

# Meeting the testing challenges of Wi-Fi-enabled devices

Familiarity with the guidelines and methodology of the standardized approach used by the Wi-Fi Alliance test engine for the certification of Wi-Fi-enabled application-specific devices (ASDs) can streamline the certification process and facilitate the performance testing of these wireless designs.

By Charles Wright and Jeff Abramowitz

**W**i-Fi is an increasingly popular connectivity technology in games, phones, printers and a host of other platforms that were not contemplated when the original 802.11 standard was specified in 1997. Vendors in these emerging market segments, however, are quickly discovering the complexity involved in incorporating Wi-Fi into a product design, and the difficulties of testing connectivity.

Wi-Fi Alliance certification validates the interoperability of Wi-Fi devices from different manufacturers, ensuring an optimal user experience. It is a critical testing step in bringing Wi-Fi products to market. The Wi-Fi Alliance has recognized the challenges of testing the exploding product category of ASDs and has recently introduced the Wi-Fi Alliance test engine methodology in an effort to address them.

### Application-specific devices

ASDs are non-PC-based devices with embedded Wi-Fi connectivity. According to market research firm IDC, ASD shipments have grown by more than 50% in the past year, and nearly 300 million devices are forecast to sell in 2010 (See Figure 1).

ASDs are not networked devices in the traditional sense and lack a common interface for control, operation or testing. Each device has a unique user interface, without for example, a keyboard or touch screen, and may use different security mechanisms. In addition, these platforms typically do not support “off-the-shelf” traffic generators and performance measurement tools.

These factors make Wi-Fi performance and interoperability measurement complex and costly.

The continued lack of a standard, cost-effective testing methodology can potentially restrict the growth of this device category. Manual testing is often difficult or impossible. Without a methodology to streamline the testing process, testing expenses will be higher, resulting in higher product costs and lower product quality.

### Wi-Fi Alliance test engine methodology

The Wi-Fi Alliance is a global, non-profit industry association that promotes wireless technologies. The alliance provides its members with testing and certification programs to ensure the interoperability of wireless products based on the IEEE 802.11 specification. Since the certification program began in 2000, more than 3000 products have been “Wi-Fi Certified.”<sup>[1]</sup>

When the Wi-Fi Alliance certification process and programs were originally developed, the vast majority of 802.11 clients were PC-centric network equipment or network clients, and certification testing adequately addressed them. In subsequent years, the number of non-PC-centric Wi-Fi devices has grown significantly, along with a dramatic increase in non-standard 802.11 devices.

These non-PC-centric devices, which include cell phones, gaming devices, and MP3 players, require a different testing approach than PC-based client devices. As a result, the Wi-Fi Alliance has developed a

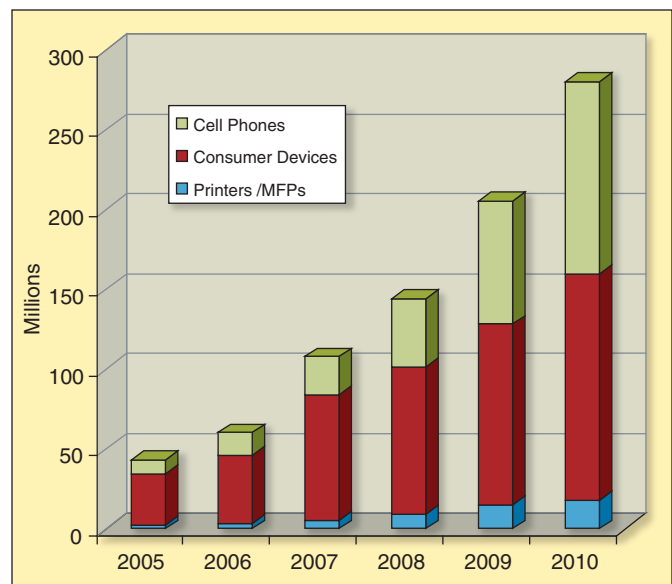


Figure 1. Dramatic growth is forecast for Wi-Fi-enabled ASDs.

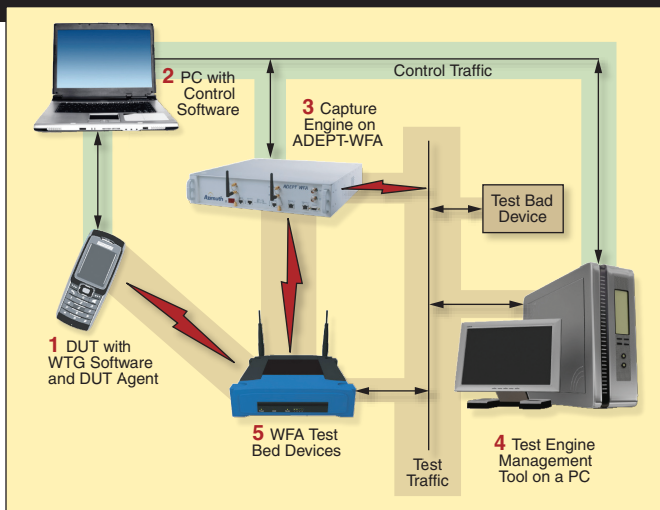
new test engine methodology that allows station tests to be streamlined for any type of product. The key component is a framework for client testing that is extensible to any Wi-Fi client and does not compromise the integrity of the comprehensive series of Wi-Fi testing processes.

