# Moving Beyond Legacy Backbone Architectures

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AIRVINE

Over the last 20 years, Wi-Fi has emerged as the dominant indoor data access technology. It is supported on devices of all types from laptops to smartphones and cameras to copy machines. The primary method of backhauling Wi-Fi Access Points is copper cabling. Back before the turn of the century it was Cat5, and since then the industry has moved on with Cat5e, Cat6, and even Cat7 cabling.

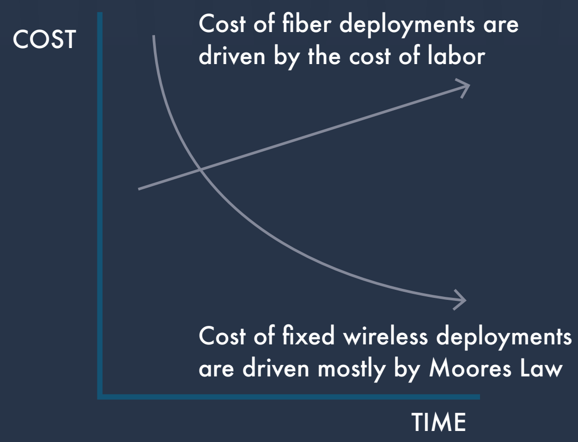
The use of copper cabling made sense as it could deliver the required throughput and was readily availble. Cat5 was good for a hundred megabits/sec at a range of up to 100 meters, which was more than enough for legacy applications. However, it is the nature of data networking that everything must go faster, have lower latency, and even greater range with each new generation of technology.

The wireless industry is now in the process of launching Wi-Fi 6 (aka IEEE 802.11ax) which will deliver broadband speeds to the desktop. This technology cannot be backhauled by older Cat5 cabling, which still makes up most of the installed base in commercial buildings worldwide.

The options for the industry are to push forward with new generations of copper cabling (Cat6 or 7), or deploy fiber, or make the jump to wireless backhaul. There are significant issues with pulling more copper, and they are as follows:

| Cable Standard | Maximum Bandwidth | Maximum Distance | Maximum Data Rate |
|---|---|---|---|
| Cat5 | 100 MHz | 100 Meters | 100 Mbps |
| Cat5e | 100 MHz | 100 Meters | 1 Gbps |
| Cat6 | 250 MHz | 100 Meters<br>55 Meters | 1 Gbps<br>10 Gbps |
| Cat6a | 500 MHz | 100 Meters | 10 Gbps |
| Cat7 | 600 MHz | 100 Meters | 10 Gbps |

1) It is a labor-intensive process that gets more expensive with every passing year. Contractors must be hired to pull the wire, and that cost will vary greatly depending on geography. Other factors that will contribute to the cost are the type of building, the kind of business (hospitals operate 24 by 7), hard ceilings versus drop ceilings, type of building materials, new construction versus retrofit, plenum ratings on cable, building codes, and the list goes on. This is in contrast to wireless technology where the cost to deploy is dominated by Moore's Law which states that any function that can be designed into an ASIC will get less expensive and much faster with every passing year.




2) The pulling of cable is a solution that does not lend itself to moves, adds, and changes. Technicians must go on-site and start re-running wire through ceilings and walls. It's an expensive, disruptive, and time consuming process that is ill suited to today's need for business agility. The network must adapt quickly to the needs of the business and not the other way around.

3) It can take a great deal of time to pull wire inside a building. In some cases, accessing the building is not difficult and can be done at night or on weekends, both of which increase the cost. In other cases, the business operates 24 by 7 (hospitals for instance), and it is a big problem to have technicians crawling around for days or weeks on end.

4) Older buildings increase the difficulty in pulling wire, which can increase the cost. This was borne out by the difficulty in pulling the Cat5 cable that now backhauls Wi-Fi Access Points. Most enterprises are loathed to go through that misery yet again just to get another equally inflexible solution.

So, if pulling wire isn't always the answer for next-generation backbone networks, what's the alternative?

Wireless technologies have been making great strides of late, and the push into the millimeter-wave bands, and specifically the V-band, is providing the answer.

## THE V-BAND

The V-band is located up around 60 GHz (57 to 71 GHz in the U.S.) and is 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 (14 GHz) required 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) The spectrum 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 propagate 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 noticeable co-channel interference.

6) Since the V-band doesn't propagate very far, there is no danger of interference from a source outside your building or even on a different floor. This is not the case with, for example, Wi-Fi signals in the 2.4 or 5.8 GHz bands.

7) Rain and foliage are both problems for the V-band, but neither is a factor indoors.

8) Transmit power is less than ten milliwatts making it very low power. Much lower than Wi-Fi or 4G/5G cellphones.

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 on 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, but this does require a few modest changes to the protocol.

Why is the V-band better suited to backhaul than to access?

The answer here revolves around its ability to operate in a non-line of sight (NLOS) environment. Signals in the millimeter-wave bands have a hard time passing through obstructions such as conference rooms, furniture, people, elevators, equipment, and bathrooms. In a fixed wireless deployment, clever engineering and sensible network design can overcome these limitations. Something that is not easily done with a user walking around an office building with a millimeter-wave enabled smartphone.

