Propagation Planning for Contests
Using Propagation Predictions to Develop a Band Plan
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Propagation planning for a contest effort is quite similar to propagation planning for a DXpedition (the latter work, titled *Propagation Planning for DXpeditions*, is available at **http://www.arrl.org/tis/info/pdf/propplan.pdf**). For both, you need to know when the bands are open. What separates propagation planning for contesting from propagation planning for DXpeditions is the extra step for contests to assure that you're always on the band that gives you the highest *score* – which may not necessarily be the band that gives you the highest *rate*. The goal of this article is to provide a 3-step process that generates an *a priori* contest band plan to maximize your score.

This process is only needed for contest categories that require a decision with respect to which band to be on at any given time. So if you're a multi-multi with a dedicated station and sufficient operators on each band, then this doesn't apply - all you need are propagation predictions on each band to your target areas. Likewise if you're a single-band entry, this also doesn't apply - all you need are propagation predictions for your band to your target areas. Neither of these categories requires a "which band should I be on?" decision.

The concept behind these steps is the fact that our propagation predictions are statistical over a month's time frame [note 1]. The prediction of whether there's enough ionization to get an electromagnetic wave from Point A to Point B is a probability, as is the comparison of the predicted Signal-to-Noise Ratio (SNR) to a user-selected criteria. Multiplying these two probabilities together for the most important paths and picking the highest overall probability should statistically put you on the right band at the right time to maximize your score.

Will adhering to these steps make you a winner? Not necessarily. Competitive contesting requires efforts in many areas other than propagation. Understanding propagation is just one piece of the larger puzzle.

Will adhering to these steps help everyone? Again, not necessarily. If you're an experienced contester operating from a familiar QTH in a familiar contest, these steps probably won't help at all. On the other hand, if you're operating from an unfamiliar QTH (in terms of knowing when the bands are open) or are in an unfamiliar contest (unique point structure to different areas of the world), these steps should help improve your score.

Let's go through the steps, and then we'll follow up with an example.

Step 1: Know the Contest

In order to maximize your score, you need to intimately know the contest. You need to know whom you can work. You need to know what the multipliers are. And you need to understand the point structure of the contest to identify which contacts are most valuable. The only way I know how to do this is to sit down and carefully read the contest rules. Take notes if necessary.

The output of this step is the high-level strategy that identifies which QSOs are most important (they're all important, of course – but some are more important than others when it comes to scoring!)

Step 2: Run Predictions for the Paths for Your Most Important QSOs

We'll use VOACAP (the Voice of America's version of IONCAP) for this exercise. It can be downloaded for free at **elbert.its.bldrdoc.gov/hf.html**. There are several excellent resources to bring you up to speed with VOACAP: OH6BG's VOACAP Quick Guide at **www.uwasa.fi/~jpe/voacap/**, ON5AU's monthly Propagation writings at **www.antennex.com**, and my introductory tutorial at `www.arrl.org/tis/info/pdf/Voacap.pdf`.

VOACAP gives us the two necessary parameters that we need: the MUFday probability and the REL (short for Reliability) probability. The former indicates the probability (in terms of the number of days of the month) of having enough ionization to get RF from your QTH to your target area. The latter indicates the probability that the predicted SNR meets your selected criteria.

What you'll do is run predictions from your contest QTH – but not to every place in the world on every band. Using the output of Step 1, you'll just run predictions for the most important paths. And you'll do it on the bands deemed most important. The example after Step 3 should help make this step clear.

Step 3: Be Flexible During the Contest

I cannot stress the following point enough – do not apply the band plan that comes out of this process as 'cast in concrete'. Treat it as a guideline. Thus you may need to be flexible and make changes on the fly.

The reason you need to be flexible is because the band plan was based on the model of the ionosphere used in our propagation prediction software – it gives monthly median results. On any given day of the month, the next higher band could be better than the best band per the prediction. Or the best band per the prediction may not be open and you'll have to move down one band. Again, all it says is 'be flexible'.

