Lord Howe ISLAND BOARD

NSW GOVERNMENT

Connectivity – Lord Howe Island

Aug 23 2023

1 About Respiro

Respiro is a specialist cybersecurity & network consultancy. Based in Sydney, we have been operating since 2004. Our principal consultants individually have over 25 years' experience in network and cybersecurity.

We offer the full suite of network and cybersecurity services; strategy & architecture, workplace technology consulting, and security services with our select partners.

2 Purpose of Engagement

The Lord Howe Island Board are exploring their options for introducing public connectivity on the Island through cellular, Wi-Fi, and low power IoT (Internet of Things) networks. A current state assessment of the island's communications network will be conducted. High level options for enhancing the network will be researched and evaluated, considering feasibility, suitability, emerging technologies, and industry trends.

3 Current State Assessment

Lord Howe Island currently has no cellular connectivity. There is a pre-paid public Wi-Fi service available in the CBD and a few surrounding areas, as well as the Tourism centre (please see **Appendix 1** for locations). Businesses and residents only connectivity option was the NBN (high latency, limited data) satellite service until recently when Starlink (low latency, unlimited data) became available to which many residents and businesses have installed and subscribed to this service for their personal use. The NBN service has responded to Starlink entering the market by offering an unlimited data option although speeds remain the same as before.

Lord Howe Island has a copper network and landline telephony that is currently serviced by Telstra. Heavy rain can disrupt this service (island wide) as it is reliant on a centralised point of uplink via satellite. Currently the landline system forms an important part of the islands ability to communicate. There is general concern from the Lord Howe Island residents that Telstra will cease to maintain the copper network on the island (especially if they are successful in installing a microcell tower under the blackspot program). The rest of Australia is trending away from landline systems so this is a legitimate issue to raise.

The island has an existing VHF network that is used for emergency (Police, Marine Rescue, SES, RFS, Hospital) and support services from the LHIB. Restricted to radios programmed for this frequency, this is a critical service and the primary method for safety communications on the island. The use of this network for other communications would need careful consideration to ensure the primary safety role is not compromised.

4 Public Connectivity

Lord Howe Island is a unique case, there is currently no cellular or free public Wi-Fi service. Deploying some cellular coverage is possible through the Mobile Blackspot program but residents' views are divided on whether this should be done due to the impact on the Island lifestyle vs support for improved business ease and safety. Providing Internet connectivity through Wi-Fi for visitors to a site or location is not new, it has been commonplace in public locations like shopping centres, airport lounges etc for over a decade. Use of this service has become less significant in recent years as the cost of available cellular data has dropped and the available bandwidth over these networks has increased.

4.1 Benefits

Deploying a network for the public on the Island has broader goals than just public Internet access; network connectivity can improve the services to visitors:

4.1.1 Enhanced Experience

Some visitors to the Island may appreciate the lack of network connectivity and others will not, that is beyond the scope of this report to analyse. With public network connectivity, especially Wi-Fi there is the ability to steer visitors to enhanced experiences such as:

- Local nature and historical information
- Wireless audio guided tours
- School and youth targeted activities delivered online
- Links to related sites for further involvement (local historical sites and detail, flora and fauna groups)

4.1.2 Safety

Improving visitor, resident and workers safety is likely to be a key concern. Connectivity can deliver:

- Improved awareness of the number of visitors to sites; – weather alerting
- Visitor ability to call for help
- Location awareness of staff and contractors when working in remote sites

4.1.3 Visitor Data

Technology to collect and report footfall traffic (number of users visiting, accessing location and sites etc) are readily available, improving in accuracy and becoming more affordable. There is a trend towards IoT style devices that, due to local processing of data within the device, can gather and report enriched data in just a small data packet, thus only requiring a low bandwidth network to transmit successfully.

Accurate and consistently applied visitor data provides opportunities for LHIB to better understand:

- Number of visitors, when, where visited, time spent, activities undertaken; - what locations, events and activities are attracting visitors
- Gauging sufficiency of facilities and services; - are facilities sufficient for visitor numbers
- Budget and project planning; - targeting of resources to locations most used, expand successful (commercial and community) activities

4.1.4 Scientific and Heritage Monitoring

Managing the upkeep of facility blocks, trail repair, managing camp sites, pest and weed management, native fauna and environment monitoring, are all time consuming and costly exercises. Sensors and control technology is increasingly used to undertake monitoring, improve the data collected, and automate access and facility usage. Without any network connectivity there is no monitoring of the status or operation of these sensors, and data retrieval requires a manual visit which is a time consuming and expensive activity. Network connectivity for these sensors has obvious economic benefit. A network for high visitor traffic areas with advanced services needs higher bandwidth but only required in a small area, while a network for sensors requires low bandwidth but across a much greater area.

5 Network Options

Cellular and Wi-Fi networks are the connectivity options that most people are familiar with. High data rates are necessary for interaction with people where an enhanced visitor experience is expected or desired.

- **Cellular**: A cellular network or mobile network transmits 4G and 5G from cells providing radio coverage over a wide geographic area. High data rates are possible, especially with 5G, but 5G with its higher frequency and shorter wavelength, does not transmit as far as 4G. Cells transmit the signal, and come in macro (the typical tower that everyone is familiar with) and small cells. Small cells use less power, have smaller antennas, can be inside buildings and give coverage ranging from 50m to 2km depending on the topology of the space.

  The Mobile Black Spot Program (the MBSP) is a government initiative that invests in telecommunications infrastructure to improve mobile coverage and competition across Australia. Telstra applied under the program and was successful in being funded. They have proposed a small cell for the island. The LHIB has been requested to grant owners consent to Telstra to install the small cell.

  https://www.infrastructure.gov.au/media-communications-arts/phone/mobile-services-and-coverage/mobile-black-spot-program

- **Wi-Fi:** These are the most widely used computer networks in the world. They are used globally in home and small office networks to link devices together and to a wireless router to connect them to the Internet and in wireless access points in public places like coffee shops, hotels, libraries, and airports to provide visitors with Internet connectivity for their mobile devices. Wi-Fi can connect clients up to 30m to 50m or more with a directional antenna. Topology and obstructions will reduce the range significantly.

Low Power, low bandwidth IOT networks (Low Power WANs) are typically sufficient for machine to machine (M2M) traffic. These interactions involve small data packets and one-way traffic (e.g. a water sensor transmitting level data). IOT devices continue to develop and local processing at the device enables more intelligent devices to operate on a low bandwidth WAN e.g. a footfall sensor that captures an image of an object triggering the passing of a sensor, interprets whether the object is human or animal then transmits the processed data back to base.

