



## Cisco Migrates Global Wireless LAN to Cisco IOS Software for Enhanced Functionality, Manageability, and Security

**Cisco IT Case Study / Wireless / Wireless Local Area Network:** This case study describes the migration to Cisco IOS Software of Cisco IT's internal wireless LANs within the Cisco network, a leading-edge enterprise environment that is one of the largest and most complex in the world. Cisco customers can draw on Cisco IT's real-world experience in this area to help support similar enterprise needs.

“The goal was to develop an easily replicable strategy that would allow engineers to convert the current Cisco Aironet 350 and 1200 series access points from VxWorks to Cisco IOS Software.”

—Michael Anderson, Network Engineer, Global IT Transport

### Background

Cisco® IT deployed a worldwide wireless LAN (WLAN) in 2000. More than 3100 Cisco Aironet® 350 Series access points were installed at more than 280 sites in 85 countries. Today, this wireless network has more than 40,000 wireless clients and more than 35,000 users—essentially every employee at Cisco Systems®.

When the network was deployed, WLAN access points (Cisco Aironet 350 Series and subsequently, Cisco Aironet 1200 Series) used the VxWorks operating system, unlike most Cisco network devices, which use Cisco IOS® Software. In mid-2003 support became available for Cisco IOS Software on the Cisco Aironet 350 Series access points (It was already available on the Cisco Aironet 1200 Series Access Point.) With Cisco IOS Software support for these access points, Cisco IT could run a common operating system across wired and wireless network devices.

Standardizing on a single platform makes management, support, and future enhancements easier, which helps improve overall system availability. Maintaining a separate wireless platform with different interfaces required Cisco IT to develop separate sets of skills and training for each platform, driving up costs for training and system maintenance.

Migrating the access points from VxWorks to Cisco IOS Software allowed Cisco IT to take advantage of new features on the existing WLAN hardware, some of which include:

- Ability to use the same troubleshooting and debugging methods used for Cisco routers and switches to help identify root causes of problems.
- Helping to ensure support for new Cisco IOS features: Wi-Fi Protected Access (WPA) standards, wireless domain services (WDS) support for the CiscoWorks Wireless LAN Solution Engine (WLSE), and others.
- Saving power by supporting client Address Resolution Protocol (ARP) caching on access points. This feature helps access points respond to ARP requests on behalf of a client, thus extending the life of the client by allowing it to be in idle mode.



- Configuring scalable authentication architectures by supporting multiple RADIUS servers based on Service Set Identifier (SSID).
- Extending quality of service (QoS) into the wireless environment to support successful delivery of voice and data traffic across the network using advanced QoS features in Cisco IOS Software. Many Cisco employees are using IP Communicator (a software-based IP phone on their wireless laptop PCs) or a Cisco Wireless IP Phone 7920 (a hardware wireless IP phone) for voice communications within Cisco locations.
- Using CiscoWorks WLSE capabilities, including rogue access point detection and location, air/radio frequency scanning and monitoring, interference detection to isolate and locate network interference, black hole mitigation, and assisted site surveys that automatically determine optimal transmission power per channel.
- Support for 802.11g radios and simultaneous use of 802.11a and 802.11g radios for greater flexibility. Cisco IOS Software provides support for 802.11g, a wireless protocol that can provide up to 54 Mbps throughput, more than the 11 Mbps the 802.11b standard currently provides.

VxWorks used a different command-line interface (CLI) than Cisco IOS Software, which added complexity to the network management process. “From a network operations perspective, moving to Cisco IOS Software would mean that engineers would only need to know one set of CLIs,” says Michael Anderson, Cisco network engineer.

The phase-out of support for VxWorks, together with the advantages of Cisco IOS Software, persuaded Cisco IT to proceed with the migration of all access points from VxWorks to Cisco IOS Software. In addition, Cisco Aironet 340 Series access points, which do not support Cisco IOS Software, would be replaced.

## Challenge

With the decision to migrate the WLAN access points to Cisco IOS Software, the challenges for Cisco IT were to:

- Create a global migration strategy
- Identify a stable software release
- Develop a standard configuration for the Cisco IOS Software used on Cisco Aironet 350 and 1200 series and other access points
- Help ensure that existing network management capabilities would continue to be supported
- Train support personnel on the new Cisco IOS tools

## Develop a Global Strategy for Migration



Although not as capital- or resource-intensive as the initial deployment of the global WLAN, the one-time migration of all access points from VxWorks to Cisco IOS Software still posed a significant effort in planning, development, testing, and coordination.

### **Identify a Stable Software Release**

Because both Cisco Aironet 350 and 1200 series access points were deployed on the network, Cisco IT had to identify a release of Cisco IOS Software that would help ensure a stable, error-free operation with all standard client bases, which include predominantly Windows 2000, as well as Linux, Mac, Cisco Wireless IP Phone 7920s, PDAs, and others. In July 2004, Cisco IT selected Cisco IOS Software Release 12.2(15)JA1. (Check with your Cisco account manager for the current recommended Cisco IOS Software release.)

