WHITE PAPER

Optimize Your Wi-Fi Network

XIRRUS®

High Performance Wireless Networks

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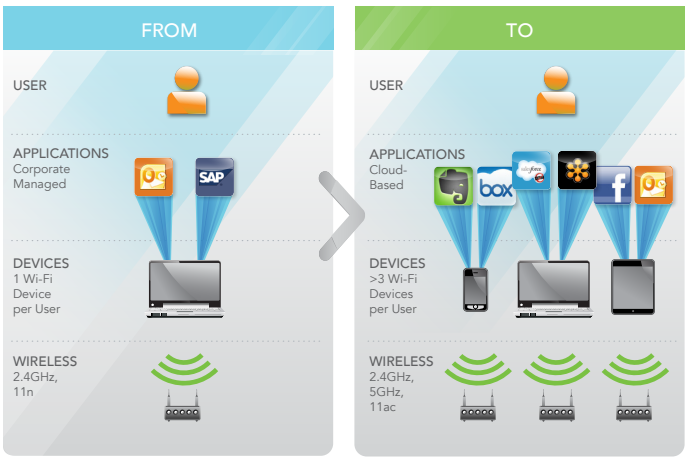
Introduction

Driven by the rapid evolution of mobile devices, the move to cloud-based applications and data, and the continued development of new wireless technologies, Wi-Fi has become the network of choice for connectivity. Most new devices no longer have wired connectivity—for them Wi-Fi is the only option. IT managers now count Wi-Fi as an essential business facility.

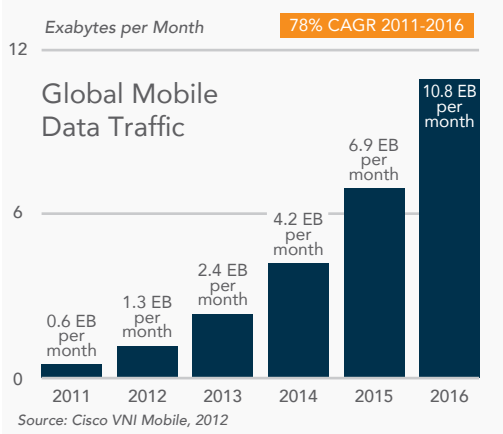
Portable devices will soon outnumber personal computers in the workplace and at home. Since late 2011, more smartphones and tablets are being sold than personal computers. The trend will continue; by 2015 it is estimated[1] that the number of portable devices in the enterprise will be three times that of laptops and desktops. Tablets alone could match the number of personal computers.

The profile of Wi-Fi usage in the enterprise has dramatically changed in recent years—from an overlay access network supporting a relatively small number of applications running primarily on laptops, to a mission-critical network supporting a plethora of personal and corporate applications accessed from many different devices.



The Changing Character of Wi-Fi Usage

This is clearly evident in the growth of mobile data traffic. Global mobile data is expected increase exponentially, reaching 10.8 Exabytes[2] per month by 2016.[3] Within the enterprise, Wi-Fi device data consumption is expected to surpass wired data usage sometime in 2015.



Global Mobile Data Traffic Trends

The Wi-Fi standards bodies have worked hard to develop new standards to satisfy these growing demands, moving from IEEE 802.11a/b/g/n to 802.11n to the upcoming 802.11ac supporting over 1Gbps data rates. IEEE 802.11ac also addresses the capacity issue by restricting usage to the 5GHz band, where seven times as much bandwidth is available versus the commonly congested 2.4GHz band.

> "...by 2015 it is estimated[1] that the number of portable devices in the enterprise will be three times that of laptops and desktops."