- **Cellular LTE:** A cellular low-power wide-area network (LPWAN) is a data network that utilizes a specific class of wireless technologies. It allows for long-range communications at low bit rates for devices connected to the cellular network via low-power standards. Commercially viable network access can be delivered by a Private APN, essentially a unique frequency is deployed by the telco provider and custom SIM cards are

programmed to this frequency only. The cost of deploying this custom Private APN commercially viable if a customer is connecting over 5000 devices across the country.

LoRa: LoRa (from "long range") is a radio communication technique. **LoRaWAN** (Wide Area Network) defines the communication protocol and system architecture. Together, LoRa and LoRaWAN define a Low Power, Wide Area (LPWA) networking protocol designed to wirelessly connect battery operated devices to the Internet in regional, national, or global networks, and targets key Internet of Things (IoT) requirements such as bi-directional communication, end-to-end security, mobility and localization services. The low power, low bit rate, and IoT use distinguish this type of network from a wireless WAN that is designed to connect users or businesses, and carry more data, using more power. The LoRaWAN data rate ranges from 0.3 kbit/s to 50 kbit/s per channel. LoRaWAN networks are delivered by a LoRaWAN gateway which transmits the signal and connects back to the Internet or private network.

- **Sigfox:** Sigfox 0G technology is a Low-Power Wide-Area (LPWA) networking protocol owned by UnaBiz. It is designed to connect sensors and devices securely at low-cost in the most energy efficient way to enable Massive IoT.

VHF Radio: VHF radio networks operate in licensed frequencies unlike Wi-Fi networks that operate in the unlicensed frequency space (hence why they are cheaper and easy to deploy by anyone). Radio networks needs a device programmed to the specific network frequency so access to the network is not easy.

4G/5G cells, Wi-Fi access points and LoRaWAN gateways all need a similar physical model of deployment:

- A cell, access-point, or gateway that advertises the signal to the clients
- An elevated location to place this signal advertising device (a pole, a tower, or a building)
- Connectivity back to a network to access the Internet or a private network

Fib is the primary method to deliver this and the NBN is the default Australian backbone fibre network. Telcos have their backbone fibre that competes with the NBN and private fibre runs exists where organisations have a need that the NBN or commercial providers cannot see a commercial return.

Microwave wireless backhaul is commonly used where line of sight connectivity is available and fibre installation is expensive. Microwave backhaul is considered safe and is affordable for smaller deployments. Technology developments have introduced the use of Near Line of Sight capable antennas, but the service speed will be degraded.

Wireless backhaul using the same protocols as client Wi-Fi has progressed in recent years and can support moving objects in a way that microwave wireless cannot. For point-to-point links for backhaul, the use of directional antenna makes this viable and the cost of hardware will be much less. The challenge with using the same 802.11 Wi-Fi as clients is the potential for competing signals in the same unlicensed frequency as the 802.11 signals. Where existing structures and buildings exist and line of sight is available it may be worth trialling the use of 802.11 wireless backhaul to a location to extend citizen Wi-Fi, the potential for service disruption may be acceptable.

Satellite Backhaul is a solution for use in fringe areas (e.g. remote rural areas) and sometimes as an emergency/temporary measure (e.g. a disaster area or in place of a microwave link whilst waiting for licence approval). The technology can deliver 150Mbps/10Mbps (downlink/uplink). However, latency is a challenge as there is a round trip delay of circa 500-600ms for a geostationary satellite. Satellite backhaul is the proposed solution from Telstra for Lord Howe Island.

Low-Earth orbit (LEO) satellites are satellites that orbit the Earth at a height of 180–2,000km. This is significantly lower than geostationary orbit (GEO) satellites, which orbit at around 36,000 kilometres from Earth. Because of the lower altitude of LEO satellites, it takes less time for a signal to travel from a device (such as a computer) to the satellite and back (known as latency), allowing for faster transmission of data. SpaceX Starlink is currently the only commercially operating LEO satellite service available in Australia. The number of providers is expected to grow in the coming 1-3 years. Other LEO satellite service providers that are expected to service Australia, include OneWeb, Amazon, Iridium, Telesat and LeoSat. Connectivity to an LEO service requires clear sky access to maintain a consistent connection.

Backhaul connectivity requires analysis of each specific location; no single method will provide for all sites.

5.1 Network Security

Any deployment of an expanded or network needs to ensure it is secure i.e. it must consider the following:

- Confidentiality - User and machine data transmitted across the network remains within the confines of the client and the target host. Personal data is not shared or lost.
- Integrity - The network users or machines connect to is the one they are expecting, rogue networks are not masquerading as valid public networks.
- Availability - Network access is not disrupted.

Cellular networks (both 4G/5G and LPWAN) are considered secure, there is a direct 1:1 connection between the device and the cellular provider. Identity is authenticated via the device's SIM chip, and the connection between the

mobile device and the provider is encrypted by default. It is highly unlikely that someone would simulate a 4G/5G signal to intercept a connection due to the infrastructure cost required and most risks are with the client device.

Public Wi-Fi networks carry a reputation for being insecure after numerous breaches and the ready availability of tools to simulate networks and harvest user data and passwords. Wi-Fi security protocols are secure if applied correctly ensuring the client's data is confidential, but the challenge with public Wi-Fi networks is that the average user or client has no way of knowing whether sufficient controls are in place to protect them. It is prudent for users to only use Wi-Fi networks with caution and for mundane activities not requiring usernames and passwords. Deploying a visitor portal to enrich the visit experience needs to consider whether requiring users to create accounts and login for further and deeper visitor data capture is worth the risk to the visitor and the reputation risk of this personal data being lost to bad actors.

LoRaWAN networks support mutual authentication, integrity protection and confidentiality. Mutual authentication is established between a LoRaWAN end-device and the LoRaWAN network as part of the network join procedure. This ensures that only genuine and authorized devices will be joined to genuine and authentic networks. LoRaWAN MAC and application messaging are origin authenticated, integrity protected, replay protected, and encrypted. This protection, combined with mutual authentication, ensures that network traffic has not been altered, is coming from a legitimate device, is not comprehensible to eavesdroppers and has not been captured and replayed by rogue actors.

5.2 User and Data Processing

Alongside the initial network access there is a need to control and manage where the client, whether a person or an IoT machine, can connect to once on the network. This is for security (both for the client and data confidentiality) and to ensure the use of the network provides the full benefit to LHIB i.e. LHIB want to inform the visitor about available services and experiences at the site, and gather data about the visitor for site visit analysis, not just grant access to the Internet for their convenience.

