The proliferation of mobile devices and applications increases strain on resources throughout the enterprise wireless LAN. Basic architecture and resource management provisions of most wireless LAN solutions struggle and cannot scale as access points are added to the network.

**Solution**

The Juniper Networks wireless LAN solution intelligently and effectively manages all resources end to end to deliver the highest performance and scalability available in the industry. Yet despite its power and sophistication, Juniper’s wireless LAN solution is equally simple to manage.

**Benefits**

- Virtual Controller Cluster™ delivers nonstop availability with virtually unlimited scalability
- Distributed packet forwarding and encryption minimize bottlenecks on controllers at network's core
- Access point load balancing and band steering minimize bottlenecks at network’s edge
- Bandwidth controls, stringent QoS and dynamic CAC ensure users get resources they need

With the copious amount of bandwidth afforded by the 802.11n standard, wireless LANs are capable of delivering superb performance. Whether they do or not is an entirely different matter—one that is greatly determined both by the architecture of the system, and by a variety of value-added, performance-enhancing features that some vendors have and others lack.

With some wireless LAN solutions, much of the newly found capacity cannot be fully utilized, because the potential high throughput is undermined by other resource management limitations inherent throughout the infrastructure. For example, the centralized controllers become a common culprit when these are used for forwarding and/or encrypting traffic; bandwidth and quality-of-service management provisions often fail to deliver suitable performance for different users and different applications under different situations; the total traffic load shifts as users roam about the enterprise, creating imbalances in resource utilization that create migrating bottlenecks; devices connect at different data rates, either because they lack support for 802.11n or they are somewhat distant from the access point, causing airtime fairness issues. And the proliferation of wireless devices and applications, especially those that are bandwidth-intensive such as video, only put additional strain on available resources.

The Juniper Networks wireless LAN architecture does not suffer from any of these limitations and, in fact, offers industry-leading performance and scalability, resulting in the most reliable bandwidth availability and quality of service as users remain simply connected while moving around the enterprise. Juniper’s advantage stems from Smart Mobile, an intelligent switching architecture that provides more flexible ways to utilize the combined resources of the wireless LAN infrastructure. Load balancing from the controllers at the core to the access points and radios at the edge delivers consistently high performance by minimizing resource contention. Distributed packet forwarding, inspection and encryption leverage the processing power built into access points to prevent the centralized controllers from ever becoming a bottleneck. And as the wireless LAN grows, Juniper’s innovative Virtual Controller Cluster scales incrementally, affordably and seamlessly right along with it.

**The Challenge**

Wireless LAN resource management has become substantially more complex with the proliferation of mobile devices. Many of these devices support only 2.4 GHz to preserve battery power, which results in a disproportionate percentage of clients converging on the 2.4 GHz band, while the 5 GHz band remains underutilized. This imbalance alone can waste up to half of available resources. Some devices—such as Voice over wireless LAN (VoWLAN) phones—are always on, causing them to consume precious resources even when not being used.
The advent of IEEE 802.11n has both helped and hurt resource management. The additional and copious bandwidth makes it possible for any access point to support more users with good performance. But legacy and/or always-on devices can create conflicts and consume an unfair share of resources, such as the additional airtime required for 802.11a/b/g-based access.

These challenges become even greater as users begin to use multiple devices, perhaps concurrently, and the number of mobile applications increases. For example, most smartphones are now dual-mode with support for Wi-Fi. And many smartphones are now used more for data applications (for example, browsing, instant messaging and bandwidth-intensive video) than for voice communications.

**Juniper Networks Wireless Resource Management**

Juniper Networks excels in the efficient utilization and management of available wireless LAN resources. Juniper employs a variety of techniques—including controller virtualization, distributed forwarding, dynamic load balancing, band steering, and sophisticated bandwidth and quality-of-service (QoS) controls—that together are able to recover over 50 percent more network capacity from the existing infrastructure. By improving resource utilization and minimizing congestion, Juniper is able to deliver a more reliable and satisfactory mobility experience more cost effectively.

**Virtual Controller Cluster**

Centralized controllers are one of the most important resources in any wireless LAN. Juniper Networks’ innovative Virtual Controller Cluster makes this resource both reliable and scalable. The Virtual Controller Cluster utilizes proven virtualization techniques to create a cohesive cluster or pool of cooperating wireless LAN controllers. The cluster provides many-to-many redundancy where all controllers act as backups for one another. With this active/active approach, each controller maintains a copy of the configuration of all other controllers at all times. The result is a holistic, self-healing configuration where all controllers are fully utilized, and if one should fail, one or more of the others instantaneously take over control of the failed controller’s access points and all of its current sessions.

