Wi-Fi Mobile Convergence:
The Role of Wi-Fi CERTIFIED®

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on behalf of the Wi-Fi Alliance

Wi-Fi Alliance
April 2006

Executive Summary

Wi-Fi Mobile Convergence (WMC) presents mobile carriers with a unique opportunity. It allows them to offer advanced new services to their subscribers, lowering churn and increasing average revenue per user, while increasing network capacity and coverage, and improving spectrum management. Subscribers will also benefit from convergence as it brings broadband connectivity and seamless coverage to their handsets, and gives them the convenience of a single handset and lower costs. Convergence capitalizes on a widespread Wi-Fi infrastructure (millions of homes, offices and hotspots worldwide) and the affordability and versatility of the technology.

WMC devices include phones, smartphones, and other mobile terminals with both cellular and Wi-Fi interfaces, designed to access either network with ease, automatically selecting the best available network at each location. Support for handover may allow devices to switch between air interfaces without dropping a voice call.

The Wi-Fi Alliance has managed a very successful certification program since 2000 that supports end users with out-of-the-box interoperability among vendors. Initially it was geared towards data applications in laptops, but with the increased range of devices and applications, Wi-Fi certification has been extended to include programs that support the functionality required by WMC devices, such as Quality of Service (QoS) with Wi-Fi Multi-Media™ (WMM™), power saving with WMM Power Save, and security with Wi-Fi Protected Access 2™ (WPA2™) and Extensible Authentication Protocol (EAP).

A comprehensive certification initiative for converged devices, developed exclusively to meet the requirements of WMC devices and to simplify their certification process, is planned for release later in 2006.

Prior to April 2006, the Wi-Fi Alliance certified more than 20 converged handsets via its Application Specific Device (ASD) program, which was developed to accommodate Wi-Fi enabled devices that lack a traditional PC operating system and uses customized test plans, developed by the manufacturer in conjunction with the Wi-Fi Alliance.

The success of WMC devices will be further strengthened by collaborative relationships between the Wi-Fi and the cellular industries on issues such as handover, radio performance, power consumption, interference, and roaming that affect both the cellular and the Wi-Fi infrastructure. The Wi-Fi Alliance is committed to establishing liaison relationships with cellular associations and standards bodies and to continuing its current collaboration with the Fixed-Mobile Convergence Alliance (FMCA), the Cellular Telecommunications and Internet Association (CTIA) and the Open Mobile Alliance (OMA).

About the Wi-Fi Alliance

The Wi-Fi Alliance is a global, non-profit industry association of more than 250 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, more than 2,500 products have been designated as Wi-Fi CERTIFIED®, encouraging the expanded use of Wi-Fi products and services across the consumer and enterprise markets.

About Senza Fili Consulting

Senza Fili Consulting (www.senzafiliconsulting.com) provides advisory support on wireless data technologies and services. Our expertise extends to cellular communications, WiMAX, Wi-Fi, and other fixed and mobile Broadband Wireless Access (BWA) technologies. We assist vendors in gaining a better understanding of the service provider and end-user markets. We work alongside service providers in developing a wireless data strategy and in assessing the demand for wireless services. Independent advice, a strong quantitative backing, and an international perspective are the hallmarks of our work.

At Senza Fili we have in-depth expertise in financial modeling, market forecasts and research, white paper preparation, business plan support, due diligence, training, and evaluation of end-user requirements. Our clients are international and span the entire value chain: they include fixed and mobile operators, ISPs, wireless ISPs, other service providers, vendors, solution providers, system integrators, investors, and industry associations.

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Introduction

Wi-Fi and cellular networks are rapidly converging, opening the way for innovative services and usage scenarios that benefit both end users and mobile carriers[1]. The Wi-Fi Alliance is a strong proponent of Wi-Fi Mobile Convergence (WMC) and has prioritized efforts to make the integration of Wi-Fi and mobile devices easier and to improve the performance of the voice and multimedia applications that are at the core of converged services.

The Wi-Fi Alliance manages robust testing and certification programs. It plans to introduce new programs specifically designed for converged devices that will meet the requirements of carriers and manufacturers. Furthermore, the Wi-Fi Alliance has taken on a pivotal role in cross-industry partnerships aimed at creating an ecosystem where different wireless technologies can successfully coexist and benefit from each other.

This white paper discusses the main drivers behind WMC and role of the Wi-Fi Alliance in promoting WMC through its certification programs and its collaboration initiatives with industry and standards associations.

What is Wi-Fi Mobile Convergence?

Wi-Fi offers wireless broadband connectivity in the local area networks found in the home, enterprise and public hotspots. Mobile cellular networks provide wide area coverage with a more limited throughput. WMC combines the strengths of both Wi-Fi and cellular networks to expand the functionality of mobile devices like phones, smartphones and PDAs.

A converged phone can use Wi-Fi where available and the cellular network nearly everywhere else (Figure 1). The phones are designed to seamlessly switch to the cellular network when Wi-Fi is not available, without requiring subscriber intervention. The phone can also switch between networks if congestion occurs. For example, at home or in the office, a Wi-Fi handset can provide connectivity in areas with limited cellular coverage.

