Defining WLAN Performance Parameters

SUMMARY

A number of factors will determine Wireless Local Area Network (WLAN) performance. When specifying WLAN performance, there is currently no industry standard testing methodology. Because of this, published results are sometimes inconsistent and often confusing to consumers or others making buying decisions. This white paper outlines some of the key performance factors that should be taken into account and suggests that a standard benchmark be developed to deliver consistent and meaningful results.

INTRODUCTION

WLAN performance is an indicator of how productive a wireless user's connectivity will be, and thus is a key metric when a consumer or an IT organization makes a purchasing decision. Just as buyers compare the processor performance of one system vs. another, or of one processor vs. another, buyers also want to accurately compare WLAN performance. The key to WLAN performance is the wireless environment in which the wireless network resides as well as the design of the system and subsystem components such as the radio antenna.

This white paper summarizes some of the key factors affecting performance and suggests the need for consistent throughput and range measurements.

SPECIFYING PERFORMANCE

Throughput is defined as the speed at which the data can be transferred between the access point (AP) and the client at a given range. Each access point provides a coverage radius. The throughput varies across the WLAN's coverage radius depending on the obstacles encountered and the system design. Though the performance of a mobile device depends on the performance of the device, access point and the network to which the access point is connected, this paper mainly focuses on the client side.

Table 1 summarizes some of the key factors affecting throughput and range performance. Most of these factors should be taken into account when either specifying the design of the WLAN client or the wireless AP infrastructure.

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Table 1: Key Performance Factors Affecting Throughput and Range

Factor	Dependencies	Impact
Interference	Other devices occupying same frequency spectrum (e.g., microwave, cordless phones, Bluetooth*, etc.)	Impacts Signal-to-Noise Ratio (SNR) – minimum power difference between the wanted received signal and the noise.
Scattering and Multipath Fading	Obstacles	Increases transmission errors because of: ■ decreased power at certain frequencies; ■ the time difference between different received components (delay spread) makes the received signal spread in time domain.
Antenna Type	Antenna gain	Antenna gain is the power gain in comparison to an isotropic antenna measured in isotropic decibels (dBi). Antenna directivity increases antenna gain in a given direction. In client devices, omnispherical antenna is most suitable as it allows the device to operate in any position.
	Antenna diversity	Very important in preventing multipath fading especially for increasing range.
	Antenna cable length	Loss in the cable depends on the length of the cable – cable loss degrades SNR significantly and should be minimized.
System Design	Receiver sensitivity	The receiver has a minimum received power threshold that the received signal must have to achieve certain bit rate. If the received signal power is lower than the threshold, the maximum bit rate could be decreased, impacting performance. Receiver sensitivity depends both on RF and baseband design.
	Transmit power	Higher transmit output power provides better performance, but is usually limited by regulatory requirements (e.g., FCC).
	Turn-around time	Time it takes to switch between transmit and receive modes.
Network Load	Number of users	Number of users affects performance as the medium is shared.
	Traffic mix	Some applications may be more demanding in terms of bandwidth as compared to others.
Location Factors	Distance between AP and client	As distance between the AP and the client increases, data rate would drop.
	Orientation	Performance could be affected by the orientation of the client depending on the location of the antenna and also location of AP.

Since every wireless users' environment will likely differ, there is no way to predict exactly what performance can be obtained in any one environment or at any instance. However, there can be an industry-standard benchmark to gauge relative performance. Key to developing a repeatable test is the comprehensive definition of the test environment: AP settings, AP placement relative to WLAN clients, isolation from outside interference, etc. In addition, it would be beneficial to be able to vary the position of the client in a controlled fashion to establish roaming performance and impact to throughput.

BENEFITS OF INTEL® CENTRINO™ MOBILE TECHNOLOGY IN IMPROVING PERFORMANCE

Intel® Centrino™ mobile technology† provides Wi-Fi CERTIFIED* wireless LAN support and Intel Centrino mobile technology-based notebooks are verified by service providers. This verification means that the hotspots have been tested by the service providers to work with common notebook configurations built on this technology. This minimizes the possibility of the user encountering hotspots that are incompatible. To help reduce interference with certain Bluetooth* devices, WLAN adapters support Intel Wireless Coexistence System. To prevent multipath fading that can severely degrade performance, adapters support antenna diversity. The adapters also support great battery life benefits of Intel Centrino mobile technology.

BENEFITS OF IBM® THINKPAD™ TECHNOLOGY IN IMPROVING PERFORMANCE

IBM was the first PC manufacturer to integrate WLAN technology into Intel processor-based notebook products. IBM designs its own WLAN antennas for optimal gain and locates them in the ThinkPad™ LCD assembly in order to improve range performance. IBM's UltraConnect antenna design uses dual diversity for optimal signal reception. Working with companies such as Intel, IBM has utilized WLAN adapters in ThinkPad notebooks with the highest performance levels consistent with the key factors outlined in Table 1. Finally, to provide both ease-of-use and fast, secure wireless connectivity, IBM developed its Access Connections connectivity software, which is included on all ThinkPad models.

CONCLUSION

Intel and IBM are committed to providing WLAN products of the highest quality and performance. WLAN performance is dependent on both key design factors in the client hardware as well as the wireless network infrastructure environment. This paper outlines these key factors and suggests that the consumers and IT purchasing managers will benefit from the existence of an industry benchmark that provides consistent throughput and range measurements.

† Wireless connectivity and some features may require you to purchase additional software, services or external hardware. Availability of public wireless LAN access points is limited, wireless functionality may vary by country and some hotspots may not support Linux-based Intel Centrino mobile technology systems. System performance measured by MobileMark* 2002. System performance, battery life, wireless performance and functionality will vary depending on your specific operating system, hardware and software configurations.

For more information see: www.intel.com/products/centrino/more_info

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