



Wi-Fi CERTIFIED™ Makes It Wi-Fi

An Overview of the Wi-Fi Alliance Approach to Certification



Wi-Fi Alliance®
September 2006

"Lots of new technologies claim to be transformative, productivity-enhancing and liberating. But only a few really live up to those claims. One of them is Wi-Fi, the wireless networking technology that has truly revolutionized the way people use the Internet."

Walter S. Mossberg, Wall Street Journal, August 10, 2006

About the Wi-Fi Alliance

The Wi-Fi Alliance is a global, non-profit industry association of hundreds of member companies devoted to promoting the growth of wireless Local Area Networks (WLANs). With the aim of enhancing the user experience for mobile wireless devices, the Wi-Fi Alliance's testing and certification programs ensure the interoperability of WLAN products based on the IEEE 802.11 specification. Since the introduction of the Wi-Fi Alliance's certification program in March 2000, thousands of products have been designated as Wi-Fi CERTIFIED™, encouraging the expanded use of Wi-Fi products and services across the consumer and enterprise markets.

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Executive Summary

Wi-Fi Alliance certification has been a key driver for worldwide Wi-Fi adoption. Wi-Fi CERTIFIED devices have been tested for interoperability to improve the user experience. Consumers show a clear preference for Wi-Fi CERTIFIED devices and many enterprise users require Wi-Fi Alliance certification.

Wi-Fi CERTIFIED products offer benefits to all players in the value chain. Certified interoperability supports lower return rates, reduced support costs, higher consumer satisfaction and increased sales volumes. High volumes lead to economies of scale and lower product costs that can then be passed along from component vendors to systems manufacturers and on to end users.

The Wi-Fi Alliance certification program has been a catalyst for the industry because it has led to a positive user experience. The Wi-Fi Alliance approach to certification is based on principles that help ensure interoperability, backward compatibility and innovation.

Wi-Fi was initially a technology found predominantly in laptops, PC cards, access points and wireless routers. This is changing rapidly, with an increasing number of phones, PDAs, consumer electronics devices, printers, and all manner of mobile and stationary devices now available with embedded Wi-Fi connectivity. Wi-Fi Alliance certification has evolved to meet the specific requirements introduced by these new devices and the applications they support. Recently added certification programs, such as Wi-Fi Multimedia (WMM[®]) and WMM Power Save, are ideal for mobile phones, consumer electronics, and real-time applications.

The first Wi-Fi CERTIFIED product was announced in 2000. Since then thousands of products have been certified and numerous certification programs have been launched. Certification programs include basic connectivity, security, authentication, and Quality of Service (QoS). Some of the most anticipated programs that will be introduced in the future are in the areas of simplified setup of security-enabled home networks, radio performance, convergence with cellular, and high throughput.

This white paper explains some of the unique elements of the Wi-Fi Alliance certification program and the certification process, and provides insight into how the program is evolving.

If you have questions about the Wi-Fi Alliance certification program please send an email to: certifications@wi-fi.org.

Introduction

Wi-Fi has been an unconditional success story—one that has taken the industry by surprise and that continues to exceed industry expectations. The Wi-Fi Alliance brand is widely recognized and respected. In a recent survey conducted for the Wi-Fi Alliance, Sentient Services found that 54% of U.S. respondents and 44% of Japanese ones were familiar with the Wi-Fi CERTIFIED mark. Respondents stated that the key reasons to choose Wi-Fi CERTIFIED products over ones that lack certification include demonstrated interoperability, reliability, security and signal strength. In another survey conducted by Kelton Research on behalf of the Wi-Fi Alliance, 79% of respondent chose their Wi-Fi over their fixed phone and 80% chose Wi-Fi over their iPod[®] ¹.

A key driver to adoption is Wi-Fi Alliance certification which helps ensure interoperability among equipment vendors. A Wi-Fi CERTIFIED device helps to ensure a positive user experience in a Wi-Fi network, whether at home, at work or at hotspots worldwide.