The same controller load-balancing and automatic failover capabilities also permit zero-downtime maintenance, including the addition of new controllers to increase overall capacity. When a new controller is added to the cluster, it automatically inherits its configuration and immediately takes its fair share of the total, newly rebalanced load. For this reason, the Virtual Controller Cluster makes the scalability of a Juniper wireless LAN virtually unlimited. And because the entire cluster is managed as a single controller, Juniper’s sophisticated capabilities are far easier to manage compared to other wireless LAN solutions that employ “home” and “hot standby” controllers.

**Distributed Forwarding**

Juniper Networks eliminates what is often the biggest bottleneck in other wireless LANs—the need to route all traffic through centralized controllers for packet forwarding, deep packet inspection and in some cases, encryption. Juniper’s Smart Mobile intelligent distributed switching leverages the processing power in access points to make local forwarding decisions. By switching as much traffic as possible at the network’s edge, as shown in Figure 1, distributed forwarding minimizes the load on the central controllers load (while still preserving centralized management and control), and it reduces latency for delay-sensitive voice and video applications.

![Centralized WLAN - Not Optimized for Voice](image1)

![Smart Mobile - Voice-optimized Traffic Flow](image2)

*Figure 1: Local forwarding at the access point minimizes latency*
of these devices operate only in the 2.4 GHz band. As the proliferation of tablets and smartphones, as most of these devices operate only in the 2.4 GHz band to conserve power. Band steering complements client and access point load balancing to make better use of access point resources, thereby improving performance for all users.

Band steering works by moving as many laptops as possible to the 5 GHz band to better balance the load between the two unlicensed bands. With their larger batteries, laptops can readily provide the additional power needed to operate in this higher frequency range. Depending on the mix of client devices, band steering is able to reclaim up to 40 percent of the total capacity in a crowded network.

Bandwidth and QoS Controls

In addition to distributing, balancing and steering traffic to avoid congestion, Juniper provides a full suite of dynamic and granular controls over the bandwidth and QoS based on user identity. Centralized, policy-based enforcement makes it easy to match constantly changing resource utilization to the service level and other requirements of user groups or even individual users. Although performance issues do not constitute a reliability problem per se, they can be (and are) perceived by users as network failures. For example, a minor and temporary increase in congestion could cause latency and jitter to increase enough to become disruptive to VoWLAN calls.

Juniper enables QoS profiles and bandwidth limits to be established on a per-user, per-SSID and/or per-application basis to enable service-level agreements. Two common ways for implementing role-based enforcement of QoS provisions include simply giving different classes of users different SSIDs or VLANs, and/or assigning different priorities to specific users identified in the directory server. User-centric policies can then be used to adjust these profiles, depending on the application usage and other user behaviors. For example, once the bandwidth limit is reached for an individual user, a group of users or a specific SSID (either as a percentage of total capacity or in Kbps), the heaviest users can be temporarily throttled back to lower throughput levels. Or the accounting capabilities in RADIUS or other directory servers can be used to track utilization by all users over time, with rules established and applied based on a combination of weighted fair queuing (WFQ) and bandwidth limiting to temporarily throttle back the usage of any chronic bandwidth abusers.

Dynamic Call Admission Control

Another important provision is Juniper’s dynamic call admission control (CAC), which is far superior to the session-based CAC used in most other wireless LAN solutions. In environments with substantial VoWLAN traffic, it is desirable to implement some form of CAC. CAC’s role is to limit the number of active VoWLAN sessions to avoid a situation where the network becomes so congested that quality deteriorates for everyone. The public switched telephone network (PSTN) also has a form of CAC to limit the number of calls, recognizable by the familiar “all circuits busy” message or “fast” busy signal.