Sensible deployment usually involves mounting radios close to the ceiling where obsructions can be minimzed. Clever engineering can be used to relay a signal around an obstruction or punch right through it. Much depends on equipment design and the amount of attenuation inherent in different building materials. V-band signals can pass through sheetrock (aka drywall) without much trouble, whereas brick, stone, concrete, and cinder block are more difficult to penetrate.

## ROLLING OUT A WIRELESS BACKBONE

The standard approach in enterprise networking is to backhaul traffic to a wiring closet on each floor of a building. In older buildings, this is usually done with Cat5 copper cabling, and in newer buildings it can be done with Cat6 or even Cat7.

A wireless solution eliminates the need to pull wire by deploying radios 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. In other cases, a ring can be formed by connecting several Wi-Fi Access Points together and relaying the signal around in a circle and back to the wiring closet. This technique increases network robustness by repeating the signal at various points in the network, while also lowering the cost and protecting against failures by providing two paths back to the wiring closet.

This approach 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, or it can be used to upgrade the entire network.

By far, the most compelling value proposition for wireless backbones is that they enable rapid moves, adds, and changes to better support business agility. This is not easily done with a wired solution.

Zone cabling can make things a bit easier, but it will still be necessary to have technicians on-site to pull cables through ceilings and walls. In a modern building with drop ceilings this is quite a bit easier to do than in an older building with hard ceilings. In either case, it is a disruptive, expensive, and time-consuming process.

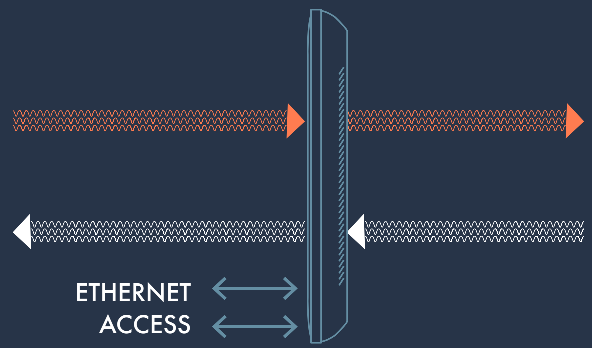
With a wireless solution, a Wi-Fi 6 Access Point can be quickly and easily moved from one location to another. All that is required is AC power for the millimwter-wave radio doing the backhaul. Fortunately, this is almost always available in ceilings to power the florescent lights that blanket office buildings worldwide. The wireless moves, adds, and changes process should take about 20 minutes in most situations. Modern technology can automatically reacquire the signal from the nearest neighbor radio without any special pointing of the equipment. Network changes become quick, inexpensive, and non-disruptive when using millimeter-wave technology.

## Airvine WIRELESS BACKHAUL SOLUTION

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 copper cabling (Cat6/7) to backhaul Wi-Fi Access Points and other apps, will soon give way to wireless for all the reasons discussed earlier. The Airvine solution can match the throughput and reliability of a wired deployment without costly and cumbersome cabling. Networks can be deployed in a matter of hours and then reconfigured just as quickly when business imperatives change. This promises to usher in the era of the totally wireless enterprise.

The Airvine solution operates in the unlicensed V-band and utilizes an IEEE 802.11ad chipset. The system consists of a network of WaveTunnel™ nodes that can deliver multi-gigabit speeds in line of sight (LOS) or non-line of sight (NLOS) applicatioons. In an NLOS situation, the WaveTunnel nodes can relay a signal around or punch right through an obstruction. The relay function is enabled by equipping each node with a radio pointed in the the upstream direction and a second one pointed downstream.

The two 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 per radio. Since a WaveTunnel node can use both radios at the same time, it provides a total throughput of 6.3 Gbps. 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) capable.




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

## KEY CAPABILITIES

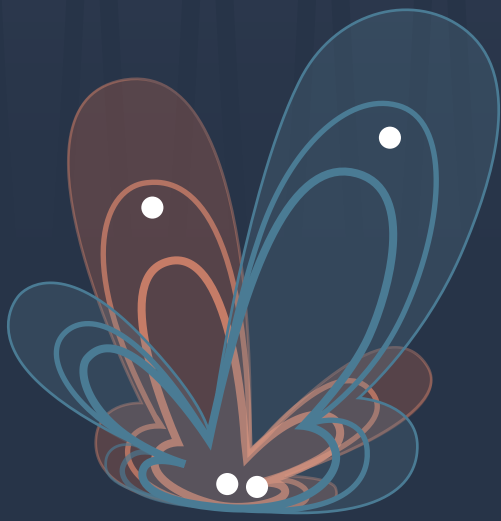
1) **Electronic beamforming** – enables the system to deliver a very narrow beam to the far end, which maximizes the energy delivered while at the same time minimizing co-channel interference.

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 plus or minus 60 degrees along the azimuth.

3) **Ability to operate in near field or far field** – which means that when talking to 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 enabled if the network is configured as a ring. The nodes on either side of the break will turn the ring back on itself.



5) **Extended range in NLOS scenarios** – is made possible because the system can relay RF signals 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 Access Point.

The Airvine architecture represents the next stage in the evolution of the enterprise backbone network. The era of the all-wireless enterprise has arrived.

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.