The scope of Wi-Fi Alliance certification has broadened as Wi-Fi technology has matured and become more popular. The need for interoperability has increased as Wi-Fi is now embedded not only in access points, wireless routers and laptops, but also phones, PDAs, printers, game consoles and other consumer electronics devices. Wi-Fi must now support new applications that have strict content delivery and performance requirements, such as Voice over IP (VoIP), gaming and content streaming. Wi-Fi networks now support diverse functionality and must be capable of operating in more complex environments, where a higher number and variety of devices have to coexist and interoperate.

Since Wi-Fi Alliance certification started in 2000, more than 10 certification programs have been launched and more than 3,400 products have become Wi-Fi CERTIFIED (Figure 1).

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¹ Survey conducted by Kelton Research in June 2006 on behalf of the Wi-Fi Alliance.

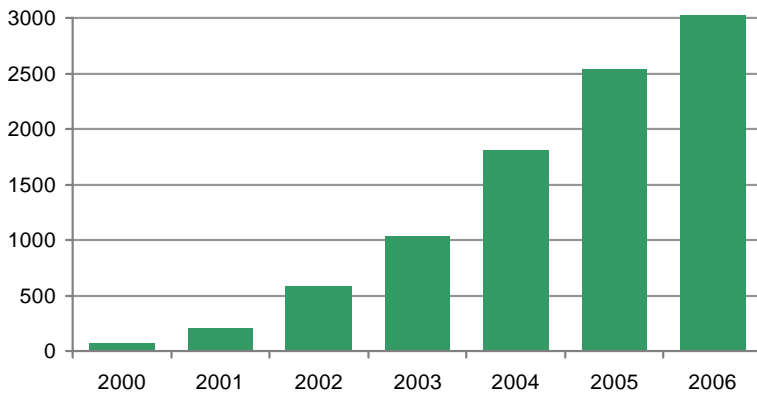


Figure 1. Cumulative number of Wi-Fi CERTIFIED devices as of August 2006

Certification initially focused on fundamental PHY and MAC functionality (IEEE 801.11b) to ensure basic connectivity and interoperability. It moved then to include:

- Security: Wi-Fi Protected Access (WPA) and Wi-Fi Protected Access 2 (WPA2), with Extensible Authentication Protocol (EAP) and Extended EAP for authentication
- Increased throughput: IEEE 802.11g and IEEE 802.11a
- QoS: Wi-Fi Multimedia (WMM)
- Power conservation: WMM Power Save.

Certification will soon include support for simplified network setup supporting advanced security features (Wi-Fi Protected Setup™) and measurement of radio performance for Wi-Fi mobile converged devices.

This white paper presents an overview of Wi-Fi Alliance certification. It outlines the benefits this program brings to the industry and describes the Wi-Fi Alliance approach to certification. It also provides additional information on the process of certification and the certification programs available. Finally, this paper outlines the evolution of Wi-Fi certification to support new functionality, devices and applications. More information on specific programs may be obtained from documents listed in the “Additional Resources” section.

The Benefits of Wi-Fi CERTIFIED Products

Wi-Fi certification benefits all the players in the value chain. Some of the most commonly encountered benefits are listed in Table 1. Equipment users can easily identify certified products by the Wi-Fi CERTIFIED logo (Figure 2) often displayed on the product packaging. A more detailed Certificate of Interoperability (Figure 3), available for viewing on the Wi-Fi Alliance web site and often included with product documentation, provides additional information about product functionality for technologists and discerning buyers.

The Wi-Fi Interoperability Certificate is important for vendor equipment, service providers and users worldwide, and is becoming increasingly crucial for them to succeed in the Wi-Fi market. Enterprise customers, governments and certain vertical markets routinely require products to be Wi-Fi CERTIFIED, while the Wi-Fi CERTIFIED logo is one of the main elements that guides purchase decisions among consumer users.

