The Next 3 dB

Tom Taormina, K5RC

I am a pragmatist by nature. Long ago I developed and validated a theorem stipulating that regardless of where you are in contesting, your *next* 3 dB of signal improvement will be expensive. Electronics 101 tells us that doubling the transmitter's power effectively improves the signal by 3 dB. Properly stacking two five-element 20 meter beams theoretically yields a 3 dB improvement over a single antenna. Before buying an amplifier or stacking Yagis, we apply cost/effort and return-on-investment calculations, either consciously or due to limited resources, time or importance to you (and to your family).

Let's analyze these two scenarios. If you're S8 with 750 W and a five-element Yagi, you'll be S8.5 by plugging either of the above variables into the equation. At first blush, that 3 dB increase is hardly audible, and going forward with the improvement may not make practical sense. If you're 449 in a pileup, however, that extra 3 dB may make the difference between working the station or not. One-half S unit in the ARRL November Sweepstakes won't help much when signals typically are very strong, but it may be of particular consequence in a DX contest.

Increasing power from 750 W to 1500 W is relatively painless. Stacking Yagis is not so simple. You can quickly analyze the benefit of an amp and, if so inclined, add one to your station at modest cost and effort. You may be motivated — and have the resources — to stack two Yagis. On the other hand, you may not have the real estate. Then again, you may be able to do *both* of these things and, in the process, gain 6 dB — one full S unit — of signal improvement! This sort of outcome makes the cost-benefit analysis more compelling.

Gaining 3 dB in a modest station is pretty straightforward. But what if you've worked hard and put together a competitive SO2R station with a couple of towers supporting monobanders? The next 3 dB in *that* scenario is likely to be extremely expensive and time consuming, and it may even require a move to the country. How do you objectively analyze what to do next to gain that 3 dB advantage?

The "Operator Enhancement Corollary"

This is where the "Operator Enhancement Corollary" (OEC) enters the next 3 dB equation. The OEC assumes I have the talent and drive to be a really competitive operator but need a station to match my abilities. I'm willing to make the commitment of time and resources to achieve the goals I've set. My business and family life can be prioritized to accommodate this indulgence. The OEC allows us to make more emotional judgments about spending $5000 for a transceiver or $900 for an SO2R box. These types of enhancements do not fit into the 3 dB improvement analysis so easily, because you can't measure their effect with a field strength meter. You probably won't double your contest scores by spending $300 for headphones when your $30 set has worked satisfactorily for years. So, the OEC places a *subjective* burden on each of us, assuming we have to justify our station enhancements to ourselves or a "higher power" (eg, spouse?).

I have always been on a tight budget. The original K5RC/K5GA multiop station was built in the late 1970s with an initial outlay of $1600. Most of the towers were scrounged or donated, and I repaired radios at night to buy cable clamps and coax. The 3 dB rule wasn't a huge factor, because our benchmark was a tribander and a two-element 40 meter Yagi from my first station. To achieve the *next* 3 dB over the seven-tower station was going to require a monumental commitment of time and money, however.

The "I-Want-It Factor"

Serendipitously, about the time the K5RC/K5GA station was peaking in its potential, NA5R came on the scene and wanted to build a "no-compromises" multiop contest station. The design called for 200-foot towers and stacked Yagis on every band from 80 through 10 meters. The 3 dB and OEC factors were no longer statistically viable measures as we embarked on that project. A third and more powerful corollary had to kick in. This is called the "I Want It Factor." While the motivation for the NA5R/K5RC station was to provide an extremely competitive environment for a cadre of up-and-coming operators, the rationale to expend what some might consider an obscene amount of money can only be explained by the I-Want-It Factor.

Having been part of NASA's Project Apollo team for 14 years, my preferred definition is, "We just made up our minds to go to the moon, and we did it." Since building a multiop contest station is a team effort, "I want it" is, therefore, more accurately defined as, "We just made up our minds and did it."

Unfortunately, Hurricane Alicia paid us a visit in 1983 and took down 13 towers at the old and new stations. That setback was followed by business disasters, divorces and other inconveniences that put plans for a serious multiop station on hiatus for more than 20 years.

