Hawaii AREDN MESH Deployment

The Hawaii Allstar Repeater Group and Hawaii Emergency Amateur Radio Network, Inc (HEARDn), a 501C3 corporation, have agreed to cooperate in deploying AREDN MESH nodes in Hawaii. Other radio clubs in Hawaii will be asked to join in building a statewide network

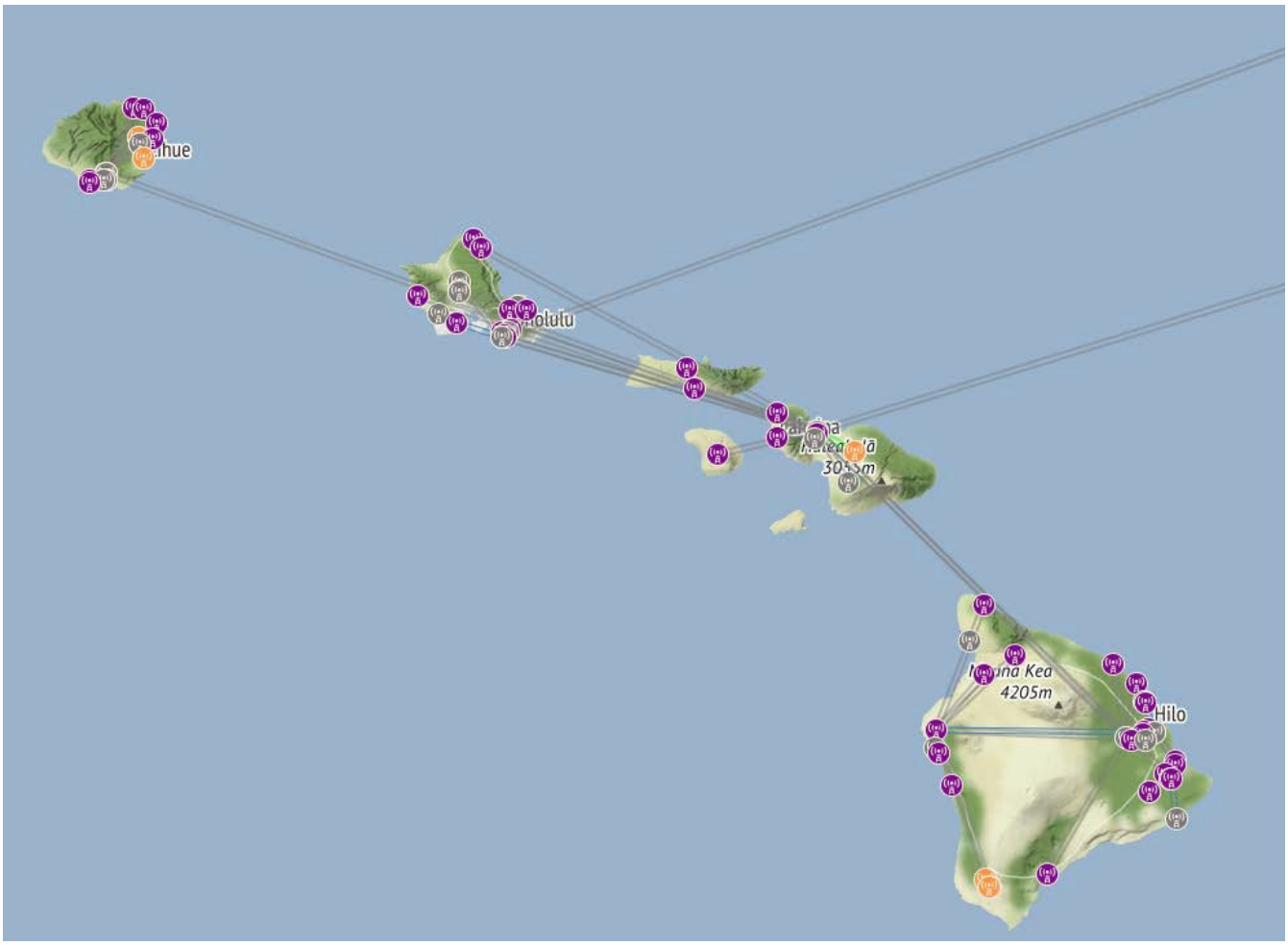
Inter-Island Links

The Allstar Repeater group has advanced plans for interisland Ubiquity links. *Recognizing the importance of backhaul links, HEARDn will prioritize funding of those projects. The plan is to harden the network with the goal of creating an intranet connection utilizing backup power Batteries, generators, and/or Solarcapability.*