The integration of Wi-Fi and cellular networks extends beyond data to voice calls. Converged mobile devices may support voice over Wi-Fi and, with Unlicensed Mobile Access (UMA) or Session Initiation Protocol (SIP), they can be tightly integrated with existing cellular networks. Depending upon an individual carrier's business strategy, handover between the two networks can allow subscribers to continue a conversation without even being aware that the phone has switched between the two networks. In addition to making calls, subscribers are able to receive calls on their usual mobile number. Alternatively, on some WMC devices, end users can initiate and receive calls with third-party Voice-over-Internet Protocol (VoIP) applications, but in this case, calls

[1] For simplicity, throughout this paper we refer to mobile carriers as including Mobile Virtual Network Operators (MVNOs). MVNOs also include fixed carriers that have an MVNO agreement with a mobile carrier.

cannot be handed off to the cellular network unless the mobile carrier supports the service.

Most of the Wi-Fi traffic from converged devices is likely to be generated within private Wi-Fi networks, either in the home or in the office. Hotspots will also be magnets for mobile Wi-Fi devices, as subscribers will be able to connect to the Internet and place calls. Although most end users are unlikely to make a habit of going to the nearest hotspot to place a call, hotspot access will be attractive for long or international calls, or for bandwidth-intensive data applications.

Wi-Fi enabled mobile phones entering the market today are aimed both at business and consumer users, and are evolving towards a battery life, size and design competitive with those without Wi-Fi. With the high volume of sales expected and greater integration between Wi-Fi and cellular interfaces, it is expected that the cost of adding Wi-Fi to a handset will become negligible over time, further extending the reach of Wi-Fi among mobile devices.

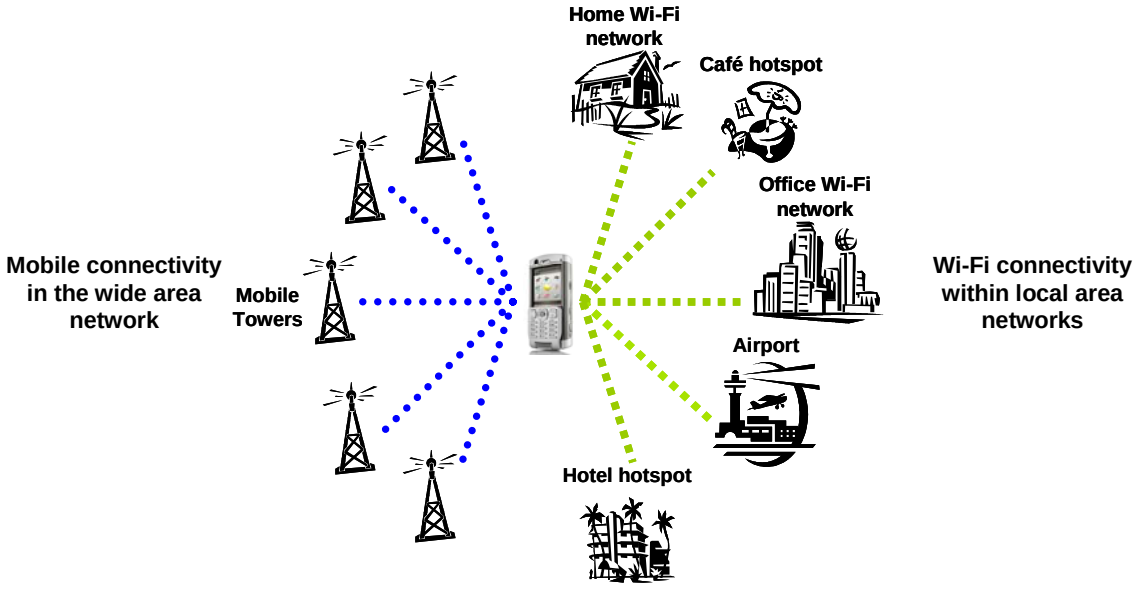


Figure 1. Wi-Fi and mobile convergence

Why Wi-Fi Mobile Convergence?

Wi-Fi was initially created as a data technology, optimized for Internet access and other applications that require a best-effort broadband connection, typically run from a laptop computer. The huge success of Wi-Fi and the subsequent ubiquity and low cost of Wi-Fi devices and infrastructure has made Wi-Fi the ideal candidate for both emerging applications that require real-time connectivity (such as VoIP, video and audio streaming and gaming) and for new mobile devices (phones, smartphones, PDAs, game stations and other consumer electronic devices).

End-users have grown increasingly comfortable in using Wi-Fi unlicensed spectrum bands for high-priority and real-time applications, as well as basic data access. The trend towards managed networks in the enterprise and hotspot environments further

eases concerns about unlicensed spectrum as they provide additional control of the network in terms of access, security, and interference.

