WHITE PAPER

The TRUTH About Wireless Data Rates

By Carl J. Weisman
Senior Engineer, 5G Wireless Solutions

5G wireless solutions

Even people with little or no wireless networking expertise appreciate the accelerated data rates available for wireless networks that operate to standards like 802.11b and 802.11g (see table I). But what do these data rates really mean in practical terms?

802.11b	802.11g
11 Mbps	54 Mbps
5.5 Mbps	48 Mbps
2 Mbps	36 Mbps
1 Mbps	24 Mbps
	18 Mbps
	12 Mbps
	9 Mbps
	6 Mbps

Table I. Available instantaneous data rates for 802.11b and 802.11g

The first thing to understand is the difference between *instantaneous* data rate and *aggregate* throughput, both of which are specified in bits per second (or megabits per second, Mbps). Instantaneous data rate is the rate at which the data (the bits, the ones and zeros) are entering your computer at any instant in time. It does not mean that each of these bits is useful to you, nor does it mean you can receive these bits continuously at that rate.

The aggregate throughput is the rate at which the "useful" bits are entering your computer averaged over some period of time. (This is the rate that dictates the end user experience.) For example, suppose you have an automobile that is capable of going 100 mile per hour but you can only drive it for 30 minutes each hour (maybe the engine needs to cool off). Your instantaneous rate would be 100 miles per hour while you were moving (assuming your floored it), but since you could only cover 50 miles in that hour, your aggregate throughput would be 50 miles per hour. Now if you are trying to show off your new Porsche to impress someone, then your instantaneous rate is the one that you care about. But if you are crossing the country in your Hyundai, then your average (or aggregate) rate is the one you care about, because that is the one that will tell you how long it's going to take to make the journey.

Data rates specified for 802.11 like those shown in Table I are instantaneous data rates. They tell you how fast you are moving (when you're moving), but not how long it's going to take to get there. And it always takes longer to get there because in 802.11 networks, aggregate throughputs are always lower than instantaneous data rates.

There are two factors that keep 802.11 aggregate throughputs from equaling their instantaneous data rates. The first one is data overhead. When you send or receive data wirelessly, in addition to the bits you are moving, the 802.11 protocol adds additional bits to specify things like where the data came from, where the data is heading, and the order in which it should be read. While these additional bits are necessary for the proper functioning of the wireless network, they are not part of the useful information that you are sending or receiving (e.g., part of an e-mail message) and therefore lower the aggregate throughput.

The other factor that lowers the aggregate throughput is dead time—or waiting time—and in 802.11 networks, there's a lot of waiting. You're either waiting for an acknowledgement that your message was sent successfully or you're waiting for someone else to get done so that you can have a turn. (Just as in wired Ethernet, only one person can transmit at a time in wireless networks.) And in general, the more people that are trying to use the wireless network at the same time, the longer the wait, on average, for each user. It's as if you had a 100 mile per hour Porsche that you weren't allowed to drive. To make matters worse, users connecting wirelessly at the lower instantaneous data rates slow down the aggregate throughput for everyone. This occurs because the same size file takes longer to transfer at 1 Mbps instantaneous data rate than at 11 Mbps instantaneous data rate which means it ties up the channel that much longer (and therefore you're waiting is longer).

Because of all this, it is not uncommon for several users receiving 11 Mbps instantaneous data rates to all be experiencing only 1-2 Mbps aggregate throughputs. That means, from a user experience perspective, all these users are sharing a 1-2 Mbps connection, even though the bits are entering their computers at 11 Mbps. This 1-2 Mbps gets divided up among the various users and produces the individual aggregate throughputs.

If there are a lot of people on the wireless network, or if there are a few people transferring very large files (e.g., streaming video), the user experience will not be as good as you thought. Just as a note, 256 Kbps aggregate throughput is about all that most DSL services guarantee, and in most cases this provides an acceptable user experience.

The lesson here is to not get caught up in the hype and the fantastic instantaneous data rates promised by wireless networks. It is better to take a more realistic approach by estimating conservative aggregate data rates and dividing them up among the total number of end users to get a rough idea of what kind of network experience the end user can expect.

ABOUT THE AUTHOR:

Carl Weisman is currently a Senior Engineer at 5G Wireless Solutions. He is the author of *The Essential Guide to RF and Wireless* (Prentice Hall, 2002) which is becoming one of the industry's standard texts. He possesses a BSEE, MSEE and MBA, served at Hughes Aircraft Company as a design engineer working on radar for fighter aircraft, and spent several years in sales and marketing of RF and wireless hardware for companies including Avantek-Hewlett Packard and M/A-COM-AMP. He can be reached at carl@5gwireless.com or 800.916.1611.

ABOUT THE COMPANY:

5G Wireless Solutions, Inc., located in Marina del Rey, CA, is a portfolio company of 5G Wireless Communications, Inc. (OTCBB: FGWC), a Business Development Company. The company creates and markets wireless broadband solutions for university and municipal campuses, and provides wireless networking equipment to a select group of VARs and WISPs through its Authorized Channel Partners program. Customers enjoy high performance internet access at lower acquisition, implementation and maintenance costs than most major competitors because of uniquely enhanced Wi-Fi base stations. 5G Wireless Solutions products are distinguished by their exceptional service area range, throughput speeds, number of concurrent users, non-line-of-sight (NLOS) capabilities and unique security protocol. These enhancements are compatible with standard IEEE 802.11b Wi-Fi equipment for "last mile" roaming and point-to-multipoint networks. 5G's value proposition - significantly increased performance at the lowest possible Total Cost of Ownership (TCO) - is quickly becoming a key consideration in the strategic deployment of the wireless experience.

5G WIRELESS SOLUTIONS, INC.
4136 DEL REY AVENUE
MARINA DEL REY, CA 90292
PHONE: (800) 916 1611 FAX:
(310) 823 0981
WWW.5GWIRELESSSOLUTI
ONS.COM