Value chain player	Benefits of Wi-Fi CERTIFIED equipment
Chipset designers, Original Design Manufacturers (ODMs)	Interoperability among Wi-Fi CERTIFIED equipment opens a large addressable market for Wi-Fi chipset designers and ODMs, where economies of scale can significantly bring costs down. Wi-Fi integration in devices with multiple wireless interfaces is an emerging and attractive market for chipset designers and ODMs and one that requires certified devices, as interoperability is an essential requirement.
Original Equipment Manufacturers (OEMs)	Certification helps ensure interoperability with other equipment vendors' products and allows OEMs a further measure to test quality in their equipment before introducing it into the market, thus reducing overall support costs. Wi-Fi CERTIFIED branding enables worldwide recognition and facilitates entry into new markets.
Application developers	The global reach of Wi-Fi means that applications that support Wi-Fi can be marketed worldwide, lowering development costs and enlarging the addressable market. Wi-Fi Alliance certification programs such as WMM, WMM Power Save, and Wi-Fi Protected Setup provide additional functionality that enables application developers to bring more advanced applications to market.
Service providers	Certification brings interoperability to large-scale deployments. Support for Wi-Fi devices is streamlined, even in multi-vendor deployments, helping to contain costs. High awareness of the Wi-Fi CERTIFIED brand among subscribers and can increase marketing impact of new product offerings.
Retailers	The Wi-Fi CERTIFIED logo is conducive to higher sales and higher customer satisfaction, supporting lower return rates and customer service costs. It also helps sales representatives to direct customers to the appropriate product and to identify the functionality it supports.
Enterprise customers	Whether deploying a new infrastructure or integrating new equipment into an existing infrastructure, using Wi-Fi CERTIFIED products ensures interoperability of Wi-Fi products from multiple vendors. Fewer network problems and support calls are also often cited as additional advantages of Wi-Fi CERTIFIED products.
Consumer users	Wi-Fi CERTIFIED is a trusted brand that offers interoperability, standards-based security, easy installation, and reliability. It is an assurance that an independent third party has tested the product in numerous configurations and with a diverse sampling of other devices to ensure compatibility with other Wi-Fi CERTIFIED equipment.

Table 1. Benefits of Wi-Fi CERTIFIED products by value chain player



Figure 2. Wi-Fi CERTIFIED Logo

Wi-Fi® Interoperability Certificate
Certification ID: WFA4853

This certificate indicates the capabilities and features that successfully completed interoperability testing by the Wi-Fi Alliance. You may find detailed descriptions of these features at www.wi-fi.org/certification_programs.php.

Certificate Date: April 30, 2007
Category: Reference Design (please select secondary categories)
Company: White Lion
Product: product_name
Model/SKU #: model_number/sku

This product has the following Wi-Fi Certifications:

IEEE Standard	Security	Multimedia	Special Features
IEEE 802.11a IEEE 802.11b IEEE 802.11g IEEE 802.11n draft 2.0 IEEE 802.11h IEEE 802.11d	WPA™ - Enterprise, Personal WPA2™ - Enterprise, Personal EAP Type(s) EAP-TLS EAP-TTLS/MSCHAPv2 PEAPv0/EAP-MSCHAPv2 PEAPv1/EAP-GTC EAP-SIM	WMM™ WMM Power Save	CWG-RF Profile (contact manufacturer for results) Wi-Fi Protected Setup™ PIN PBC

For more information: www.wi-fi.org/certification_programs.php

Figure 3. Wi-Fi Interoperability Certificate

Moving Beyond the Laptop

Wi-Fi was initially developed as a technology that would offer the same functionality as Ethernet® using a wireless interface. Laptops, PCs and access points—the main devices on Ethernet networks—initially were the primary devices targeted by the equipment vendors.