Wi-Fi has rapidly developed in response to the demand to support converged applications and devices. Three key enablers of convergence emerge:

- **Quality of Service (QoS).** Wi-Fi now supports QoS through the 802.11e-based Wi-Fi Multimedia™ (WMM™) program. It enhances support for real-time applications such as voice, video and audio streaming, or gaming, by making it possible to prioritize traffic from different applications.

- **Advanced power save mechanisms.** WMM Power Save significantly extends the battery life of Wi-Fi mobile devices and paves the way for the mass adoption of Wi-Fi in mobile phones and other devices with multiple wireless interfaces.

- **Security.** The mandatory Wi-Fi Protected Access 2™ (WPA2™) certification, and optional Extensible Authentication Protocol (EAP) certification for enterprise and public access devices bring advanced security to Wi-Fi devices, which is a requirement for mobile devices that are more difficult to protect than PCs.

These technological advances have enabled a much more robust support of WMC devices that meet the stringent requirements of mobile carriers for both voice and data. In addition, mobile carriers and end users alike greatly value the potential interoperability, out-of-the-box simplicity of use, low cost, and wide availability of Wi-Fi CERTIFIED devices that have driven adoption since WMC devices first became available. The arrival of both advanced WMC handsets supporting rich content applications for early adopters and less expensive ones aimed at the larger consumer market, has also encouraged mobile carriers to plan for converged services that appeal to both the consumer and business market segments (**Figure 2**).

Figure 2. Examples of WMC devices

The market for WMC devices is expected to grow rapidly, fueled by a synergy of demand from both mobile carriers and mobile subscribers. Support of WMC from mobile

carriers is crucial to market adoption because to a large extent they control which devices their subscribers use. Most mobile carriers in developed markets are expected to offer WMC devices within the next year and some have announced WMC services that integrate Wi-Fi data access and voice services with their cellular networks. BT Fusion in the UK and T-Mobile in Germany are among those carriers who have announced a roll out of WMC services over the next few months. Many other carriers are actively involved in trials and plan to offer WMC services.

Wi-Fi benefits mobile carriers in multiple ways:

- **Efficient management of spectrum resources.** By funneling voice and data traffic through Wi-Fi networks, WMC devices reduce traffic on the cellular network, where capacity is often severely limited and expensive to increase. This is particularly important for data applications that typically place a heavier burden on the cellular infrastructure.

- **Improved in-building coverage.** Even in regions with a high density of cellular base stations, there are often areas of poor coverage, typically inside buildings. Improving coverage is expensive and often it is not a cost-effective strategy. In countries such as the U.S., limited cellular coverage is still a largely unresolved issue. With WMC devices, subscribers can still avail themselves of all the services they are accustomed to (voice, voicemail, Short Message Service (SMS) and other data applications) if a Wi-Fi network is available in areas of poor cellular coverage. Subscribers no longer have to miss calls simply because they have poor or nonexistent cellular coverage inside buildings.

- **Increased bandwidth.** Advanced applications like video or audio streaming require a high throughput rate that Wi-Fi easily supports, but which is typically unavailable in cellular networks. While cellular technologies will soon be able to support up to 2 Mbps throughput, Wi-Fi throughput ranges from five to ten times that rate, depending on network conditions and number of concurrent users. Moreover, the Institute of Electrical and Electronics Engineers (IEEE) 802.11n standard, due for ratification in late 2007, is expected to increase Wi-Fi throughput by at least four times.

- **Market segmentation.** WMC device capabilities enable mobile carriers to introduce advanced services that help to segment the market more effectively. For instance, a carrier may charge consumer subscribers less when they place or receive calls from home than when they are within other Wi-Fi networks, or offer business users free calls to their colleagues within the office.

- **Higher ARPU (Average Revenue Per User), lower churn.** The costs to transport voice and data traffic over Wi-Fi networks are lower than those for the cellular network. In addition, it is expected that the overall ARPUs will increase, as lower call and connection charges promote higher usage and accelerate the trend towards fixed-to-mobile substitution. Furthermore, the combination of mobile and Wi-Fi connectivity is a value-added service to subscribers that makes them less likely switch to another carrier.

Subscribers also stand to benefit from the addition of Wi-Fi to their mobile handsets:

- **A richer, more dynamic broadband experience.** With more affordable and accessible wireless broadband access, many subscribers will explore data applications on their mobile devices for the first time. They will be able to do so with a higher-throughput broadband connection on their phones, using the familiar Wi-Fi interface. Wi-Fi enables subscribers to access an even richer set of multimedia applications, such as content streaming and gaming, in addition to advanced voice services.

- **Seamless coverage.** Improved indoor coverage does not require intervention from the subscriber. The technology allows a device to automatically select the best network available, based on signal strength, traffic and the subscriber's preference. Different carriers are expected to follow a variety of approaches to support WMC devices. In some cases, the cellular-to-Wi-Fi handoff may be transparent to the user, while in others, the subscriber may be notified of the transition or only be able to switch to particular Wi-Fi networks (for instance, those covered by preferred roaming partnership arrangements).

