Building Better Backbones

October 2020

Over the past three years, Airvine has been developing an indoor fixed wireless solution that will fundamentally change the enterprise backbone industry. The legacy approach of pulling fiber or copper (Cat6/7) to backhaul Wi-Fi Access Points and other apps, will soon give way to wireless. The Airvine solution can match the throughput and reliability of these solutions without costly and cumbersome cabling. Networks can be deployed in a matter of hours and then reconfigured just as quickly when business imperatives change. Airvine will usher in the era of the all-wireless enterprise.

Airvine's technology operates in the unlicensed V-band up around 60 GHz (57-71 GHz in the U.S.) and utilizes an IEEE 802.11ad chipset. It can backhaul enormous amounts of data without the need for cabling of any kind. The V-band is an excellent choice for this application as it has been divided into six 2.16 GHz channels, each of which can deliver 4.6 Gbps at the physical layer using a 16 QAM modulation.

THE AIRVINE TARGET MARKET

The Airvine solution has been designed for indoor enterprise applications and is ideally suited to a variety of different deployment scenarios, including:

a) Situations where the network needs to support moves, adds, and changes on a regular basis. Wired networks are very difficult to reconfigure, whereas the Airvine solution lends itself to rapid change.

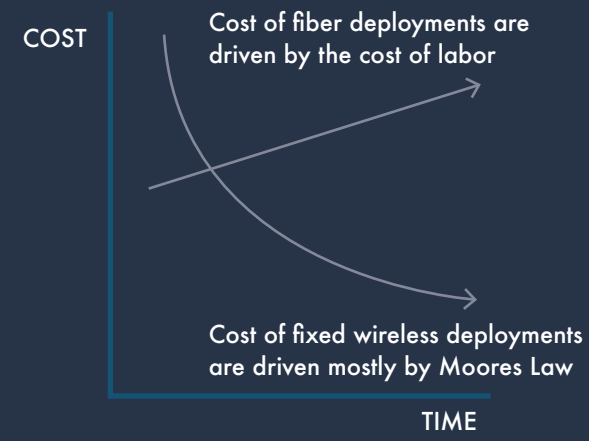
b) It is well suited to locations where the pulling of fiber or copper is problematic. This is usually the case with older structures that made extensive use of brick, stone, concrete, or cinder blocks. Buildings with "hard" ceilings also make the pulling of cable very difficult.

c) Locations that require an overlay to an existing Cat5 network to support a high-speed Wi-Fi 6 network. In this case, the goal isn't to replace an old Cat5 network, but leave it in place and overlay it with something much faster.

d) Businesses that require the network to be installed in a few hours instead of days or weeks. It's not always possible to access a site for the long periods of time required to pull new cabling. Examples here include organizations that run 24 x 7 such as hospitals.

e) It can be used to transmit data between buildings or for connecting temporary installations back to the primary location (COVID tents in hospital parking garages).

The Airvine solution can also be much less expensive than pulling wire. The dominant factor in a wired deployment is the cost of labor, which can vary greatly depending on geography. Other factors include the type of ceiling (hard versus drop (aka acustic)), new construction versus an upgrade, the type of wall material, building codes, the need for industrial grade plenum cable, and the list goes on.



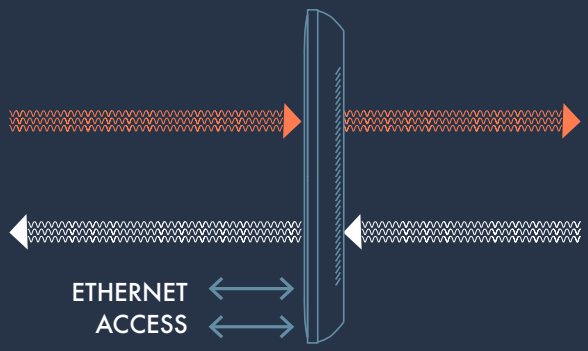
Whereas, the cost to deploy wireless technology is dominated by Moore's Law, which states that any function that can be performed by an ASIC will become more powerful and less expensive with every passing year.

In summary, the Airvine sweet spots are when the enterprise

needs a lot more capacity quickly, or when the network is liable to change on a fairly regular basis, or both.

THE AIRVINE ARCHITECTURE

The Airvine architecture consists of a network of WaveTunnel™ nodes that can deliver multi-gigabit speeds in line of sight (LOS) or non-line of sight (NLOS) scenarios. In an NLOS situation, the WaveTunnel nodes can relay a signal around an obstruction or punch right through it. The relay function is accomplished by equipping each node with a radio that is pointed in the upstream direction and a second radio that is focused in the downstream direction.