Things have changed dramatically since then. The satisfaction of Wi-Fi enabled laptop users, the low cost of Wi-Fi modules, vast number of Wi-Fi hotspots, and the expectation from the user community that the technology can deliver even more have pushed equipment vendors to look beyond laptops to develop a new wave of products that includes fixed and mobile phones, PDAs, game consoles, cameras, handheld computers, and countless fixed and mobile devices (Figure 4).

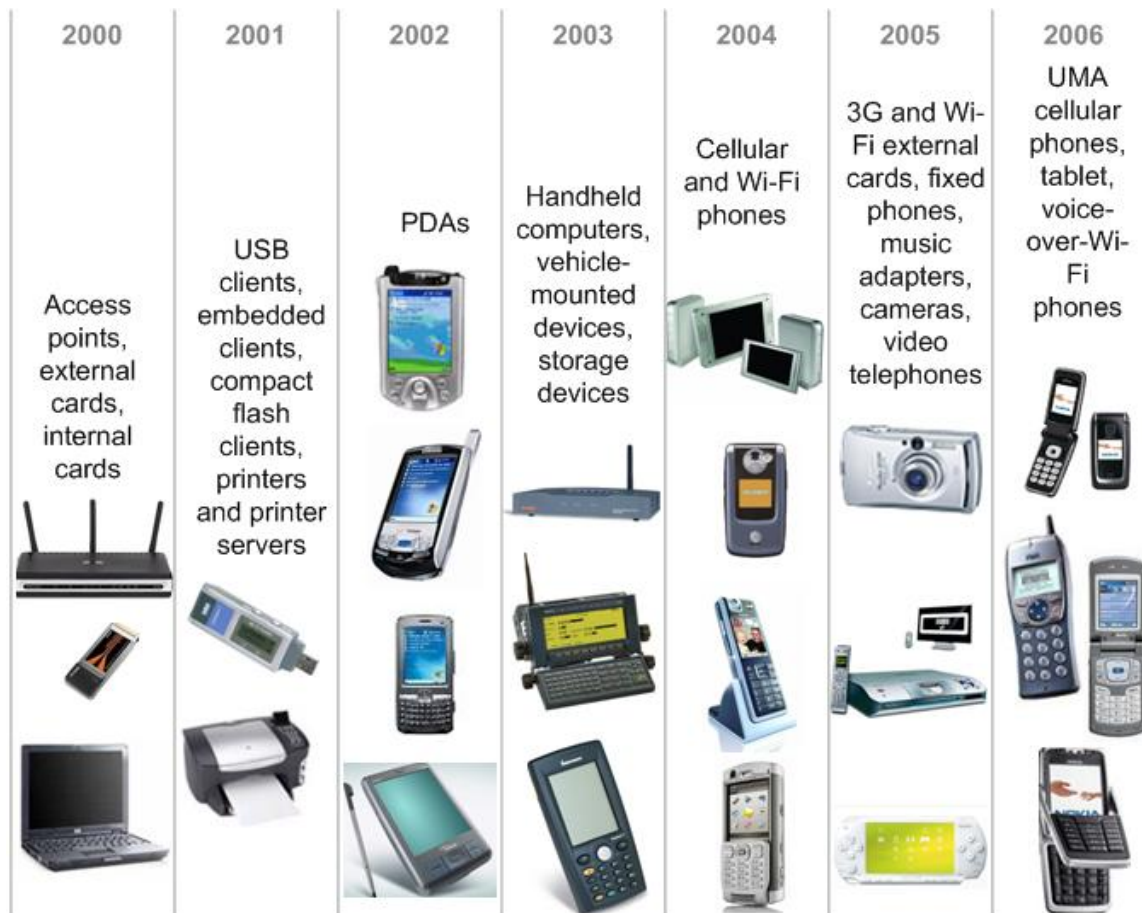


Figure 4. The evolution of Wi-Fi CERTIFIED devices

New devices mean new applications to support and new requirements to satisfy. For instance, voice devices promote the use of Voice over Wi-Fi (VoWi-Fi) applications, which require low latency, jitter and packet loss, as well as advanced power save mechanisms and robust security. Certification programs such as WMM, WMM Power Save and WPA2 address these requirements and ensure that real-time applications such as VoWi-Fi are supported. In the future, a certification program that includes IEEE 802.11n functionality will also ensure the availability of the throughput needed to support the higher traffic levels generated by the expansion of local area networks (such as is increasingly the case in the average home) and by the extensive growth in IP video and audio traffic.