Current Hawaii AREDN MESH map

The map is available on Internet at

http://arednmesh.wh6av.org:8888/meshmap



Hawaii Nodes

The primary node interface hardware will be the MikroTik ac lite. This unit when flashed as an AERDN MESH router supports Ethernet interconnection for up to three devices and provides Part 97 2.4 GHz AREDN plus Part 15 5GHz Wi-Fi. Both Wi-Fi services allocate DHCP IPs in the AREDN 10.x private address space which is shared with all node that are part of the network.

MikroTik hAPs are being allocated to repeaters and Winlink gateways with existing commercial Internet tunnels creating a public Internet link. HEARDn and participating clubs will assist in funding of permanent AREDN MESH RF linking. Appendix A is an explanation of the network and the various levels of links involved. See Appendixes B thru E for and overview of devices currently installed in the Hawaii network. Others will be added as use in Hawaii dictates. The current list of AREDN MESH supported platform devices should be consulted for the list of devices compatible with the latest release of AREDN MESH software - https://www.arednmesh.org/content/supported-platform-matrix/

This paper addresses a network node naming convention intended to promote node deployment either virtually using Internet tunnels or with actual Ubiquity links

Node Naming

The Hawaii node naming convention follows the suggestions of the ARES LAX group which has been a mentor in promoting Hawaii use of digital technologies for Emergency Communications. The NE ARES LAX group has a network of over 200 AREDN MESH nodes serving Los Angeles community.

The naming convention is a sequence of tags, separated by hyphens, starting with the call sign of the control operator of the node router, which is actually an Amateur Radio transceiver operating on the 2.4 GHz Part 97 Amateur allocation – Wi-Fi channels -1 and -2.

Following the callsign, separated by a dash will be a single digit Hawaii Zone number identifying the island where the node is located.

1	KAUAI	4	MOLOKAI	7	
2	OAHU	5	LANI	8	
3	MAUI	6	HAWAII	9	

Optionally a town name or other identifier may follow the zone to make the identifier unique when a given callsign has more than one node. A list of towns used for the ARRL EmComm groups is in Appendix E.

Nodes in the US Pacific territories will use the island name instead of a Hawaii Zone number,

AMERICAN SAMOA	GUAM	ROTA	SAIPAN	TINIAN

Note: the node identifier should use upper case letters only in the Hawaii network.

Here are examples of node names that are part of the initial Hawaii network deployed.

WH6AV-2	NH6NN-5	WH6FG-1
WH6CYD-2	WH6FXL-5	NH6HI-1-KUKIOLONO

HUB Nodes

Each island will have at least one HUB node configured to route all traffic off the island. The word HUB will be appended to the node name, e.g. WH6AV-3-HUB.

Currently configured HUBs are,

KAUAI	WH6FG-1-HUB	MAUI	WH6AV-3-HUB	LANI	WH6AV-3-HUB
OAHU	NH6NN-2-HUB	MOLOKAI	WH6AV-3-HUB	HAWAII	WH6DVI-6-HUB

IP Addresses

The Hawaii network conforms to AREDN MESH standards for Class A and B IP addresses. This table describes the octets used in the level 2 Hawaii AREDN network to direct intra and inter island traffic between nodes.

Class A IP addresses for nodes are generated by the AREDN MESH flash software from a unique node name. (see Node Naming, above). Class B addresses are generated by AREDN MESH software for tunnel servers. Class C addresses are those of the local LAN of an individual Amateur hosting the AREDN MESH node.

Hawaii AREDN MESH Network						
Destination Code	Island/Department	Extension	Repeater Node	Class A	Class B	Class C
0	Back Office	0XXX	0XX	10.x.x.x	172.x.x.x	192.168.x.x
1	Kauai	1XXX	1XX	10.x.x.x	172.x.x.x	192.168.x.x
2	Oahu	2XXX	2XX	10.x.x.x	172.x.x.x	192.168.x.x
3	Maui	3XXX	3XX	10.x.x.x	172.x.x.x	192.168.x.x
4	Molokai	4XXX	4XX	10.x.x.x	172.x.x.x	192.168.x.x
5	Lanai	5XXX	5XX	10.x.x.x	172.x.x.x	192.168.x.x
6	Hawaii	6XXX	6XX	10.x.x.x	172.x.x.x	192.168.x.x
7	Stateside	7XXX	7XX	10.x.x.x	172.x.x.x	192.168.x.x
8	EOC	8XXX	8XX	10.x.x.x	172.x.x.x	
9	Emergency Departments	9XXX	9XX	10.x.x.x	172.x.x.x	

