Frequently Asked Questions
Q1 2022

AIRVINE

1. **Who started the company and what was the initial vision?** Hatch Graham's initial vision was to create a self organizing wireless backbone in the V-band (57 to 71 GHz) for in-building bandwidth expansion. The system would be able to penetrate walls and have a range of up to 100 meters.

2. **What problem is Airvine solving?** Bandwidth needs are increasing rapidly, and legacy backbones (CAT5/5E) cannot keep up. This problem affects commercial buildings in all market segments. There are over 5 million such buildings in the U.S. alone, and over 90% of them have old wiring that must be upgraded.

3. **What is the size of the addressable market?** Airvine technology represents a major improvement on structure wiring for in-building enterprise backhaul. This is a $6 billion a year industry just for the infrastructure (mostly cable) and that represents about 10-15% of the cost of an install, the rest is labor. Structured wiring is a very labor-intensive process, whick makes this is a very large market.

4. **What innovations has Airvine made?** The Airvine has developed a very high-gain (approaching 30 dBi) beamforming antenna along with very sophisticated software to enable the system to deliver gigabit/sec data transfer rates regardless of building construction.

5. **Is this solution based on patented technology?** Yes, three broad patents were awarded that cover all aspects of network design, and a fourth patent is pending.

6. **Why hasn't in-building wireless backhaul been attempted before?** Penetrating walls at 60 GHz and traversing longer distances are hard problems to solve. The technologies to make this happen at low cost have finally become available. Our team has led the way in areas like antenna gain, interference rejection, LNA noise figure, along with filter and modem technologies.

7. **What are the ideal use cases for Airvine's solution?**

    - Any situation where there will be regular moves, adds, and changes that must be accomplished in a timely fashion.
    - Areas where it is difficult or cost-prohibitive to pull fiber or copper cable
    - When upgrades are required in a building that is being leased and you don't expected to be there for another 10 years.
    - When a Wi-Fi 6/6E retrofit is required, but the enterprise operates 24 x 7 and can't tolerate the disruptions required to pull cable
    - Environments where longer distances must be traversed with obstructions of various types.
    - When additional access networks are required to support IOT, Augmegnted Reality, or private 5G (future release) .

PRODUCTS / TECHNOLOGY

8. **What are the products being offered and developed by Airvine?** The initial Airvine product set includes high-capacity WaveTunnel™ nodes along with network management software that can be deployed on premise or in the cloud.

9. **How does the Airvine system work?** In a typical configuration, the Airvine system will operate as a dual counter-rotating wireless ring that allows Wi-Fi APs to access the backhaul network at selected points along the ring. Private 5G small cells could also be supported with a future release of the product.

10. **What are the differences between the Airvine system and structured wiring?** The Airvine system can match the performance of structured wiring without costly and cumbersome cabling. It can also be quickly installed and just as quickly reconfigured, which is not easily done with fiber or copper cabling.

11. **Is the Airvine system based on proprietary or industry standard technology?** The first-generation product uses Industry-standard 802.11ad silicon, industry standard digital baseband silicon, and a custom high-performance beamforming antenna array. This array can pack 256 elements into 20 cm^2 of circuit board space and deliver close to 30 dBi of antenna gain.

12. **What is meant by dBi?** dBi measures antenna gain in a specific direction relative to an isotropic antenna which is a hypothetical antenna that radiates equally in all directions. A gain of 30 dBi means that a beamformed signal will be 1000 times stronger (as seen by the receiver) than a signal that has not been beamformed.

13. **How is traffic encapsulated between nodes?** Between WaveTunnel nodes, standard 802.11 packets are used, the same as any 2.4 or 5 GHz Wi-Fi Access Point except it operates at 60 GHz.

14. **How does Airvine uniquely address in-building backhaul requirements in ways that other 60 GHz equipment vendors can't?** By applying a revolutionary RF antenna design coupled with technical advances such as beamforming, beam steering, 16 QAM modulation, forward error correction (FEC) and much more. To our knowledge Airvine is the only supplier of in-building wireless ring technology.

15. **How does Airvine's system work with existing enterprise WLANs?** The Airvine system accepts an Ethernet connection from a Wi-Fi Access Point or an external Ethernet switch.