- **More flexibility on call and connection charges.** In their efforts to encourage fixed-to-mobile substitution, some mobile operators may elect to pass on some of the cost savings from Wi-Fi calls to the subscribers and reduce the calling charges of traffic transported over Wi-Fi. Alternatively, they may provide different rates for calls made over a Wi-Fi network versus those made over the cellular network. This will vary from carrier to carrier.

- **One phone, one number, one bill.** Mobile subscribers have a strong attachment to their phone. A mobile phone is viewed as a personal device, which stores important contact information. If it weren't for the additional cost, many subscribers would prefer to use a mobile handset rather than a fixed one. An increasing number already use a mobile phone exclusively. Wi-Fi in the handset will accelerate the trend towards a more pervasive use of the mobile handset, especially if use within the home or office network is linked to lower costs and enhanced services. Better still, a single phone simplifies the subscriber's life: the same number can be used regardless of location and only one contract is required.

Wi-Fi CERTIFIED: Helping to Ensure Interoperability

The Wi-Fi Alliance has a strong commitment to enriching the functionality of converged Wi-Fi mobile devices and to ensure that they meet the requirements of carriers and subscribers alike. The role of the Wi-Fi Alliance goes well beyond advocacy. Since March 2000, the Wi-Fi Alliance has defined Wi-Fi test plans and has operated a certification program that helps ensure interoperability among devices from different vendors, certifying more than 2,500 products since the program's inception.

Wi-Fi certification is available for both access points and clients and includes several programs, some of which are mandatory and others optional:

- IEEE standard (air interface): 802.11 a, b, and/or g (mandatory).

- Security: WPA2 Enterprise or Personal (mandatory), depending on device designation.

- Authentication (WPA2 Enterprise devices only): Extensible Authentication Protocol with Transport Layer Security (EAP-TLS), EAP-TTLS/Microsoft Challenge Handshake Authentication Protocol version 2 (MSCHAPv2), Protected EAP (PEAPv0)/EAP-MSCHAPv2, PEAPv1/EAP Generic Token Card (EAP-GTC), EAP Subscriber Identity Module (EAP-SIM) (All EAP methods supported by a device are tested and must pass, though vendor-specific certification is available as an option).

- QoS: WMM (optional).

- Power saving: WMM Power Save (optional, requires WMM certification).

- Regulatory requirements: 802.11d/h (optional).

Certification tests are conducted in independent Authorized Test Labs of the Wi-Fi Alliance. Certification indicates that the product interoperates with all Wi-Fi CERTIFIED products.

Products certified under optional programs are interoperable with all Wi-Fi CERTIFIED products but can only take advantage of the additional capabilities when both the access point and the subscriber device support them and have them activated. For instance, a handset can have WMM functionality enabled only if both the handset and the access point have been certified for WMM.

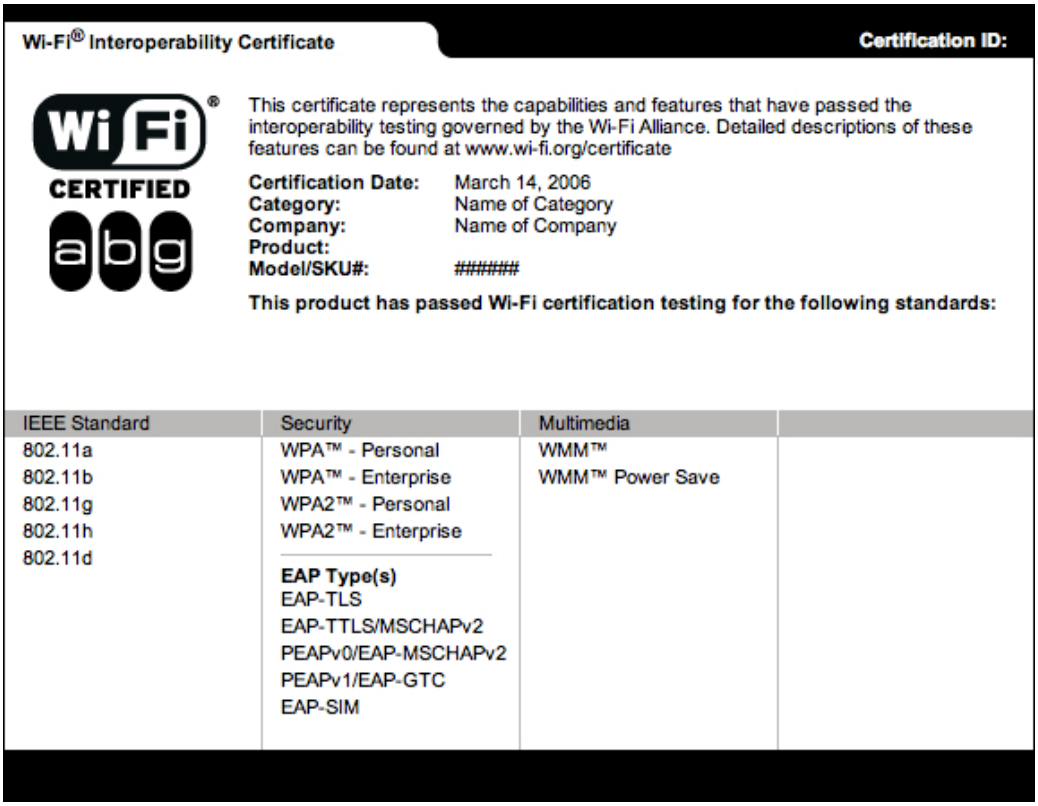
Upon successful completion of the tests, manufacturers receive a Wi-Fi Interoperability Certificate (Figure 3) that indicates the certification programs that their product has passed. The manufacturer also gains the right to use the Wi-Fi logo (Figure 4) when marketing the product. Additional information about the Wi-Fi Alliance certification program and a database of Wi-Fi CERTIFIED products are available at www.wi-fi.org.