To help in this area, you should periodically check the next higher band. And use the NCDXF/IARU beacons on 20m through 10m to give a real-time assessment of these higher bands.

Now let's go through an example.

Example: A Multi-Single Effort from the Caribbean for CQWW CW

This example will compare the process to a contest effort that already happened to see how well the process does. In 1997, K1TO, W5ASP, K9MK, and I did a multi-single effort in CQWW CW from ZF1A [note 2]. We ended up winning the World and setting a new World record (which has since been broken, and there's a corollary to the old saying about 'love' - it's better to have broken the record and lost it than to never have broken it at all).

Since we were a multi-single entry, we had a decision to make as to what band the run station should be on for each hour of the contest.

Being in the Caribbean meant our QSOs with the major ham population areas were worth different points. QSOs with North America were only worth 2 points, whereas QSOs with Europe and Japan were worth 3 points. Thus our most important QSOs were with Europe and Japan.

Should we therefore run predictions from ZF to Europe and Japan on all the bands? No – because not all the bands are considered to be 'run' bands. 160m and 80m are better considered as bands to be on for a short period of time to pick up mults. So all we really need to do is run predictions on 40m, 20m, 15m, and 10m. We'll include 10m even though the smoothed sunspot number for November 1997 was 34 – we don't want to miss any short duration openings.

Note that we're ignoring North America. That's ok, as being so close to North America says we're going to work them anyway. We want the run station to be on the band that gives us the highest probability for the best *score* (3 pointers), not the best *rate* (2 pointers).

A comment about SNR, desired REL, and antenna gains is in order. I'll use an SNR of 27dB in a 1Hz bandwidth (0dB SNR in a 500Hz bandwidth) as the input parameter to VOACAP for our CW operation. For SSB, an SNR of 40dB in a 1Hz bandwidth (5dB SNR in a 3KHz bandwidth) is a good choice to input to VOACAP, and that gives around 70% intelligibility. As for the desired REL, I'll use 50% (regardless of the mode). For the antenna gains, try to be as accurate as possible with these values, especially over frequency with the Transmit antenna, as this will impact the results (through SNR).

Figure 1 shows the MUFday and REL parameters, along with the product of those two parameters, from ZF to Europe and Japan on 40m through 10m for November 1997 [note 3]. The highest overall probability is shaded green for each hour, and this is what VOACAP says is our best band to be on to meet our 'best score' goal. The second highest overall probability is shaded blue. Finally, 10m is shaded red.