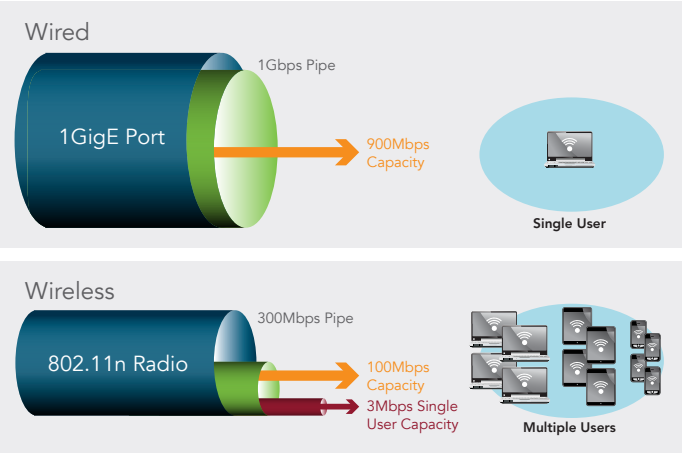
1 Business Insider, "The Future of Mobile," 2012.

2 An Exabyte is a million terabytes, i.e. 10^{18}.

3 Cisco VNI Mobile, 2012.

The Wi-Fi Optimization Mandate

Wireless LANs are very different than the wired Ethernet networks that they are replacing. Wired networks provide high throughput without much overhead; even with a large user community of wired clients, each user can achieve hundreds of Mbps from a Gigabit Ethernet network. A Wi-Fi network, on the other hand, uses a shared medium and is typically provisioned with less than 5% of the capacity per user compared to the wired network. Wi-Fi networks require a significant amount of overhead in order to handle the shared medium and remain compatible with earlier technologies. For example, a single 802.11n radio may have a maximum stated rate of 300Mbps, but only about 100Mbps is actually available after overhead is accounted for. Then considering multiple users sharing the medium and some limited clients with reduced performance, the result is typically less than 5Mbps capacity available for each wireless user.

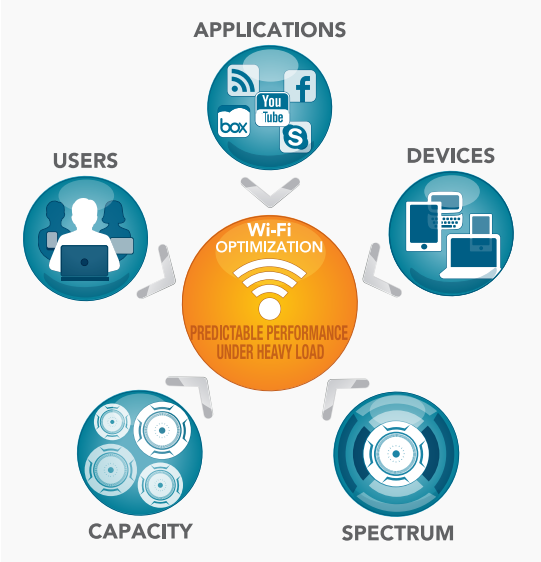


Bandwidth Differences between Wired and Wireless Networks

Given these constraints, wireless infrastructure must be optimized to be able to provide predictable performance, especially when operating under heavy load. Business-critical applications cannot be acceptably delivered over wireless without these types of optimizations in place. It has never been more important to carefully design wireless LANs with the flexibility to satisfy both today's and future needs.

Leveraging experience with thousands of wireless LAN installations, Xirrus has developed a set of solutions that address Wi-Fi's primary deficiencies to enable the deployment of efficient, optimized networks. These solutions focus on solving the issues in these five key areas:

- **Users**—providing hassle-free access and security for all users with low IT overhead
- **Applications**—enabling effective control of applications to ensure predictable performance
- **Devices**—handling the unique characteristics of the multitude of device types on wireless networks
- **Spectrum**—maximizing the usage of the limited RF spectrum available to Wi-Fi
- **Capacity**—deploying the necessary amount of wireless capacity to meet user density requirements



The Five Key Areas for Wi-Fi Optimization

Wi-Fi infrastructure providers have historically concentrated on the user and the device elements of the problem—ensuring it is easy and secure for users to join and to attach their new devices to the wireless network. The focus must extend, however, to the other areas to truly address the performance element of the equation.

"By 2015, 80% of newly installed wireless networks will be obsolete because of a lack of proper planning."

