Ask-Wi.Com

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"The Access Point"

Access Our 14 Years Of Wireless Networking Experience

One advantage of being in the wireless WAN business is that we get to spend a lot of time outdoors on rooftops, on towers, and on mountaintops. From these locations, we sometimes see some great views. This picture was taken from one of our antenna sites in Los Gatos, California. We were looking north towards San Francisco which is 60 miles away. The faint whiff of blue just to the right of the center of the picture is the San Francisco Bay. The picture was taken on February 2, 1999 and the photographer was Bob Fike.

In this issue, I'll review the FCC 3:1 rule which allows higher-power operation, I'll give you a "rule-of-thumb" to help you deploy reliable wireless links, I'll recommend a useful (and free) throughput-testing tool, and I'll briefly talk about my upcoming wireless workshop in Atlanta.

Jack Unger - President, Ask-Wi.Com Inc.

The FCC 3:1 Rule

Can I Ever Exceed 4 Watts ?

*Some of you know about the **3:1 rule** but for those who have not heard about it or who want a review, here it is.*

*To minimize interference between different wireless users in the license-free 2.4 GHz band, the FCC limits the amount of power that you can radiate. The limit is **+ 36 dBm EIRP**, which is **4 watts**. EIRP stands for Equivalent Isotropic Radiated Power. EIRP is calculated by taking the transmitter output power in dBm, subtracting any transmission line loss in dB, and adding the gain of the antenna in dBi. Here's an example, a transmitter output of + 27 dBm minus a transmission line loss of – 6 dB plus an antenna gain of + 12 dBi would yield an EIRP of + 33 dBm EIRP (27 minus 6 plus 12 = 33). This EIRP is less than + 36 dBm so it is FCC-legal.*

*Sometimes we want a way to use more power to make a link work reliably over a longer distance. This is when the 3:1 rule comes to our rescue. The 3:1 rule allows us to **increase our antenna gain by + 3 dBi** if we **turn down the transmitter power by - 1 dBm**. We start from + 30 dBm (1 watt) of transmitter power and an antenna gain of + 6 dBi. We increase our antenna gain by + 3 dBi (to + 9 dBi) and turn down our transmitter power to + 29 dBm. (NOTE: This requires having the ability to software-configure the transmitter power to a lower level). Assuming no transmission line loss, our EIRP is now + 38 dBm (29 plus 9 = 38).*

*Did we just increase or decrease our chance of interfering with another network? True, our EIRP has gone up but when our antenna gain went from + 6 dBi to + 9 dBi, the **beamwidth of our radiated signal went down**. When antenna gain goes up, that's the same thing as saying that the antenna focuses the transmitter* *power into a narrower radiated beam. The narrower beam is **less likely to hit other networks and cause interference**.*

*The downside of the 3:1 rule is that it's **only legal in a point-to-point link**. The upside is that it's useful in long (for example, 20 or 30 mile) links AND it can also be used at the CPE end (customer-premise-equipment end) of a link back to a point-to-multipoint access point (AP). The FCC considers the CPE end (only) as being part of a point-to-point link because the CPE is only communicating with one other point (the AP) therefore **the CPE (but only the CPE) can use the 3:1 rule**. The 3:1 rule can not be used at the AP end where the maximum legal EIRP is still + 36 dBm.*

*One more thing, you can **apply the 3:1 rule multiple times** to the same endpoint. For example, you can increase the antenna gain by another + 3 dBi (to + 12 dBi) if you turn down the transmitter power by an additional 1 dBm (down to + 28 dBm). Your EIRP is now + 40 dBm. You can continue to apply the 3:1 rule over and over until your antenna becomes too large to mount or too difficult to aim. Practically speaking, this means that the largest antenna that can be used is about + 24 dBi. By the time your antenna gain reaches + 24 dBi, your transmitter power is down to + 24 dBm and your EIRP is + 48 dBm (64 watts).*

Fade Margin "Rule-of-Thumb"

Are Your Links Reliable ?

Microwave signals fade as normally as you and I breath. To deploy reliable links, we need to design our links with enough extra signal to overcome these fades. This extra signal is called the fade margin or the system operating margin (SOM). Fade margin, like other wireless power measurements, is measured in dB. For a receiver to reliably receive an incoming signal, the incoming signal must be above the receiver “threshold”. The threshold is the weakest signal level (in dBm) that a particular receiver can hear and successfully decode with a low bit-error rate. For example, an incoming signal with a power level of –70 dBm is louder than (above) the threshold of a receiver that has a threshold of –85 dBm. In this case, the incoming signal is 15 dB louder [(-70 dBm) minus (–85 dBm) = 15 dB]. Another way of saying this is “there is 15 dB of difference between a –70 dBm signal and a –85 dBm signal”. The incoming signal has a 15 dB fade margin above the receiver threshold.