For visitors connecting to a Wi-Fi network this is achieved through all users connecting to the network being directed to a landing page on initial access. The landing page, commonly seen in airport lounges and other public Wi-Fi networks, can enable the user to login with a personal email account or mobile number, create a local account, accept the terms of use, be directed to local attractions and other local experiences on offer, allow the user to pay for additional bandwidth if required or beyond a time limit if one is set. Many captive portal solutions exist and they are relatively inexpensive given the competition, the cost is usually based on the number of Wireless Access Points deployed. A single provider should be selected and used across all deployment of public / citizen Wi-Fi, this enables a consistent user experience, control, and data collection.

IoT machines deployment will proliferate. Failure to plan and manage their connection to the network will result in cybersecurity breaches, data silos, and inefficient and costly engagements with multiple providers.

The Microsoft security architecture for IoT provides a good logical reference model: *Please see* **Appendix 2**

https://learn.microsoft.com/en-au/azure/iot/iot-security-architecture?context=%2Fazure%2Fiot-hub%2Frc%2Frc

6 Connectivity Modelling

6.1 Cellular

A cellular network is a radio network distributed over land through cells where each cell includes a fixed location transceiver known as base station. These cells together provide radio coverage over larger geographical areas. User equipment (UE), such as mobile phones, is therefore able to communicate even if the equipment is moving through cells during transmission.

Cellular networks are classified by the signal transmitted 3G, 4G, and 5G.

3G refers to third-generation cellular technology which was first introduced at the turn of the decade in in 2001. 3G was capable of data speeds of up to 7 Mbps. 3G networks brought improved voice call quality, reduced background noise, and enhanced call reliability. 3G networks also introduced basic data services such as mobile internet browsing, emails, and multimedia messaging (MMS). Telstra's 3G network is scheduled to be closed down in mid-2024,

4G was introduced in 2009, 4G typical download speeds range from 5 up to 100 Mbps, depending on various factors such as location, network congestion and device capabilities. 4G enabled users to create mobile hotspots, sharing their high-speed internet connections with other devices, such as laptops or tablets.

The latest technology on the market in Australia – **5G** offers ultra-high-speed data transfer (up to 10Gbps) and significantly improved performance, especially in crowed areas where there are large numbers of connected users. 5G can support streaming 8K video and downloading entire episodes in seconds. 5G uses a much higher frequency and smaller wavelength than 4G, the distance the signal can travel is much smaller and 50-200m connectivity from the antenna should be expected as the limit.

5G is still evolving as a standard. **5G Advanced** is an enhancement of the 5G standard promising (and delivering in tests) wider coverage, higher speed, and better cell management for the telco. The 5G Advanced improvements will eventually be rolled into 6G, along with further enhancements. There is a significant difference in technology capabilities and what technology is supported by the telecommunications provider. Telcos are huge businesses and change is not quick, any introduction of new technology requires mammoth effort in the back end to change build, support and roll-out processes. Asking a telco to introduce non-standard technology to a location may be successful with political or economic support but it is not going to be an easy process and is more likely to fail.

Base-stations consist of:

(i) The antennas – to send and receive radio signals within the cell.

(ii) The tower or supporting structure – where the antennas are mounted, this could be a building, mast or tower.

(iii) Hardware – supports the operations of the base station often called the BTS (Base Transceiver Station) and is stored in a cabinet or shelter.

(iv) A link back to the digital exchange which can either be a cable or wireless connection.

The antenna type is used as classification for cell sites, cell technology is continually progressing. As a guide only, as provider cell type selection will change over time:

Base Station Type	Typical Coverage Radius (assume 4G)	Typical Use
Femtocell	10m	home or office use
Picocell	200m	high rise building, hotel or car park use
Microcell	1-2km	shopping centres, transport hubs, mine sites, city block, temporary events or natural disasters.
Macrocell	5-32km	suburban, city and rural use
Macrocell – Extended Reach	50-150km using extender cell technology	suburban and rural use

Table 1 Cell Types

Femtocell, Picocell and Microcell are grouped under the term 'small cell'. The variance in range within these small cell types makes accurate estimates of coverage difficult. ACMA's guide to small cells is for coverage of 50-200m but it does not clarify if this is 4G or 5G:

https://www.acma.gov.au/sites/default/files/2019-11/Small%20cells_fact%20sheet.pdf

6.1.1 Blackspot Proposal

LHIB have a proposal from Telstra/Downer (Downer acting as the construction entity for Telstra) for the deployment of one 4G small cell proposed to be deployed at the northern end of the island with an adjacent satellite dish for network backhaul. The cell is being offered under the Federal Government Mobile Blackspot Program. Through early evaluation of the limited coverage of the proposal, LHIB requested a quote from Telstra for an additional cell and were advised they have a budget cost of approximately $254,000.

With just the single cell, overlaying small cell ranges, even at very approximate scale for both worst case (200m) and best case (2000m) shows the inadequacy of this proposal to provide cellular coverage for the island:

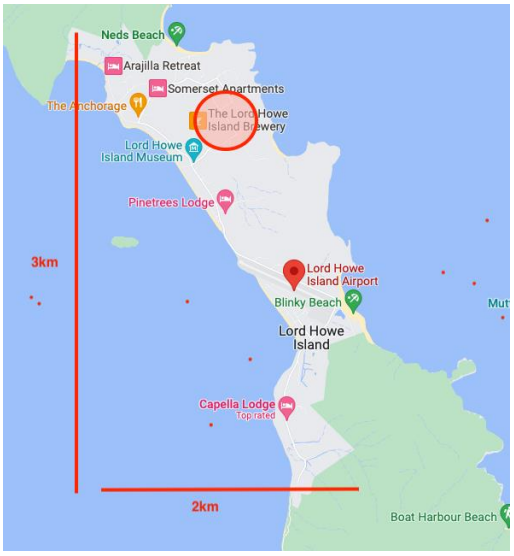

Figure 1 Single cell coverage estimate 200m range

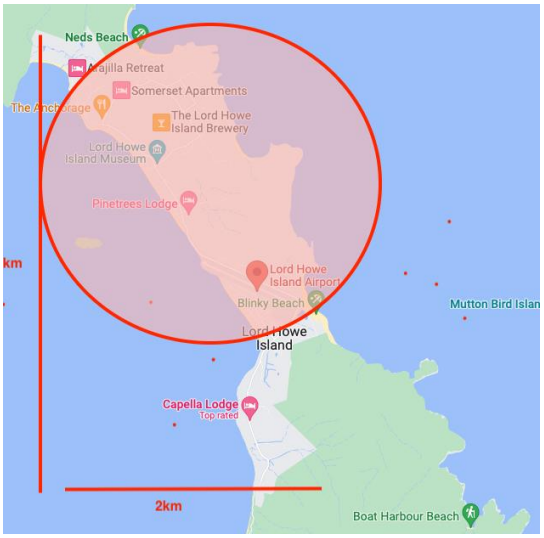

Figure 1 Single cell coverage estimate 2000m range

If the two cells are deployed the expected coverage depends on the type of cell deployed by Telstra. The 2000m range is not guaranteed.

