White Paper

Intel Information Technology

Computer Manufacturing

Mobility Platforms and Standards

Network in a Box

Wireless LAN Architecture for Small Offices

Intel IT is developing a new wireless LAN (WLAN) architecture for small offices that accelerates network setup schedules by as much as a month and reduces costs by an estimated 43 percent over four years. We implemented our design using a single device that can supply all required network capabilities, including WLAN, LAN, WAN, and Voice over Internet Protocol (VoIP). By using WLAN as our primary connectivity method and taking advantage of new integrated network devices, we are significantly increasing our agility and productivity, eliminating excess infrastructure, and reducing costs.

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IT@Intel

Executive Summary

Intel IT is developing a new wireless LAN (WLAN) architecture for small offices that accelerates infrastructure configuration time from months to days and delivers an estimated 43 percent net present cost savings over four years. Our new architecture uses wireless as the primary connectivity method and enables us to converge data, voice, and video onto a unified network infrastructure. We implemented our design on a single device—a network in a box—that can supply all the network capabilities required by a small office, including WLAN, LAN, WAN, and Voice over Internet Protocol (VoIP).

This network solution for small offices offers several advantages over traditional LAN implementations, including:

- Reducing the timeline for setting up network infrastructure by up to a month
- Simplifying network installation to setting up a pre-configured router and plugging in cables, which requires less experienced IT personnel
- Eliminating excess infrastructure, significantly reducing wiring requirements and equipment that would be necessary for separate data, voice, and WAN networks

By implementing WLAN as the primary connectivity method and using new devices that integrate data, voice, and video, we are dramatically improving our process for setting up a small office, increasing our agility and productivity, and reducing network setup and maintenance costs. We have adopted a standards-based approach to our design, adding proprietary specifications where necessary, and we are implementing our architecture and design using the Cisco Unified Wireless Network*.

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Business Challenge

In today's business environment, companies move in and out of office spaces at a rapid pace for a variety of reasons. For example, business opportunities open up in new locations, real estate costs increase in existing locations, or the physical space no longer fit the needs of the organization. One of the major challenges of moving into a new office is setting up the infrastructure for separate data, voice, and WAN networks. Installing routers, switches, wiring, and access ports can take from weeks to months and requires a significant capital expenditure.

Intel IT is developing a new primary wireless network architecture that reduces configuration and installation time from months or weeks to several hours for small offices, reducing costs and empowering our increasingly mobile workforce. Wireless LANs are popular and have been widely deployed at Intel, generally as a secondary access method, but they also are maintained as separate networks alongside the wired LANs, which is expensive.

Figure 1 shows a traditional office setup with completely separate voice and data networks. This infrastructure requires separate wiring and equipment for each service: a private branch exchange (PBX) for voice and the switch for data services, for example.

Our new architecture and design integrates wired and wireless LAN infrastructure and establishes high-performance wireless as the primary access method, enabling us to deliver data, voice, and video to mobile users on laptops, handsets, and other devices. We implemented our design using a single device—a network in a box—that can supply all of the network capabilities required by a small office: WLAN, LAN, WAN, and VoIP.

By implementing our primary wireless architecture through a single device, we eliminated excess infrastructure and wiring and dramatically simplified network implementation. Our streamlined network setup involves installing a pre-configured router and plugging in cables, which requires less-experienced personnel, reduces installation time and costs, and increases our agility.

