Proxim Wireless LAN Interoperability

White Paper

Why is Interoperability Important?

An inherent challenge in the evolution of any product category in the networking industry is making sure the products work together. This is the very essence of healthy market competition, and a process that ultimately benefits you, the consumer. Multi-vendor competition encourages vendors to find more cost-effective means of developing products, lowering prices to the consumer. Competing vendors will also strive to add features and enhancements to products in order to set themselves apart from other offerings.

With networking products, interoperability is especially crucial. The function of networking products is to transfer data reliably from one point to another, which requires guaranteed interoperability from end-to-end. Additionally, as networks are long-term investments, they must allow for flexible expansion in order to address as yet unidentified future requirements. The benefits of interoperability to the customer are clear: a wider choice of products from multiple vendors and the security of knowing interoperable products will work together. Conceptually, here is how it works:



A lack of interoperability may pose problems, depending on the application for which the product is being used. For a closed, vertical application that will never expand or need enhanced performance or features, interoperability may not be an issue – the entire system can be purchased from a single vendor. However, such a closed-end situation is rarely the case; the goal of networking is to allow all communications systems to have access to each other in an interoperable environment.

What is Interoperability?

Interoperability to a network manager or administrator means plug-and-play operation independent of manufacturer, and that the product works in the user's environment, with the user's application. In a network environment, an administrator should expect that products within a specific category from different manufacturers should work with each other. The ideal level of interoperability will provide seamless, fully compatible, and high performance operation among different product categories from various vendors. Clients, whether they are laptops, pen computers, scanners, modems, point-of-sale computers, or others must be able to communicate with each other and the host infrastructures. These hosts can be access points to wired backbones, or other wireless devices acting as centralized servers. For maximum flexibility, network administrators must have absolute certainty that wireless devices they purchase from various vendors will interoperate.

While the technical definition of interoperability is specific to a particular product category, the process to reach multivendor interoperability is well understood and general across all product categories. Given that a standard, or open interface, has been defined, then the steps to reach interoperability are summarized below:



Step	Purpose
1) Formation of Industry Body	Drives the interoperability process and facilitates needed technical compromises among competing manufacturers
2) Interoperability Test Suite Development	Used by the independent test lab to verify 1) compliance to the specification, and 2) multivendor interoperability
3) Selection of Independent Test Lab	Verifies that equipment is interoperable. Provides reports of problem areas that do not meet interoperability requirements.
4) Selection of Interoperability Metrics	Although a specification is defined, an accepted definition must exist that shows when a product is interoperable. This metric can either be testing against a 'golden' unit accepted as complying to the standard, or testing to a test suite performed with proper measurement equipment. This baseline must cover both conformance to the standard and interoperability. This is arguably the most difficult portion of the process to complete with a committee-driven standard.
5) Interoperability Testing	Provides concrete, reproducible results of the extent of interoperability
6) Rework and Re-testing	Invariably, with a complex specification, variations in interpretation and development will result in product incompatibilities. At this point, some, if not all, vendors must make changes to their products and resubmit for testing.

A surprising, but important, point is that the definition of a standard does not guarantee multivendor interoperability.

Defining Interoperability for Wireless LANs

Wireless networks pose a set of interoperability challenges that do not apply to hard-wired, infrastructure network products. With client units that are mobile more often than not, the fluid, ever-changing state of the network requires detailed definitions of interoperability.

Five specific areas are vital to wireless LAN interoperability:

- Data communication. Reliable, timely data communication must occur between clients, as well as from client to host/access point and back.
- Security. Data must be secured from unauthorized access, but at the same time, clients and access points must be able to recognize and share security schemes.
- Roaming. Due to the very nature of wireless devices, clients must have the ability to roam among access point locations without losing connectivity or data integrity. Access points must be able to communicate with each other about roaming clients in order to facilitate successful roaming.
- Configuration. Client and host settings must be configurable among different vendors' products. This includes selections such as country settings, domain identification, channel and sub-channel choices.
- Coexistence. Wireless products must peacefully co-exist with other wired and wireless products without interference.