Compared with static session-based CAC, Juniper’s dynamic CAC solution offers superior management of available resources based on its ability to recognize the always-on nature of the many VoWLAN-enabled devices, and it only takes into account those with active voice calls in its session count. This ensures that no bandwidth is wasted by being reserved for users who do not actually need it because they are not currently on any calls.
Airtime Fairness

An often-overlooked provision is airtime fairness. Some wireless LAN solutions implement airtime fairness to favor 802.11n-capable devices over legacy 802.11a/b/g devices. The ostensible goal is to prevent legacy clients from slowing down the newer, faster 802.11n clients. But this approach is at best an interim one. Juniper avoids such “class warfare” by instead taking into account the user, the user’s application requirements, the device, and the current data rate of the session. For example, an important user with an 802.11n device might have associated with a distant access point at a lower data rate, and if no better connection is currently available at that user’s location, more airtime is warranted. For VoIP applications, Juniper’s QoS provisions also differentiate between 802.11b and 802.11g devices—and they permit greater airtime for the slower 802.11b sessions.

Features and Benefits

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<th>FEATURE</th>
<th>BENEFIT</th>
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<td>Virtual Controller Cluster</td>
<td>The active/active configuration offers superior scalability and makes full use of all resources by eliminating the need for an idle (and costly) “hot standby” controller.</td>
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<td>Distributed Forwarding</td>
<td>Distributed packet forwarding and encryption leverage the processing power in access points to improve overall performance and to help prevent controllers from becoming a bottleneck.</td>
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<td>Load Balancing</td>
<td>Load balancing among access points and controllers makes better use of available resources to ensure the best performance possible.</td>
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<td>Band Steering</td>
<td>Band steering further enhances performance for all users by automatically and effectively balancing the load between the 2.4 GHz and 5 GHz bands in 802.11n access points.</td>
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<td>Bandwidth and QoS Controls</td>
<td>Centralized, policy-based enforcement makes it easy to match constantly changing resource utilization to the service level and other requirements of all users.</td>
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<td>Dynamic Call Admission Control</td>
<td>Dynamic CAC overcomes the wasteful practice of static solutions by ensuring that only active calls are counted with always-on VoWLAN devices.</td>
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<td>Airtime Fairness</td>
<td>Juniper ensures airtime fairness by taking into account the user, the user’s application requirements, the device, and the current data rate of the session.</td>
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Solution Components

Juniper Networks® WLC Series Wireless LAN Controllers—WLC Series controllers provide users with a seamless, secure and exceptionally reliable roaming experience wherever they are and no matter what device they are using. Meeting the needs of any size network, from small branch offices or retail outlets to large enterprises and university campuses, identity-based networking policies enable users to have a common experience with consistent services across wide geographies.

Juniper Networks WLA Series Wireless LAN Access Points—These provide indoor and outdoor client access as well as active scanning of the airwaves. The WLA Series delivers reduced latency, massive scalability, and high performance for wireless VoIP, video, and location services.

Juniper Networks WLM Series Wireless LAN Management—In addition to RF planning, the WLM Series Wireless LAN Management suite unifies infrastructure, security and services management—enabling network administrators to plan, configure, deploy, monitor, and optimize wireless networks of any size and geography, all from one console.

Summary – Keeping Users Simply Connected

Juniper Networks’ Smart Mobile intelligent switching lives up to its name. It’s smart about how resources are managed and utilized from the core to the edge. It’s smart about how it continuously balances the load to minimize, if not eliminate, bottlenecks anywhere in the infrastructure. It’s smart about leveraging the distributed processing power available in access points to handle packet forwarding, inspection and encryption. It’s smart about how it handles different devices with different capabilities under different conditions. And it’s smart about how it manages available bandwidth and controls QoS to deliver a high quality of experience for all users.

A vitally important aspect about being smart is, of course, being both intelligent and intuitive about managing the end-to-end wireless LAN infrastructure. And here, too, Juniper excels with resource management provisions that are far easier to use than most other wireless LAN solutions. Simply connected; simply managed.

As the number of mobile devices and applications continues to proliferate, Juniper Networks continues to stay one step ahead of the growing demand by maintaining the industry-leading high performance and unsurpassed scalability through the effective (and cost-effective) utilization of the wireless LAN’s precious resources.
Next Steps
To learn more about Juniper’s wireless LAN solutions, please go to www.juniper.net/us/en/products-services/wireless/ or contact your Juniper account representative.

About Juniper Networks
Juniper Networks is in the business of network innovation. From devices to data centers, from consumers to cloud providers, Juniper Networks delivers the software, silicon and systems that transform the experience and economics of networking. The company serves customers and partners worldwide. Additional information can be found at www.juniper.net.