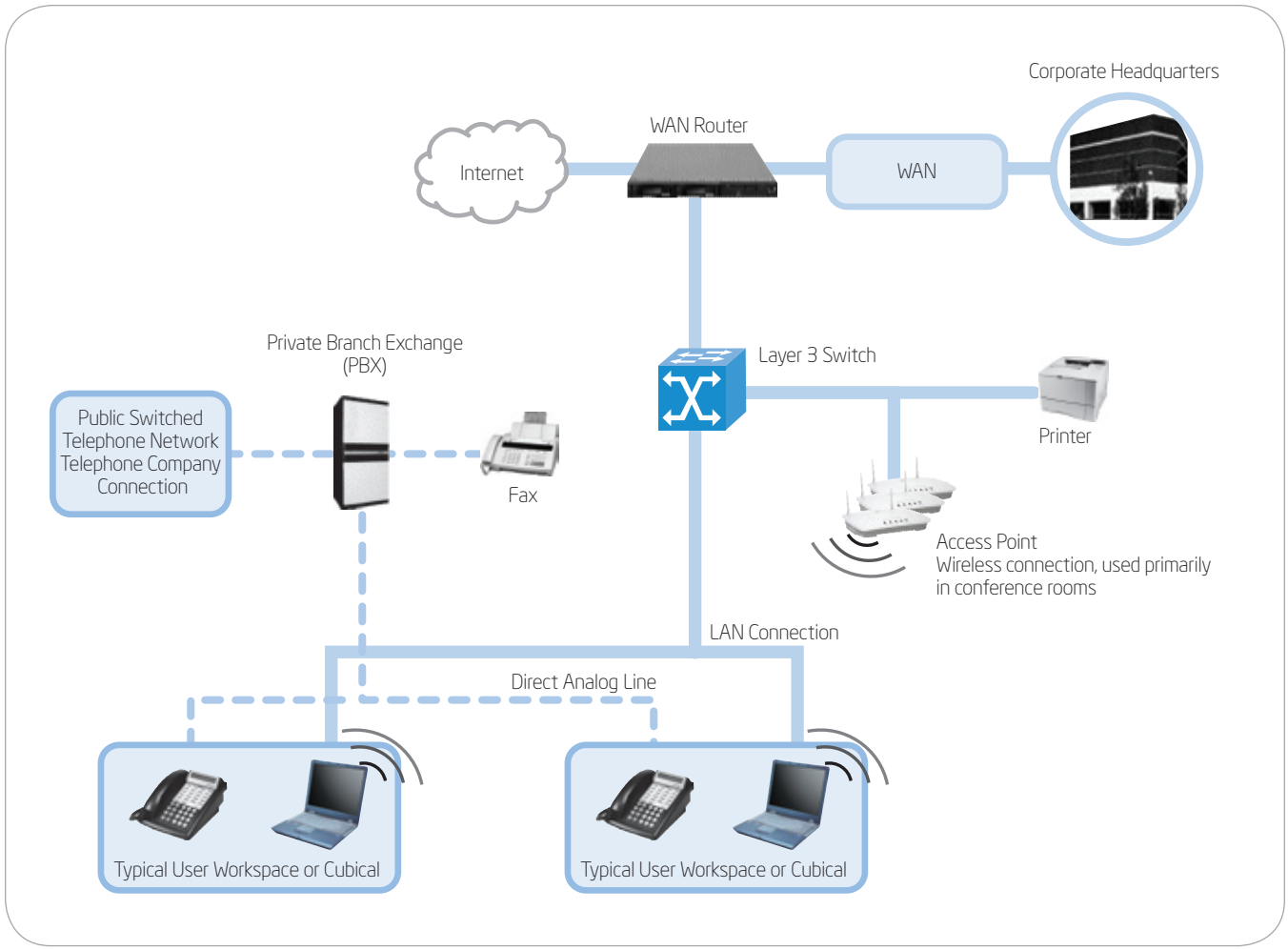


Figure 1. Traditional office network infrastructures require separate voice and data networks and wired connections to workspaces.

Solution

We determined our requirements and implemented our primarily wireless architecture and design using the Cisco Unified Wireless Network, which supports the Cisco Compatible Extensions* and the Business Class Wireless Suite* feature set developed by Intel and Cisco. We adopted a standards-based approach to our design, adding proprietary specifications where necessary.

Primary Wireless Design Requirements

Our small office primary wireless network required a device and an architecture that delivers WLAN, LAN, WAN, and VoIP. Table 1 lists the high-level requirements and capabilities we used when looking for a device to supply these integrated services.