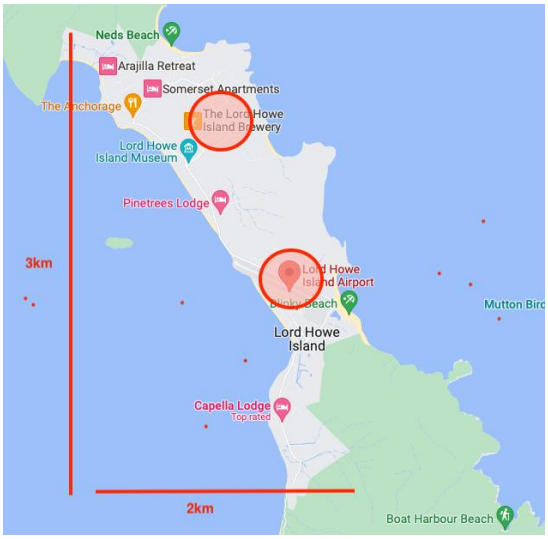

Figure 2 Two cell coverage estimate 200m range

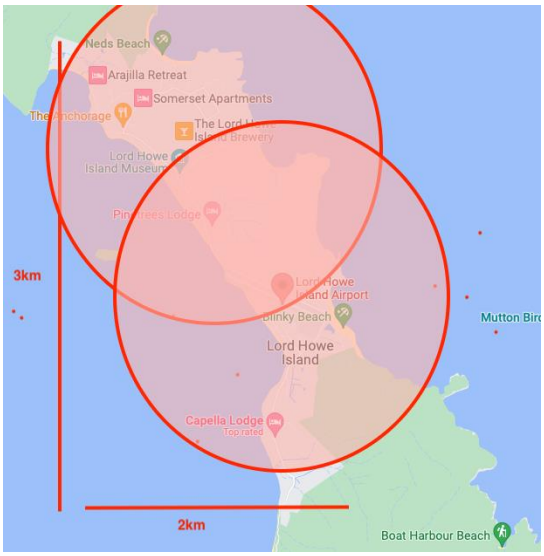

Figure 3 Two cell coverage estimate 2000m range

6.1.2 Options

The estimated coverage are only estimates as there is no detail from Telstra on the model of cell proposed. LHIB have requested further detail from Telstra regarding estimated coverage to be expected, however this has not be forthcoming. A range of 5km would comfortably cover the island from the proposed single location, through this is not expected from a microcell.

If the coverage is less than 5km and partial coverage of the habited part of the island is not deemed sufficient then options exist:

1. **Request Telstra investigate upgrading the proposal to a macrocell**. A macrocell would deliver the required coverage. There is precedent for macro cells to be deployed under the Mobile Blackspot Program: https://www.infrastructure.gov.au/sites/default/files/documents/round2-regional-connectivity-program-funded-projects-september2022_0.pdf

   Examples:

Applicant	Location	Description	Grant amount
Telstra	Kununurra	The project will deploy one new Telstra macro base station at Kununurra and one Telstra small cell base station at the Frank Wise Institute of Tropical Agriculture, providing new coverage to the area.	$657,650
Telstra	Christmas Island	The project will upgrade four Telstra 2G macro cell base stations to 4GX macro cell base stations at Christmas Island and deploy one new Telstra 4GX macro cell base stations at Christmas Island's airport.	$4,682,625
Telstra	Doomadgee	The project will deploy a new Telstra macro cell base station to provide new coverage to the Aboriginal township of Doomadgee.	$957,200
Telstra	Acacia Hills	The project will deploy one new Telstra macro cell mobile base station to service the rural locality of Acacia Hills.	$902,925

Table 2 Example blackspot grants Jan 2023

2. **Request Telstra to investigate the deployment of additional small cells** to provide adequate coverage for the habited part of the island. The Telstra small cell proposal states the site requirements as:
   - Power be extended to the Small Cell location via a 2 core cable with 1m of free cable out of the ground.
   - Access to the customer supplied mains power switchboard and local supply point.
   - Ground leveling of the proposed site to the required dimensions (5m x 5m) and ensure the site:
     - Is level and accessible by suitable vehicles
     - The topsoil and any organic materials have been removed to a minimum of depth of 100mm below ground level.
     - Backfill compound area with compacted road base to achieve a minimum of 95% dry compaction or 100kpa safe bearing.
   - Ensure compound surface is level for water to drain away and not to pool in the compound area.

Candidate sites have been suggested for consideration, further analysis of these should be taken re the available cell's range, the number of cells and most suitable locations can then be selected.

3. **Engage a 3rd party to undertake analysis to obtain an independent proposal** for coverage of the complete habited part of the island. Present this to the Telco Authority for consideration under the Mobile Blackspot Program e.g. commscope, oratel . This analysis could research the cost and viability of deploying a fiber backbone across the habited area of the island and along all roads. The analysis could ascertain the deployment requirements for this fiber backbone to be used by Telstra or other telcos for a 4G/5G mesh of small cells around the island, back to a single backhaul satellite. This fiber backbone could also provide broadband connectivity for residents.

6.2 Wi-Fi

Respiro have conducted a predictive site survey for sites on Lord Howe Island to gauge current infrastructure and the changes required to support a wireless network. Please see **appendix 3.1** for observations.

1) Old settlement
2) Neds Beach
3) The Jetty
4) Under the Pines / CBD
5) The Playground
6) The Hospital
7) Middle Beach
8) The Airport
9) Cobbies Corner
10) Little Island Start
11) North Bay
12) Intermediate Hill

Figure 4 - Map showing Wi-Fi locations for sites 1-7

Figure 5 - Map showing Wi-Fi locations for sites 8-10 & 12

Figure 6 - Map showing Wi-Fi location for site 11

6.2.1 Wi-Fi Infrastructure

The foundations of a successful wireless network are as follows:

- Ensure the WAP is mounted in an area where it is able to maximise its coverage area i.e., the WAP needs to be in a position where its signal can reach as far as possible while being unobstructed by other objects/devices that will block, disrupt, or cause interference with its radio signals.
- A switch or WLC (Wireless LAN Controller) must be connected to the WAP to ensure that packets can be routed.
- Sufficient power is needed in order to run the devices.

Please see **appendix 3.2** for network equipment required to establish wireless networks at the 12 sites spanning across Lord Howe Island.