Top Wireless Issue That Might Derail Your Mobile Strategy.
Paul DeBeasi, October 2011

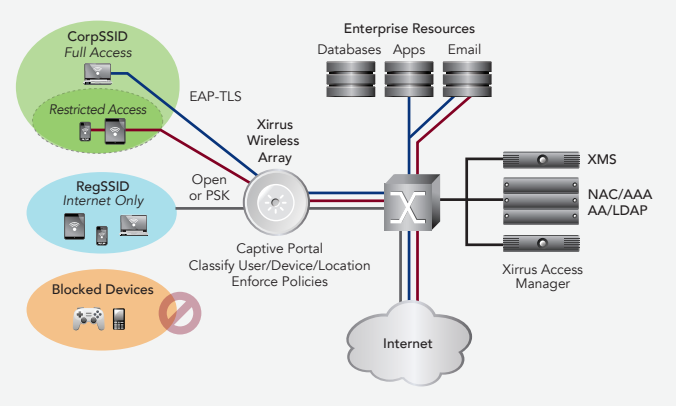
Gartner

User Optimization

An efficient Wi-Fi infrastructure should facilitate easy and complete access by its user community, without undue overhead. When authorized users come within range of the wireless LAN, the infrastructure must quickly authenticate and connect them regardless of the number and type of devices that they use. It must be able to rapidly incorporate new employees and guest users. The infrastructure must provide the means of allowing employees' personal devices to access critical business applications and data without sacrificing security.

On the other side of the coin, unknown users must be quickly segregated. Where free or paid guest access is allowed, quick and easy registration must be available. Guest traffic must be isolated from normal business traffic and in some cases, performance limit policies applied.

Xirrus provides a robust authentication and access control solution with Xirrus Access Manager, ensuring users and their devices are quickly identified, authorized, and provided access with minimal intervention from IT staff and without recurring user interaction. The Xirrus Access Manager facilitates global management of users—allowing seamless access at any corporate location for corporate users, guest users, and various types of BYOD devices.



Application Optimization

The uncontrolled growth of Wi-Fi bandwidth usage is often the single most significant problem in many wireless LAN deployments. This growth is primarily attributable to the dramatic increase in the number of BYOD devices on wireless networks and the sheer numbers and types of cloud-based applications those devices are running. In a recent survey by Nielsen,[4] smartphone users were found to have installed an average over 40 applications. There is also a significant increase in use of bandwidth-hungry video, and not just for entertainment purposes. Over half of all Internet traffic is now video. And finally, increasing data consumption places a growing burden not only on Wi-Fi networks, but on WAN uplinks as well.

Application traffic control is necessary to guarantee that business-critical applications perform without degradation while ensuring an acceptable user experience for all other permitted traffic. Specifically, network usage must be prioritized for bandwidth-intensive applications that are critical to business, including file sharing, e-mail, collaboration, desktop virtualization, and ERP. Collaboration tools that involve real-time video or audio usage, such as WebEx™, GotoMeeting™ and VoIP, must be given highest priority. A failure to identify, prioritize, and limit application traffic makes it possible for just a few users to destroy everyone's quality of experience. In the worst case, the enterprise may be unable to conduct its business.

Xirrus Application Control's unique implementation controls application traffic at the edge of the network where the traffic originates. Non-critical traffic is limited or rejected before it has a chance to clog the corporate infrastructure. This type of control at the network edge can reduce 30% or more of the traffic in the core network, easing the strain on other network resources such as firewalls, content filters, etc. Distributing application control to each Xirrus Array/AP results in a uniquely scalable architecture that puts the processing power where it is needed most—at the edge—and eliminates the single point of failure associated with centralized systems.