Implementation

We chose the Cisco 3845 Integrated Services Router* as the best match for our requirements and architecture. We used a number of optional modules for this router:

- 48-port power over Ethernet (PoE) Fast Ethernet switch module for supplying the required LAN ports capabilities and connecting the WLAN access points
- Call Manager Express, the small office VoIP PBX solution embedded in the Cisco IOS* software
- Unity Express, a voice mail and auto-attendant module
- Wireless controller module
- Voice and fax extension module for direct connection of analog phones and fax machines

Although the Cisco 3845 Integrated Services Router has various WAN and encryption capability modules, we decided to leave WAN capabilities outside the scope of this design and use a separate router for WAN connectivity. We made this decision based on the complexity of our WAN infrastructure and a management decision to keep WAN infrastructure independent of the LAN complex. Other organizations may decide to take advantage of these modules and integrate WAN capabilities into the device.

Table 1. Requirements for Small Office Network in a Box

Wireless LAN as the Primary Connectivity Method	▪ High-availability environment that can recover from a failed access point or radio frequency interference ▪ 5 GHz 802.11a and 2.4 GHz 802.11g connectivity ▪ Support for all clients, including desktops, laptops, personal digital assistants, and Wi-Fi* phones ▪ Easy out-of-the-box installation and control of access points ▪ Central management servers for tracking and, if necessary, blacklisting clients, as well as detecting and mitigating a wide variety of security offenses
LAN Requirements	▪ Sufficient 100/1000 switch ports to support servers, printers, and other office devices; at least 10 ▪ Support for multiple virtual LANs for separate voice and data services, power over Ethernet (PoE) 802.3af, Quality of Service (QoS) 802.1p, and port authentication 802.1x ▪ Support for multiple IP routing protocols, including Routing Information Protocol (RIP) version 2, Enhanced Interior Gateway Routing Protocol (EIGRP), and Open Shortest Path First (OSPF) ▪ Server capabilities with Dynamic Host Configuration Protocol (DHCP), including vendor-specific attributes ▪ IP multicast support and Internet Group Management Protocol (IGMP) snooping
WAN Requirements	▪ Support for various WAN technologies at a cost effective price point, including asynchronous transfer mode (ATM), frame relay, and integrated services digital network (ISDN). The preferred WAN technology for deployment may depend primarily on the service provider or carrier offerings available to the site: service availability, pricing, geography, and service level agreements ▪ Sufficient bandwidth for small office sites, typically between 1 and 45 megabits per second (Mbps) ▪ QoS packet classification and marking ▪ Encryption using IP Security (IPsec) ▪ Multicast support ▪ Voice trunking
Voice over Internet Protocol (VoIP) Telephony Requirements	▪ Capacity for working as a standalone gatekeeper and also with remote gatekeepers ▪ Support for the most widely used codecs: G.711, G.726, G.729, and certain wideband codecs ▪ Support for Session Initiation Protocol (SIP) endpoints ▪ Emergency services call routing, voice mail functionality, automated attendant functionality, and support for conference calls
General Requirements	▪ Remote management capabilities and secure management access ▪ Support for various types of access control lists (ACLs)

Design

Figure 2 shows the logical network design for our network in a box. Access points connect to PoE capable ports in the integrated router. They receive their addresses dynamically from a Dynamic Host Configuration Protocol (DHCP) service configured on the router and they automatically detect the controller, which is integrated inside the router. An access point establishes control and data tunnels to the controller and the controller automatically configures the access point based on templates. This process provides the access point with the correct OS version, security settings, and other settings and services.

The primary wireless service is only available on the 5.2 GHz 802.11a band and is secured using full 802.11i encryption. Corporate Remote Authentication Dial in User Service (RADIUS) servers that are shared between the LAN and WLAN perform user authentication. Our legacy WLAN and virtual private network (VPN), which are provided for users who still need them, are available on the 2.4 GHz 802.11b and 802.11g band and go through on-site demilitarized zone (DMZ) firewalls for added security.

An interface, most commonly a primary rate interface (PRI), connects to the external public switched telephone network (PSTN).