6.2.2 Backhaul

There are three different backhaul solutions that can be applied to each site. These options are as follows:

1. Starlink set up for each site.
    - Along with switches and WAPs, this option will require all the hardware associated with star link. This includes the satellite dish and router.
2. Utilise wireless bridges between sites to act as a point-to-point link to a centralised uplink, the uplink would most likely be a Starlink set up or some other infrastructure already present on the island.
    - Wireless bridges will require line of site, in between sites.
    - A wireless bridge works in pairs, with one device at each site point at each other.
3. Running fiber between sites and to a centralised point for uplink.

Please see **appendix 3.3** for the backhaul modelling that includes the required number of switches and WAPs for each backhaul option mentioned above, along with the supporting infrastructure present on site

6.2.3 Cost Estimates

Estimate on the order of magnitude cost to deliver a connectivity network across 12 locations consisting of:

1. Dedicated Wi-Fi infrastructure
    a. Wireless Access Points (WAPs)
    b. Poles of WAPs (if needed)
2. Dedicated backhaul to the internet.

6.2.4 Dedicated Wi-Fi Infrastructure

Each sample site was surveyed, the following outlines an initial estimate for each site, these estimates will change when technology selection, site selection etc are changed. These estimates are provided to give a guide on the order of magnitude costs for the Lorde Howe Island sites.

Item	Description	QTY	Unit Cost	Total cost ex Gst
Old Settlement				$31,627
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR76 Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mounting Pole	Used to mount the WAPs	1	1000	1000
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Pole Mount	Mount used for WAP attached to pole	1	160	160
Neds Beach				$30,467
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400

Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mx95 Switch License	Advanced Security License and support	1	11000	11000
The Jetty				$30,467
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Under the Pines				$30,467
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
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Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058

Mx95 Switch License	Advanced Security License and support	1	11000	11000
The Playground				$30,467
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
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Switch	Meraki MX95 switch	1	8058	8058
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Middle Beach				$31,627
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mounting Pole	Used to mount the WAPs	1	1000	1000
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Pole Mount	Mount used for WAP attached to pole	1	160	160
The Hospital				$36,426
WAPs	MR76, Meraki Outdoor Wireless Access Point	2	$5559	$11118

Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mx95 Switch License	Advanced Security License and support	1	11000	11000
The Airport				$26,426
WAPs	MR76, Meraki Outdoor Wireless Access Point	2	$5559	$11118
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Cobbies Corner				$31,627
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400

Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mounting Pole	Used to mount the WAPs	1	1000	1000
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Pole Mount	Mount used for WAP attached to pole	1	160	160
Little Island Start				$31,627
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mounting Pole	Used to mount the WAPs	1	1000	1000
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Pole Mount	Mount used for WAP attached to pole	1	160	160
North Bay				$31,627
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900

Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mounting Pole	Used to mount the WAPs	1	1000	1000
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Pole Mount	Mount used for WAP attached to pole	1	160	160
Intermediate Hill				$31,627
WAPs	MR76, Meraki Outdoor Wireless Access Point	1	$5559	$5559
Antenna for WAP	MA-ANT-20. Additional antenna for the Meraki AP.	1	$550	$550
Meraki MR Licence	Gain access to centrally managed cloud solution for Meraki WAPs	1 (1 year licence, can be upgraded to 3 or 5 years at additional cost)	$400	$400
Outdoor Cabinet	An outdoor cabinet required for the network equipment that will be installed on site.	1	$900	$900
Installation	2 technicians will be required to be onsite to install and configure the wireless networking equipment	2	$2000	$4000
Switch	Meraki MX95 switch	1	8058	8058
Mounting Pole	Used to mount the WAPs	1	1000	1000
Mx95 Switch License	Advanced Security License and support	1	11000	11000
Pole Mount	Mount used for WAP attached to pole	1	160	160
Total for All Sites				$414,482

6.2.5 Dedicated Backhaul to Internet

The current mode of connectivity considered is through utilising Starlink low orbit satellites. Pricing for the 12 sites:

Lord Howe Island	
Option 1: Starlink 2TB	
Hardware	$2,999
Starlink Monthly fee	$748
3-year ownership per site	$29,927
3-year ownership for 12 sites	$359,124
Option 2: Starlink + wireless bridge	
Hardware	$2,999
Starlink monthly fee	$748
Wireless bridges (ubiquity AF-24)	$1,650 a pair, $21,450 for 13 pairs
3-year ownership for 12 sites	$51,377
Option 3: Trench and Run Fiber (9KM distance between sites)	
Trenching	$30 per metre, $540,000 for 9KM
Conduit	$25 per metre, $450,000 per metre
Cabling	$15,000
Total	$1,005,000

6.3 Network - Radio

The island has an existing VHF network that is used for emergency (Police, Marine Rescue, SES, RFS, Hospital) and support services from the LHIB. Restricted to radios programmed for this frequency, this is a critical service and the primary method for safety communications on the island. The use of this network for other communications would need careful consideration to ensure the primary safety role is not compromised.

Additional channels advertised from the radio network are possible, and having a set of handheld radio devices that can be loaned out to visitors for safety reasons could be an option but this capability could also be achieved by a set of Personal Locator Beacons (PLBs) that can be loaned. These operate in the Marine Rescue frequency and would require no change to the island VHF radio network.

Deploying fixed sets in weatherproof storage (with solar power to provide ongoing charging) at remote locations could be a consideration for emergency communications for visitors, the sets would require regular visits to confirm they are working correctly.

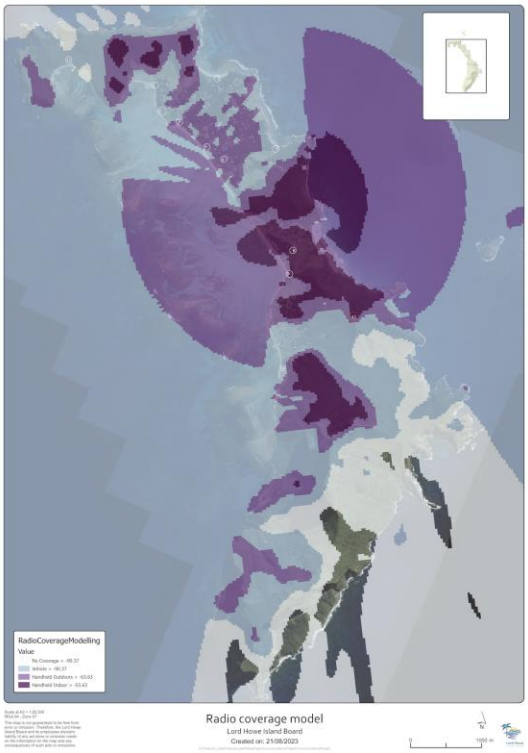


Figure 7 – Current VHF radio coverage (estimated)

6.4 Island Cabling Infrastructure and Landline

The Island has a copper network and landline telephony. There is no NBN fiber on the island. Installing a fiber backbone along the existing pit and trench runs should be investigated. Substituting the island's copper network that currently sustains landline connections is a viable option. Nonetheless, implementing this change involves taking into account the necessity of upgrading landline handsets. The current phones are incompatible, as they presently draw power through the copper lines, a functionality that can't be replicated over fiber optics. Adapting the phone service to Voice over Internet Protocol (VoIP) is imperative, wherein each inhabitant would need a compatible modem and handset. While this transition might pose challenges, it's noteworthy that landline usage in Australia is progressively waning; numerous households have already forgone landlines for years.

