a greater choice of jobs to pick from, likely leading to an increased job satisfaction as they can choose something they would enjoy rather than being constrained to the needs and accredited education institutes of their small town. Furthermore, increased income would also allow them to better afford the growing cost of groceries and other living essentials to improve their life.
4. Equity – Being able to book sessions to use the computers allows everyone in the community to have an even chance of using the computer to increase their income and skills.

Implementation Benefits

LAN's can be relatively cheap to set up. Furthermore, buying the cat 6 ethernet cables and computers in bulk will provide a considerable reduction in the set up expenditure.

Design constraints

1. Low area coverage – Users can only receive internet from the network if they are connected by an ethernet cable, unlike having a wide area network or a wireless LAN (Mishal, 2020).
2. Server failure will cause device disruption – Because the computers will not store their own information, they will all be dependent on the functionality of the server. Thus if the server fails, users may not be able to retrieve their account information and use the computers to the full capacity to benefit them (Mishal, 2020).
3. Potential for policy violations – Because all data of the LAN computers is saved in the server it means the admin will be able to check personal data of users which is outside of their scope which includes computer usage. If incorrect practices are taken by both the users and the admin, the admin will be able to see sensitive information such as bank details or even medical details (Mishal, 2020).
4. Viruses are easily spread – Some types of malware viruses travel by network meaning that if a user downloads a virus on their computer, this virus will be able to connect and spread to all the other computers in the network causing many possible disastrous ramifications. However with this correct firewall virus protection software, chance of this spread can be greatly reduced (Mishal, 2020).

Word Count

Jinjuta Suksuwan (1206 words): Part A and education issue in part B

Ruffin Remad (1077 words): Part A and telehealth issue in part B

Nur E Siam (1237 words): Part A and telehealth issue in part B

Nicolo Taraborrelli (1395 words): Part A and income issue in part B

Thomas Horsley (1203 words): Part A and all technical parts of each learning issue in part B

Total 6083 words (cover, table of content, and word counts excluded)

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