The upstream and downstream radios each use one of the six V-band channels. Throughput at the physical layer is 4.6 Gbps, which translates into a payload of 3.15 Gbps. Since both WaveTunnel radios can operate at the same time, they provide a total throughput of 6.3 Gbps per node. In addition to acting as a relay node for upstream and downstream neighbors, a WaveTunnel node can also pick-up and drop-off traffic via its Gig Ethernet ports, which are also PoE (power–over-Ethernet) enabled.

This approach allows the Airvine solution to backhaul locations that are up to 100 meters away from the wiring closet with or without intervening obstructions and at multi-gigabit speeds.

The V-band is the perfect choice for indoor enterprise backhaul applications for the following reasons:

1) It utilizes unlicensed spectrum
2) Provides interference protection
3) No rain fade and no foliage
4) Lots of spectrum (14 GHz)
5) Really wide channels (2.16 GHz)
6) Silicon is readily available
7) Has the right propagation characteristics
8) Future enhancements at the ASIC level will push throughput up towards 40 Gbps

The existence of an IEEE standard for the V-band has enabled the merchant silicon industry to enter the market in a big way. The primary focus of these vendors is in using the V-band to provide access. This drives chipsets into handsets and laptops, and while that might be where the volume is, the real sweet spot for the V-band will be as a backhaul technology. This does require a few modest changes to the protocol.

ATTENUATION

Attenuation is always a mitigating factor with any wireless technology, and the amount of path loss is heavily dependent on the building materials that are used. V-band radio signals can pass through sheetrock (aka drywall), whereas brick, stone, concrete, and cinder block are much more difficult to penetrate. The Airvine solution, when dealing with high attenuation building materials, is to place additional radios in the path to provide a relay function. A brick wall might require a WaveTunnel radio on each side to drive the signal through the obstruction. In this case, the two nodes may only be a foot or two apart.

In most office buildings, sheetrock is the primary building material that lies in the line of sight. Airvine radios can drive a signal through several sheetrock walls with only a modest impact on path loss.

In addition to building materials; equipment, furniture, plants, and people can also attenuate RF signals. The best way to avoid this kind of path loss is to mount the radios against the ceiling. This has the added advantage of getting them close to the AC power sources that supply the always ubiquitous fluorescent lights found in most office buildings.

THE AIRVINE ADVANTAGE

The Airvine advantage comes from a combination of hardware innovation, proprietary software, and the use of the unlicensed V-band. This combination allows the system to function automatically, reliably, and at scale.

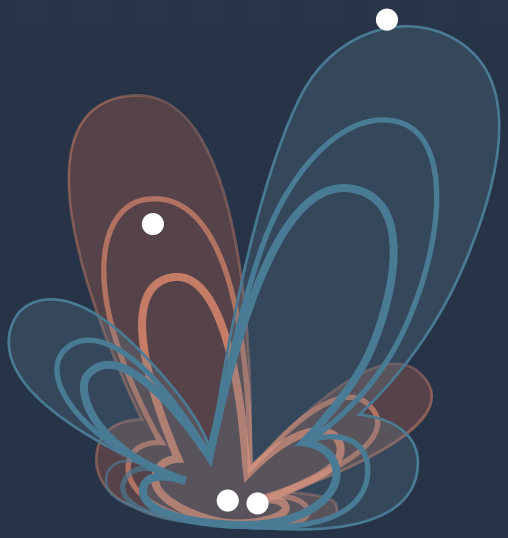
1) **Electronic beamforming** – enables the system to deliver a very narrow beam to the far end, which maximizes the energy delivered while at the same time minimizing co-channel interference. The more energy that gets delivered to the receiver, the greater the throughput. The Airvine radio excels in this regard with an antenna gain of 30 dBi.

2) **Automatic beam steering** – allows the unit to be quickly and easily installed by techs without any RF skills. Only the most general pointing of the unit is required, after that, it's all automatic. The beam can steer itself ±60 degrees along the azimuth. This helps the system

to turn corners when a node is operating in a ring.

3) **Ability to operate in near field or far field** – which means that when communicating with a radio that is several tens of meters away, the system uses beamforming to focus a very narrow pencil-wide beam of RF energy at the far end. If, however, the radio is on the other side of a wall (2 feet away), it uses a much more disperse pattern to get more energy to the receiver.

