

Overview

Quantenna Communications, Inc. is a leading developer of silicon for intelligent wireless networking that delivers guaranteed high-speed wireless bandwidth in any size home, anytime, anywhere. The company's patented technology ensures guaranteed bandwidth in Wi-Fi home networks, wireless enterprise networking systems and consumer electronics devices. The Quantenna family of standards-compliant 802.11n silicon offers unprecedented performance of up to 1 Gbps for real-time video, Internet protocol television (IPTV) and high-definition television (HDTV) transmissions over wireless networks within homes and the reliability carriers demand to deliver triple-play services.

Today, other wireless chipsets in the market offer spotty performance, limited coverage, poor reliability and unpredictable bandwidth. The Quantenna family of chipsets is the only semiconductor solution that can deliver guaranteed and predictable bandwidth across any size home or office network by combining a 4x4 radio transceiver/antenna, concurrent dual band mode, mesh networking and transmit (Tx) beamforming. With its advanced CMOS Power Amplifier (PA) technology, Quantenna has integrated high-efficiency PAs to enable game-changing size, power, and performance along with the lowest bill of materials (BOM) cost.

Quantenna was founded in 2006 by leading experts in the semiconductor, wireless and networking industries. The company has received more than \$27 million in Series A and B funding from some of Silicon Valley's most esteemed venture capital firms, including Sequoia Capital, Venrock Associates, Sigma Partners and Grazia Equity. Headquartered in Sunnyvale, Calif., Quantenna has offices in India, Europe and the United States.

The Market Opportunity

Quantenna serves multiple segments of the wireless market with advanced silicon solutions that establish a new, significantly higher standard of performance and reliability for home networking, carrier deployment, enterprise networks and consumer electronics. While a vast majority of consumers are eager to upgrade their existing 802.11a/b/g Wi-Fi devices to 802.11n, they would do so only if there is a significant improvement in the reliability. Quantenna's guaranteed Wi-Fi bandwidth solution gives consumers the long-awaited reason to upgrade to 802.11n.

According to industry analysts, the overall growth of the Wi-Fi chipsets market, particularly 802.11n-based solutions, is on the rise, fueled by the demand for video and other high-bandwidth applications. In fact, ABI Research estimates that 440 million Wi-Fi chipsets will be shipped in 2008 – a number that will continue to grow over the next few years. ABI also has indicated in a June 2008 report that 802.11n Wi-Fi consumer access point shipments will grow to around 88 million by 2013.

Previously, consumers and manufacturers only had access to 802.11a/b/g/n chipsets that offer low-speed connectivity and limited performance. These solutions fall far short of the reliability, rate and range necessary for true triple play services and the transmission of real-time video services including IPTV, standard definition and high definition TV over wireless networks. Quantenna's family of advanced wireless silicon solutions delivers guaranteed Wi-Fi bandwidth for these true multimedia services and for distribution within homes. These solutions solve a major hurdle in wireless networking by enabling OEMs to integrate Quantenna's silicon into their equipment to offer high-speed and predictable bandwidth throughout the home.

The Quantenna family of chipset solutions was developed for the following market segments:

- **Home networking:** Home gateways, access points and intelligent access.
- **Enterprise wireless LAN:** High-end routers, mesh plugs, LCD projectors, printers, laptop and desktop computers.
- **Carrier Triple-Play Services:** WLAN access points, intelligent access plugs, DSL home gateways, cable gateways, set-top boxes.
- **Consumer electronics:** Flat panel TVs, personal video recorders, game consoles, video cameras.

Additionally, the company offers the Quantenna Plug, a compact form factor that plugs directly into an electrical outlet and serves as a full access point with routing and mesh networking capabilities. When combined with the other 4x4 radios, Tx beamforming and concurrent dual band, the Quantenna plug enables carriers and end users to take advantage of one or two plug-and-play Quantenna plugs per home for guaranteed Wi-Fi bandwidth and complete wireless coverage.