In order for VoIP landline services to operate optimally and reach their maximum potential, a strong and stable internet connection is essential. Broadband internet through fiber connections are highly suitable for this purpose. However, a comprehensive evaluation is required to determine whether the current NBN or Starlink connections would provide sufficient performance to transition to VoIP systems in the immediate future. This approach could serve as a strategic solution to address the potential challenge of Telstra discontinuing maintenance of the copper network. By adopting this strategy, both residents and businesses would be able to retain their landline functionality without relying on the traditional copper network.

Figure 8 – Telecom cables and pits

7 Summary

The benefits of building a connectivity network are clear, it provides a foundation for improved resident digital connectivity, digital connectivity for visitors, expanded monitoring, and additional safety connectivity. The question of which network should be deployed is complex:

Cellular connectivity is being offered by Telstra and the Black Spot Program. Complete details on the coverage have been provided but they come with many caveats. There is a risk that the proposed deployment is disappointing for a large proportion of the island residents.

It is not commercially viable to deploy a Wi-Fi network across the whole Island, the number of access points, interconnecting infrastructure and local backhaul solutions, all add up to a lot of hardware that needs deployment and maintenance.

The radio network should be reserved for emergency and safety operations, its deployment should be invested in to ensure it can deliver to its purpose.

Strategically, if digital communications are desired then the island should investigate the deployment of a fiber backbone across the habited part of the island. This is what the NBN has done for most habitations on the Australian mainland. There is a reason that fiber is deployed, it offers much faster communications and it has a lifespan of several decades. A fiber backbone that can be used by both residents, telcos and 3rd party commercial entities could support a 4G/5G mesh across the island and fiber broadband to residents. No large towers would be required, smaller cellular transmitters can be deployed by mounting on buildings etc, this is how the 5G network is being rolled out in cities.

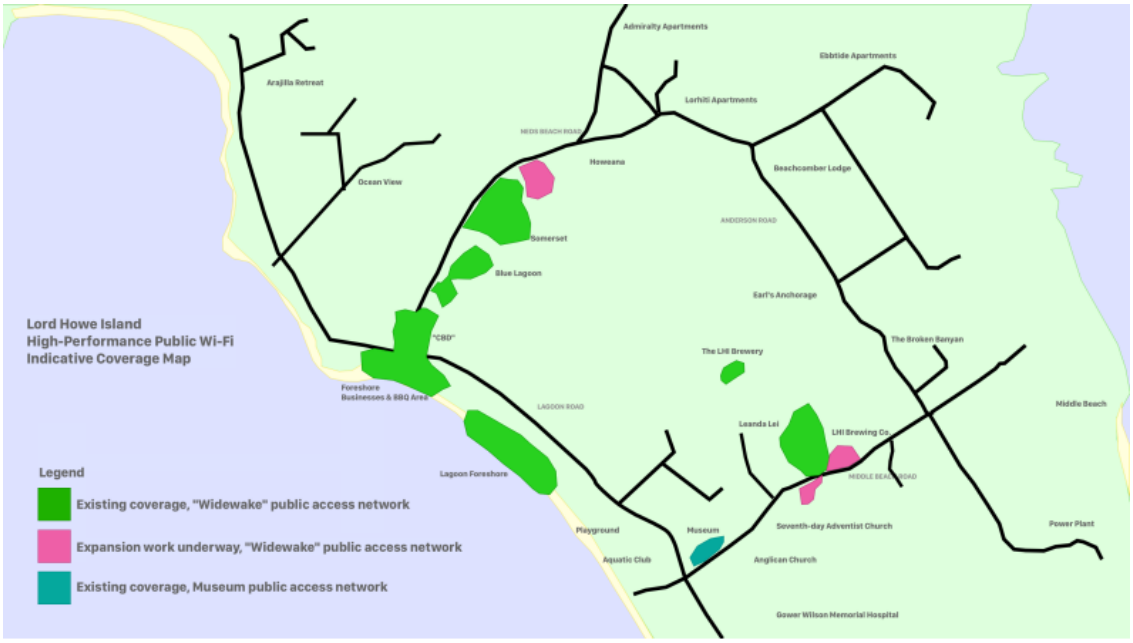
Advances in the 5G network, 5G Advanced and the next generation 6G may render the fiber backbone unnecessary and this is a gamble for the LHIB, but the same question has been asked by governments across the world and fiber continues to be rolled out. As a replacement for the island's copper network that supports the landlines, this is possible, however, it requires consideration to replace the landline handset. Existing phones will not work, they currently get their power across the copper, and this is not going to happen over fiber. The phone service would need to move to VoIP (Voice over Internet Protocol) with each resident requiring a modem and handset that can support this. This could be a challenge, however, the trend of landline usage across Australia is decreasing significantly, many households have not had a landline for many years.

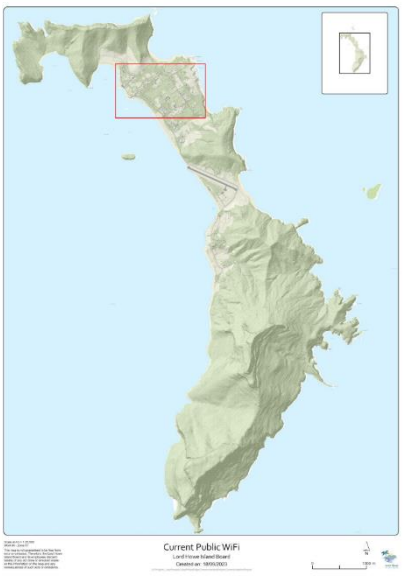
Investigating and costing a shared fiber backbone will take time and may risk losing out on Black Spot Program funding. Tactically, to provide connectivity sooner, the LHIB could approve Black Spot Program Telstra cell deployment and fund a second (and or third) cell at the middle and southern end of the Island. For any specific areas that the LHIB wish to enhance the visitor experience then deploying a visitor Wi-Fi could be undertaken but only in

key locations. The more public Wi-Fi locations are deployed, the more support infrastructure is needed, and the ongoing costs increase.