Node Interconnections

The AREDN MESH web site has a list of transceivers compatible with current AREDN MESH software http://AREDNMESH.org). This document will only list equipment successfully installed in the Hawaii network. Members of HEARDn are available for advice and experience with these transceivers in Hawaii.

Connected Devices/Services

Each hAP has three ethernet ports that can connect to devices at that locale. Based on feedback from the LAX group, standardizing these names is important to allow ease of use of the network. Finding a device at a point on the network is much easier if all nodes use common nomenclature. The following is a list of common terminating devices that can use the hAP router to connect to the AREDN network or Internet, if an AREDN connection is not available.

Standardized Device Tags	Usage
AS	All-Star Repeater connected to the network
DMR	DMR Repeater connection to network
WL2K	A Winlink gateway connection via RMS RELAY
PBX	Free PBX supporting Hawaii VoIP
Nnnn	VoIP phone – N is island number; nnn extension

A. If more than one device is connected to a node, the second and third will have the number appended with a dash, e.g. AS-2, WL2K-2.
B. If the device is capable of transmitting in the Amateur Part 97 RF allocations and has a call sign different from the node, its call should be appended with a dash, e.g. KH6DL-WL2K-KH6SW
C. VoIP phone in the network are assigned by island with up to 999 numbers supported.

1	KAUAI	4	MOLOKAI	7	
2	OAHU	5	LANAI	8	
3	MAUI	6	HAWAII	9	

For users connected to the network, the current VoIP directory is available at http://10.210.190.25/phonebook

Examples of complete alphanumeric name of devices at “WH6AV-3” would be,

WH6AV-3-AS	WH6AV-3- WL2K	WH6AV-3001	WH6FG-1017

Resiliency

Nodes should document availability of generator, solar power and battery backup. The presentation format is pending. There are backup sites on the four main islands – Kauai, Oahu, Maui and Hawaii.

Network Interconnections.

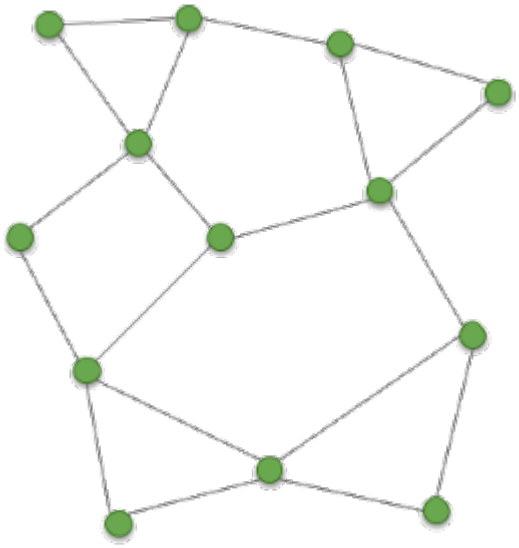
Our mission is to support Part 97 compliant nodes allowing sending parties to have their traffic quickly and accurately relayed and delivered to a receiving party. Owners of nodes connecting to the network assume no liability or makes any representations about the content of messages.

Winlink Gateway Frequency Assignments.

For RF Gateways connected to the Hawaii AREDN MESH network will coordinate HF and VHF frequency assignments considering - (1) Coverage area, (2) Support of Interisland connectivity and (3) Network throughput. See Appendix G for the latest agreed assignments.

Appendix A -Network Topologies

Every AREDN® node is capable of automatically joining an AREDN® mesh network which is operating with the same SSID, channel, and bandwidth. A *Mesh* topology consists of independent nodes which each explore their surroundings by broadcasting their identity and listening for their neighbors' responses. Once nodes identify others within radio range, they share this information so that each node has a picture of the network topology. Periodic updates adjust the routes based on changes in signal quality or loss of a link, allowing the network to adapt to changing conditions. Since there are usually several possible routes between nodes, and since network disruptions typically effect only part of the network, a *Mesh* topology can be self-healing.