The Wi-Fi Alliance Approach to Certification

The paramount goal of Wi-Fi Alliance certification is to help ensure a great user experience. This focus on user experience has shaped the overall approach of the Wi-Fi Alliance certification program: Wi-Fi CERTIFIED products have to demonstrate that they can perform well in networks with other Wi-Fi CERTIFIED products, running common applications, in situations similar to those encountered in everyday use.

This pragmatic approach stems from three tenets, around which certification is centered:

- **Interoperability** is the primary target of certification. Rigorous test cases are used to ensure that products from different equipment vendors can interoperate in a wide variety of configurations.
- **Backward compatibility** has to be preserved to allow for new equipment to work with existing gear. Backward compatibility protects investments in legacy Wi-Fi products and enables users to gradually upgrade and expand their networks.
- **Innovation** is supported through the introduction of new certification programs as the latest technology and specifications come into the marketplace. These certification programs may be mandatory (e.g. WPA2) or optional (e.g. WMM). Equipment vendor differentiation and inventiveness are preserved in areas that are not covered by certification testing.

The Wi-Fi Alliance definition of interoperability goes well beyond the ability to work in a Wi-Fi network. To gain certification under a specific program, products have to show satisfactory performance levels in typical network configurations and have to support both established and emerging applications. A user that purchases a Wi-Fi enabled laptop, for instance, would not be satisfied if the laptop established a connection with the home network, only to get the throughput of a dial-up connection. Similarly, subscribers using a Wi-Fi enabled mobile phone would be disappointed if they had a high-speed connection but the quality of the call could not be guaranteed.

The Wi-Fi Alliance certification process includes three types of tests to ensure interoperability. Wi-Fi CERTIFIED products are tested for:

- **Compatibility:** certified equipment has been tested for connectivity with other certified equipment. Compatibility testing has always been, and still is, the predominant component of interoperability testing, and it is the element that most people associate with “interoperability”. It involves tests with multiple devices from different equipment vendors. Compatibility testing is the program component that helps to ensure devices purchased today will work with Wi-Fi CERTIFIED devices already owned or purchased in the future.
- **Conformance:** the equipment conforms to specific critical elements of the IEEE 802.11 standard. Conformance testing usually involves standalone analysis of individual products and establishes whether the equipment responds to inputs as expected and specified. For example, conformance testing is used to ensure that Wi-Fi equipment protects itself and the network when the equipment detects evidence of network attacks.
- **Performance:** the equipment meets the performance levels required to meet end-user expectations in support of key applications. Performance tests are not designed to measure and compare performance among products, but simply to verify that the product meets the minimum performance requirements for a good user experience as established by the Wi-Fi Alliance. Specific performance tests results are not released by the Wi-Fi Alliance.

The introduction of new applications and devices is continuously expanding the concept of interoperability and raising performance requirements. For instance, data applications such as web surfing and email tolerate higher latencies than real-time applications like voice and video. The increasing importance of these applications has led not only to the introduction of new certification programs, but also to an increased emphasis on conformance and performance testing.

The Process of Certification

Certification tests are conducted in independent Wi-Fi Alliance Authorized Test Laboratories (ATLs) that are located in different regions to facilitate vendor access (**Figure 5**). In addition, the Wi-Fi Alliance Technical Operations group research and development laboratory oversees the Wi-Fi Alliance certification programs and coordinates activities with the ATLs.