This report identifies the benefits of network connectivity, explores the connectivity options, and provides rough order of magnitude (ROM) costs for network deployment. The challenges of delivering and deploying any infrastructure on the Island make it difficult to accurately estimate costs and this needs to be factored into the accuracy of the estimates provided.

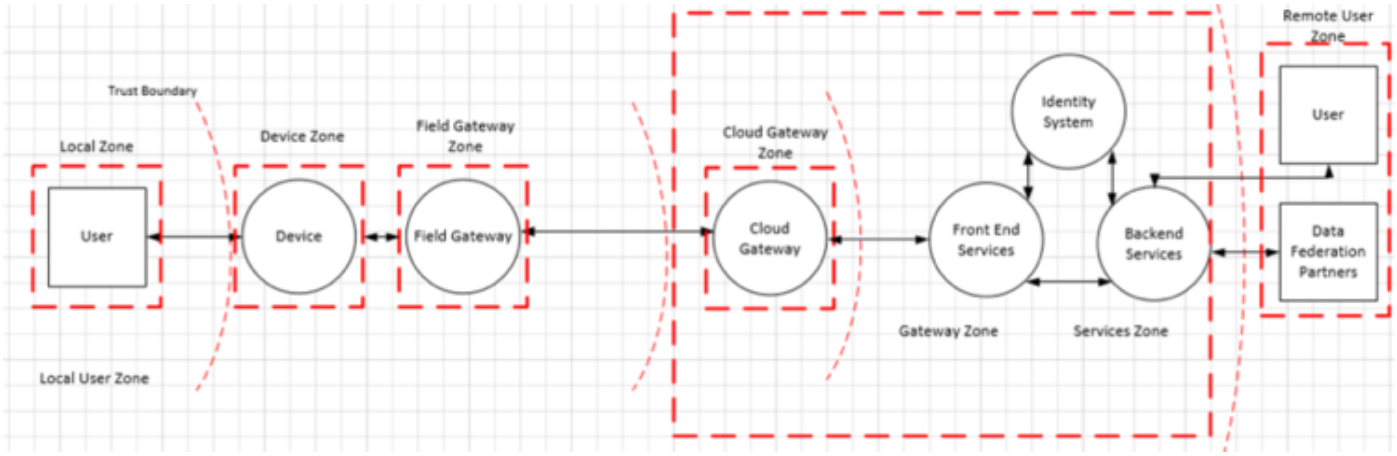
8 Appendix 1:


Admiralty Apartments
Ebbtide Apartments
Arajilla Retreat
Larhilli Apartments
Howeana
Beachcomber Lodge
Ocean View
Somerset
Blue Lagoon
Earl's Anchorage
"CBD"
The LHI Brewery
The Broken Banyan
Foreshore
Businesses & BBQ Area
Middle Beach
Leanda Lei
LHI Brewing Co.
Lagoon Foreshore
Playground
Museum
Seventh-day Adventist Church
Power Plant
Aquatic Club
Anglican Church
Gower Wilson Memorial Hospital
Lord Howe Island
High-Performance Public Wi-Fi
Indicative Coverage Map
Legend
Existing coverage, "Widewake" public access network
Expansion work underway, "Widewake" public access network
Existing coverage, Museum public access network


Current Public WiFi

9 Appendix 2:

The Microsoft security architecture for IoT



From this model a deployment architecture should be planned, and providers / technology selected.

Device Zone: These devices will vary greatly and will be selected by the local deployment based on their requirements. Standards for identification, connectivity, security, OS patching etc. should be created and published.

Field Gateway: A consistent deployment across all locations results in many devices connecting. A standard LoRaWAN gateway deployed under the control of a central body (eg LHIB) with a standard model of access to the Internet will result in control of devices connecting.

Cloud Gateway: A cloud gateway is a system that enables remote communication from and to devices or field gateways deployed in multiple sites and enables a cloud-based control and data analysis system.

Services zone

A service can collect data from the devices and command and control those devices. A service is a mediator that acts under its identity towards gateways and other subsystems to store and analyse data, issue commands to devices based on data insights or schedules and expose information and control capabilities to authorised end users.

In a large multi-user and multi-group environment it is key that a cloud gateway and service zone solutions are deployed to create an environment that can be used by multiple teams and business units in a secure way. For LHIB this may not be necessary and could be overkill. A single network, perhaps several gateways and antennas could be managed by a small team for all users.

10 Appendix 3:

10.1 Sites

The table below lists observations we have made for the 12 sites on Lord Howe Island.

Point of interest	Comment	Location	Existing Wi-Fi	Existting backhaul	Power	Existing Infrastructure
1) Old Settlement						
Old Settlement Beachfront	Picturesque beach on the north side of the island. As many residents live on this side, along with tourists, we would expect to see moderate internet usage in this area	Outdoors	No	No	Tap into current power from the toilet.	Satellite imaging shows very little in the form of infrastructure, as is to be expected of a beach. Poles will need to be installed to mount WAPs
2) Neds Beach						
Neds Beach, beachfront, just outside of the shed	Calm, family beach. This would see similar internet usage as that of the old settlement	Outdoors	No	No	Tap into current power from the shed	Satellite shows a paved road leading a shed on the beachfront, the shed may serve as a mounting point for a WAP

3) The Jetty						
The Jetty carpark	Place where people will come to fish or board boats. Internet usage here would be quite minimal	Outdoors	No	No	Tap into current power from the jetty building	Satellite shows two buildings and a carpark. Either one of the buildings would be suitable for mounting a WAP
4) Under the pines CBD						
Outside Lord Howe Island Marine Park	Central CBD area, this is where you would see the highest rate of internet usage	Outdoors	No	No	Tap into the distribution pillars	Many buildings surrounding the area, ample area where power can be tapped into and mount WAPs. It would be safe to assume there would also be some trenches in the area where fiber could be run
5) The Playground						
Playground area	Family area where children play. This site	Outdoors	No	No	Tap into the power from	Images online show the existing

	would see moderate internet usage				the public toilet	playground with a large sail, and lamp posts, these may be suitable mounting points for WAPs
6) The hospital						
Gower Wilson Memorial Hospital	The hospital would be an area with a high density of people. As such, it would be safe to assume that there would be moderate to heavy internet usage in this area	Outdoors	No	No	Tap into distribution pillars around that area, or could tap into the power from the hospital	Satellite images show quite a few buildings on this site, any of which would serve as mounting points for WAPs. It's important to note that due to the thick surrounding bush, multiple APs would be required for this area.
7) Middle Beach						
Middle beach	One of the quieter beaches on Lord Howe, here we would expect to see	Outdoors	No	No	Tap into the power from the powerhouse	Imaging does not show much if any infrastructure, aside from

