TECHNOLOGY BRIEF

802.11ac

XIRRUS®

High Performance Wireless Networks

802.11ac Technology Brief

Introduction

Across the world, consumers are using smartphones and tablets to stay connected – at home, in the office, in a classroom, at a conference. Over 1 million smartphones are activated each day and tablets are forecasted to outsell desktops by late 2013. With Wi-Fi now the dominant wireless technology for data used by mobile devices, the industry rolls out its latest Wi-Fi standard: 802.11ac.

Over the next few years, 802.11ac will make its way into consumer and enterprise networks, replacing 802.11n with data rates in excess of 1Gbps and future iterations taking the standard to over 6Gbps. 802.11ac operates only in the 5GHz spectrum, which contains 7 times the bandwidth of the 2.4GHz band. But 802.11ac will maintain backward compatibility with existing 802.11n equipment to simplify network migration to the new technology. The following table summarizes the key characteristics of 802.11ac.

	802.11n	802.11ac	802.11ac (Future)
IEEE Standard Approval	July 2009	Mid 2013 (plan)	Mid 2013 (plan)
First Available Product	2007	2012	TBD
Max Data Rate	450 Mbps (today)	1.3 Gbps	6.9 Gbps
Channel Width (MHz)	20, 40	20, 40, 80	20, 40, 80, 160
Spatial Streams	Up to 3 (today)	Up to 4	Up to 8
RF Bands	2.4 GHz, 5 GHz	5 GHz	5 GHz
Modulation Type	Up to 64-QAM	Up to 256-QAM	Up to 256-QAM

Ratification of the IEEE 802.11ac standard is expected in 2013 with the associated Wi-Fi Alliance certification program expected to launch in early 2013. Consumer-grade 802.11ac equipment is already shipping from leading consumer wireless LAN vendors showing confidence in the passage of the standard.

802.11ac Performance Gains

Several technologies are used to enable 802.11ac to achieve its performance improvements. 802.11ac uses enhanced modulation techniques that push beyond 64QAM used by 802.11n to 256QAM, making the spectrum 30% more efficient. 802.11ac also provides increased channel bandwidth by supporting 80MHz channels, while 802.11n today supports 20MHz and 40MHz channels. Wider channels offer higher effective data rates, with 80MHz more than doubling the capacity of 40MHz.

Future generations of 802.11ac chipsets will push the standard even further with support for up to 8 spatial streams and 160MHz channels, taking the theoretical data rates up to 6.9Gbps.

Multi-user MIMO or MU-MIMO is another key element of the 802.11ac standard which promises performance benefits. MU-MIMO is advanced MIMO (multiple-input and multiple-output) technology that uses multiple radios within an AP to communicate simultaneously to multiple clients. MU-MIMO promises to be an important advancement in Wi-Fi when it becomes available in future 802.11ac products.

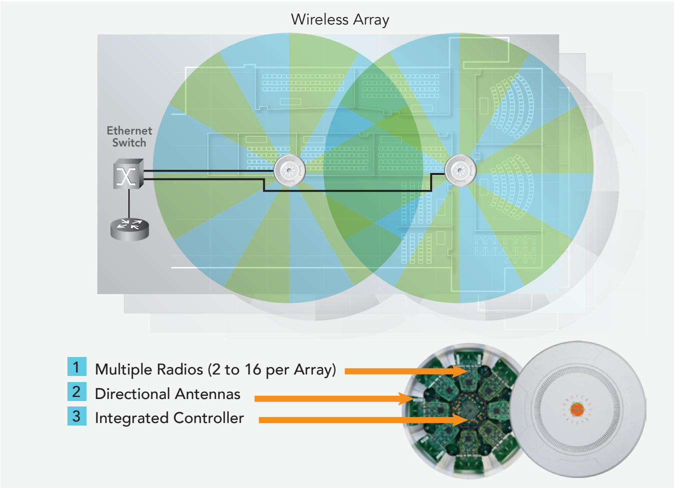
The Xirrus 802.11ac Advantage

Xirrus' 802.11ac Solution

With an average wireless equipment refresh cycle of 4-5 years, it is vital that customers making wireless infrastructure investments today consider their plans to accommodate 802.11ac on their networks. The BYOD (Bring Your Own Device) phenomenon pushing smartphone and tablet usage virtually guarantees 802.11ac will make its way onto corporate wireless networks soon as these devices begin supporting the standard.