	EU												JA											
	40m			20m			15m			10			40m			20m			15m			10m		
UTC	MUFday	REL	product	MUFday	REL	product	MUFday	REL	product	MUFday	REL	product	MUFday	REL	product	MUFday	REL	product	MUFday	REL	product	MUFday	REL	product
00	0.98	0.87	0.85	0.08	0.52	0.04	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.91	0.72	0.66	0.35	0.78	0.27	0.02	0.13	0.00
01	0.98	0.85	0.83	0.05	0.37	0.02	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.76	0.66	0.50	0.10	0.31	0.03	0.00	0.00	0.00
02	0.98	0.87	0.85	0.09	0.54	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.53	0.63	0.33	0.01	0.02	0.00	0.00	0.00	0.00
03	0.99	0.88	0.87	0.15	0.68	0.10	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.33	0.52	0.17	0.00	0.00	0.00	0.00	0.00	0.00
04	0.98	0.88	0.86	0.07	0.47	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.00	0.00	0.16	0.33	0.05	0.00	0.00	0.00	0.00	0.00	0.00
05	0.96	0.86	0.83	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.06	0.06	0.14	0.32	0.04	0.00	0.00	0.00	0.00	0.00	0.00
06	0.93	0.88	0.82	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.37	0.37	0.21	0.50	0.11	0.00	0.00	0.00	0.00	0.00	0.00
07	0.98	0.96	0.94	0.01	0.08	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.62	0.62	0.36	0.77	0.28	0.00	0.00	0.00	0.00	0.00	0.00
08	0.99	0.94	0.93	0.28	0.81	0.23	0.00	0.00	0.00	0.00	0.00	0.00	0.99	0.65	0.64	0.52	0.83	0.43	0.03	0.18	0.01	0.00	0.00	0.00
09	0.98	0.89	0.87	0.19	0.72	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.98	0.59	0.58	0.25	0.69	0.17	0.00	0.00	0.00	0.00	0.00	0.00
10	1.00	0.76	0.76	0.19	0.69	0.13	0.00	0.00	0.00	0.00	0.00	0.00	0.96	0.60	0.58	0.16	0.61	0.10	0.00	0.00	0.00	0.00	0.00	0.00
11	1.00	0.29	0.29	0.82	0.88	0.72	0.01	0.00	0.00	0.00	0.00	0.00	0.96	0.59	0.57	0.13	0.58	0.08	0.00	0.00	0.00	0.00	0.00	0.00
12	1.00	0.00	0.00	0.99	0.97	0.96	0.62	0.89	0.55	0.02	0.14	0.00	0.98	0.68	0.67	0.03	0.17	0.01	0.00	0.00	0.00	0.00	0.00	0.00
13	1.00	0.00	0.00	0.99	0.88	0.87	0.82	0.90	0.74	0.19	0.68	0.13	0.98	0.26	0.25	0.05	0.19	0.01	0.00	0.00	0.00	0.00	0.00	0.00
14	1.00	0.00	0.00	0.99	0.83	0.82	0.82	0.90	0.74	0.18	0.69	0.12	0.99	0.00	0.00	0.14	0.40	0.06	0.00	0.00	0.00	0.00	0.00	0.00
15	1.00	0.00	0.00	0.99	0.77	0.76	0.81	0.89	0.72	0.17	0.67	0.11	0.99	0.00	0.00	0.19	0.42	0.08	0.00	0.00	0.00	0.00	0.00	0.00
16	1.00	0.00	0.00	0.99	0.76	0.75	0.75	0.89	0.67	0.08	0.48	0.04	0.99	0.00	0.00	0.10	0.18	0.02	0.00	0.00	0.00	0.00	0.00	0.00
17	1.00	0.00	0.00	0.99	0.82	0.81	0.53	0.85	0.45	0.01	0.02	0.00	0.98	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
18	1.00	0.00	0.00	0.93	0.81	0.75	0.10	0.55	0.06	0.00	0.00	0.00	0.99	0.00	0.00	0.03	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00
19	1.00	0.00	0.00	0.73	0.81	0.59	0.00	0.02	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.16	0.24	0.04	0.00	0.00	0.00	0.00	0.00	0.00
20	1.00	0.27	0.27	0.32	0.66	0.21	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.61	0.63	0.38	0.00	0.00	0.00	0.00	0.00	0.00
21	0.99	0.72	0.71	0.11	0.42	0.05	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.92	0.71	0.65	0.27	0.66	0.18	0.00	0.00	0.00
22	0.90	0.79	0.71	0.13	0.67	0.09	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	0.98	0.77	0.75	0.73	0.88	0.64	0.13	0.59	0.08
23	0.95	0.86	0.82	0.10	0.60	0.06	0.00	0.00	0.00	0.00	0.00	0.00	1.00	0.00	0.00	1.00	0.89	0.89	0.74	0.91	0.67	0.05	0.30	0.02

Figure 1 – Probabilities for ZF1A to EU and JA for CQWW CW 1997

If we stick to the green shading, we'd only be on 40m and 20m. But remember note 1 – because of it we really need to factor in the second highest overall probability if it's close. For example, from 1300 to 1600 UTC, we should keep an eye on 15m, as it's not too far behind in probability to 20m – the day-to-day variability of the ionosphere could easily make 15m the preferred band during one or both days of the contest weekend. Similarly, we should keep an eye on 10m from 1300 to 1500 UTC – the likelihood of it being a major player is quite low, but we need to make sure we're there for any possible openings to catch Qs and mults.