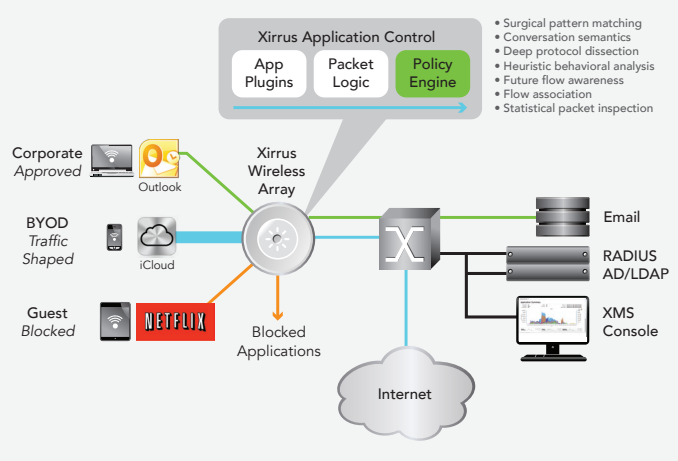
4 http://blog.nielsen.com/nielsenwire/?p=31891

"The ability of the Xirrus system to support a BYOD policy was vital when thousands of students from all over the world come to use our facilities. From accessing internet services, emailing, or transferring files to printing—IESE Business School users can now complete tasks instantly using the Xirrus wireless network."

Tomás Tomeo, Director of Corporate Development, IESE Business School

Xirrus Application Control uses sophisticated deep packet inspection (DPI) technology. It analyzes application traffic in detail to not only identify the application in use (e.g. Facebook), but also the specific usage (e.g. a Zynga game running within Facebook). Even encrypted data connections are heuristically analyzed to identify application type. Application Control maintains a constantly growing library of over 1,000 business and recreational applications, divided into 15 categories including collaboration, social media, games, remote access, database, e-mail, networking, and more.

The use cases for Application Control are many, e.g. business applications can be prioritized, inappropriate activities can be blocked, and recreational applications can be rate-limited. In the following example, full access is provided to a corporate user running Outlook, iCloud syncs on smartphones are rate limited, and streaming media access is blocked.



Example of Application Control Use Cases

Device Optimization

Enterprises have begun to implement BYOD policies that encourage employees to bring their portable devices to work. Tablets and other mobile devices, however, have limited Wi-Fi capabilities. Their transmit power is often much lower than that of a laptop. This dramatically impacts network design; the target signal strength at the edge of wireless network needs to be much higher (-65 dBm) to handle these devices as opposed to what has commonly been used for laptop-based networks (-72 dBm). This means a smaller area that can be covered by each access point, and more access points will be required.

Smartphones and tablets run at lower Wi-Fi data rates. Although the maximum data rate for 802.11n connections is 450Mbps, this speed requires the use of three antennas and bonding of two 20MHz channels. Most tablets and smartphones use only one antenna and many do not bond channels, resulting in maximum data rates of 65 to 150Mbps. Further, older devices tend to operate in the 2.4GHz radio band, where there is more contention for limited channels and more interference from non-Wi-Fi devices.

Xirrus Arrays and Access Points identify and classify devices by their operating system (iOS, Windows, Blackberry, Android), device type (table, phone, notebook, media device), wireless standard (802.11a/b/g/n), and RF bands (2.4 and 5GHz). They optimize the performance of these devices and the network in a number of ways.

When moving around a facility, smartphones and tablets tend to stay connected to the same AP even when a much stronger signal is available from a closer AP. Xirrus has developed a specialized Roaming Assist functionality for these "sticky" clients. Roaming is coordinated between Xirrus Arrays/APs in a wireless network to move device from one Array at optimized times instead of waiting for the device to make the roaming decision on their own.

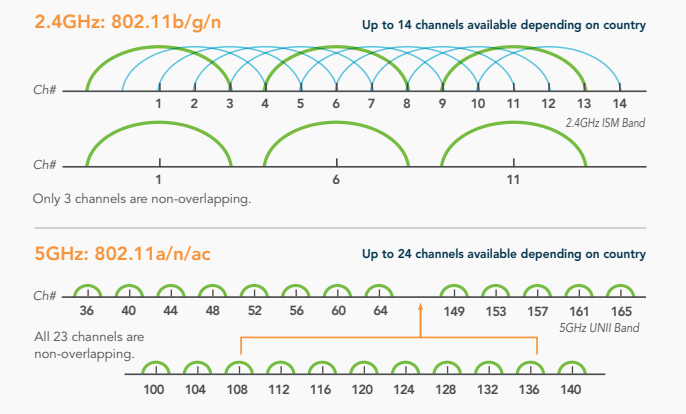
Devices based on Apple iOS, including iPads, iPhones, and iPods, use a proprietary Bonjour protocol for automatic device naming, discovery, and advertisement of services such as AirPrint and AirPlay across a wireless network. Xirrus' Bonjour Director transports Bonjour traffic between Arrays/APs that would otherwise be blocked by wired network components so that these devices can successfully operate across an enterprise network.