This automatic ability to form a mesh network is built into the AREDN® firmware on each node. Every node within radio range of other nodes will be able to participate in the network to extend its reach, provide route redundancy, or host services needed on the network at large. This basic network may serve its purpose perfectly for a short-term network deployment in support of a local event, or even for more permanent communication between nodes which are always within radio range.

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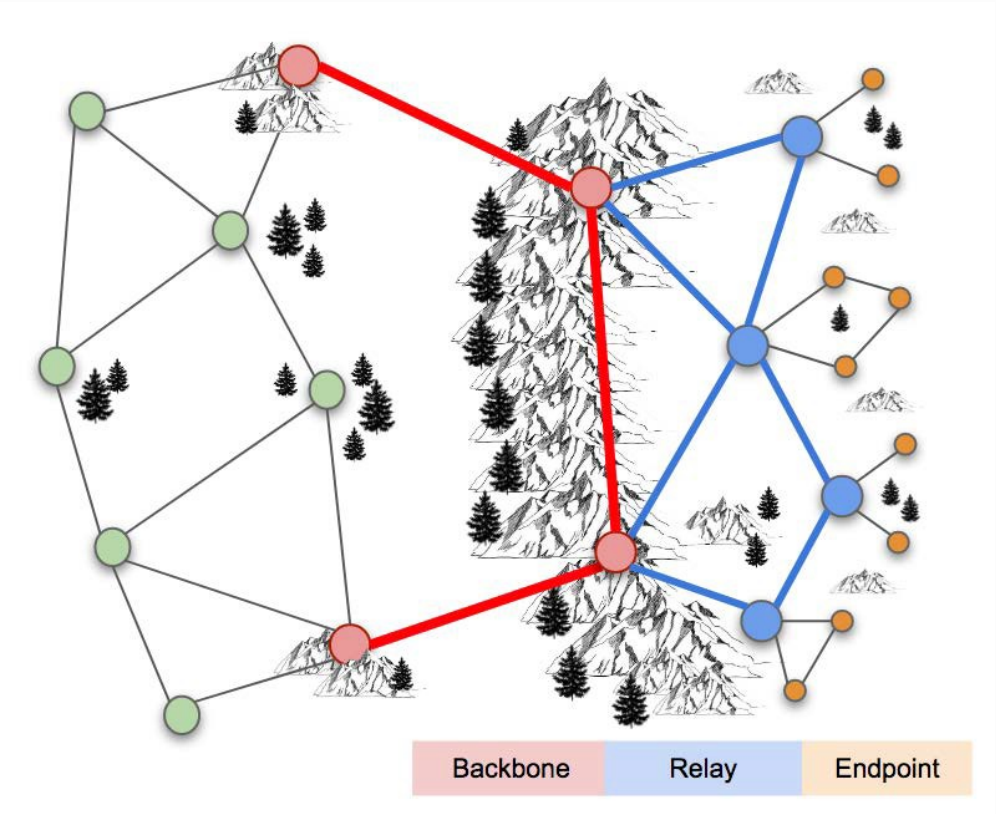
Types of Links

A variety of factors could isolate groups of mesh nodes from each other. For example, distance, terrain, structures, or foliage may prevent some of the nodes from communicating via RF. For long-term or permanent deployments there may be a need for special types of network links that connect what are called mesh "islands." A *link* consists of both sides of a radio path, including the two devices that communicate back and forth across that path.



Backbone Links

As the name implies, these links form the backbone or superhighway along which large amounts of data can travel for long distances at relatively high speed. Typically, backbone or "backhaul" links are permanent installations on mountain peaks, tall buildings, or high towers. They are usually point-to-point links with large high-gain antenna systems running on reliable power sources. In some cases, these links are designed with redundant radios which help ensure path protection. Backbone links can operate over distances between 10 to 30+ miles.

Relay Links

Relay links bridge the gaps between endpoint nodes. Their primary purpose is to pass network data, but there may be cases where they also serve as mesh access nodes for users. Sometimes these links are called “mid-mile”, “distribution”, or “intermediate” nodes. They are usually installed on medium-height towers or buildings in order to achieve high signal quality with good line of sight to other relay nodes. Depending on conditions, intermediate links may operate over distances between 3 to 10+ miles.