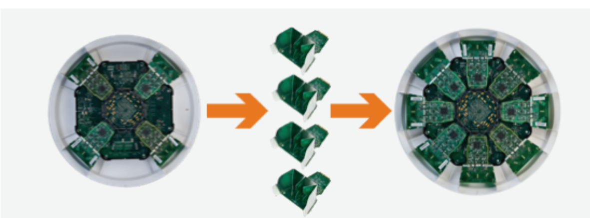
Xirrus delivers a wireless solution that is 802.11ac-ready today. Our modular, multi-radio architecture provides a smooth migration path for customers by pushing beyond traditional AP and controller architectures with our unique Array infrastructure characterized by the following design components:

- Multi-radio design with 2, 4, 8, 12, and 16 modular APs per Array. In contrast, conventional APs have only 2 fixed radios.
- Directional antennas that provide much longer range than omni-directional antennas on traditional APs, resulting in 50-75% fewer Arrays per deployment.
- Integrated controller that places all network processing and intelligence directly in the Array at the edge compared to a centralized controller in the core network.



The unique architecture of the Xirrus Array affords a number of key advantages when considering the move to 802.11ac.

- **Upgradability.** When 802.11ac radio modules become available, there will be no need to uninstall existing hardware from Xirrus. Simply add the new 802.11ac module radios in the chassis' empty slots. Different radio types can be operated in the same Array chassis – 802.11n, 802.11ac, and other technologies added in the future. This allows our customers to simplify installation and upgrades, lowering costs over time by maintaining existing chassis, cabling, and switches.

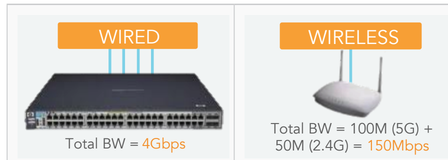


- **Technology Migration.** The modular, multi-radio design of the Array flexibly operates with different wireless client types (802.11a/b/g/n/ac) in the same environment without compromising performance. Individual radios can be dedicated to operate with slower 802.11bgn (2.4GHz) clients, faster 802.11an (5GHz) clients, or the new fastest 802.11ac clients – all within a single Array. Running mixed (slow and fast) clients on the same radio significantly slows down fast clients since the wireless medium is being shared. As more 802.11ac clients enter the environment, radios can be reconfigured easily.
- **Spectrum Optimization.** Every radio within a Xirrus Array can be configured to operate in either the 2.4GHz or 5GHz spectrum. This capability enables wireless networks to be optimized to leverage available spectrum for maximum performance. While most clients support 2.4GHz today, this spectrum is very crowded with non-Wi-Fi usage (Bluetooth, microwave ovens, etc.) and contains only 3 channels (60MHz) of bandwidth. The 5GHz spectrum is much cleaner and contains 21 channels (420MHz). With the ability to assign radios to bands based on current client mix and then migrate this mix over time, the Xirrus Array provides significant flexibility compared to conventional 2-radio APs which are fixed with 1 radio in 2.4GHz and 1 radio in 5GHz.

Is 802.11ac Enough?

At Xirrus, we are excited by the development of 802.11ac. The increase in performance that it provides is critical, however is it enough to allow users to transition all their network usage over to wireless?

Most Wi-Fi networks today provide only a fraction of the capacity enjoyed by wired users and with wired applications and devices migrating to wireless, wired network performance becomes the new benchmark. Most wired networks run Gigabit Ethernet and deliver close to 100Mbps of bandwidth to the user (accounting for uplink aggregation). In contrast, most Wi-Fi networks are still designed to provide less than 5Mbps per user – see the following table.



	WIRED	WIRELESS
Number of Users	48	48
User Connections	48 GigE ports	2 radios (1x2.4G, 1x5G)
User Bandwidth	Dedicated	Shared
Uplinks	4 GigE	1 GigE
Capacity Limiting Factor	Uplinks	Radios
Capacity per User	4Gbps / 48 = 83Mbps	150Mbps / 48 = 3Mbps

Many design guidelines by vendors and industry experts advocate that 5Mbps or less is enough for most users. However if this is true, why did the wired network transition from 10Mbps to 100Mbps to 1,000Mbps over the past 20 years? Either we are overprovisioning on the wired or we are under-provisioning on the wireless in today's designs. At Xirrus we believe it is the latter. Wired gigabit infrastructure has enabled networked medical imaging, HD video services, life-size video telepresence, and much more. The same high capacity requirements are needed on our wireless networks as devices we work and play with become increasingly mobile.