The Wi-Fi Alliance Approach to Certification for WMC Devices

Certification requirements for WMC devices are much more challenging than those for data-only devices with a single wireless interface, such as laptops. There is a greater variety in device form-factors and a stronger need to support real-time applications, advanced power saving mechanisms and multiple wireless interfaces. New primary beneficiaries of certification have also been added: mobile carriers and their subscribers.

The Wi-Fi Alliance understands these requirements well. It has adopted a two-pronged approach to the certification of WMC devices which combines the adoption of a carrier-focused approach to certification testing with an expansion of the scope of Wi-Fi certification.

The Wi-Fi Alliance views this as an ongoing process, where further certification programs supporting WMC will be added and testing methodologies refined. Feedback from vendors, mobile operators, related industry associations and subscribers is important to this process.



Wi-Fi® Interoperability Certificate

Certification ID:

CERTIFIED

abg

This certificate represents the capabilities and features that have passed the interoperability testing governed by the Wi-Fi Alliance. Detailed descriptions of these features can be found at www.wi-fi.org/certificate

Certification Date: March 14, 2006
Category: Name of Category
Company: Name of Company
Product:
Model/SKU#: ######

This product has passed Wi-Fi certification testing for the following standards:

IEEE Standard	Security	Multimedia
802.11a	WPA™ - Personal	WMM™
802.11b	WPA™ - Enterprise	WMM™ Power Save
802.11g	WPA2™ - Personal	
802.11h	WPA2™ - Enterprise	
802.11d	**EAP Type(s)**	
	EAP-TLS	
	EAP-TTLS/MSCHAPv2	
	PEAPv0/EAP-MSCHAPv2	
	PEAPv1/EAP-GTC	
	EAP-SIM	

Figure 3. Wi-Fi Interoperability Certificate

Figure 4. Wi-Fi CERTIFIED Logo

The Wi-Fi Alliance currently supports the certification of WMC devices for core interoperability and security. To date, close to 20 converged phones have become Wi-Fi CERTIFIED.

In addition, the Wi-Fi Alliance is developing a comprehensive program optimized for WMC devices to meet the expectations of carriers. The program will offer radio frequency reporting and a suite of tests for conformance, performance and compatibility that will help to ensure handset interoperability. Slated for launch in 2006 and beyond, the program will address challenges that are specific to mobile converged devices, namely:

- **Wider range of devices.** In the WMC space, the laptop is not the universal form factor. Instead, mobile phones, smartphones, PDAs, and other mobile devices with

different form factors, interfaces and application-specific requirements, will proliferate.

- **Coexistence with other wireless technologies**. It is important that the Wi-Fi interface in WMC devices coexists within the cellular infrastructure without interference, so tests will be available to measure this. The two different wireless interfaces are expected to hand off traffic from one to the other as needed.

- **Testing criteria**. Mobile carriers exercise a high degree of control over the handsets they adopt, as the devices need to be fully integrated with the carriers' cellular networks. The carriers typically sell the handsets and provide customer support. Because of this, carriers demand extremely robust and detailed compliance, interoperability and performance tests.

Radio Frequency Testing

To date, all Wi-Fi certification programs focus on interoperability. The Wi-Fi Alliance convergence initiative is planned to include a certification program that focuses on radio frequency testing. This will be the first program to test the parametric performance of Wi-Fi devices. This departure from the customary approach has been prompted by requests from mobile carriers for a detailed assessment of equipment performance. These are practices that they have come to rely upon when planning the network, deciding which handset devices to adopt and which services to support.

The test plan for radio frequency testing is being developed by the Wi-Fi Mobile Convergence Task Group, which includes a strong presence from mobile carriers and device manufacturers. It will measure the device performance in an environment with standard Wi-Fi traffic, without the need to set them into a special test mode.

In order to assess the radio performance of a WMC device, the following parameters will be tested for each of the air interfaces (a, b, g) supported:

- Transmit power.

- Receive sensitivity.

- Antenna performance.

Conducted and radiated tests will be carried out for the transmit power and receive sensitivity testing. Further tests will be conducted to measure the desensitization of the receive sensitivity in the presence of the cellular radio.