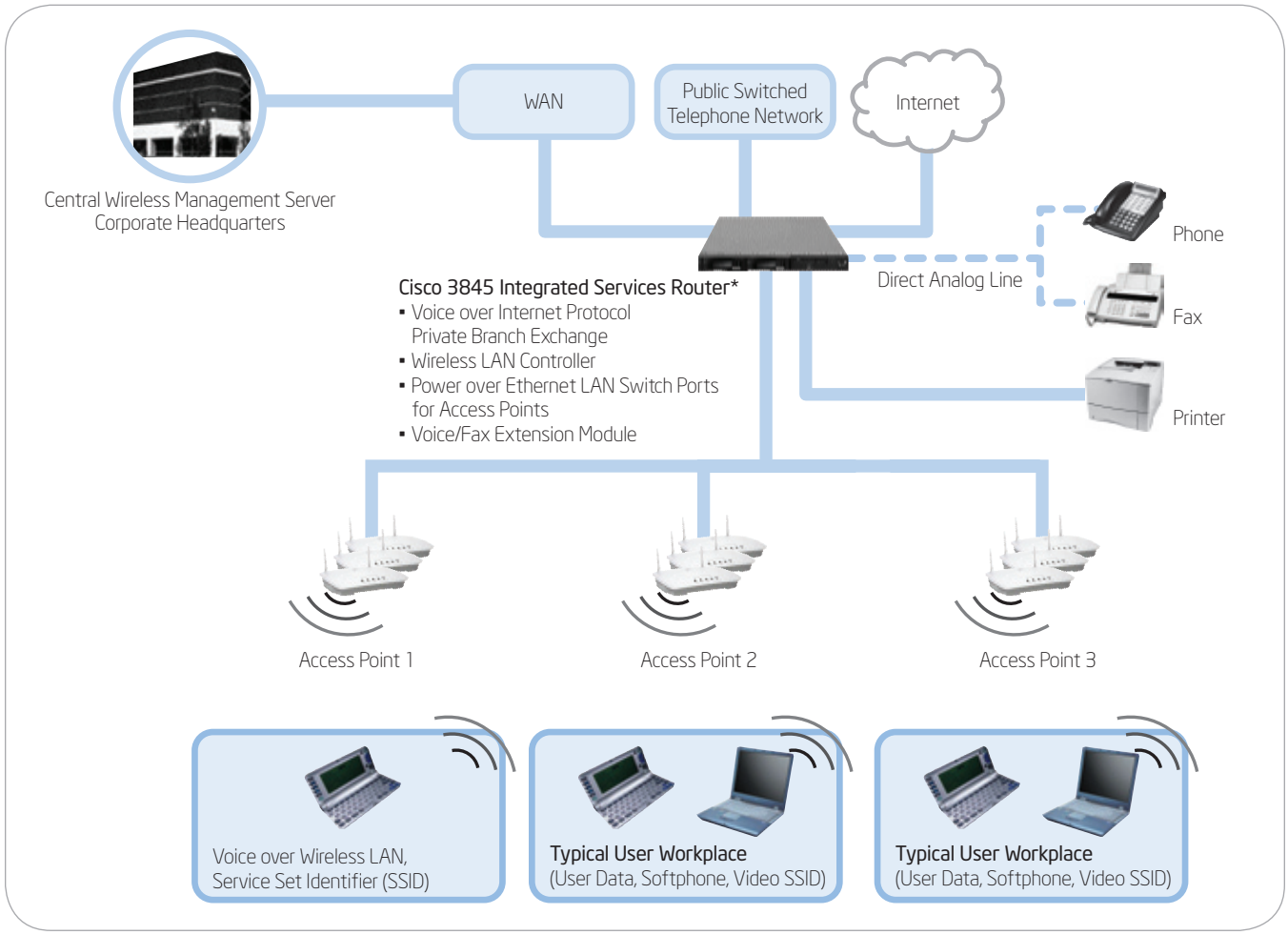


Figure 2. The logical design for the small office network in a box integrates wired and wireless LAN infrastructure and establishes high-performance wireless as the primary access method.