Detailed tests encompassing each of the above areas are required to verify complete interoperability among different vendors' products in a variety of situations. However, core interoperability can be defined and tested very simply by any network administrator seeking to confirm product interoperability by employing this simple test:

Client A (from Manufacturer A) should be able to connect to Access Point B (from Manufacturer B), while Client B connects to Access Point A. The clients should be able to roam seamlessly between Access Points A and B without reconfiguration or loss of connectivity.



Status of Wireless LAN Interoperability

The 802.11 Standard. In an effort to define a standard for wireless LAN products, the IEEE ratified the 802.11 standard in June 1997. This standard defines the "over the air" interface between a wireless client and a base station or access point, as well as among wireless clients. While three types of physical (PHY) interfaces are defined by 802.11, the modulation schemes supported by the three interfaces (infrared [IR], direct sequence spread spectrum [DSSS], and frequency hopping spread spectrum [FHSS]) are incompatible. For a more detailed analysis of the 802.11 standard, refer to the Proxim white paper, What is 802.11?

A close examination of the standard demonstrates that definition of a standard interface does not, by default, guarantee interoperability, due to variations in interpretation and implementation of the specified interfaces. The ratification of an IEEE standard is a significant step towards the definition and development of standards-based, interoperable products. However, due to variations in implementations of the standard and uncertainty about how the committee plans to address the outstanding issues, it will be some time before it can be assumed that "802.11-compliant" products are interoperable.

Completeness of the 802.11 Standard

Within each of the 802.11-defined PHY interfaces, one key component required for complete interoperability, as outlined in the previous section, is not clearly defined—roaming.

• The standard does not specify the handoff mechanism to allow clients to roam from one host/access point to another.

Status of Multivendor Interoperability for 802.11-based Products

Industry vendors are aware of the outstanding issues that hinder interoperability. To address these issues, industry vendors developing 802.11 products have retained an independent testing facility, the University of New Hampshire (UNH) Interoperability Lab (IOL). The IOL has completed three rounds of 802.11 interoperability testing. The following table shows the status of interoperability as of August 1998.

Participating vendors can take those results and incorporate any necessary modifications back into product development cycles; however, true multi-vendor 802.11 interoperability is likely to take multiple development cycles. Meanwhile, vendors will continue to produce 802.11 products that will use proprietary methods and algorithms.

The OpenAir[™] Standard.

As an alternative to the 802.11 standard, a multi-vendor forum has been established to specifically address the issues of wireless LAN interoperability. The Wireless LAN Interoperability Forum (WLI Forum) was created in 1996 to allow vendors of wireless LAN products to work together to specify an interoperable standard, and provide test suites to prove interoperability.

Vendors who participate in the WLI Forum have designed their products to conform to a specification referred to as OpenAir. This specification describes the physical (PHY) and Media Access Control (MAC) layer Radio Frequency (RF) interfaces. OpenAir products are based on a Frequency Hopping Spread Spectrum (FHSS) radio that operates in the unlicensed 2.4 GHz Industrial, Scientific and Medical (ISM) band. For more information about the WLI Forum, go to www.wlif.com