For the radiated tests, the unit under test will be mounted so as to simulate real-world conditions. Measurements will be taken in an EMC anechoic chamber at several hundred orientations of the device so as to produce a set of results that represent the performance in 3D space (Figure 5). The conditions and procedures for the radiated 3D WMC tests take place in ISO 17025 accredited labs such as those in the American Association for Laboratory Accreditation (A2LA) in the U.S.

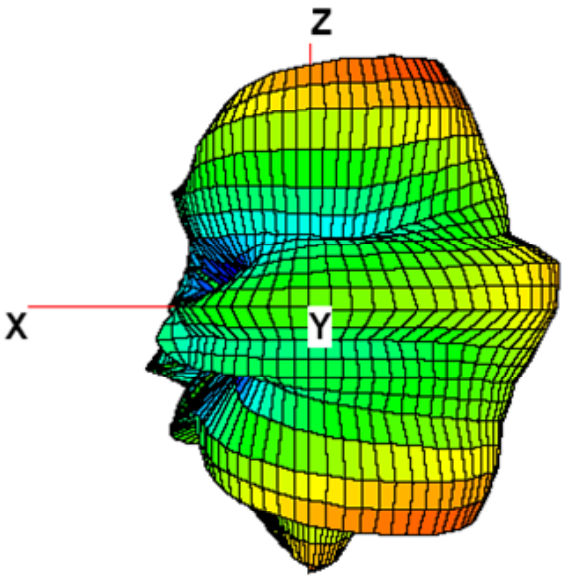


Figure 5. Three dimensional profile of Wi-Fi radio strength in dB from a cellular phone observed at China National Telecommunication Metrology Station (CNTMS), a Wi-Fi Alliance Authorized Test Lab

Manufacturers of WMC devices submitted for tests will receive performance scores in a detailed report which the manufacturer can then share with a carrier, so that the carrier can compare the performance of different devices under consideration for inclusion on the network. WMC Radio Performance is optional and, unlike other certification programs, does not have a pass/fail component.

Towards a Turnkey Approach to Interoperability Testing

The second component of the Wi-Fi Alliance convergence certification initiative planned for launch later this year addresses the specific requirements of converged devices. The test plans initially developed for laptop devices are not optimized for WMC devices. Currently WMC devices are tested under the Application Specific Device (ASD) program which uses a more complex customized test plan, placing a heavier burden on the manufacturer.

Under the new program, devices will be tested for 802.11 a/b/g interoperability with some requirements modified as appropriate on the basis of the expected performance of the device. Two product classes will be initially defined:

- **Narrowband Wi-Fi Phone**, with a throughput requirement of 300 kbps.
- **Broadband Wi-Fi Phone,** with a throughput requirement of 1 Mbps or higher.

There will be two options for each product class:

- **Home and small office environment**, with a network of limited size.

- **Enterprise and hotspots environment**, with a larger number of access points and more advanced functionality.

The program will test for the following capabilities:

- Indication of Wi-Fi network and service availability.
- Selection of the wireless interface (Wi-Fi or cellular) of choice when both are available.
- Successful voice and data connectivity when a Wi-Fi network is available.
- Operation without any adverse impact or interference caused by the cellular network.

Handover between cellular and Wi-Fi networks will not be tested within the program as they are considered to be beyond the scope of Wi-Fi certification. Handover certification will require a joint effort with cellular standards and testing bodies (see below).

Other Wi-Fi Alliance Certification Programs Supporting Convergence

In addition to convergence-specific certification programs mentioned above, there are several active certification programs that address the functionality requirements of WMC devices:

- **WMM** [1] certification provides QoS capabilities in Wi-Fi networks. This is a requirement for real-time multimedia applications. WMM functionality can be enabled only in networks where both the access point and the end-user device are certified for WMM and individual applications support it.
- **WMM Power Save** [2] extends the battery life of mobile devices and is optimized for applications like voice over Wi-Fi. Like WMM, it requires that both the access point and the device are certified for WMM Power Save and that applications support it.
- **WPA2** [3-6] and **EAP** are mandatory certification programs that provide government-grade encryption and authentication mechanisms. With WPA2 and EAP, Wi-Fi provides a level of security equivalent to that offered within mobile networks.

The Wi-Fi Alliance expects to roll out additional certification programs in the future. For some programs, the timing is largely tied to standardization work within the IEEE 802.11 work group. The expected programs include:

- **Simple Config** aims to facilitate security set-up in home and small office networks.
- **Voice over Wi-Fi** supports Voice over Wi-Fi devices for home and small office environments, and later, for enterprise environments. Once introduced, all WMC devices will be required to pass the appropriate class of this program.
- **802.11n** aims to provide support for higher throughput in Wi-Fi networks. A certification program is planned following the IEEE ratification of the standard.

The Wi-Fi Alliance is also monitoring progress of other standardization work on enhancing network coexistence that is being done within the IEEE 802.11k (Radio Measurement), IEEE 802.11r (Fast Roaming), which will be included in upcoming Voice over Wi-Fi certification programs, as well as IEEE 802.11u (Interworking) task groups.