In 1997, Midge, K7AFO, and I moved from Texas to Nevada. We found 10 acres on a 6400-foot ridgeline with great takeoffs to Europe and Japan. Since I was still struggling to build a successful consulting practice, we agreed that two or three towers would be all I might erect at the new QTH. That's when I discovered that the Next 3 dB was like malaria. It may go into remission for years, but sooner or later, you will have another outbreak.

With the impetus provided by our both

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Figure 1—*Before:* The Phase I station configuration before the 2007 CQ WW CW Contest

becoming members of NCCC and getting caught up in club spirit, the Next 3 dB soon escalated into OEC, as I saw an opportunity to provide a competitive station for club members. Four towers, however, would certainly be enough for my contesting goals to support the NCCC drive for the SS gavel.

Dreams Reawakened

In 2006 we hosted The Great Armadillo Reunion at our home. This gathering of Texas DX Society members and friends commemorated our accomplishment of activating every county in the W5 call area over a three-year period (1983-1986). One unforeseen outcome of that assembly was a renewed interest among graying TDXS members to fix their broken antennas and get back into contesting. Also rekindled was NA5R's ambition to fulfill the plans we'd abandoned in 1983 to build a world-class contest station. The Field Day operation during the Reunion marked the first time NA5R had been on the air in 23 years, and that experience proved to be a big incentive. By this time, the four-tower station had achieved many of the stateside contest objectives with NCCC resulting in several shiny new SS Gavels, so attaining The Next 3 dB was going to present some major challenges.

We kicked around the idea over the ensuing months, but a call from Don, K5AAD, launched us into action. Don's brother David was the former N5JJ (SK). He offered us the antenna farm that N5JJ had been building if we would come to Texas and dig it out of the yaupon bushes. The idea struck me that this would be a viable project to honor the memory of N5JJ and our other good friend and TDXS member "Rowdy," K5LZO (SK). Thus the N5JJ-K5LZO Memorial Station concept was born.

The antennas from Texas became the Next 3 dB, and in short order I had five towers on the property. NA5R (now W5FU) got really pumped when I found two large stations that had been dismantled in NCCC territory, and we acquired the K6ZM and KA6W towers and antennas. At this point OEC had clearly taken over, clouding any Next 3 dB logic. By the fall of 2007 we were up to eight towers and had a five-year strategic plan in place. That plan would take us into "we-just-made-up-our-minds-and-did-it" mode. We have budgeted time and resources to achieve a highly competitive multiop station for up-and-coming contesters and the station to realize their potential by the time the sunspots peak again.

Given that background and with no desire (or insanity) to compete from the West Coast with W3LPL, K3LR and KC1XX, what does the Next 3 dB look like when you already have eight towers and two well-equipped operating positions in place for 2007 CQ WW CW?

Defining the Requirements

An engineer by training, I felt a requirements document and system design as well as mandatory design reviews were in order. In August, 2007, N5OT operated NAQP CW, and Mark gave me the feedback I needed to make the SO2R setup more competitive. (While I can use the SO2R function, my serial mind cannot adjust to changing bands when I am running three a minute). After consulting with W5FU, I developed the requirements document. The station would have two identical SO2R stations. This way we could continue to support the NCCC Sweepstakes effort and still be able to quickly reconfigure those stations for M/2 DX contests.

Once the concept was clear, the outside work was formulated. Through the wise counsel of Dean, N6BV, and Dave, W6NL, it became apparent that we needed to replace the tribanders and dipoles with stacks of monobanders and Yagis. With Dean's *High Frequency Terrain Analysis* (*HFTA*) program, a day's worth of computer time yielded precise locations and heights for the antenna farm. Drawing upon the valuable lessons learned at Contest University 2007, we deemed the use of OWA (optimized wideband array) Yagis a must for the station.