Endpoint Links

Endpoint links are used to connect destination nodes to the mesh network. Sometimes these links are call “last mile”, “tactical”, or “terminal” nodes. Usually these nodes serve either as the originator or the final destination for network traffic. Depending on local conditions, endpoint links typically operate over distances of 3 miles or less.

Different types of radio links may be needed to connect all of the mesh nodes that are required in order to fulfill the purposes for your network. The ultimate goal is to have a reliable data network that accomplishes its purpose for providing services to the intended destinations and users.

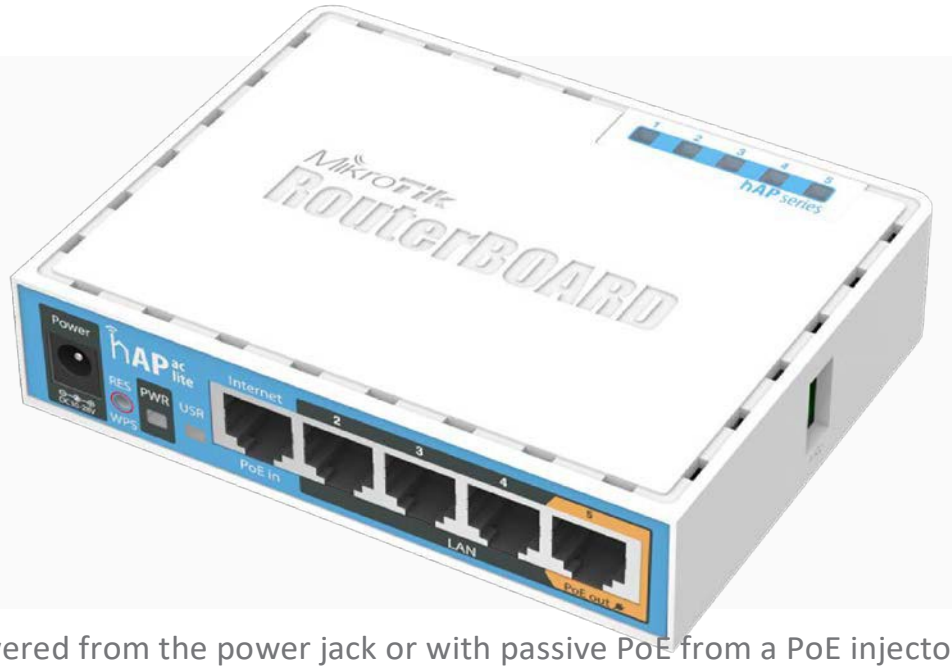
Appendix B – hAP ac Lite Router Node

The hAP ac lite is a Dual-concurrent Access Point, that provides Wifi coverage for 2.4GHz and 5GHz frequencies at the same time.

The device is very small and will look good in any home or office, wall mounting anchor holes are provided.

- Dual chain wireless 2.4GHz
- Single chain wireless 5GHz
- 650MHz CPU
- 64MB of RAM
- Five x 10/100Mbps Ethernet ports
- Passive PoE output on port 5
- USB port for 3G/4G modem

24V 1.2A
Power



The hAP ac lite can be powered from the power jack or with passive PoE from a PoE injector. The power adapter is included. Unit provides PoE output function for port 5 - it can power other PoE capable devices with the same voltage as applied to the unit. Maximum load on the port is 500mA.

The hAP ac lite is preconfigured, so all you need to do, is plug in the internet cable, the power, and start using the internet by connecting to the MikroTik network.

Specifications

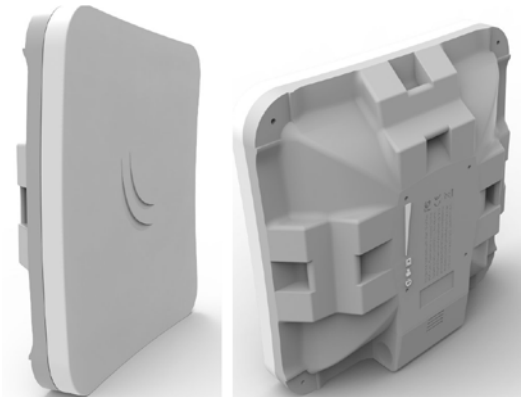
Product code	RB952Ui-5ac2nD (International) RB952Ui-5ac2nD-US (USA)			
CPU nominal frequency	650 MHz			
CPU core count	1			
Size of RAM	64 MB			
Storage type	Flash			
Storage size	16 MB			
10/100 Ethernet ports	5			
Wireless bands	5 GHz radio		2.4 GHz radio	
Operating frequency	International	5150 - 5875 MHz	International	2412 - 2484 MHz
	USA	5170 - 5250 MHz 5725 - 5835 MHz	USA	2412 - 2462 MHz
Protocols	802.11a/n/ac		802.11b/g/n	
Chains	Single chain		Dual chain	
Antenna gain	2 dBi		1.5 dBi	
Wireless chip model	QCA9887		QCA9531	
Antenna beam width	360°			
PoE in	Yes			
PoE out	Yes (Ether5), 0,5 A			
Supported input voltage	8 V - 30 V (Jack or Passive PoE)			
Extras	USB 2.0 Type A full size port, 1 A			
Dimensions	113 x 89 x 28mm			
License level	4			
Operating System	RouterOS			
CPU	QCA9531			
Max Power consumption	7 W			