Industry-wide Cooperation Initiatives

Convergence by definition includes different technologies. As a result, several industry and standards bodies have to cooperate to create an ecosystem in which device manufacturers, end users and service providers benefit from technology coexistence. In the case of WMC, handover, power consumption, radio performance, interference, and roaming across technologies all involve the cellular and the Wi-Fi networks alike, and involve both end-user devices and network infrastructure.

The Wi-Fi Alliance collaborates with related industry associations and standards bodies to address these issues and establish testing procedures that will prevent industry fragmentation and strengthen interoperability, while addressing the requirements of mobile carriers.

Multiple cellular technologies are deployed worldwide (e.g., GSM, EDGE, WCDMA, HSDPA, CDMA, and EV-DO) and the Wi-Fi Alliance is committed to certifying devices that work with all of them. However, the Wi-Fi Alliance believes that a common approach to WMC from related industry associations would be beneficial to all the parties involved, and is working to ensure standardization for the most widely-supported and lowest-cost convergence solutions to make them available to the largest number of subscribers.

The Wi-Fi Alliance is already involved in several partnerships with other related industry organizations:

- **Fixed-Mobile Convergence Alliance** (FMCA, http://www.thefmca.co.uk/). The FMCA, a global alliance of telecom operators organized to accelerate the convergence of fixed and mobile products and services, and the Wi-Fi Alliance established a formal liaison agreement in 2005 and are working together to ensure the alignment of product requirements for WMC products.

- **Cellular Telecommunications and Internet Association** (CTIA), http://www.ctia.org). CTIA and the Wi-Fi Alliance have a liaison relationship centered around collaboration on the development of certification programs for converged devices.

- **Open Mobile Alliance** (OMA, http://www.openmobilealliance.org/). The OMA and the Wi-Fi Alliance have established a formal liaison to cooperate on the management of Wireless Local Area Network (WLAN) configuration in WMC devices.

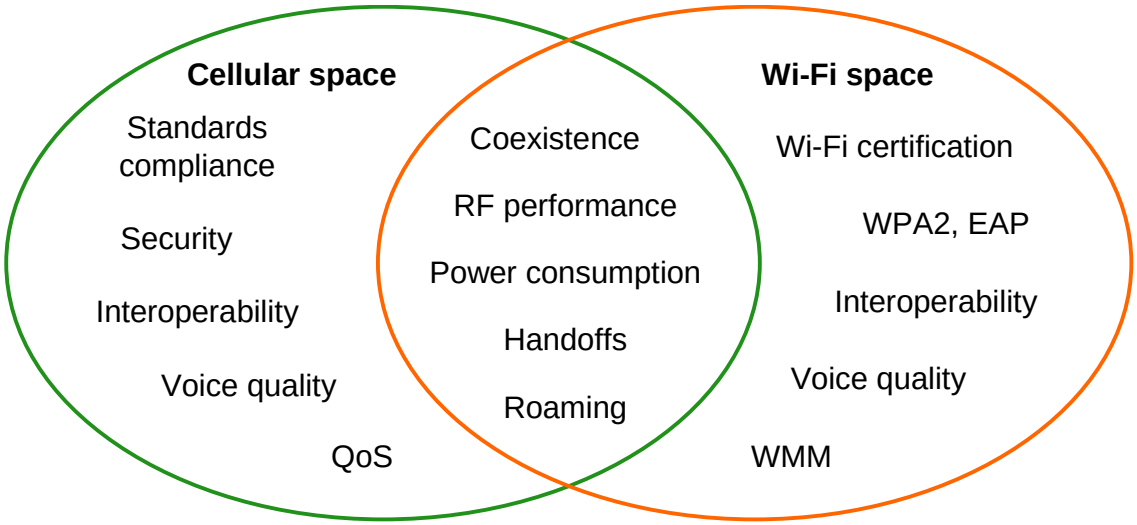


Figure 6. Wi-Fi and cellular coexistence

Conclusions

The convergence of Wi-Fi and mobile devices and services extends the reach of Wi-Fi to new devices and applications. It gives end-users the opportunity to choose different network interfaces, depending on their location and their needs. Mobile carriers can offer a wider range of services, and extend the reach and capacity of their networks.

The Wi-Fi Alliance has expanded the scope of its certification program and is moving towards a carrier-grade testing approach to address the specific requirements of WMC devices and to address the needs of mobile carriers. A strong supporter of WMC, the Wi-Fi Alliance manages several certification programs that support WMC (WMM, WMM Power Save, WPA2, and EAP) and currently certifies converged devices for core interoperability and security. Later in 2006, the Wi-Fi Alliance plans to launch certification programs that have been specifically developed for WMC devices.

Convergence presents challenges to the Wi-Fi and cellular industries. A variety of technical issues must be addressed across industries in order to ensure a mutually beneficial coexistence. Cooperation between the Wi-Fi Alliance, cellular industry associations and standard bodies is crucial to address issues that arise from the interworking of the two wireless interfaces that cannot be resolved unilaterally. The Wi-Fi Alliance has established partnerships aimed at improving network coexistence and the performance of WMC devices. This joint work will play a crucial role in promoting adoption of converged devices and services, and will constitute the initial blueprint for a wider integration across wireless technologies.

