

Intelligent In-building Wireless Backhaul for the Enterprise -- Q1



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 with copper cabling, which made sense as it could deliver the required throughput and was readily available. CAT5 copper cabling 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.

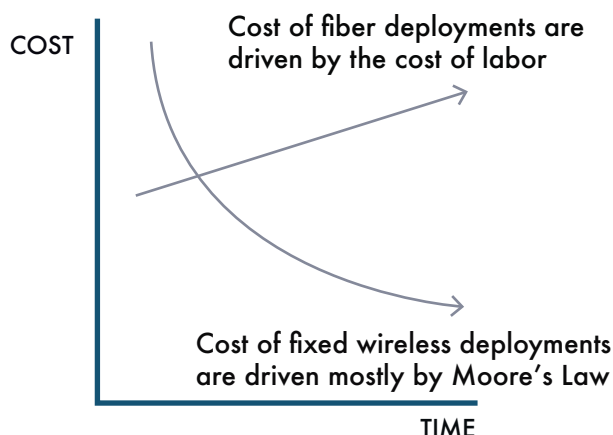
The wireless industry is now in the process of launching Wi-Fi 6 and 6E (IEEE 802.11ax) which will deliver broadband speeds to the desktop. This technology cannot be backhauled by older CAT5 cabling, and this has forced many enterprises to look at upgrading to CAT6 or CAT7 copper cabling.

Cable Standard	Maximum Bandwidth	Maximum Distance	Maximum Data Rate
CAT5	100MHz	100 Meters	100 Mbps
CAT5e	100 MHz	100 Meters	1000 Mbps
CAT6	250 MHz	100 Meters 55 Meters	1000 Mbps 10 Gbps
CAT6a	500 MHz	100 Me- ters	10 Gbps

Structured wiring solutions based on CAT6 copper cabling is one option, but more forward looking enterprises are starting to look at wireless backhaul. This technology can easily overcome the many drawbacks that come with pulling wire:

1) Structured wiring 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 enterprise (hospitals operate 24 by 7), hard ceilings versus drop ceilings, building materials, new construction versus retrofit, plenum ratings on cable, building codes, and the list goes on. This is in contrast to wireless backhaul 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 faster and less expensive 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 backhaul, what's the alternative?

THE V-BAND

The V-band stretches from 57 to 71 GHz in the U.S. and is well suited to the construction of in-building enterprise backbone networks for the following reasons:

- 1) It is the only unlicensed band that has the spectrum (14 GHz in the U.S.) required to match fiber in performance.
- 2) Each V-band channel is 2.16 GHz wide and 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 or applicable regulatory body.
- 4) At 60 GHz, each antenna element is smaller than a thumbtack, which allows large antenna arrays to fit into a very small space (20 cm²). These large arrays create 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.

WIRELESS IN-BUILDING BACKHAUL

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 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 people, elevators, equipment, and bathrooms. In a fixed wireless deployment, proper 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 obstructions can be minimized. Clever engineering can be used to relay a signal around an obstruction or punch right through it using a high-gain beamforming antenna. 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 WIRELESS BACKHAUL

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 millimeter-wave 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 replace legacy copper cabling.

The most compelling value proposition for wireless backhaul is that it enables rapid moves, adds, and changes to better support business imperatives. This is not easily done with a structured wiring 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 millimeter-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. Millimeter-wave radios can automatically reacquire the signal from the nearest



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/sec speeds in line of sight (LOS) or non-line of sight (NLOS) applications. 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.



neighbor radio without any special pointing of the equipment. Network changes become quick, inexpensive, and non-disruptive.

AIRVINE WIRELESS BACKHAUL SOLUTION

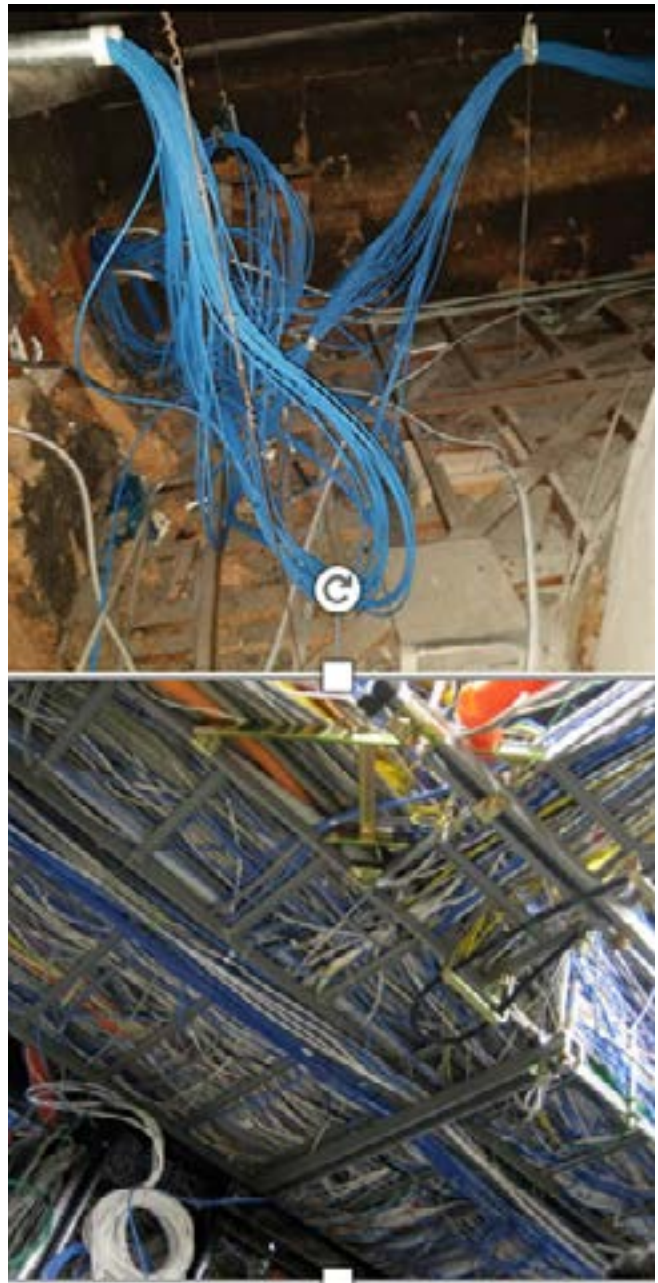
Over the past four years, Airvine has been developing an in-building fixed wireless solution that will fundamentally change the enterprise in-building networking. The legacy approach of pulling copper cabling to backhaul Wi-Fi Access Points and other apps, will soon give way to a wireless solution for all the reasons discussed earlier. The Airvine solution can match the throughput and reliability of a wired deployment without costly and cumbersome



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/sec 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 required, after that it's all automatic. The beam can steer itself ± 45 degrees along the azimuth.
- 3) Extremely high side lobe suppression concentrates most of the RF energy into the main beam and very little finds its way into the side lobes. The unit can provide greater than 20 dB of suppression, which means any side lobes that might exist are 100X weaker than the main beam.
- 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, beamforming 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 era of costly and cumbersome cabling is over!

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.