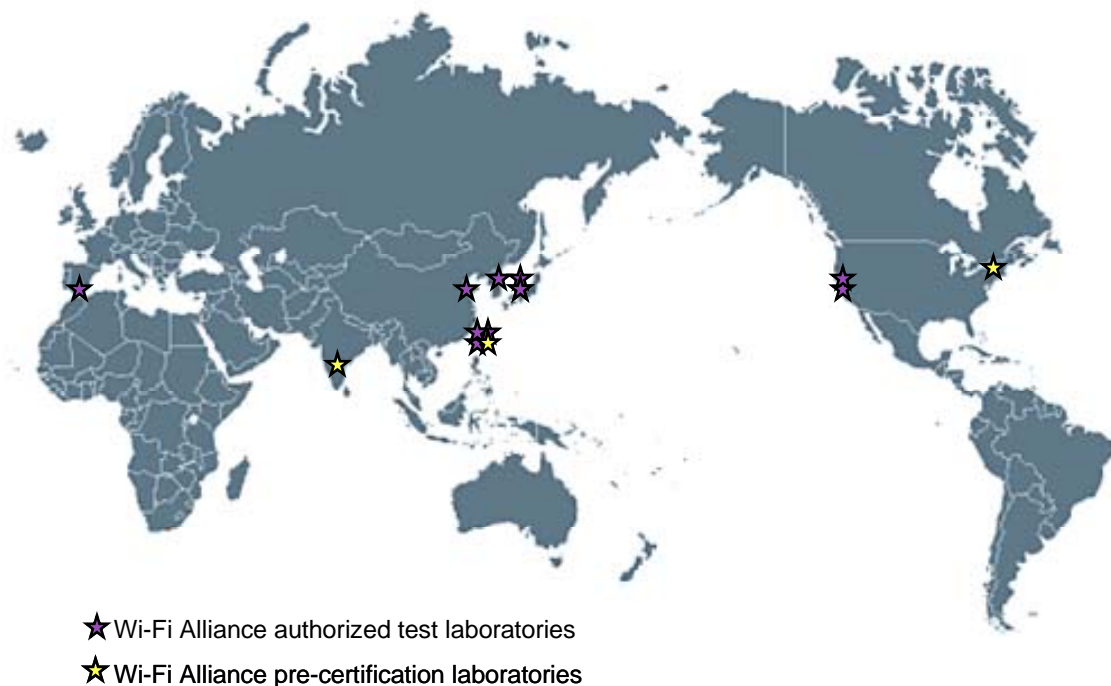


Figure 5. Worldwide locations of Wi-Fi Alliance Authorized Test Laboratories, as of August 2006

Equipment vendors receive a Wi-Fi Interoperability Certificate (Figure 3) that indicates the certification tests that their product passed. Additional information about Wi-Fi Alliance certification and a database of Wi-Fi CERTIFIED products are available at <http://www.wi-fi.org>.

Certification Programs

The Wi-Fi Alliance supports multiple certification programs as shown in Table 2. Some programs are mandatory as they cover basic functionality such as the wireless interface or security. Others are optional since the functionality they support is required only by some devices or applications.

Certification program	Start date	Mandatory/ optional	Standard version	Description
IEEE 802.11b	2000	Mandatory (one of 802.11 a, b, or g)	IEEE 802.11b	Wireless interface
IEEE 802.11g	2001		IEEE 802.11g	Wireless interface Requires IEEE 802.11b
IEEE 802.11a	2002		IEEE 802.11a	Wireless interface
IEEE 802.11n draft 2.0	2007	Optional	IEEE 802.11n draft 2.0	Wireless interface
IEEE 802.11d	2004	Optional	IEEE 802.11d	Regulatory requirements
IEEE 802.11h	2004	Optional	IEEE 802.11h	Regulatory requirements
WPA – Personal, Enterprise [2] [4] [6] [7]	2001	Mandatory	Based on a subset of IEEE 802.11i elements	Security Mandatory since 2003
WPA2 – Personal, Enterprise [2]	2003	Mandatory	IEEE 802.11i	Security Mandatory since 2006
EAP, vendor-specific EAP	2005	Mandatory	N/A	Security Mandatory since 2006 Includes EAP-TLS, EAP-TTLS / MSCHAPv2, PEAPv0 / EAP-MSCHAPv2, PEAPv1 / EAP-GTC, EAP-SIM
WMM [5]	2004	Optional	Based on a subset of IEEE 802.11e elements	QoS and Wi-Fi and mobile convergence
WMM Power Save [3]	2005	Optional	Based on a subset of IEEE 802.11e elements	QoS, Wi-Fi and mobile convergence, and power saving Requires WMM

