WaveTunnel Data Sheet
Pilot Program Feature Set
Q1 2022

AIRVINE

OVERVIEW

WaveTunnel™ technology has been designed to enable in-building broadband wireless backbones. This approach offers much greater flexibility and lower costs than legacy structured wiring solutions based on CAT6 copper of fiber cabling. It is also less cumbersome, faster to deploy, and easily supports moves, adds, and changes. It is ideal for backhaulng Wi-Fi 5, 6, and 6E access points. This technology can also be used with IoT networks and in the future, private 5G networks. It uses the V-band up at 60 GHz. This is an unlicensed band with more than enough spectrum to match the throughput of a wired solution, but without any of the downside of actually having to pull wire.

FEATURES

Architecture
Each WaveTunnel node has two radios, one pointed in the upstream direction and the other in the downstream direction. Each radio operates in a time division duplex (TDD) mode where it is either transmitting or receiving, but not both at the same time. In addition to the two V-band radios, each node also has four Gigabit Ethernet ports that are used to add/drop traffic to locally attached Wi-Fi access points and IoT devices. One of these ports can also provide power-over-Ethernet (PoE) to a locally attached Wi-Fi AP. WaveTunnel nodes are designed to be ceiling mounted or wall mounted and are for indoor use only.

Throughput
Each radio uses one of the six 2.16 GHz V-band channels to deliver 4.6 Gbps at the physical layer using 16 QAM (quadrature amplitude modulation) which reduces to a payload of 3.15 Gbps. With 2 radios in each node, the total throughput is 6.3 Gbps.

The V-band
Consists of unlicensed spectrum that sits between 57 and 71 GHz in the U.S. Other parts of the world are doing similar things with this band. There is enough spectrum in the V-band to allow a wireless backbone solution to match the throughput of a wired solution.

Four Gig Ethernet ports w/PoE-out
Each Ethernet port can support speeds up to 1 Gbps in support of locally attached Wi-Fi 5/6/6E access points, IoT devices, and eventually private 5G cellular services. One of these locally attached access devices can be powered from the WaveTunnel node via PoE-out at up to 25 watts.

Survivability
WaveTunnel nodes can be deployed in a dual counter-rotating wireless ring configuration (Note: this feature will not be available until GA in Q2 of 2022). In this scenario, the upstream and downstream radios enable wireless rings to operate in both the clockwise and counter-clockwise directions. Nodes can relay traffic from neighbor nodes as well as add/drop traffic to a locally attached Wi-Fi access points. If a node on the ring fails, the neighbor nodes will sense the failure and internally loopback all traffic. This guarantees that data can still reach the wiring closet and from there go on to the Internet.

Internet-of-Things (IoT)

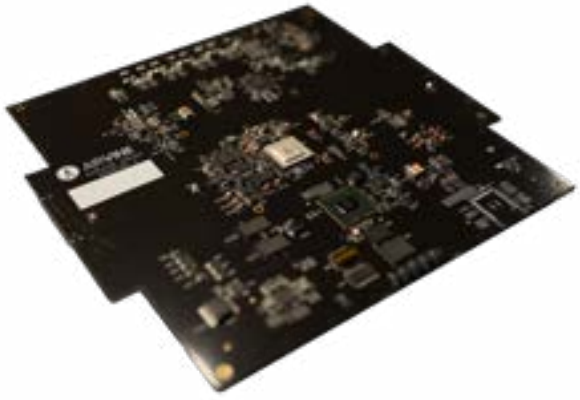
WaveTunnel technology is especially well suited to Internet-of-things deployments which often require separate networks for added security, and connectivity to locations that might not otherwise have wireless service. This is easily enabled with Airvine technology.

Cloud management

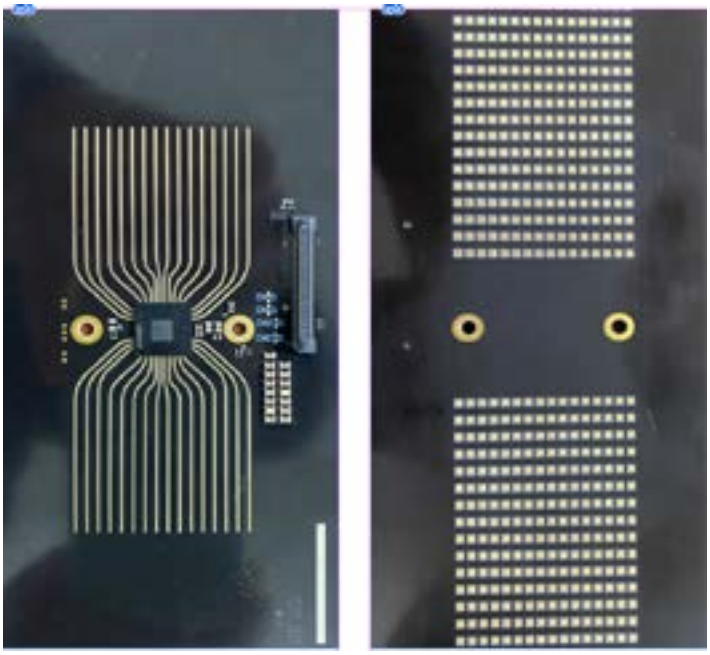
In the Pilot release, Airvine will support an on-prem web based management tool as well as mobile app to configure, provision, and monitor the WaveTunnel nodes. In subsequent releases, Airvine will support a cloud based management framework along with open APIs so that the Airvine WaveTunnel management system can integrate with other overarching backend systems as needed.