Table 1 outlines the *outside* progression from Phase II to Phase III (set for completion by fall 2008). As you gasp at the Phase III plans, refer back to the Next 3 dB calculations. Since anything that can be measured with a field strength meter can be plugged into a simple "Next 3 dB" equation — such as replacing tribanders with monobanders — why the apparent overkill? That answer falls into an even more obscure postulate that says, "While you're at it, why settle for just a 3 dB improvement?" Actually, owing to economies of scale, it doesn't cost much more to gain 6 dB in one fell swoop. According to *HFTA*, going from a 130-foot high dipole to stacked 80 meter beams will yield as

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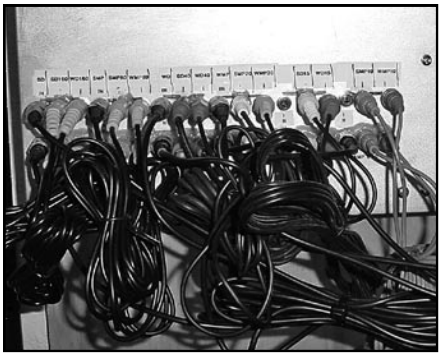

Figure 2 — The patch panel for the amplifier inputs

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Figure 3 — Amplifier RF input switching: SixPaks with band-pass filters for each band

Table 1

***Outside the Shack:* Phase II and Phase III plans**

Band	*Phase II (Fall 2007)*
160	Quarter-wave vertical, DX Engineering four-square receive antenna
80	Dipoles at 120 feet
40	4 elements at 70 feet and 2 elements at 135 feet
20	6 over 6 on a 140-foot rotating tower, 5 elements at 85 feet
15	6-element OWA, Force 12 C31XR
10	6-element OWA, Force 12 C31XR
Band	*New for Phase III (Fall 2008)*
80	3 over 3 OptiBeams on a 200-foot rotating tower
40	Raise tower to 140 feet and stack a second 4-element Yagi at 40 feet
20	Add third 6-element Yagi to stack, replace 5-element Yagi with long-boom 6-element Yagu, move 5-element Yagi to 40 meter tower
15	6 over 6 over 6 over 6 on new rotating tower
10	6 over 6 over 6 over 6 on new rotating tower

much as *17 dB gain* in one direction! We definitely can justify that using any form of measurement defined so far.

Inside the Shack

What, then, is the metric for the Next 3 dB *inside* the shack? How do we quantify OEC, and how do we define the ideal equipment configuration? The SO2R design was pretty clear because I had already acquired a MicroHam MK2R box and took N5OT's suggestions for ergonomic improvements relative to equipment placement. Radio choice took on an emotional factor because W5FU had always preferred Yaseu, and Dennis, K7BV, was a regular operator at the station. Without succumbing to the radio debate, we decided on a Yaesu MARK-V FT-1000MP and a FT-2000D for each of the two stations, mostly because any guest operator likely would be familiar with the layout and operation of these radios.

My next challenge was to quantify how to design the most competitive and functional M/2 station. When the crew showed up for the first serious DX contest effort, the 2007 CQ WW CW, the opportunity presented itself to observe human dynamics and to ask what needed to be fixed. Among the first issues tackled in 2007 was "guest-operator proofing" the amplifiers. I was tired of having the Alpha 86 and 87A continually traveling back and forth to Alpha to have pin diodes replaced because KL2A hot-switched antennas in a moment of competitive fury.

Fortunately, we discovered Emtron amplifiers, which are built like the tubes from the Russian military radios they power. They are built for abuse with many integrated safety features, plenty of headroom and forgiveness for poor tuning and hot switching antennas. Having three reliable amps was, I thought, an ideal solution for a multiop station. But *noooooo*! With input from W6EU, KY7M, N6XI, K6KR, and W5FU, I amassed a new checklist of issues aimed at accomplishing the Next 3 dB inside. Operators defined these key issues:

1. The need to be able to immediately select any of the 12 antennas on either station
2. Convenient access from either station to controls for the six rotators
3. Curing the complexity in changing bands and tuning amplifiers
4. Wattmeters visible from both stations
5. Resolving network problems with the logging software
6. Dealing with noise and heat from the amplifiers