Step	Purpose	Status	
1) Formation of Industry Body	Drives the interoperability process and facilitates needed technical compromises among competing manufacturers.	Not done . While industry vendors have retained the UNH IOL, there is no organization driving the development of the missing portions of the specification in order that they be incorporated into the standard.	
2) Interoperability Test Suite Development	Used by the independent test lab to verify 1) compliance to the specification, and 2) multivendor interoperability.	In process . Much of the MAC level tests are defined. Definition of PHY level tests and interoperability tests are in their infancy.	
3) Selection of Independent Test Lab	Verifies that equipment is interoperable. Provides reports of problem areas which areas that do not meet interoperability requirements.	Done . UNH IOL is the independent test lab retained for testing of conformance to the 802.11 standard and for multivendor interoperability. However, UNH will not certify interoperability.	
 Selection of Interoperability Metrics 	Although a specification is defined, an accepted definition must exist that shows when a product is interoperable. This metric can either be testing against a 'golden'unit accepted as complying to the standard, or testing to a test suite performed with proper measurement equipment. This baseline must cover both conformance to the standard and interoperability. This is arguably the most difficult portion of the process to complete with a committee-driven standard.	Some done. Simple point to point interoperability between 1 AP and 1 station, as well as point to multipoint interoperability between 1 AP and multiple stations. Ability of a client to roam to another AP in case of an AP failure.	
5) Interoperability Testing	Provides concrete, reproducible results of the extent of interoperability	Some done. Testing to the limited extent defined above completed.	
6) Rework and Re-testing	Invariably, with a complex specification, variations in interpretation and development will result in product incompatibilities. At this point, some, if not all, vendors must make changes to their products and resubmit for testing.	Some done. As expected, issues in interpretation of the specification have been uncovered during the three group test periods Various vendors have made changes and then retested product.	

Status of Multivendor Interoperability for 802.11-based Products

Completeness of the OpenAir Standard

The five key areas that define wireless LAN interoperability, data communication, roaming, security, configuration and coexistence are all defined in the OpenAir standard.

Status of Multivendor Interoperability for OpenAir-based Products

The WLI Forum has retained a third party test laboratory, XXCAL, to execute tests which have been defined to prove compatibility among products developed to the OpenAir standard, and produces a catalog which lists OpenAir certified products. The following table shows the status of interoperability as of August 1998.

Summary

Clearly, interoperability is an important factor for any network, and wireless LANs are no exception. The IEEE 802.11 standard is an important step towards the development of interoperable products, but it is no panacea or silver bullet. The practical evolution of the standard to the point that compliance to the standard is a guarantor of interoperability may take a significant amount of time. In the meantime, the OpenAir standard offers a means to build a wireless LAN that supports products from a variety of vendors, with the clear advantage of proven interoperability.

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Step	Purpose	Status	
1) Formation of Industry Body	Drives the interoperability process and facilitates needed technical compromises among competing manufacturers	Done. The Wireless LAN Interoperability Forum was formed in 1996 to define interoperability among wireless LAN standards. It first focused on OpenAir, and is now moving its attention towards other important wireless LAN standards such as 802.11.	
2) Interoperability Test Suite Development	Used by the independent test lab to verify 1) compliance to the specification, and 2) multivendor interoperability	Done . Completed by the Forum in early 1997. Tests interoperability of simple clients, complex clients and access points.	
3) Selection of Independent Test Lab	Verifies that equipment is interoperable. Provides reports of problem areas that do not meet interoperability requirements.	Done. The WLI Forum selected XXCal, an international independent test facility.	
 4) Selection of Interoperability Metrics 	Although a specification is defined, an accepted definition must exist that shows when a product is interoperable. This metric can either be testing against a 'golden' unit accepted as complying to the standard, or testing to a test suite performed with proper measurement equipment. This baseline must cover both conformance to the standard and interoperability. This is arguably the most difficult portion of the process to complete with a committee-driven standard.	Done . A golden client radio and golden access point were defined as the basis for compliance to the OpenAir standard and to prove multivendor interoperability.	
5) Interoperability Testing	Provides concrete, reproducible results of the extent of interoperability	Done. Testing to the test suite and the golden units are completed by the individual companies wishing to prove compliance to the OpenAir standard. Results are published several times a year in the WLI Forum catalog as well as on the web site.	
6) Rework and Re-testing	Invariably, with a complex specification, varia- tions in interpretation and development will result in product incompatibilities. At this point, some if not all, vendors must make changes to their products and resubmit for testing.	Done. As required, vendors who do not initially meet compliance to the OpenAir standard perform rework and retesting.	



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