In defining the new test engine methodology, the Wi-Fi Alliance ASD technical task group proposed a framework referred to as the Wi-Fi Alliance test engine, or simply the test engine. Its three key areas include:

1. Station configuration and control: The methodology defines a standard interface that allows vendors to design stations that can be configured for the tests and then stimulated to perform the actions required. Because the devices tested lack standard user interfaces such as a keyboard or mouse, the interface is defined independent of the vendor’s implementation.

2. Test traffic generation: A large part of interoperability testing requires the transmission and reception of traffic by the device under test (DUT) as a way to measure throughput, connectivity and functionality. The DUT station initiates or terminates this traffic, and the test engine methodology provides a traffic generation element for integration into the DUT, as well as guidelines to create this capability on the station. The traffic generator is specifically designed for devices with limited memory and processing power.

3. Test results measurement: A methodology is required to measure and report results. The test engine uses the Azimuth ADEPT-WFA



**Figure 2. The Wi-Fi Alliance test engine methodology provides a scalable approach to testing current and emerging Wi-Fi product categories and supports all facets of client device testing with five key components.**

tool and test automation to enable traffic analysis and reporting that is independent of the capabilities of the station DUT. The methodology uses intelligent capture and analysis techniques to validate connectivity, performance and functional testing.

In addressing these areas of station testing, the test engine provides a scalable approach that is suitable for the growing variety of Wi-Fi enabled products. The resulting test solution, required to certify products using the Wi-Fi Alliance test engine methodology, includes five key components (See Figure 2):

1. DUT software: The Wi-Fi traffic generator (WTG) software and DUT agent reside on the DUT. The WTG software generates the Wi-Fi traffic used in the tests, and the DUT agent software enables communications to configure and control the DUT.

2. Control PC software: The control software implements the parser for the control application programming interface (API) to convert commands to USB, enabling vendors to control their devices through their native control protocol or command set.

3. Capture engine: The capture engine provides vendors with the mechanism to capture and time-stamp all detected wireless and wired traffic (referred to as promiscuous mode) for analysis.

4. Test engine management tool: The management tool controls and configures the DUT via the control PC and executes the test plan. In addition, the management tool controls the test bed equipment, including access points (APs), to ensure a stable environment.

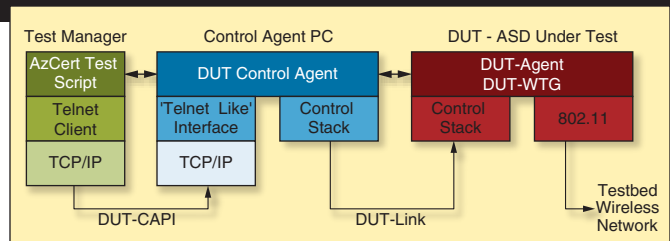
5. Alliance test bed: The test bed selects the clients and access points used as reference devices for interoperability, helping vendors verify their products in a multivendor marketplace.

The Wi-Fi Alliance provides sample software in source code form to its members. This software implements the DUT software and the control agent on the control PC, including an implementation of the DUT control API. This software is designed to prepare DUTs for Wi-Fi certification.

### Implementing the test engine

Porting the Wi-Fi Alliance software for configuration and traffic generation is the first step toward certifying a non PC-based device with embedded Wi-Fi connectivity. The Wi-Fi Alliance provides the reference implementation source code of these components to assist in installing the software on the device. The Wi-Fi traffic generator is small-footprint code that is easily portable to any operating system including Linux, Windows Mobile, VxWorks and Symbian.

ASDs are typically more difficult to configure for testing than PC-centric devices because of their unique user interfaces. With limited input options, manually configuring most ASDs for the required test cases would be tedious, if not impossible. The test engine configuration



**Figure 3. Depiction of communication between test manager and DUT.**

software standardizes programmatic control of the DUT, including the security modes WPA-PSK and WPA2-PSK and different extensible authentication protocol (EAP) types if the DUT supports enterprise authentication.

Each device may also have a unique method for sending configuration commands, such as USB, COM, IrDA and Ethernet. The test engine methodology uses the concept of a DUT control agent (DUT-CA) to abstract the control interface, allowing the user to implement configuration commands over interfaces supported by the DUT. The DUT-CA is the user's intellectual property. It secures the control interface, enabling commands to be kept secret.

The DUT-CA receives each command in the standard format specified by the test engine—essentially ASCII characters sent over a TCP socket. Each command is then translated into proprietary DUT-specific commands and executed, after which the DUT-CA may return a result. The user must test each command in the specification with different parameter settings to ensure that the DUT is configured properly after the completion of each command and that it returns correctly formatted results.