If two bands have the same overall probability, I'd go with the band that offers the most mults. For example, in Figure 1 the overall probabilities of 40m to EU and 20m to JA at 2100 and 2300 UTC are close. 40m to EU would get the nod here.

Figure 2 shows the predicted 'best band' compared to the after-the-fact actual band changes that ZF1A made.
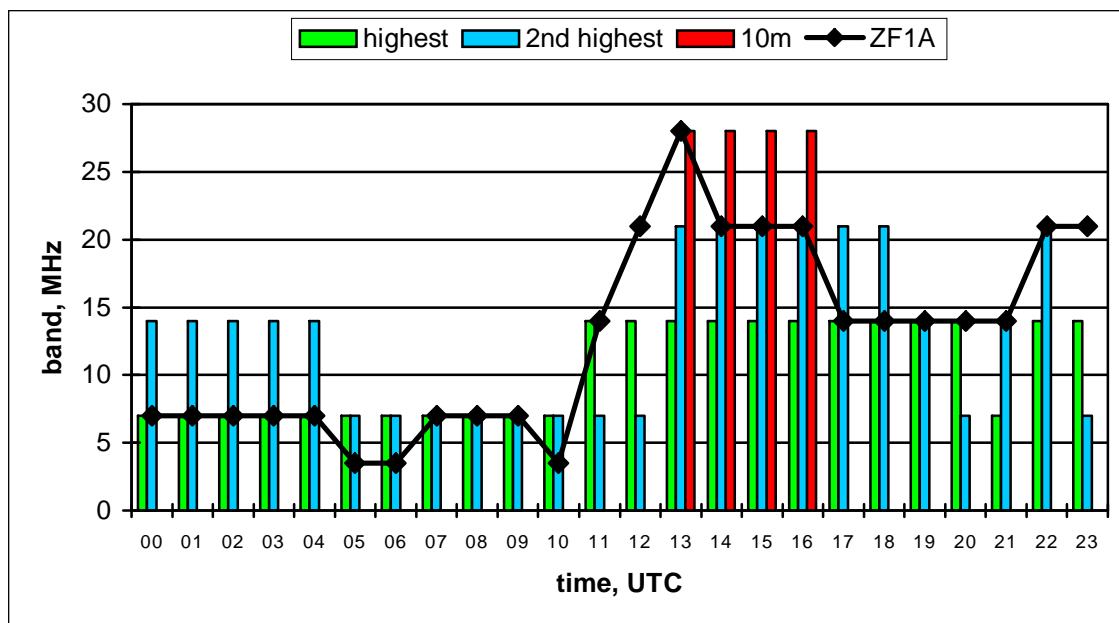

Figure 2 – Comparison of the Process to ZF1A Band Changes

Figure 2 is kind of busy, but what we would like to see is the black ZF1A line (the actual band changes) closely following the green bars (best band). As you can see, the agreement is pretty good when the comments about the second highest overall probability and 10m are factored in. And note that, indeed, the run station had excursions to 80m (and to 160m, too, even though it's not shown due to the extremely short durations). The data in Figure 2 is for the first day of the contest. The second day was very similar, but with a bit more band changes to keep the rate up.

Let me reiterate that this specific exercise compared the process to an effort that had already happened. In other words, we didn't use this process. By previous agreement, K1TO did the bulk of the run station work. He is very familiar with CQWW contests and

has operated from the Caribbean before. So here's a good example of my earlier statement that this process may not help everyone (an experienced contester operating from a familiar QTH in a familiar contest).

Before wrapping this up, I'll mention two other propagation-related factors that are important for contesting.

Get the Big Picture

This factor is identical to 'Step 2: Get the Big Picture' in the aforementioned work titled *Propagation Planning for DXpeditions*.