As these issues were folded into a revised requirements document, items 3 and 6 became the drivers for station redesign. Item 3 motivated W5FU to recommend an elegant band-changing solution: an amp for each band. This approach threw down a gauntlet for me to design the controls to allow automatic switching among the six amps with four radios. Further, I had to figure out how to control the antennas into each amplifier. After many hours of design and experimentation, a system approach took form. Having this design work effectively required making some basic assumptions. First, to make the input logic work the radios had to be assigned specific bands, so each FT-1000MP was assigned 80, 20 and 10 meters, while each FT-2000 was assigned 160, 40 and 15 meters. Next, each of the four radios was assigned to a W9XT band-decoder board. The decoders drive custom-designed relay logic that routes the T/R switching from each radio to the appropriate amplifier. It also switches one of two Array Solutions SixPaks to route the RF input to the correct amp. The RCA patch panel was included in case the amps had to be reconfigured due to an equipment failure.

While waiting for the three Emtron amps to arrive from Australia, we had to resolve other issues on the checklist. The solutions to the heat, noise, rotor access, antenna switching and station layout issues presented themselves in the form of

Table 2

Reviewing the problem checklist: **The week before the ARRL International DX Contest CW, it was time to review how we resolved the issues on our checklist.**

Problem	*Solution*
Select any of 12 antennas from either station	Install a MicroHam switch box and controls into separate amps shared by both stations
Convenient access from either station to the six rotator controls	Intall Green Heron control boxes and *Everywhere* software, allowing all rotators to be controlled on each computer screen
Simplify band changing and amplifier tuning	Use one amp per band and a install a custom switching systemcontrolled by each radio's band switch
Have wattmeters visible from both stations	Install WaveNode wattmeters that display on the computer screens
Resolve logging software networking problems	Install *Win-Test* software
Address amplifier noise and heat issues	Install amps in a separate room with noise insulation and a ceiling exhaust fan

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Figure 4—Rotor and antenna controls

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FIgure 5—*After:* The completed remodeling job

a forgotten 6×6 storage room behind the station. Consultation with a local carpenter set off a demolition and construction project that consumed a month of enforced radio silence.

We abandoned the big operating console and the office desk that appears in Figure 1 for a custom wraparound operating console made from very inexpensive laminate plywood. The main (west) station is against an outside wall, but the second (south) station now opens into the old storage room.

Antenna switching was resolved by procuring three MicroHam 4×2 switch boxes and building two controllers. One-half of each RF switch box would be assigned to one amp, giving a total of four antenna selections per band.

Since the two stations now were within reach of each other, we addressed the rotator control issue by acquiring six Great Heron RT-21 rotator control boxes and disposing of the various Create and Hy-Gain boxes. The Great Heron units also provided a convenient location for the various switch and Stack Master boxes.

To deal with network and wattmeter issues, we switched to *Win-Test* logging software because it has its own network. It also requires more display real estate, which precipitated deploying two monitors for each computer. The monitors also show the WaveNode wattmeter displays and the Great Heron *Everywhere* program that controls the rotator boxes. Table 2 reviews how we resolved each problem.

The Next Level?

After a very successful ARRL DX CW, another meeting of operators resulted in another list of issues to resolve. These are *not* Next 3 dB problems but refinements such as being able to see the WaveNode wattmeters on both computers and controlling the antenna switches with a mouse click instead of toggle switches. These issues are being addressed.

What you may want to ask at this point is, "How do you make another 3 dB improvement in the station and/or antennas?" That's part of the magic of evolutionary station design. Outside, the only hint I can give you is that W5FU wants a 3-element rotary 160 meter antenna. Inside, we are working on controlling all antenna switches, stack boxes and rotators on each station's computer screen. *Stay tuned!*

Tom Taormina, K5RC, has been building contest stations for more than 35 years. In 2007 he was among those inducted into the CQ Contest Hall of Fame. He lives in Virginia City Highlands, Nevada. A complete set of inside and outside N5JJ/K5LZO Memorial Station photos is available on his Web site, ***http://k5rc.cc****.*

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