With Quantenna's highly scalable wireless LAN solutions, carriers seeking to deploy triple-play services no longer have to worry about the size of the home, the type of walls (concrete, wooden, reinforced) or the thickness of those walls, which typically block signals and result in interference. The addition of one or more Quantenna Plugs to the home mitigates dramatically any unpredictability for carriers.

Competitive Landscape

With its breakthrough technology, Quantenna is well positioned to capture a significant share of the market. Today, vendors of wireless systems and equipment face a number of challenges:

- **Unpredictable Link and Throughput Rates:** There is no way to guarantee Wi-Fi bandwidth or performance reliability since existing suppliers offer only 2x2, 2x3 or 3x3 radio configurations, which results in unpredictable bandwidth and availability.
- **Limited Range:** With other implementations, it is not possible to network together equipment together, which limits performance and range. Additionally, current wireless silicon suppliers do not support Tx beamforming for 802.11n, limiting the coverage and range that these wireless chipsets can achieve.
- **Poor Reliability:** Current wireless chips suffer from poor and unpredictable reliability. These legacy chipsets are barely suitable for data applications and are less reliable for higher bandwidth, real-time applications such as video, IPTV and HDTV. Lack of support for mesh networking results in signal degradation and causes unpredictability and uncertainty for carriers that want to roll out triple-play services, since homes vary in size and in the number, type and thickness of walls. Additionally, there are interferences from other wireless users in the neighborhood and from other apartments or homes. If there is a problem, there is no Wi-Fi work-around for carriers other than a truck roll for re-wiring, which is a very costly proposition.
- **Footprint:** Manufacturers have to use multiple chips, printed circuit boards (PCBs) and separate front-end modules to achieve reasonable performance. This requires devices to be larger and, as a result, this drives up the total BOM cost.
- **Power:** Power is a key challenge to wireless device manufacturers as most devices typically run at less than 10 percent efficiency range, resulting in the majority of the power going up in heat. Quantenna, with its advanced CMOS power amplifier (PA) technology, has integrated high-efficiency PAs, along with many components that are normally installed as a separate front-end module, to increase power efficiency.

Quantenna's wireless chipsets are the first to overcome all of these challenges effectively and simultaneously, providing predictable reliability, highest performance, smallest footprint, and the lowest BOM costs.

Quantenna's Products and Technology

Quantenna's family of wireless solutions includes a broad range of products:

- **QHS1000:** A fully integrated chipset solution with up to 1 Gbps performance. The chipset is available as a dual 4x4 or quad 2x2 and operates on both the 2.4 and 5 GHz spectrum concurrently.
- **QHS600:** A fully integrated single chip solution with up to 600 Mbps link speed. The chip is available as single 4x4 or dual 2x2 and operates on the less crowded 5 GHz spectrum for bandwidth-intensive applications such as video.
- **QHS450:** A fully integrated single chip solution with up to 450 Mbps link speed. The chip is available as single 4x4 or dual 2x2 and operates on 2.4 GHz spectrum for data-intensive applications.
- **Quantenna OS:** A full-featured access point operating software that runs on the Quantenna family of products, dramatically reducing development time frames for equipment vendors. Quantenna also enables equipment vendors to port their own software features on to Quantenna chipsets to further reduce BOM cost.
- **QHS Plug:** A fully functional, small form factor access point that plugs directly into an electrical outlet. The Quantenna plug features an integrated mesh network element that acts as a reference system. It comes with a development kit that includes schematics, Gerber files and the BOM, and uses the QHS1000 silicon and the Quantenna OS. This small form factor plug is also ready for mass production by original equipment manufacturers (OEMs) so that they can bring intelligent access plugs rapidly to market.