### **Help Ensure Network Management Support**

Network management of the WLAN had been operating under VxWorks for several years. Cisco IT had to ensure that existing support would function correctly on the Cisco Aironet 350 and 1200 series access points running Cisco IOS Software, and also help ensure that MIB support would function correctly within the existing management tools.

### **Train the Support Team**

Although support personnel were knowledgeable about Cisco IOS Software, the unique attributes of supporting Cisco IOS Software on Cisco Aironet access points—such as radio interfaces—would require training of personnel who had become accustomed to using management tools developed for VxWorks. Engineers for wireless technology and products were familiar with the VxWorks GUI, which was different from the standard Cisco IOS Software GUI that other Cisco engineers had been using for years. Accessing the access points using the VxWorks CLI also was quite different from using the Cisco IOS Software CLI that Cisco engineers used for all other equipment.

## **Solution**

Over a five-month period beginning in late 2003, Cisco IT successfully migrated all the 3000-plus access points (Figure 1) worldwide to Cisco IOS Software. The migration has helped enable many new features simplified and enhanced network management through a single operating system, and made the wireless network more secure. For example, IT engineers can now take advantage of existing Cisco IOS scripting tools to check for access points that are configured incorrectly. One of the primary features enabled by Cisco IOS Software is a tool that searches for access point misconfigurations, a feature that was previously limited to switches and routers running Cisco IOS Software.

Cisco IT formed a global cross-functional Wireless Cisco IOS Migration team in November 2003 to design and manage the migration process. The project was divided into six steps, some of which were carried out concurrently. These steps included:

- Determining how to efficiently migrate high quantities of access points to Cisco IOS Software
- Developing a standard access point configuration supporting both the Cisco Aironet 350 and 1200 series
- Identifying a stable, reliable Cisco IOS Software image
- Helping to ensure that the configuration and Cisco IOS Software image integrated with the existing network management tools



- Pilot testing
- Migration of all access points worldwide
- Tracking the migration
- Transferring operations to production, including training, and auditing of Cisco IOS Software configurations

### **Developing an Efficient Migration Process**

Cisco IT's WLAN Cisco IOS Migration team, with help from the Wireless Network Business Unit, conducted extensive tests in the lab on Cisco Aironet access points to determine the most efficient and effective process for migrating high quantities of access points from VxWorks to Cisco IOS Software. A multistep process was required to perform the conversion:

1. Prepare a list of hosts to be converted from VxWorks to Cisco IOS Software
2. Replace VxWorks with Cisco IOS Software using an appropriate tool
3. Load the new, standard access point configuration

**Figure 1. Cisco Aironet Access Points**

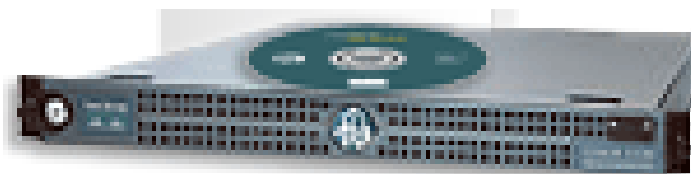


Several tools were available to aid engineers in the migration process. The preferred conversion mechanism was the CiscoWorks Wireless LAN Solution Engine (WLSE), a Cisco appliance for managing WLAN deployments (Figure 2). Cisco IT determined that this tool was the best for supporting mass automated Cisco IOS Software image upgrades



in a large campus environment. CiscoWorks WLSE assists in WLAN network, host, and radio management, site surveys, and rogue access point detection. At the time of conversion, IT used the CiscoWorks WLSE at all locations where it was available and other tools in the remaining locations.

**Figure 2. CiscoWorks Wireless LAN Solution Engine**



The conversion process using CiscoWorks WLSE began with preparing a list of access points to migrate. Next, CiscoWorks WLSE would convert an access point from VxWorks to Cisco IOS Software, which would take about 40 minutes to complete. Through lab testing, the migration team found that up to 17 access points could be converted in each batch. This limitation, a function of the processing power of the server running CiscoWorks WLSE, provided a safeguard. In the unlikely event of a power outage during conversion, all access points would lose their configurations, requiring the engineer to Xmodem a new configuration into them.

Limiting the number of access points converted at one time helped ensure that at least some of the access points in a building would remain active. After the conversion completed, CiscoWorks WLSE would have to “rediscover” all the access points and push out the new configuration. This step could be performed with no restrictions on the number of access points involved. The entire process would take about two hours.

Another tool available was the Cisco Aironet Conversion Tool, a Cisco IOS migration tool developed by the WNBU. The tool is limited to migrating one device at a time, and effective for upgrading single access points. It is not practical, however, to use in a global WLAN migration of several thousand access points.

A Cisco IT engineer developed a custom script based on the Cisco Aironet Conversion Tool to manage batch access point conversions in geographic regions beyond San Jose. This script enabled Cisco IT to convert access points in batches of up to 40.

### **Developing a Standard Configuration for Both Cisco Aironet 350 and 1200 Series**

Cisco IT already had a standard Cisco IOS Software configuration for all routers and switches that included VLANs, QoS, Secure Shell (SSH) Protocol, and other features. The challenge was to develop a standard configuration that would easily integrate Cisco IOS access points into the existing WLAN. The first step was to help ensure that the existing configuration included Cisco LEAP, Temporal Key Integrity Protocol (TKIP), SSID, and the other required features. The next step was to identify new features that should be incorporated into the configuration, such as the ARP cache. Finally, the team needed to identify and resolve any issues they encountered.