Wireless phones connect on a separate, dedicated service set identifier (SSID) and are given high priority through Quality of Service (QoS), and differentiated services code point (DSCP).

We can also offer softphone service on users' laptops but delivering both network and compute resource QoS creates some challenges. Intel and Cisco are working together on solutions to address the network QoS issues. Priority control software either internal or external to the OS could handle the compute resource requirement.

Analog phone and fax ports, with digital signal processing (DSP) in the background, handle the analog phones and fax machines. We can connect printers to additional switch ports on the router.

The WAN connects on an additional interface; the type is dependent on the technology available from the service provider, for example asynchronous transfer mode (ATM) or frame relay. We can add a separate, direct Internet connection or the small office can receive its Internet feed from corporate headquarters or the network hub.

Streamlining Network Setup

By implementing our primary wireless architecture in a single device, we can streamline network setup for small offices, reducing implementation timelines by as much as four weeks.

Figure 3 shows the process for setting up a small office network with this design. As managers make arrangements to lease or purchase the property, IT staff can begin to configure the integrated device. These preliminary steps take a few hours and include:

- Assigning IP address segments to meet the site requirements
- Planning the locations for the access points based on a pre-installation site survey using the wireless management system
- Creating a configuration for the router and loading it onto the device

When the building is available for occupancy, IT staff locates the router and the access points and then plugs in the access points, WAN,

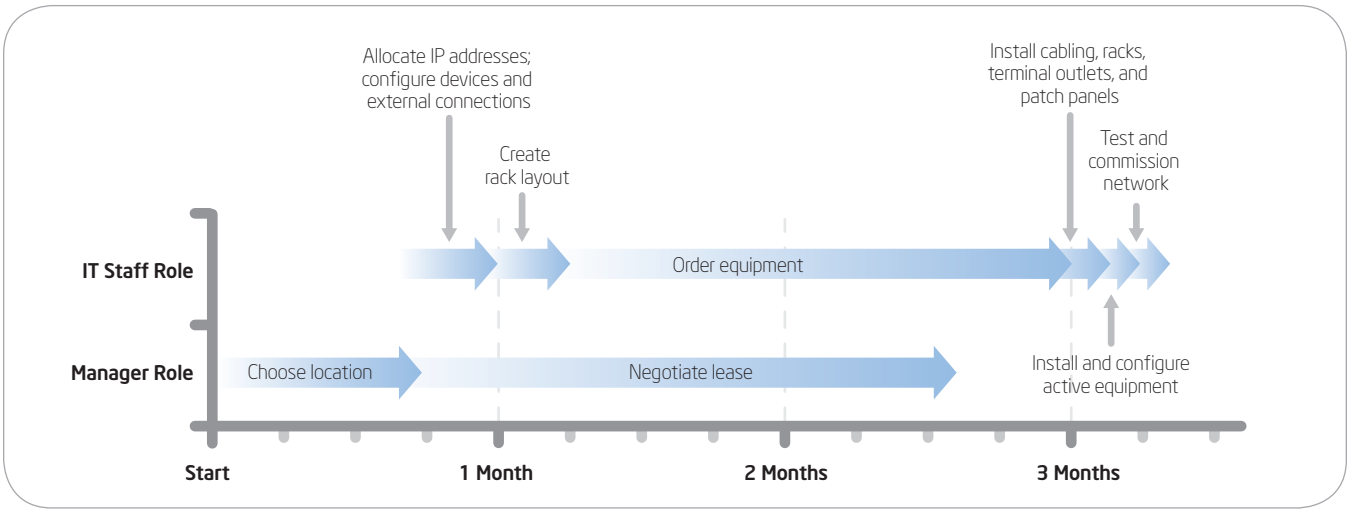


Figure 3. Setting up a small office network can be completed in a matter of hours using the wireless network in a box design.