802.11ac brings us one step closer to wired performance equivalency with greater data rates per radio, but alone is not enough. Achieving gigabit performance with 802.11ac means dedicating one radio per user. While one day this scenario may become more viable as technology costs drop, today it is impractical.

So what should the target performance benchmark be for wireless? The answer depends on the specific requirements for the network, but current design practices limit wireless deployments with capacity still well under that of wired, with wireless networks designed to provide only "good enough" performance.

More Radios Is the Real Xirrus Advantage

The most effective way of adding wireless capacity to a network is to add more radios. While 802.11ac adds more capacity per radio, the actual increase in performance for many clients will be less than one might expect. While 802.11ac will provide data rates up to 1.3Gbps, many clients in actual deployments will never experience this performance as they lack the built-in hardware support required. Tablets and smartphones, for example, typically support only one data stream and no channel bonding. The iPad and iPhone, despite supporting 802.11n, run at data rates no higher than 65Mbps, well below the 802.11n maximum of 450Mbps. Even when 802.11ac support is added to these devices, they will not support the full speeds of the technology given their size, form factor, and power restrictions.

In wired networks, supporting more users means adding more switch ports. The equivalent in wireless is adding more radios – the radio is essentially the equivalent of a switch port. So as we add more wireless users, we need to add more radios. This means adding more APs or adding more radios to each AP. Standard 2-radio APs with omni-directional antennas and 1 radio in each of the 2.4GHz and 5GHz bands cannot be deployed in a given area past a count of 3. Thus, adding more APs will not work in 2.4GHz unless there is physical isolation between them or extra 2.4GHz radios are turned off, given co-channel and adjacent channel interference causes performance degradation. Xirrus solves this issue by designing the Array with directional antennas and radio isolation to allow multiple radios to coexist in the same chassis. This approach follows the same architectural path as wired switches with high port counts. Xirrus Arrays support 2, 4, 8, 12, or 16 radios per Array.

In summary, while 802.11ac provides a definite performance boost for Wi-Fi, implementation of the technology alone will not solve the gap that exists today between wired and wireless networks. A growing percentage of clients on today's wireless networks (tablets and smartphones) have significant RF limitations and will support nowhere near the maximum data rates promised by 802.11ac. To achieve greater wireless capacity, more radios ultimately need be added to a given deployment.

802.11ac Deployment Considerations

If you are planning on deploying wireless in the near future, Xirrus recommends making the following considerations in anticipation of 802.11ac:

- **Migrate clients from 2.4GHz to 5GHz whenever possible.** 2.4GHz is fast becoming an unusable spectrum given limited available channels and congestion from overuse. With the advances of 802.11ac only available in 5GHz, support for this band must be a fundamental consideration when purchasing any wireless device.
- **Separate faster and slower clients.** Slower wireless clients will slow down the performance of faster wireless clients when operating together on the same wireless network. Look at segmenting clients so that faster clients operate together on radios independent of slower clients. This applies to 802.11abgn networks today and even more so when 802.11ac becomes available. To do this, design your network to direct faster multi-stream, wide-channel clients such as laptops to bonded channels, while connecting slower, single-stream, single-channel clients such as smartphones and tablets to separate slower, unbonded channels. The more radios you have in your infrastructure, the easier it will be to segregate clients, and thus provisioning the network with more radios is essential.
- **New AP placement.** Many existing Wi-Fi networks were designed with coverage in mind as opposed to capacity. If existing 802.11abgn APs were installed with a proper design, new 802.11ac APs may be able to be installed in the same location. The minimum signal level criteria should be -65dBm in BOTH 2.4GHz and 5GHz for full support of smartphones, tables, VoWiFi phones, etc.
- **Ensure sufficient uplink capacity to APs.** At a minimum, Gigabit Ethernet ports should be wired to each 802.11ac AP location and in some cases, two cables should be pulled. The capacity limitation of wireless today is typically in the radios, not the uplinks, but 802.11ac can change this dynamic.
- **Review backend infrastructure.** Is your firewall, NAC, or other inline network infrastructure capable of handling the faster speeds of 802.11ac and the impact of BYOD? What about your Internet pipe? A review of the current installation end-to-end is required for any upgrade to the access infrastructure.

About Xirrus

Xirrus is the leader in high performance wireless networking. The enterprise-grade Xirrus Wireless Array enables wireless connectivity for small businesses to the Fortune 500. Headquartered in Thousand Oaks, CA, Xirrus is a privately held company that designs and manufactures its family of wireless products in the USA.

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