"What really set Xirrus apart is its ability to function as an application-aware wireless switch. As new users connect, there is no degradation of experience for the already-connected users. Xirrus can scale and provide seamless roaming so that our guests always have a perfect wireless experience—no matter the traffic load."

Justin Herrman, IT Director,
Sands Expo and Convention Center

Spectrum Optimization

Wi-Fi spectrum is a limited resource with only a so much of it allocated for operation of the technology. The ability to maximize its usage is critical to being able to deploy the appropriate amount of network capacity for a given deployment, in particular on where there is dense usage. The traditional approach to handling increased bandwidth demand for more users and traffic in a dense environment is to add more Access Points. This will work only to a certain extent, but will quickly run into the spectrum limitation of Wi-Fi. Since the 2.4GHz band where Wi-Fi operates only supports three non-overlapping channels, only three APs can be effectively placed in a given area. Add a fourth AP and you must replicate the same channel, causing interference and reducing the effective throughput on that channel. The 5GHz band supports significantly more spectrum—up to 24 depending on country.

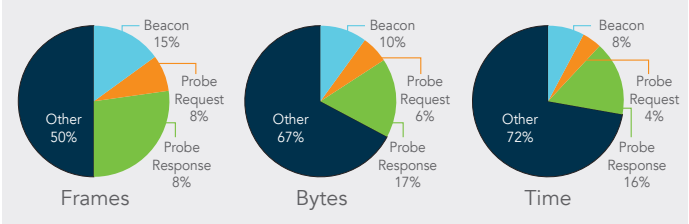


As a result of the limitations in 2.4GHz, there is an increasing move in the industry to the 5GHz band. This is evidenced by the development of the latest Wi-Fi standard—802.11ac which provides data rates in excess of 1Gbps. 802.11ac enhancements are only being developed in the 5GHz band, relegating the 2.4GHz to essentially legacy status.

Xirrus Arrays/APs sense and coordinate with the use of Wi-Fi spectrum with each other to automatically optimize its use. In an iterative and dynamic procedure, Arrays/APs assign channels in both the 2.4GHz and 5GHz bands and set per-radio power output. These features, called Auto Channel and Auto Cell, maximize coverage and minimize interference. This is complemented by the unique ability of Xirrus Arrays and Access Points to use ultra-low power settings to create very small cells and therefore more readily reuse the same channels over again in a given design, helping performance in 2.4GHz especially. In addition, load balancing algorithms assign clients to radios to even out load. When possible clients are pushed to the 5GHz band where more capacity is available.

In public areas, Wi-Fi devices—especially smartphones—are be present in large numbers but not connected to the local Wi-Fi network. These unassociated devices can consume a significant amount of Wi-Fi spectrum since they probe the air for Wi-Fi networks to connect to. Probe messages and AP responses occur at the lowest Wi-Fi rate, consuming significant air time.

One study[5] by Nikkei Communications at Shinjuku station in Tokyo in 2011 found that 28% of airtime was consumed by Wi-Fi protocol overhead (beacons and probes), see following figure. Xirrus Honeypot function automatically associates unconnected clients to a fake wireless network, effectively removing this potentially damaging overhead from the Wi-Fi spectrum. This helps improve overall wireless performance, especially in the crowded 2.4GHz spectrum.