Table 2. Wi-Fi certification programs

Certification indicates that a product has been tested and demonstrated to interoperate with other Wi-Fi CERTIFIED products. Products certified under optional programs have been tested and demonstrated to be interoperable with other Wi-Fi CERTIFIED products but they can take advantage of the optional capabilities only when they operate in networks that support those optional capabilities. For instance, a handset can use WMM functionality only if both the handset and the access point or wireless router have been Wi-Fi CERTIFIED for WMM support.

The Evolution of Wi-Fi Alliance Certification

Wi-Fi Alliance certification is constantly evolving to ensure that Wi-Fi CERTIFIED products include the latest enhancements to the IEEE 802.11 standard and to support a growing set of applications and devices. As a result, Wi-Fi functionality is extended and its performance improved, while retaining backward compatibility with legacy Wi-Fi CERTIFIED products.

The work of the IEEE 802.11 working group in areas that include enhancements in performance, security and roaming will keep Wi-Fi technology steadily improving. Among the most anticipated enhancements is IEEE 802.11n which will bring increases in throughput enabled by MAC and PHY technology innovations.

Wi-Fi users have grown accustomed to the basic data functionality that Wi-Fi affords them. They have started to use Wi-Fi in new applications and devices and expect to have the same satisfactory experience as with their laptops. These new applications and devices, and the end user expectation of Wi-Fi in them, are the main drivers for the development of new Wi-Fi Alliance certification programs.

Most emerging applications have a real-time component that translates into more stringent performance and conformance requirements. This has created a gradual shift towards an increased emphasis on these test areas in Wi-Fi Alliance certification and in the development of specific new programs designed to improve performance so that Wi-Fi CERTIFIED products can support these new applications.

Wi-Fi and mobile convergence is driving further evolution in Wi-Fi Alliance certification. The introduction of Wi-Fi mobile phones and PDAs is pushing certification beyond the realm of Wi-Fi as these devices host multiple wireless interfaces and switch between them as necessary. For instance, with an Unlicensed Mobile Access (UMA) phone subscribers can make and receive calls using the local Wi-Fi network and maintain an active call as they move between their Wi-Fi network and the cellular macro radio access network.

The need for multiple wireless interfaces to coexist peacefully and to support seamless connectivity, such as handoffs from one to the other, poses challenges for product certification and industry growth. Multiple certification bodies are coordinating efforts and, in some cases cooperating, to test how different interfaces interact with each other. For example, the Wi-Fi Alliance has developed jointly with CTIA a program to test Wi-Fi and cellular phone performance, including transmit power, receive sensitivity and antenna performance. The test plan was released on September 2006 and testing will start during Q4 2006. This performance test program is designed to assist service providers in the selection of subscriber devices. Such a collaboration model may be duplicated in the future as Wi-Fi penetrates new markets. The Wi-Fi Alliance is already involved in partnerships with several other industry organizations such as the Digital Network Living Alliance (DNLA) and the Fixed-Mobile Convergence Alliance (FMCA).

Continued efforts to enhance the user experience are now leading to new certification initiatives on network setup and security. The Wi-Fi Alliance will soon introduce a certification program on Wi-Fi Protected Setup, which simplifies Wi-Fi network setup with security features enabled. Wi-Fi Protected Setup will offer a more intuitive network setup that will be standard across equipment vendors. This will benefit consumers using Wi-Fi devices for the first time as well as seasoned users deploying or expanding more complex networks that may even include a variety of consumer electronics and phones.