High-gain beamforming antenna

Beamforming technology is essential to getting high performance in the millimeter-wave bands. Beamforming options include analog, digital, and hybrid modes. WaveTunnel nodes utilize analog beamforming, which takes a data stream from the digital baseband and runs it through a radio chain that takes it up into the V-band. Beamforming (aka phase and amplitude shifting) is done using analog phase shifters that feed 256 patch antenna elements to create a very narrow beam with a very high gain. The more patch antenna elements, the narrower the beam, and the narrower the beam the higher the gain. At 60 GHz each antenna element is only 4 mm², which allows the entire array to fit into 20 cm² of PCB real estate and is one of the advantages of operating in the millimeter-wave bands.



WaveTunnel digital board



WaveTunnel transceiver board

Beam steering for ease of installation

WaveTunnel nodes have been designed for ease of installation, which means no special RF skills are required by the installers. The units do not need to be precisely "aimed" at their neighbor node, just pointed in the general direction and the automatic beam steering function takes over and makes the final adjustments. Each radio can adjust the beam by ±45 degrees along the azimuth to lock onto its neighbor node. This makes installation easy, and it makes possible a ring-configurations which requires signals to be turned in a 360° arc.

The optimum location for a WaveTunnel node is on the ceiling. This allows the nodes to avoid people, plants, furniture, cubicles, and equipment that would otherwise attenuate the signal. When faced with an obstruction the options are to punch right through it using the high-gain antenna in the WaveTunnel nodes or route around it by the careful placement of relay nodes.

Installation APP

WaveTunnel nodes are installed and configured using a very simple mobile APP that runs on either an iPhone or Andriod device. Configuration consists of assigning nodes to networks, sequencing nodes in a ring, and naming the nodes. This APP can also be used to check the performance of the nodes in the network. For more on installation and configuration of a WaveTunnel system see the Installation and Configuration Guides.

WaveTunnel Value Proposition

WaveTunnel nodes offer the following advantages in an in-building enterprise deployment:

- Quick and easy moves, adds, and changes (10-100X faster than with structured wiring).
- Fast backhaul upgrades to support new broadband applications that require Wi-Fi 6/6E.
- No need to overbuild during installation as it is easy to add capacity at a later date.
- High-gain beamforming antenna can punch an RF signal through almost any commonly used building material.
- Excellent solution when adding additional access networks for IoT, Augmented Reality, and eventually private 5G (future feature).
- Ideal when leasing space in a building as you can take the network with you when you move.

The Importance of Link Margin in Network Design

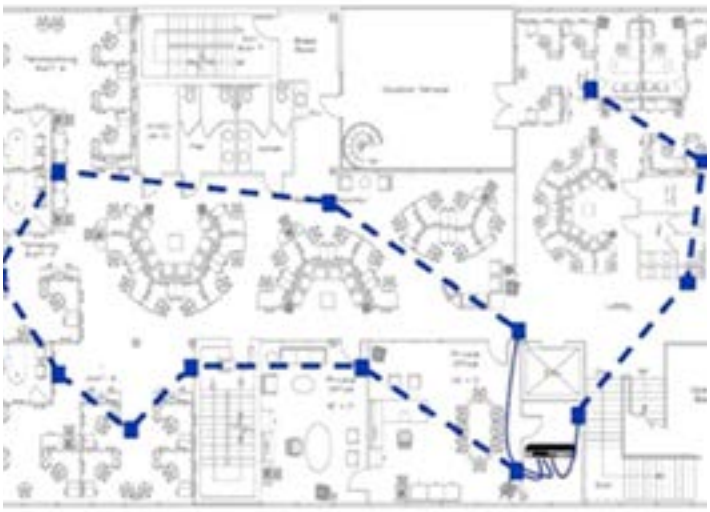
Link margin can be used to determine maximum distance between nodes. The following charts can be used to plan a WaveTunnel installation.