Wireless specifications

RATE (2.4 GHz)	Tx (dBm)	Rx (dBm)
1MBit/s	22	-96
11MBit/s	22	-89
6MBit/s	20	-93
54MBit/s	18	-74
MCS0	20	-93
MCS7	16	-71

RATE (5 GHz)	Tx (dBm)	Rx (dBm)
6MBit/s	23	-93
54MBit/s	20	-75
MCS0	23	-93
MCS7	19	-71
MCS9	16	-63

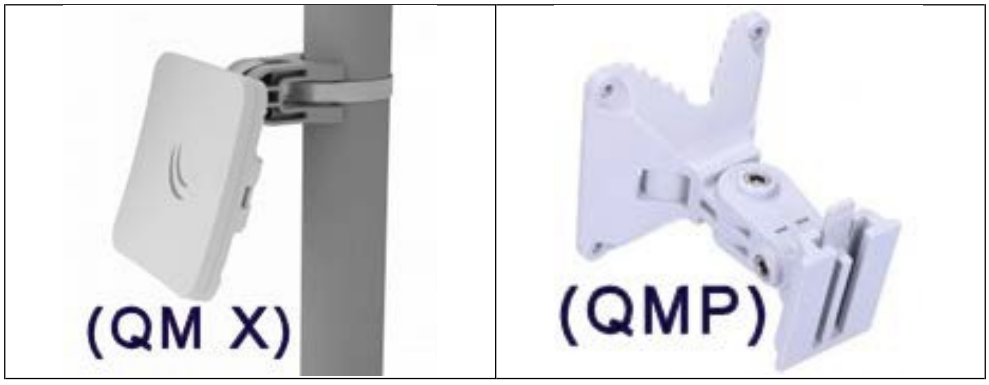
Appendix C – Point-to-Point Short-Range Link



The Micro Tik SXTsq 5 HP is a compact and lightweight outdoor wireless device with an integrated antenna, perfect for point-to-point links or as a CPE unit. It is compact, weatherproof and easy to mount. The SXTsq 5hp retains a 16 dBi antenna like the SXT 5, our previous model, yet the antenna design has been improved and the physical size has been dramatically reduced - the SXTsq is only 5 x 5 x 1½ inches. It can be held in your hand. High TX power allows a link to reach long distances.

The enclosure includes slots for directly attaching a hose clamp mount in three different mounting places, with ability to be mounted on horizontal railings. The device includes one 10/100 Mbit ethernet port. There is also an easily accessible grounding connection to protect it against lightning.

The device can be mounted on horizontal and vertical poles and masts. For precise alignment, the Quick Mount Pro (QMP) or Quick Mount X (QM X) brackets are available that allow adjustments in every angle.



Appendix D – Point-to-Point High-Power Link

The LHG XL HP5 is a 5GHz 802.11 a/n wireless device with an integrated dual polarization 27 dBi grid antenna and 630mW TX output power, designed to reach up to 25 miles in point-to-point setups at full speed.

The grid design ensures protection against wind, and the fact that the antenna element is built into the wireless unit means no loss on cables. Be sure to order the LHG XL HP5 (International) that supports 5150MHz-5875MHz range.

This 5.8 GHz antenna with integrated transceiver is typically ordered in pairs to support a link between AREDN MESH nodes.

https://www.eurodk.com/en/products/mt-lhg/lhg-xl-hp5

Appendix E –Sector Nodes

The Hawaii AREDN MESH network has deployed several wide area access nodes with 120-degree antennas using MikroTik equipment.