Product Features and Benefits

Quantenna is pioneering a new paradigm in wireless networking by offering:

- **Highest Data Rate:** With link speeds up to 1 Gbps and data throughput up to 600 Mbps, consumers can enjoy faster downloads and increased productivity.
- **Total Coverage of Any Size Home, Anywhere:** Integration of mesh networking capability with spectrum management in the Quantenna chipsets ensure total coverage of the entire home despite interferences.
- **Unrivaled Reliability and Robustness:** The Quantenna chipsets are the first and only silicon on the market today to employ 4x4 MIMO radio transceivers and Tx beamforming. Together, these technologies deliver 50 percent better performance than other 802.11n
- **Unmatched Integration:** Quantenna offers the first 802.11n chipset with concurrent dual mode and an integrated high-efficiency power amplifier (PA) with 18 dBm output power, LNA, VGA, switches, baluns, and diplexers. Quantenna's products offer the ability to choose the spectrum so the less crowded 5 GHz band can be allocated for real-time video and multimedia, while legacy data applications can use the more crowded 2.4 GHz band.
- **Lowest BOM Cost:** Because vendors can now achieve superior performance with the highly integrated Quantenna chipset – instead of requiring multiple chips and boards to achieve lesser performance – the total BOM cost is significantly reduced.
- **High Level of Security and Quality for Services (QoS):** Quantenna's compliance with the Wi-Fi security standards – such as wired equivalent privacy (WEP), Wi-Fi protected access (WPA) and Radius – provides consumers, carriers and businesses with the highest level of security for their wireless networks. Compliance with Wi-Fi multimedia

(WMM) 802.11e QoS features allows for reliable handling of multimedia transmissions between various third-party Wi-Fi devices.

Solutions

Home Networking

Quantenna's unprecedented chipset and reference design solutions enable users to enjoy guaranteed wireless bandwidth no matter where they are in the home. These solutions enable home gateways, access points and intelligent access plugs to deliver a consistent experience throughout the home without dead spots or poor connections.

Previously, users that wanted better wireless performance would be forced to install multiple access points throughout the home. However, because these devices are not networked or meshed together, users would have to select the device with the best connectivity and hope that the connection would remain consistent – a scenario that will only deliver best-effort performance.

In comparison, home networking solutions that include Quantenna's chipsets will ensure the highest performance by focusing power towards the client/station. With Quantenna, users can be assured of a consistent, high-bandwidth experience without the frustration of dropped connections or dead zones.

Enterprise Wireless LAN

As enterprises continue to focus heavily on wireless networks, it will become increasingly critical to have a wireless LAN that is robust, reliable and delivers consistent high performance. Often, IT is challenged to find solutions that deliver high performance to all areas in the office building. Users in a corporate environment will have the need to pick up the computer and travel to another office or conference room without losing the connection.

Quantenna chipsets can be integrated directly into high-end routers, intelligent access plugs, servers and PCs. The Quantenna chipset provides total coverage with guaranteed high-speed bandwidth. Additionally, the chipset supports all of the security protocols, ensuring that the corporate data remains secure over wireless connections.

Quantenna enables the company's wireless LAN delivers the consistent, reliable performance required to ensure employees productivity.

Carrier Triple-Play Services

Carriers recognize that the battle for the customer is in the home. Unfortunately, carriers have the least amount of visibility and control over the home and the equipment that subscribers are using, which results in an unreliable and unpredictable environment that is not suitable for offering triple-play services. Providers that want to offer bundled HDTV, voice and data services would need to rewire homes to create a more stable environment.

Quantenna's silicon solutions can be incorporated into WLAN access points, intelligent access plugs, DSL home gateways, cable gateways and set-top boxes, providing ease of mobility across the entire LAN. As a result, carriers can confidently accelerate deployment of revenue-generating triple-play services to compete against cable providers and can guarantee wireless performance.

Consumer Electronics

Most of today's wireless consumer electronics products offer unreliable bandwidth for wireless video transmission. By integrating the Quantenna chipset into flat panel TVs, game consoles,

PVRs and video cameras, consumer electronics manufacturers have a solution that offers consumers a more predictable experience and eliminates wiring clusters.

With Quantenna silicon integrated directly into these products, vendors will be able to guarantee wireless performance and a reliable wireless experience.

Management Team

Quantenna is led by a team of experienced executives with a long track record of building successful companies and taking them to IPO.