As the name implies, link margin refers to the extra gain in the system above and beyond what is required to support gigabit/sec connectivty in LOS situations.

WaveTunnel Link Margins in Free Space:

- **20 dB at 100 meters**
- **30.5 dB at 30 meters**
- **40 dB at 10 meters**
- **50.5 dB at 3 meters**
- **60.0 dB at 1 meter**

Link margin can also be used to predict performance in the presence of an obstruction. Different materials have different attenuation characteristics. The following chart describes attenuation characteristics @ 60 GHz for different types of building material, with cavity cinder block being the most challenging.

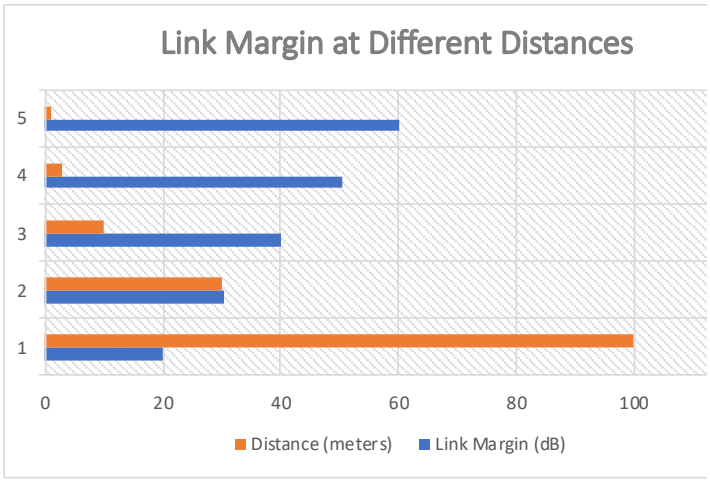


WaveTunnel nodes can operate in either a ring configuration or on a spur with multiple drops.

Attenuation (dB/cm) by material:

- Drywall -- 0.09 (0.36dB @ 4cm)
- Drywall with Semigloss -- 0.60 (2.40dB @ 4cm)
- Drywall with Flat Paint -- 0.09 (0.36dB @ 4cm)
- Ceiling Tile -- 1.12 (2.24dB @ 2cm)
- Wood -- 1.30 (2.60dB @ 2cm)
- Glass -- 4.30 (4.30dB @ 1cm)
- Cavity Cinder Block -- 11.30 (45.20dB @ 4cm)

From this table it can be seen that a 60 GHz signal can penetrate several layers of drywall even with semigloss paint. As long as the attenaution of any obstruction is less than the link margin at the desired distance, all should be good. Our early recommendation is to only try and punch through one wall at a time. Stay tuned for more updates as we head into the field trial phase.