So, what rule of thumb can we use to tell us if we have enough fade margin for our link to be reliable? Keep in mind that a “rule of thumb” is a generalization and there are exceptions but, in general, a rule of thumb is accurate enough to be a convenient way of getting work done or making a quick go/no-go decision.

In general, we need 10 dB of fade margin for wireless links that are up to 10 miles long. Above 10 miles, add one 1 dB for each additional mile over ten miles. For example, a 17-mile link would need a 17 dB fade margin; 10 dB for the first ten *miles plus 7 dB for the 7 mile of additional (over 10 mile) length. If you keep this rule of thumb in mind when you design your wireless links, you should be rewarded with reliable operation.* ***NOTE:*** *A high noise level, if present, means that you need a fade margin that is* ***above*** *the noise level.*

Throughput Testing

What's Your Wireless Throughput ?

Over the years, I've used a number of different network design and testing tools. I'd like to share one of these testing tools with you this month - a software tool that measures wireless (and wired) throughput.

Most wireless networks are deployed in order to provide reliable, affordable, high-throughput connectivity. Anyone can build a wireless network, but there is no guarantee that the network will deliver high throughput and deliver it reliably. There are a number of different ways to measure wireless throughput and they all yield somewhat different results so it's good to pick one throughput-testing tool and stick to it. The useful tool that I've stuck with over the years, is "QCheck", from Ixia. Ixia offers Qcheck at no charge and, although QCheck doesn't have the same range of features that other Ixia software products have, for the money (free), it does a very good job.

The standard QCheck installation installs both Console and endpoint software although testing between two machines does not require that the Console be installed on both machines. One machine can have only the endpoint software installed. The Console runs on Windows-based PCs but there are endpoints available for different operating systems.

My standard wireless test is to test TCP throughput using a QCheck "Data Size" of 1000 KB. The test only takes 15 or 20 seconds and the results are repeatable. >From either end of the link, you can run a test in either direction.

Be sure to test in each direction when you install a new wireless link. The upstream directly is especially important because when a point-to-multipoint access point is exposed to noise, the upstream direction (towards the AP) is usually the direction that slows down. If you install a new link and the upstream throughput is good, it's likely the link will deliver reliable, full-throughput performance. If you want to feel totally confident about the reliable performance of a new or existing link, first, measure and record the throughput. Then add a 10 or 15 dB (hardware) attenuator between one antenna and the radio. This simulates 10 or 15 dB of fading. (Remember our previous fade margin discussion?) Retest the throughput. If the throughtput did not decrease with the attenuator in place then you know for sure that the link will deliver extremely reliable service, even when fading is severe. (Remember to remove the attenuator after your throughput testing is completed.)

You can download QCheck at the following link.

- QCheck Download
- Ixia Homepage

Atlanta Wireless Workshop

Starting or Expanding a Wireless ISP ?

Call me if you're interested in joining us on June 21 and 22 at our upcoming wireless deployment workshop at Stone Mountain Park in Atlanta, Georgia. Our vendor-neutral workshop is for ISPs, wireless ISPs, independent telephone companies, City, County and State employees and for anyone who is involved (or about to be involved) in deploying broadband wireless WANs, municipal wireless networks, Wi-MAX networks, or 4.9 GHz public-safety wireless networks.

I've been leading these workshops personally since 2001 and I've trained over 2000 WISP and IT personnel. My style is not to lecture but to facilitate a focused, enjoyable, two-day interactive technical learning experience. Yes, we draw on my 14 years of wireless WAN and wireless ISP experience but it's important to me that we also draw on the experiences of everyone who attends. You won't find a richer, friendlier, or more supportive wireless learning experience anywhere.

If you're already working on network deployment plans, feel free to bring them along and I'll help you develop or improve them. It's also natural for you to have additional questions after you go home and go back to work on your own network. When questions come up, call me and I'll continue to assist you.

- **Workshop Homepage**
- **Workshop Summary**
- **Workshop Content Overview**

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Do you have questions about anything in this issue or on any other wireless subject? Pick up the phone and give me a call. I hope to talk with you soon.