	lower internet usage					the electrical generators away from the beach. Poles would need to be installed to mount APs
8) The Airport						
Airport Terminal	Busy single airport terminal. There would be heavy internet usage here	Outdoors	No	No	Tap into power from the airport building	Lots of infrastructure already present on site. Should easily be able to mount APs almost anywhere on site.
9) Cobbies Corner						
Cobbies Corner Beachfront	Small picnic area on the beach front. Here we would expect low to moderate internet usage.	Outdoors	No	No	No power on site. May have to be solar	Imaging does not show much in the way of infrastructure. Power and poles would be needed to install WAPs
10) Little Island Start						
Beach entrance, near roundabout	Starting point of the little island trail. This area would see	Outdoors	No	No	No power on site. May have to be solar	Imaging does not show any infrastructure on site. Poles

	moderate to low internet usage.					will need to be built to mount APs
11) North Bay						
North Bay Beachfront	Secluded beach accessible either on foot or by water. Here we would expect moderate internet usage	Outdoors	No	No	Current solar power + battery set up on site. If power supply is not suitable, this may require a slight upgrade.	Imaging does not show any infrastructure by we have been told solar is available. Poles will still be needed to mount APs
12) Intermediate Hill						
Bush setting	VHF radio location. Wi-Fi would be very restricted. Possible LoRaWAN gateway location but topographical inspection required	Outdoors	No	No	Current solar power + battery set up on site. If power supply is not suitable, this may require a slight upgrade.	Imaging does not show any infrastructure.

10.2 Wi-Fi connectivity modelling

Network equipment required to establish wireless networks at the 12 sites spanning across Lord Howe:

Point of interest	WAP (Wireless Access Points)	Comment	WAP Count	Switch count	Location	Existing Wi-Fi	Existting backhaul	Power
1) Old Settlement								
Old Settlement Beachfront	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	Tap into current power from the toilet.
2) Neds Beach								
Neds Beach, beachfront, just outside of the shed	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	Tap into current power from the shed
3) The Jetty								
The Jetty carpark	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	Tap into current power from the jetty building
4) Under the pines CBD								
Outside Lord Howe Island Marine Park	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	Tap into the distributio n pillars
5) The Playground								
Playground area	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	Tap into the power from the public toilet
6) The hospital								

Gower Wilson Memorial Hospital	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	2	1	Outdoors	No	No	Tap into distributio n pillars around that area, or could tap into the power from the hospital
7) Middle Beach								
Middle beach	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	Tap into the power from the powerhou se
8) The Airport								
Airport Terminal	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	2	1	Outdoors	No	No	Tap into power from the airport building
9) Cobbies Corner								
Cobbies Corner Beachfront	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	No power on site. May have to be solar
10) Little Island Start								
Beach entrance, near roundabout	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	No power on site. May have to be solar
11) North Bay								
North Bay Beachfront	MR76 + MA-ANT-20	Each WAP can support around 50 users at any one time	1	1	Outdoors	No	No	Current solar power + battery set up on site. If

								power supply is not suitable, this may require a slight upgrade.
12) Intermediate Hill								
VHF tower location	MR76 + MA-ANT-20	This is likely to be a very restricted location. Questionable benefit of Wi-Fi at this location	1	1	Outdoors	No	No	Current solar power + battery set up on site. If power supply is not suitable, this may require upgrade.

10.3 Backhaul modelling

Required number of switches and WAPs for each backhaul option mentioned above, along with the supporting infrastructure present on site:

Point of interest	Backhaul options	Location	Supporting infrastructure	Additional Infrastructure
1) Old Settlement				
Old Settlement Beachfront	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into current power from the toilet.	Options 1: cabling (copper/fiber), ethernet adapter from Starlink and poles for mounting. Option 2: wireless bridge (ubiquity AF-24), cabling, and poles for mounting Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
2) Neds Beach				
Neds Beach, beachfront, just outside of the shed	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into current power from the shed	Options 1: cabling (copper/fiber) and the ethernet adapter from Starlink. Option 2: wireless bridge (ubiquity AF-24) and cabling. Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
3) The Jetty				
The Jetty carpark	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into current power from the jetty building	Options 1: cabling (copper/fiber) and the ethernet adapter from Starlink. Option 2: wireless bridge (ubiquity AF-24) and cabling. Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.

4) Under the pines				
Outside Lord Howe Island Marine Park	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into the distribution pillars	Options 1: cabling (copper/fiber) and the ethernet adapter from Starlink. Option 2: wireless bridge (ubiquity AF-24) and cabling. Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
5) The Playground				
Playground area	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into the power from the public toilet	Options 1: cabling (copper/fiber) and the ethernet adapter from Starlink. Option 2: wireless bridge (ubiquity AF-24) and cabling. Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
6) The Hospital				
Gower Wilson Memorial Hospital	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into distribution pillars around that area, or could tap into the power from the hospital	Options 1: cabling (copper/fiber) and the ethernet adapter from Starlink. Option 2: wireless bridge (ubiquity AF-24) and cabling. Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
7) Middle Beach				
Middle beach	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into the power from the powerhouse	Options 1: cabling (copper/fiber), ethernet adapter from Starlink and poles for mounting. Option 2: wireless bridge (ubiquity AF-24), cabling, and poles for mounting

				Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
8) The Airport				
Airport Terminal	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Tap into power from the airport building	Options 1: cabling (copper/fiber) and the ethernet adapter from Starlink. Option 2: wireless bridge (ubiquity AF-24) and cabling. Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
9) Cobbies Corner				
Cobbies Corner Beachfront	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	No power on site. May have to be solar	Options 1: cabling (copper/fiber), ethernet adapter from Starlink and poles for mounting. Option 2: wireless bridge (ubiquity AF-24), cabling, and poles for mounting Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
10) Little Island Start				
Beach entrance, near roundabout	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	No power on site. May have to be solar	Options 1: cabling (copper/fiber), ethernet adapter from Starlink and poles for mounting. Option 2: wireless bridge (ubiquity AF-24), cabling, and poles for mounting Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
11) North Bay				

North Bay Beachfront	Option1: Star link Option 2: Wireless bridge Option 3: Fiber	Outdoors	Current solar power + battery set up on site. If power supply is not suitable, this may require a slight upgrade.	Options 1: cabling (copper/fiber), ethernet adapter from Starlink and poles for mounting. Option 2: wireless bridge (ubiquity AF-24), cabling, and poles for mounting Option 3: trench dug from site to core uplink site. You will also need fiber that runs the length of the trench.
12) Intermediate Hill				
VHF location	Starlink	Outdoors	Current solar power + battery set up on site. If power supply is not suitable, this may require a slight upgrade.	Cabling (copper/fiber), ethernet adapter from Starlink and poles for mounting.