Conclusions

The success of Wi-Fi Alliance certification has been one of the key drivers to Wi-Fi adoption worldwide. Users have the confidence that Wi-Fi CERTIFIED products will work seamlessly with other Wi-Fi CERTIFIED products. The Wi-Fi Alliance certification focuses on real-world conditions by testing equipment interoperability with market-ready products, by running common applications, and by keeping certification close to the requirements of the equipment users. Backward compatibility helps to ensure ease of integration of new equipment into existing Wi-Fi networks and can prolong the longevity of equipment investments.

Wi-Fi is a technology that is experiencing a rapid evolution in standards, devices and applications. Wi-Fi Alliance certification programs evolve to meet and anticipate market requirements and technology advances. Wi-Fi is increasingly embedded in converged devices including mobile phones and PDAs, and a variety of consumer electronics devices such as game consoles and cameras that make more extensive use of real-time applications such as VoIP and content streaming. The most recently introduced certification programs, WMM and WMM Power Save, specifically target these new devices and applications. In the future, the Wi-Fi Alliance expects that this trend will continue, with the introduction of new certification programs driven by application and device requirements, as well as by the evolution of the IEEE 802.11 standard.

Wi-Fi Alliance certification is entirely voluntary, but equipment vendors worldwide view it as a prerequisite to market acceptance and success. Enterprise users increasingly require equipment to be Wi-Fi CERTIFIED. Consumer users have a clear preference for Wi-Fi CERTIFIED products. As it evolves to support more devices, more applications and increased performance, Wi-Fi Alliance certification is set to expand its scope and increase its benefits to all the players in the value chain.

Additional Resources

- [1] Wi-Fi Alliance (2006) Wi-Fi Mobile Convergence: The Role of Wi-Fi CERTIFIED
- [2] Wi-Fi Alliance (2005) Deploying WPA™ and WPA2™ in the Enterprise"
- [3] Wi-Fi Alliance (2005) WMM™ Power Save for Mobile and Portable Wi-Fi® CERTIFIED Devices
- [4] Wi-Fi Alliance (2005) WPA™ for the Home
- [5] Wi-Fi Alliance (2004) Wi-Fi CERTIFIED™ for WMM™ - Support for Multimedia Applications with Quality of Service in Wi-Fi® Networks
- [6] Wi-Fi Alliance (2003) Securing Wi-Fi Networks with Today's Technologies
- [7] Wi-Fi Alliance (2003) Wi-Fi Protected Access

These white papers are available at www.Wi-Fi.org

Acronyms

ATL	Authorized Test Laboratory
CTIA	Cellular Telecommunications and Internet Association
DNLA	Digital Network Living Alliance
EAP	Extensible Authentication Protocol
EAP-GTC	EAP Generic Token Card
EAP-SIM	EAP Subscriber Identity Module
EAP-TLS	EAP with Transport Layer Security
EAP-TTLS	EAP with Tunneled TLS
FMCA	Fixed-Mobile Convergence Alliance
IEEE	Institute of Electrical and Electronics Engineers
MAC	Media Access Control [Layer]
MSCHAPv2	Microsoft Challenge Handshake Authentication Protocol version 2
ODM	Original Design Manufacturer
OEM	Original Equipment Manufacturer
PDA	Personal Digital Assistant
PEAP	Protected EAP
PHY	Physical [Layer]
QoS	Quality of Service
UMA	Unlicensed Mobile Access
VoIP	Voice over Internet Protocol
VoWi-Fi	Voice over Wi-Fi
WLAN	Wireless Local Area Network
WMM®	Wi-Fi Multimedia™
WPA2™	Wi-Fi Protected Access 2™
WPA	Wi-Fi Protected Access™

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