### **Identifying a Stable, Reliable Cisco IOS Software Image**

Cisco IT evaluated all the Cisco IOS Software features that would best support the WLAN, performing extensive testing in the lab and at pilot sites, choosing Cisco IOS Release 12.2(13)JA1 as the image most suited for the current WLAN environment. This release was able to support both Cisco Aironet 350 and 1200 series devices. Subsequent upgrades to Release 12.2(13)JA2 and, most recently, Release 12.2(15)JA have been deployed.

### **Determining that the Configuration and Cisco IOS Software Image Integrate with Existing Network Management Tools**

After the migration was complete, the team had to ensure that network management tools such as monitoring, syslog, configuration backup, and Simple Network Management Protocol (SNMP) would continue to support the access points. Extensive lab testing, pilot testing, and comprehensive audits ensured compatibility.

### **Pilot Testing**

After the migration process was thoroughly tested in the lab, several sites were selected for pilot testing. Between December 2003 and February 2004 the buildings selected were Building 12 on the San Jose campus, Amsterdam, Sydney, and Building 5 on the Research Triangle Park (RTP) campus. Participation in the pilots gave engineers in all regions valuable experience in performing migration tasks. All access points were migrated at each site using the same conversion methods developed to test for issues. The same Cisco IOS Software configuration and Cisco IOS Software releases (versions 12.02T1 to 12.2(13)JA1) were used at all pilot sites.

### **Migration of All Access Points Worldwide**

After issues uncovered in the pilot stage were resolved and procedures thoroughly tested, Cisco IT proceeded with full global implementation of Cisco IOS Software on the remaining access points. A training presentation was prepared and delivered to all support personnel responsible for managing the WLAN worldwide before the migration in each region.

In San Jose, all 40 buildings were converted using CiscoWorks WLSE within a two and a half weeks. In the evenings or on weekends, two or three buildings were converted in a single evening or day. Lists would be prepared, one to three batch jobs would be run with up to 17 access points per job, the access points would be rediscovered, and CiscoWorks WLSE would load the new configuration. “To optimize my time, I would migrate all the access points in a building,” says Erik Klaubert, who performed the migrations in San Jose. “I would do two 40-minute pushes—or maybe even three—and then I would do a single discovery job for the entire building, followed by a single configuration job, which took about three to four hours per night.”

In some instances, one or two access points would not accept the new configuration and a subsequent configuration job would be run for those access points.

### **Results**

By August 2004, 98 percent of all access points worldwide had been migrated to Cisco IOS Software. Deployment took an estimated 236 worker-hours (about one access point every five minutes) and was completed within a five-



month window—only two and a half weeks for the San Jose campus with about 40 buildings. Service was minimally disrupted because work was performed outside of regular working hours. A few access points (less than 1 percent) could not be converted and were replaced. With migration completed, the WLAN network supports all the new and enhanced features available in Cisco IOS Software.

## Lessons Learned

During the migration the team encountered several issues. In a few instances engineers had to shut down radio interfaces because of limited memory in the access points in order to push the upgrade through. Access point memory could not be upgraded, so shutting down radios was an effective and inexpensive solution.

Cisco IT staff who were authorized to make configuration changes to access points running VxWorks still needed access after the migration to Cisco IOS Software. However, at the time of the conversion, access points running Cisco IOS Software didn't support an encrypted communication method using the HTTP GUI. Concerned about security, Cisco IT disabled access for making configuration changes through the GUI, but left a Level 1 access open through the GUI.

## Next Steps

The migration to Cisco IOS Software positions Cisco for ongoing enhancements to the WLAN, including an 802.11g / 802.11a upgrade, as Cisco IT begins a hardware migration from Cisco Aironet 350 Series to Cisco Aironet 1100 Series access points. The new access points support both 802.11g and 802.11a, two separate technologies for providing higher speed wireless. Like 802.11g, the 802.11a standard supports 54-Mbps speed but uses a 5 GHz instead of 2.4 GHz bandwidth, which gives it the ability to support more wireless channels but with a smaller wireless radius. Use of 802.11a is being proposed to support greater channel availability for high-concentration areas and to support two separate wireless networks for voice and data.

CiscoWorks WLSE, currently limited to San Jose, will be deployed globally to take advantage of many new features included in the Wi-Fi Protected Access (WPA) standard, such as rogue access point detection and assisted site survey.

The Cisco Amsterdam campus is currently piloting the first Cisco Wireless LAN Services Module (WLSM), which allows secure Layer 3 roaming across wireless VLANs. Users can move from one Layer 2 VLAN to another throughout the first two floors of the Amsterdam building. The Cisco WLSM is also proving to be advantageous for wireless IP telephony. People talking on their Cisco Wireless IP Phone 7920s can move from floor to floor, and throughout the building, without losing contact because they are authenticating to another wireless VLAN.



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