Behrooz Rezvani, Ph.D., Co-Founder, Chairman and Chief Executive Officer

Dr. Behrooz Rezvani is recognized as a visionary in the field of communications systems, information technology and telecommunications networks. Prior to founding Quantenna, he founded Ikanos Communications, Inc. in 1999 and served as chief technology officer through its successful IPO in 2005 [NASDAQ:IKAN]. His pioneering work at Ikanos resulted in the first 100 Mbps over-copper technology, which was adopted as the worldwide standard by ITU-T, IEEE and ANSI for VDSL. Previously, he established the AFC-Fremont Advanced Design Center, where he managed the development of the award winning xDSL line cards and IFW-NGDLC technology. Dr. Rezvani also held management and engineering positions at Ericsson, Raynet, MicroUnity, Siemens, Rockwell and GE.

Dr. Rezvani is past-president of the DMT Alliance, an industry forum, with more than 50 members, including Alcatel, Intel and TI. He also served as editor of xDSL coexistence, the Spectral Compatibility and Management standards of the American National Standards Institute (ANSI-T1.417), and Ethernet over copper IEEE 802.3ah. Dr. Rezvani received B.S. and M.S. degrees in electronic engineering from NDSU/UND and a Ph.D. from Marquette University. He holds more than 20 patents, with 10 pending, and is a frequent speaker at industry forums.

Andrea Goldsmith, Ph.D., Co-Founder and Chief Technology Officer

Dr. Andrea Goldsmith is co-founder and CTO of Quantenna. She is on leave from her post as a professor of electrical engineering at Stanford University and is a recognized expert in the field of wireless communications and networks, with an emphasis on MIMO systems, adaptive transmission and low-power design. Her prior experience includes both academic and industry positions with the California Institute of Technology, Memorylink Corporation (where she was chief scientist), AT&T Bell Laboratories and Maxim Technologies.

Dr Goldsmith has received numerous honors for her work on wireless and MIMO communications. She is an IEEE Fellow and Distinguished Lecturer, and is on the Board of Governors for both the IEEE Communications and Information Theory Societies. Dr. Goldsmith has been granted 1 patent with 6 patents pending.

Lionel Bonnot, Vice President, Sales

Lionel Bonnot brings more than 20 years of sales and marketing experience in the telecommunications, semiconductor, systems and software industries. Prior to Quantenna, Bonnot worked as vice president of sales at Ikanos Communications, Inc., for six years, where he built the worldwide sales organization. Ikanos became the undisputed leader in VDSL2 central office and residential gateway chipsets and successfully completed its IPO in 2005. Revenues went from \$0 to over \$100 million per year in 2006 and 2007. Prior to Ikanos, Bonnot worked as director of sales for Tioga Technologies Ltd, an ADSL semiconductor

company that was acquired by STMicroelectronics N.V. He also worked in various sales, marketing and engineering positions at Radisys and Sagem.

Bonnot holds a M.S. degree in Computer Sciences from the Ecole Supérieure d'Informatique (ESI) in Paris.

Marc Mertsching, Vice President, Engineering

Marc Mertsching is a hands-on engineering executive with over 25 years experience developing chips, software, reference designs and complete systems for the telecommunications market. The hallmark of his career is the consistent achievement of first-pass success on the silicon chips that he and his teams have developed. During his career Mertsching has held a variety of technical leadership positions, at the vice president and director levels, at Amicus Wireless, RF Micro Devices, Stanford Telecom and Andrew Corp.

Mertsching has developed chipsets and system products for applications ranging from wave 2 WiMAX 802.16e, 802.11a/g WLAN, cellular telephony and IP over satellite. He has specialized in rapidly building and managing teams of 100 engineers, as well as multi-disciplinary teams that have consistently achieved low product cost, shorter development time and commercial success in a start-up environment.

Mertsching did his work towards a B.A. in Mathematics at the University of California at Berkeley. He has several patents (granted and pending) in the field of wireless telecommunications.



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