16. **Can the Airvine system be used to support IOT deployments?** Yes, the "Internet of Things" is sweeping through enterprises worldwide. It involves the connecting of "things" to the Internet using a variety of radio access technologies including Wi-Fi, cellular, Bluetooth, etc. Wi-Fi is by far the most common technology used to support IOT and these deployments usually involve a separate access network that keeps OT traffic away from the enterprise IT traffic.

17. **How does the Airvine system compare to backhaul using Wi-Fi Mesh technology?** When using Wi-Fi mesh technology, the AP must provide both access and backhaul services. This has the effect of cutting the capacity of the AP in half and it's not good for more than one or two hops. It's also not a good use of valuable mid-band spectrum.

18. **Are Airvine products designed to replace traditional structured wiring solutions or simply augment them?** The product has been designed to augment legacy structured wiring solutions. Eventually, network upgrades can be completely wireless.

19. **Is this a line of sight (LOS) only product or can it also support non-line of sight (NLOS) connectivity?** It can do both. The system can deal with obstructions in one of two ways: it can either route around them using intermediate WaveTunnel nodes to relay traffic or it can punch right through them with its high-gain beamforming antenna.

20. **What is the throughput and range of the Airvine product?** Aggregate throughput for the first-generation product will be 6.3 Gbps. The link speed is 3.15 Gbps for each of the two radios in a dual ring configuration. In LOS applications, the range is up to 100 meters. In NLOS applications, the range can still reach 100 meters depending on the nature of the obstruction.

DEPLOYMENT / OPERATIONS

21. **How is the Airvine system deployed? What is required?** An Airvine ring or spine is installed by an on-site technician using an iPhone or Android APP that sets up the beam and steers it from one WaveTunnel node to the next. The network is then configured and brought up instantly.

22. **Are there any deployment prerequisites?** None.

23. **Can Airvine be deployed faster than pulling fiber or copper? If so, by how much?** An Airvine network of WaveTunnel nodes can be installed in hours rather than the days or weeks required for copper or fiber.

24. **Are there different types of nodes that must be purchased?** No, there is only one type of WaveTunnel node.

25. **When will the WaveTunnel product become generally available (GA) and when will it begin field trials?** Field trials have already begun, with generally availability in Q2 of 2022.

26. **How many Wi-Fi Access Points can be directly attached to a Airvine node?** Each WaveTunnel node has four 1-Gbps Ethernet ports allowing it to support up to four locally attached Wi-Fi APs. The Pilot version of the system will support POE-out on just one of the 4 GigE interfaces.

27. **If an Airvine node fails, what happens?** When configured in a ring, the neighbor nodes will sense the failure and turn the ring around on itself, and the rest of the network stays up.

28. **What changes are required to an existing in-building network to support the Airvine solution?** The Airvine network only requires access to a power source, and the options include AC or PoE (power-over-Ethernet).

29. **What type of site survey, if any, is required beyond those for traditional Wi-Fi access/ coverage?** The 60 GHz links will not interfere with the Wi-Fi 2.4, 5, or 6 GHz links. A simple traffic estimate needs to be made for each Wi-Fi AP to see if it exceeds the CIR (committed information rate) allocated to it.

30. **How much power is required to support a given Airvine node?** A WaveTunnel node requires no more than 30 watts for its internal needs. If it is configured to supply power to a collocated Wi-Fi Access Point using PoE, then additional AC power would be required.

31. **Can the system support the backhaul of private 5G small cells?** Private 5G requires that a very accurate clock be passed to the small cell. This is done using the IEEE 1588 protocol. This feature is under evaluation and will be added if this technology continues to gain traction.

32. **How many V-band (60 GHz) channels are used?** Each Airvine node uses one or two of the six

available V-band channels. The very narrow beam created by the WaveTunnel antenna along with the high side lobe suppression and limited propagation characteristics of the V-band enables very high spectral reuse.

33. **Why was the V-band chosen for this application, why not use mid-band spectrum?** Almost all the mid-bands (5 and 6 GHz) are shared with legacy users of various types and care must be taken to not interfer with their traffic. This is NOT the case with the V-band at 60 GHz. This band also consists of 14 GHz (U.S.) of unlicensed spectrum which allows the Airvine system to easily support multi-gigabit/sec data rates. Something that can't be done in the mid-bands.

34. **What does a WaveTunnel node look like?**

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.