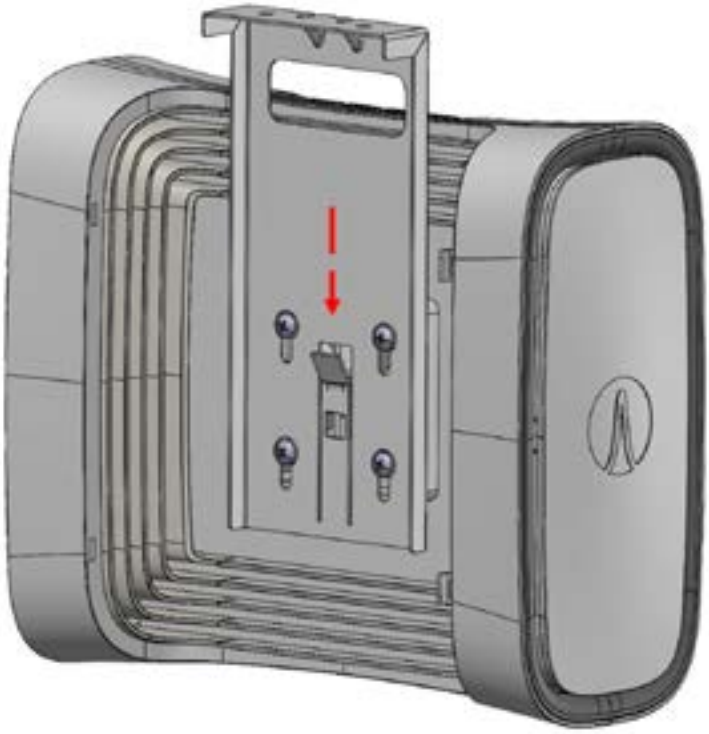


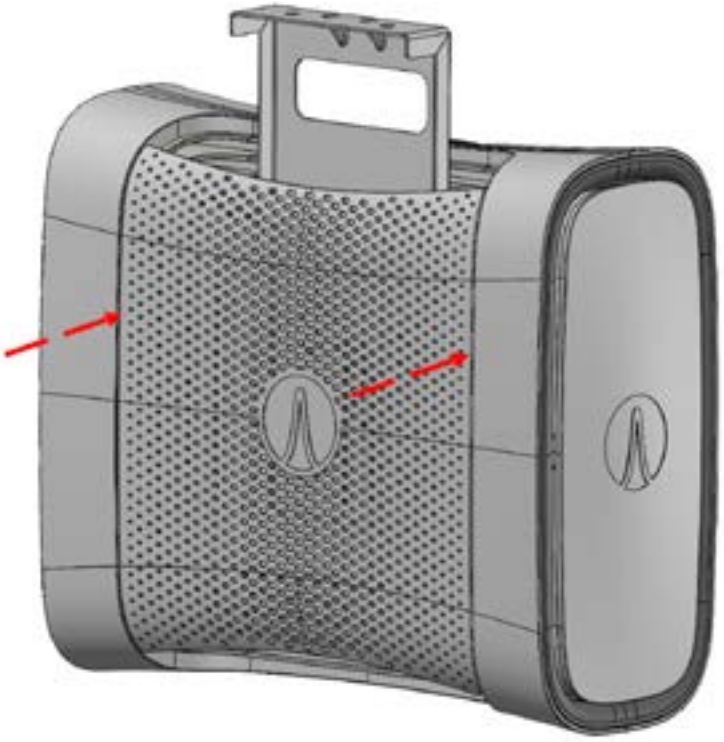
WAVETUNNEL CONFIGURATION APP

The WaveTunnel system can be configured via a mobile APP that can run on either an iOS device (iPhone or iPad) or an Android device. There is a separate configuration guide that steps the user through the process and it can be found in the Product Section of the Airvine web site.. The following charts show the kind of information that can be provided by that APP.

MOUNTING BRACKET DETAILS

For more information on the mounting of the WaveTunnel unit please see the Installation Guide, which can be found in the Product Section of the Airvine web site.





WAVETUNNEL SPECIFICATIONS

Physical and Performance	
Dimensions	11.37 cm x 23.73 cm x 27.25 cm
Weight	5.3 lbs
Network Interface	(4) 100/1000 Ethernet ports
Power options	AC or POE-in
Power supply	External power brick is required in the Pilot phase
Maximum power consumption	30 watts when not providing POE-out
Number of radios per node	2
Maximum data rate per radio	3.15 Gbps
Maximum data rate per node	6.3 Gbps
Latency	50 usec per node
IEEE standards	802.11ad
Mounting	Ceiling mounted or wall mounted
Frequency range	57- 71 GHz (US FCC)
Channel width	2.16 GHz
Certification	FCC, CE, and UL

Environmental	
Operating temperature	0 - 40 degrees C
Operating humidity	5 to 95% noncondensing
Altitude	15,000 feet

Antenna Board	
Design	Internal beamforming array with 256 elements
Transmit antenna gain	28 dBi
Receive antenna gain	28 dBi
Side lobe suppression	>20 dB
Average transmit power	+8 dBm
Maximum transmit power	+11 dBm
Beam steering	±45 degrees along the azimuth
Modulation type	16 QAM, QPSK, BPSK
Maximum EIRP (US FCC)	+39 dBm
Average EIRP (US FCC)	+36 dBm

I/O Ports	
Port 1	100/1000 Ethernet Port; RJ45; POE-in
Port 2	100/1000 Ethernet Port; RJ45; POE-out
Port 3	100/1000 Ethernet Port; RJ45
Port 4	100/1000 Ethernet Port; RJ45

LED Indicators

WaveTunnel 2	Indicates that link 2 is operating
Ethernet	Indicates Ethernet activity
Status	Indicates the WaveTunnel node is operating properly
WaveTunnel 1	Indicates that link 1 is operating
Power	Indicates the Wavetunnel node is powered up properly

Ordering Information

Will be made available before the WaveTunnel enters GA

Regulatory Compliance

Will be made available before the WaveTunnel enters GA

Screw the mounting bracket into the ceiling, snap the WaveTunnel unit onto the bracket, plug into AC power, configure with the smartphone APP, and you are done!

ABOUT AIRVINE

Airvine is a fast-growing Silicon Valley innovator of intelligent broadband wireless backhaul solutions for the enterprise. The company has developed the industry's first in-building 60 GHz wireless system that exceeds the speed and rivals the reliability of existing structured wiring solutions at a fraction of the deployment time and cost. Patented RF innovations extend the range and gain of wireless signals, penetrating walls and steering around obstacles that impede transmission. Something never before possible within the 60 GHz band.