If you're operating from an unfamiliar QTH, print out a great circle map (also called an azimuthal equidistant map) centered on your contest location. This will give you headings to the major contest population areas and to everywhere else in the world for multiplier hunting. It will also give you distances to your target areas, which could be important for short path / long path decisions. Finally, it gives you an indication of how high in latitude your paths to the major ham population areas go. This leads right into the next section.

Understand The Impact of Disturbances to Propagation

There are three main categories of disturbances to propagation: geomagnetic field activity (designated as G in the NOAA scales), polar cap absorption events (designated as S in the NOAA Scales), and radio blackouts (designated as R in the NOAA Scales). For more information on the NOAA Scales, visit **www.sec.noaa.gov/NOAAscales/**.

Geomagnetic field activity is caused by CMEs (Coronal Mass Ejections) and coronal holes and can result in degraded propagation at auroral latitudes and decreased F2 region ionization at mid to high latitudes (and on some occasions geomagnetic field activity can *increase* low latitude F2 region ionization – see the September/October 2005 issue of NCJ for details on this). Geomagnetic field activity is generally the most detrimental to contesting, as the duration can be for many days. A good example of geomagnetic field activity adversely affecting a contest is W4ZV's experience in CQWW CW in 2001. The details of this are in the Propagation column in the January/February 2003 issue of NCJ. Another good example is what happened to 10m in CQ WPX CW 2002 – see the March 2003 issue of CQ magazine for these details.

A polar cap absorption event (called a PCA) is due to energetic protons from big solar flares causing increased absorption on those paths across the polar cap (the area inside the auroral oval). PCAs only occur on average at the rate of six per year. Thus for all intents and purposes the probability of a disruption to a contest by a PCA is quite low.

Radio blackouts are due to electromagnetic radiation at X-ray wavelengths (1 - 10 Angstroms) from big solar flares causing increased D region absorption on the daylight side of the Earth. Radio blackouts are generally of short duration, so their impact is not as

severe as geomagnetic field activity. And due to absorption being inversely proportional to the square of the frequency, the higher bands will be affected last and will return to normal first. A good example of a radio blackout adversely affecting a contest is N9XX's ZF2RR operation in CQWW CW in 2000. The details of this are in the Propagation column in the September/October 2002 issue of NCJ.

Summary

What we've done is use the inherent probabilities in our propagation prediction software (specifically VOACAP in this case) as the basis for a 3-step process to develop a band plan for contest categories that require a decision as to which band to be on at any given time. Although this process was intended for single-transmitter categories, it should work nicely for two-transmitter categories, too – the second highest overall probability would be for the second transmitter.

This process may not help everyone, nor should it be treated as a rigid plan. Here's another corollary to the old saying about 'love' that I try to adhere to – it's better to have a plan and change it than to never have had a plan at all.

Finally, Figure 1 was put together manually. There's no reason why this process with VOACAP couldn't be put in software so that a band plan is spit out automatically after the output of Step 1 is determined.

Notes:

1. Our model of the ionosphere is a monthly median model, and as such it gives us monthly median results. The reason we have a monthly median model of the ionosphere is because we don't have a good handle on the myriad of factors that cause the ionosphere to vary on a day-to-day basis. More details on this interesting subject are in the Propagation column in the August 2004 issue of WorldRadio.

2. You can read about this effort in the November/December 1998 issue of The National Contest Journal (NCJ).

3. Note the many instances on 40m of a high MUFday value coupled with a low (or zero) REL value. All this says is that there is enough ionization to get 7MHz RF from ZF to Europe and Japan, but absorption is prohibitive. Also note the several instances (10m to Europe from 1300 to 1600 UTC, for example) of a low MUFday value coupled with a high REL value. This says that if the band opens (and it's a big 'if' with the MUFday value so low), the SNR should be great – with absorption inversely proportional to the square of the frequency, this makes sense.