The great excitement and expectation among subscribers is a sign that the market is ready for converged devices. However, convergence is still in its early adoption stage and industry associations, manufacturers and mobile carriers still have a great deal of work ahead to propel converged devices into the mass market. The Wi-Fi Alliance is eager to accept this challenge and looks forward to retain its leading role in promoting and facilitating the proliferation of converged devices and applications.

Additional Resources

[1] Wi-Fi Alliance (2004) Wi-Fi CERTIFIED™ for WMM™ - Support for Multimedia Applications with Quality of Service in Wi-Fi® Networks (http://www.wi-fi.org/white_papers/whitepaper-090104-wmm/)

[2] Wi-Fi Alliance (2005) WMM™ Power Save for Mobile and Portable Wi-Fi® CERTIFIED Devices (http://www.wi-fi.org/white_papers/whitepaper-120505-wmmpowersave/)

[3] Wi-Fi Alliance (2003) Securing Wi-Fi Networks with Today's Technologies (http://www.wi-fi.org/white_papers/whitepaper-020603-securingwifi/)

[4] Wi-Fi Alliance (2003) Wi-Fi Protected Access (http://www.wi-fi.org/white_papers/whitepaper-042903-wpa/)

[5] Wi-Fi Alliance (2005) WPA™ for the Home (http://www.wi-fi.org/white_papers/whitepaper-101805-wpaforhome/)

[6] Wi-Fi Alliance (2005) Deploying WPA™ and WPA2™ in the Enterprise (http://www.wi-fi.org/white_papers/whitepaper-022705-deployingwpawpa2enterprise/)

IEEE 802.11 Glossary

802.11a	An IEEE standard for a wireless network that operates at 5 GHz with theoretical rates up to 54Mbps.
802.11b	An IEEE standard for a wireless network that operates at 2.4 GHz with theoretical rates up to 11Mbps.
802.11d	An IEEE specification that allows for configuration changes at the Media Access Control layer (MAC layer) level to comply with the rules of the country in which the network is to be used.
802.11e	An IEEE standard that adds QoS features and multimedia support to the existing 802.11b, 802.11g, and 802.11a wireless networks.
802.11g	An IEEE standard for a wireless network that operates at 2.4 GHz Wi-Fi with theoretical rates up to 54Mbps.
802.11h	802.11h supports Dynamic Frequency Selection (DFS) and Transmit Power Control (TPC) requirements to ensure the coexistence of Wi-Fi and other types of radio frequency devices in the 5 GHz band.
802.11k	A task group of the IEEE 802.11 committee working on radio resource measurement enhancements to provide interfaces to higher layers for radio and network measurements.
802.11n	A task group of the IEEE 802.11 committee whose goal is to define a standard for high throughput speeds of at least 100Mbps on wireless networks. The standard is expected to be ratified by 2007. Some proposals being fielded by the task group include designs enabling up to 540 Mbps. Multiple-Input-Multiple-Output (MIMO) technology, using multiple receivers and multiple transmitters in both the client and access point to achieve improved performance, is expected to form the basis of

	the final specification.
802.11r	A task group of the IEEE 802.11 committee working on fast roaming and fast Basic Service Set (BSS) transition.
802.11u	A task group of the IEEE 802.11 committee with a goal to develop a standard specifying interworking with external networks.

Source: IEEE 802.11 (http://grouper.ieee.org/groups/802/11/) and Wi-Fi Alliance

Acronyms

3G	Third Generation
A2LA	American Association for Laboratory Accreditation
ARPU	Average Revenue Per User
ASD	Application Specific Device
BSS	Basic Service Set
CDMA	Code Division Multiple Access
CTIA	Cellular Telecommunications and Internet Association
DFS	Dynamic Frequency Selection
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
EV-DO	(CDMA) EVolution Data Optimized
FMCA	Fixed-Mobile Convergence Alliance
GSM	Global System for Mobile Communications
GPRS	General Packet Radio Service
HSDPA	High Speed Downlink Packet Access
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Standards Organization
MAC	Media Access Control
MIMO	Multiple-Input-Multiple-Output
MSCHAPv2	Microsoft Challenge Handshake Authentication Protocol version 2
MVNO	Mobile Virtual Network Operator
OMA	Open Mobile Alliance
PDA	Personal Digital Assistant
PEAP	Protected EAP
QoS	Quality of Service

SIP	Session Initiation Protocol
SMS	Short Message Service
TPC	Transmit Power Control
UMA	Unlicensed Mobile Access
VoIP	Voice over Internet Protocol
WCDMA	Wideband CDMA
WLAN	Wireless Local Area Network
WMC	Wi-Fi Mobile Convergence
WMM™	Wi-Fi Multimedia™
WPA™	Wi-Fi Protected Access™
WPA2™	Wi-Fi Protected Access 2™