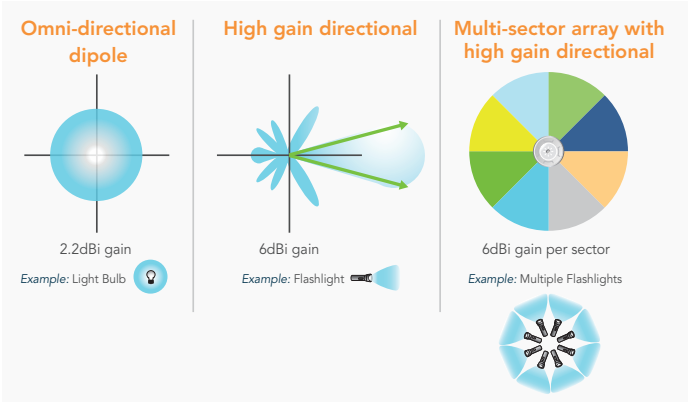


Example of Overhead from Unconnected Wi-Fi Clients

Capacity Optimization

Wi-Fi is a shared medium—you can only place so many users on a given radio before performance begins to suffer. Handling a high density of wireless users and/or a high traffic capacity therefore comes down to providing more wireless radios for communication. Leveraging the available spectrum to the greatest extent possible requires up to 27 radios—the total number of channels available with Wi-Fi. Traditional APs operate with just two radios—one each fixed in 2.4GHz and 5GHz. This means up to 24 APs would be required in a given area to fully utilize the spectrum and provide maximum Wi-Fi capacity.

Traditional APs utilize omnidirectional antennas that transmit wireless signal in a 360-degree pattern—similar to a light bulb. Xirrus Arrays utilize directional antennas to focus that same energy in a specific direction—similar to a flashlight—helping to isolate radios within a given chassis to enable a multi-radio Array design. Each radio is software programmable to either 5GHz or 2.4GHz operation, meaning more spectrum and thus more capacity can be delivered with each multi-radio Array compared to a traditional fixed two radio AP.



Directional Behavior of Xirrus Arrays

5 IEEE 11-11/1413R0.

Xirrus Arrays are specially designed to make a large number of radios available in a given geographic area and to control those radios so as to maximize coverage and performance. The Xirrus product line offers Arrays with 2 to 16 radios as well as a 2 radio Access Point. Together, the products enable all types of use cases to be addressed—from low density up to ultra-high density scenarios.

Xirrus' wireless solutions are inherently scalable. Arrays/APs offer more radios and can be upgraded with additional radios as demand increases. Xirrus radios can be switched from 2.4GHz to 5GHz operation as devices move to this more efficient band. Most significantly, radios can be upgraded with new technologies as they become available, including the upcoming 802.11ac standard.

Conclusion

Today's mobility requirements are forcing a rethink of how wireless networks are designed. It is necessary to break away from traditional architectures that result in Wi-Fi networks that just "don't work" or will not scale. An application-aware infrastructure that ensures high availability for mission-critical applications is absolutely essential. A future-proof Wi-Fi infrastructure must use all available spectrum be able to expand its capacity and coverage as needed and to take advantage of new technologies.

Xirrus offers a portfolio of Arrays and Access Points to address the full range of requirements from small enterprises up to highly dense environments. These solutions provide the upgradeability and flexibility to adapt to changing requirements over time. With the rapid pace of change in today's mobile world, this ability is more important then ever.

Network planners must be able to address all levels of optimization to ensure a properly performing wireless network—at the user, device, application, spectrum, and capacity levels. Skipping any of these areas will most result in a weak link in the chain, hindering the ability to provide a wireless service that is robust and reliable.

To learn more about Xirrus solutions to optimize the Wi-Fi network, see our series of white papers and applications notes at:

- http://www.xirrus.com/Resources/White-Papers.aspx
- http://www.xirrus.com/Resources/Application-Notes.aspx

To experience how organizations depend on Xirrus, visit xirrus.com/TV.

About Xirrus, Inc.

Xirrus is the leading provider of high-performance wireless networks. Xirrus' Array-based solutions perform under the most demanding circumstances with wired-like reliability and superior security. The Xirrus wireless solutions provide a vital strategic business and IT infrastructure advantage to the education, healthcare, government and enterprise industries that depend on wireless to operate business-critical applications. Headquartered in Thousand Oaks, CA, Xirrus is a privately held company that designs and manufactures its products and solutions in the USA. For more information please visit: **www.xirrus.com** and follow us on Twitter: **@Xirrus**.

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