Base Box Router

SMA Cable

mANT 19s Sector Antenna

The Base Box device is an outdoor five gigabit ethernet port router with PoE output on four ports/ It also supports passive PoE input and passive or 802.3af/at PoE output. Ethernet ports 2-5 can power other PoE capable devices with the same voltage as applied to the unit. It has 128 MB RAM, 16 MB of storage and a 800MHz CPU. There is a cable hood for protection against moisture. Also available are three additional places for antenna connectors, in case you wish to use the BaseBox miniPCIe slot to make a dual band device.

The case can be opened with one hand and is protected against the elements. USB, Ethernet, and grounding wire exits are provided on the bottom, behind a protective door.

Two models are available - BaseBox 2 and BaseBox 5 (2 or 5GHz wireless, respectively). Comes with a mounting loop for tower/pole mounting, and a separate DIN rail mount is also provided. Package includes a PoE injector and power supply unit.

The sector mANT antennas are a perfect companion for the BaseBox and other outdoor wireless devices. It is a dual-polarization 19dBi 120-degree beam with sector antenna with two RP-SMA connectors. The antenna comes with a metallic U bolt type mount.

Appendix F - **Hawaii AREDN MESH Communities**

North Hawaii County		**South Hawaii County**		**South Honolulu County**		**Kauai County**
Hakalau		Captain Cook		Aina Haina		Anahola
Hawi		Hawaii National Park		Ala Moana		Eleele
Honoka`a		Honaunau		Honolulu		Hanalei
Honomu		Ho`okena		Hawaii Kai		Hanamaulu
Kamuela		*Kilauea*		Honolulu Int'l Airport		Hanapepe
Kapa`au		Miloli`i		Kahala		Kalaheo
Kawaihae		Na`alehu		Kaimuki		Kapaa
Kohala Estates		Ocean View		Kakaako		Kealia
Laupahoehoe		Pahala		Kalama Valley		Kekaha
Ninole		Volcano		Kuliouou		Koloa
O`okala				Liliha		Lawai
Pa`auilo		**North Honolulu County**		Makiki		Lihue
Papa`aloa		Aiea		Manoa		Makaweli
Puako		Barbers Point		Nuuanu		Princeville
Waikoloa		Ewa Beach		Palolo		
Waimea		Ewa Villages		Punchbowl		**Lanai**
		Haleiwa		Waikiki		Lanai City
East Hawaii County		Hickam AFB				
Ainaloa		Iroquois Point		**Windward Honolulu County**		**Maui**
Hawaiian Acres		Kapolei		Ahuimanu		Alahele
Hawaiian Beaches		Maili		Hauula		Haiku
Hawaiian Paradise Park		Makaha		Kaaawa		Hana
Hilo		Makakilo		Kahaluu		Kahului
Kalapana		Mlilani		Kahana Bay		Kihel
Kapoho		Nanakuli		Kahuku		Kula
Kea`au		Pearl Harbor		Kailua		Lahaina
Kurtistown		Pearl City		Kaneohe		Makawao
Leilani Estates		Pupukea		Kawela Bay		Paia
Mountain View		Schofield Barracks		Laie		Pukalani
Nanawale Estates		Sunset Beach		Lanikai		Puunene
Orchidlands Estates		Wahiawa		M C B H Kaneohe Bay		Wailuku
Pahoa		Waialua		Maunawili		
Papaikou		Waianae		Punaluu		**Molokai**
Pepe'ekeo		Waimea Bay		Temple Valley		Hoolehua
Pohok		Waipahu		Waihole		Kaunakakai
		Whitmore Village		Waikane		Kualapuu
				Waimanalo		Maunaloa
West Hawaii County						
Holualoa						
Kailua Kona						
Kealakekua						
Keauhou						
Kona						

This document is for reference only. The official frequencies are documented on the Winlink.org wseb site. Always use the Winlink channel selector file for most recent frequencies. Please remember to update regularly and before planned events and emergencies.

Note the center frequency is ALWAYS Dial plus 1500 Hz for all HF modes. VARA HF 2300Hz uses audio frequencies from low frequency equal to DIAL+350 Hz to high frequency DIAL+2650 Hz. VARA HF 500 Hz uses audio frequencies from low frequency equal to DIAL+250 Hz to high frequency DIAL+1750 Hz.