To cause the DUT to perform an action, the test manager issues an appropriate command. This command passes through the control network and arrives at the PC that runs the ASD control agent, which ultimately controls the DUT. The DUT then executes the command and performs the action required for the test (Figure 3).

Although this architecture was originally designed for certification testing of ASDs, it is important to recognize that vendors can also use these tools for performance and certification testing of ASDs and traditional Wi-Fi devices.

### Certification testing

The test engine architecture automates test plans through scripts and libraries that allow vendors to:

- operate the DUT through the API defined in the test engine methodology;
- generate traffic from the test manager PC or DUT through the ASD wireless traffic generator;
- capture the resultant activity;
- analyze the results and determine whether the device has passed or failed the test.

Many of the certification test cases require traffic capture and analysis of packets to and from the DUT to determine test results. By capturing packets on its 802.11 and Ethernet interfaces, and performing stateful analysis on those packets, the capture engine is used to:

- verify the number of test packets successfully sent and received by the DUT during the test;
- measure the throughput performance of the data transfers;
- validate that the content of the packets is in accordance with test plan requirements.

The capture engine used in running the test is the Azimuth ADEPT-WFA, and Azimuth also provides software automation to control and run the test. The Azimuth AzCert test engine WPA2 test script performs the certification on the test engine DUT. It also automates configuration of the DUT, traffic generation from the DUT and the control PC and captures test packets using the ADEPT-WFA. The script automatically determines the throughput achieved for all the traffic tests and determines if those test cases have passed or failed.

The AzCert test can run as a semi-automated or fully automat-

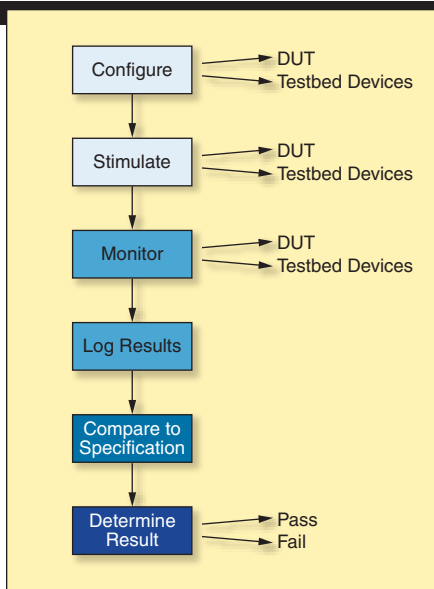


Figure 4. ASD Wi-Fi Certification test script flow chart.

ed script. While the same test script and license are used in both cases, not all features are available using the semi-automated script. In the semi-automated approach, which is run on the user's PC, the script prompts the user to configure any test bed APs, stations and security servers required for the test. The automated approach is run on a dedicated server, and test steps and analysis can be batched and performed without operator assistance.

tested simultaneously in unattended mode.

In addition, while the test engine provides a standard interface and methodology to facilitate the implementation and automation of the Wi-Fi certification testing process, the same methodology can also be applied to performance testing. The net result is a methodology that is expected to be cost effective and efficient for vendors and test labs to implement. The new approach meets the challenges of testing the growing number of Wi-Fi-enabled devices and will enable continued proliferation of interoperable, Wi-Fi Certified products. **RFD**

## References

1. "Wi-Fi Certified Makes it Wi-Fi," Wi-Fi Alliance, September 2006.

## ABOUT THE AUTHORS

Charles Wright is the chief scientist at Azimuth Systems. He has 20 years of experience in digital communications and signal processing. Wright was involved with early 802.11a development, and is the chair of the 802.11 Task Group T, which is writing a recommended practice for evaluating 802.11 wireless performance. He earned his Ph.D. and BSEE from Worcester Polytechnic Institute, and his MSEE from the University of Southern California.

Jeff Abramowitz is the vice president of marketing for Azimuth Systems. He joined Azimuth in August of 2005 from Broadcom, where he was the senior director of marketing responsible for its Wi-Fi marketing and business development. Abramowitz has 20 years of experience in the wireless industry; the last 11 years have been marketing Wi-Fi systems and semiconductors. He received a BSME from the University of Pennsylvania, a MSEE from MIT and an MBA from Stanford's Graduate School of Business.

## Scalability enables universal testing

As the number of products with embedded Wi-Fi connectivity multiplies, the test engine methodology provides vendors with a scalable testing approach. Originally targeted at application-specific devices, the approach can be used for all Wi-Fi products. The benefits of this new methodology include:

- a standard approach that simplifies device implementation and can be used by different vendor platforms;
- a standard platform to run the certification test, which can reduce the cost to certify at a Wi-Fi Alliance authorized test lab;
- the ability to run the same test that will be run at the lab, enabling reliable "pre-certification;"
- fully automated certification test that multiple SKUs to be



# For those subscribers who buy...

You can access our Buyers Guide online at <http://buyersguide.rfdesign.com>