4) **Automatic Recovery from a Network Outage** – is supported if the network is configured as a ring. The nodes on either side of the break will turn the ring back on itself. This kind of survivability is not available with most cable cuts.



5) **Extended range in NLOS scenarios** – is made possible by relaying the RF signal through intermediate nodes, each of which is equipped with high-gain, narrow-beam antennas.

6) **The ability to add and drop traffic at intermediate nodes** – is an incredibly useful feature as it allows the intermediate nodes to operate as both a relay of network capacity for upstream locations and as an end node in support of a locally attached Wi-Fi 6 access point.

ROLLING OUT A NETWORK

The standard approach in enterprise networking is to backhaul traffic to a centralized wiring closet on each floor of a building. In legacy deployments, this is usually accomplished with Cat5 copper cabling, and in newer buildings it can be supported with Cat6 or even Cat7. The Airvine solution eliminates the need to pull wire by deploying WaveTunnel nodes in selected locations. In some cases, the endpoints (usually Wi-Fi Access Points) can be located on a spur heading out from the wiring closet, and in other cases, a ring can be formed by the careful positioning of WaveTunnel nodes. This technique increases network robustness by providing each Wi-Fi AP with two paths back to the wiring closet.

THE ADVANTAGES OF THE V-BAND

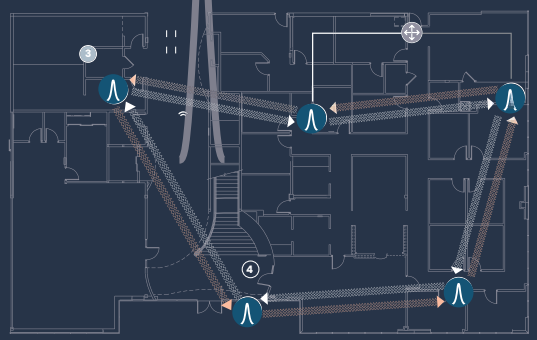
The V-band is located up around 60 GHz and is especially well suited to the construction of indoor enterprise backbone networks for the following reasons:

1. It is the only unlicensed band that has the spectrum needed to match fiber in performance
2. Each V-band channel (2.16 GHz) has more capacity than all the spectrum under 6 GHz that has been allocated for telecommunications services of all types combined.
3. This band does not require a license, which saves the enterprise the time and trouble (not to mention expense) of acquiring spectrum from the FCC.
4. At 60 GHz the antennas are the size of a thumbtack which allows large antenna arrays to fit into a very small enclosure. These large arrays are what makes possible very narrow, pencil-thin beams (aka beamforming).
5. Since V-band signals don't propogate very far, it is possible to get very high spectral reuse. In a 60,000 square foot office building, the same V-band channel can be used dozens of times without any meaningful co-channel interference.
6. Since the V-band doesn't propogate very far, there is no danger of interference from a source outside the building or even on a different floor. This is not the case with, for example, Wi-Fi signals in the 2.4 and 5.8 GHz bands.
7. Rain and foliage are both problems for the V-band and neither is a factor indoors.
8. Transmit power is less than 10 milliwatts making it extremely low power. Much lower than Wi-Fi or 4G/5G cellular signals.

The Airvine architecture can be used to build an overlay network for a new deployment of Wi-Fi 6 access points while

leaving the existing Cat5 network alone. It can also be used to upgrade the entire network. The great strength of the Airvine solution is in its ability to enable rapid moves, adds, and changes to better support business agility.

The Airvine architecture represents the next stage in the evolution of the enterprise indoor backbone network.



SUMMARY

AIRVINE	COPPER OR FIBER DEPLOYMENT
Deploys in a few hours	Deploys in days or weeks
Quick, easy, and inexpensive moves, adds, and changes	Change is much harder as techs need to pull wire through ceilings and walls
Multi-gigabits/sec transfer rates	Cat5 delivers a 100 megabit/sec transfer rate
Can automatically reroute traffic in case of an outage	Will be down until the cable can be repaired
Future products will support speeds in the tens of gigabits/sec range	If you need greater throughput then new cabling will be required
Deployment cost is driven by Moore's Law	Deployment cost is driven by the cost of labor
Deploys pretty much the same regardless of building type	The type of building plays a big role in the viability of an upgrade project involving cable
Easy to deploy in a new building or a retrofit	Much easier to pull wire in new construction

ABOUT AIRVINE

Airvine is a fast-growing Silicon Valley innovator of advanced high-capacity wireless solutions. The company has developed the industry's first indoor 60 GHz wireless system that exceeds the speed and rivals the reliability of existing cabling 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.