Table 2. Comparison of Setup Times for a Small Office Network in a Box and a Traditional Wired Network

	Estimated Time	
Setup Steps	Traditional Wired Network	Office Network in a Box
1. Decide to set up a new office		
2. Choose the location	2-3 weeks	2-3 weeks
3. Develop the lease or purchase contract (occurs in parallel with steps 4, 5, and 6)	1-3 months	1-3 months
4. Create the logical design and bill of materials for the project based on the location and user requirements	1 week	1 week
5. Create cabling and rack layout design (occurs in parallel with step 4)	3 weeks	1 week
6. Order equipment	3-6 weeks	3-6 weeks
7. Install cabling, racks, terminal outlets, and patch panels	2 weeks	1 week
8. Install and configure active equipment	1 week	2 days
9. Test and commission the network	1 week	2 days
Time Savings:	About 4 weeks	

Table 3. Estimated Cost Savings for Small Office Network in a Box over Four Years

Design	Net Present Cost in U.S. Dollars
Traditional Wired Setup	USD 104,000
Small Office Network in a Box	USD 59,500
Estimated Savings:	USD 44,500 (43%)

telephone circuits, an optional Internet feed, and electricity. Since the device is pre-configured, less experienced personnel can install the network.

For very small installations, two or three access points can be placed on top of the router. Servers and other devices can be placed in close proximity to the router to limit the amount of wiring required. User areas don't require any wiring, significantly lowering the time and cost to set up the network as compared to a setting up a traditional wired network infrastructure. Table 2 shows the estimated time savings for implementing the wireless network in a box as compared to a traditional wired network for a small, 100-person office.

Cost Savings

In addition to accelerating network setup time, implementing the wireless network design also reduces net present costs by an estimated 43 percent over a four-year period.

We compared the costs of implementing our primarily wireless network design to a traditional wired setup using the following assumptions:

- Office area accommodates 100 people
- Density is one person per 10 square meters of net office area
- Traditional wired setup includes a secondary wireless network
- Voice services on the traditional wired setup use a standard time-division multiplexing (TDM) PBX
- Total costs include the initial setup cost as well as the support contract costs over four years

Table 3 shows the estimated cost comparisons and four-year net present cost savings for the office network in a box implementation.

Conclusion

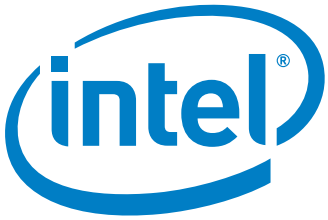
Our architecture and design offer small offices a groundbreaking network implementation using WLAN as the primary access method. With the entire infrastructure in a single device, we eliminate excess wiring, dramatically simplify network implementation, and increase agility. In addition, based on our hypothetical small office outlined above, we estimate a 43 percent savings over four years in network setup and maintenance costs by using the small office network in a box instead of a traditional wired setup. Our network in a box implementation has shown us that WLANs can achieve the performance, reliability, QoS, and manageability needed to deliver converged services, and we will continue to investigate new applications of this technology.

Authors

Gilad Shinman is a wireless LAN engineer with Intel Information Technology.

Acronyms

ACL	access control list
ATM	asynchronous transfer mode
DHCP	Dynamic Host Configuration Protocol
DMZ	demilitarized zone
DSCP	differentiated services code point
DSP	digital signal processing
EIGRP	Enhanced Interior Gateway Routing Protocol
IGMP	Internet Group Management Protocol
IPsec	IP Security
ISDN	integrated services digital network
Mbps	megabits per second
OSPF	Open Shortest Path First
PBX	private branch exchange
PoE	power over Ethernet
PRI	primary rate interface
PSTN	public switched telephone network
QoS	Quality of Service
RADIUS	Remote Authentication Dial In User Service
RIP	Routing Information Protocol
SIP	Session Initiation Protocol
SSID	service set identifier
TDM	time-division multiplexing
VoIP	Voice over Internet Protocol
VPN	virtual private network
WLAN	wireless LAN
Wi-Fi*	wireless fidelity



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