The NCDXF/IARU International Beacon Network—*Part 1*

This worldwide beacon network, in operation for almost 15 years, is now being expanded to a multiband system.

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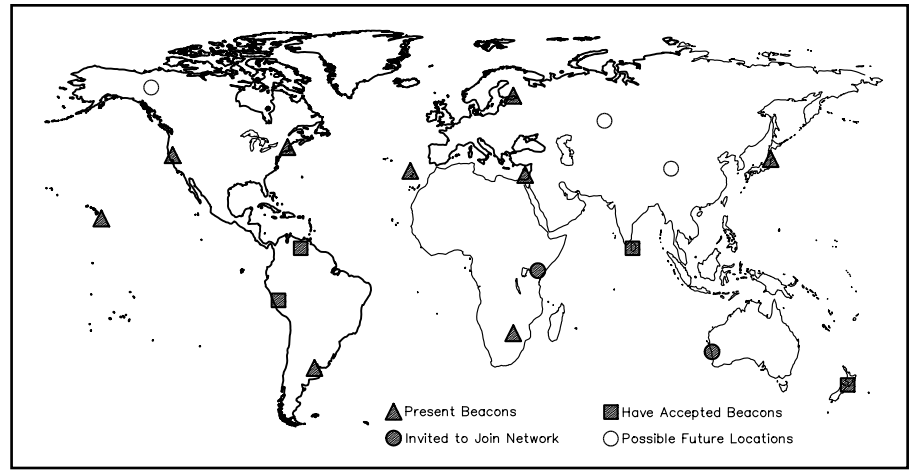
The present 14.1-MHz beacon network is one of those neat achievements that comes about when the vision, technology, and cooperative energies of many people combine to create something unique and useful. The worldwide network consists of nine frequency-sharing CW beacons that have been in operation continuously for almost 15 years. The network is there for every listener to use as a do-it-yourself propagation tool. Each beacon transmits a one-minute message every 10 minutes, 24 hours a day.

Over the next year or so, the network will be modernized and made even more useful. New beacons will be added to the nine that are now active, and all of them will be able to operate on up to five bands. The transmissions will be shortened to 10 seconds, so that the listener can monitor 18 beacons in three minutes. This two-part article explains how the current network evolved and how you can expect to use the modernized network.



The NCDXF/IARU International Beacon Network, showing existing and future beacon locations.

Phase I, the First Beacon

The 14.1-MHz beacon network was the creation of the Northern California DX Foundation (NCDXF).[1] The first beacon was designed and built from scratch by Jim Ouimet, K6OJO, in 1979, based on a suggestion by O. G. "Mike" Villard, Jr, W6QYT. You may remember Mike as the person who introduced SSB on the amateur bands in the late 1940s. This "Phase I" beacon was duly licensed by the FCC for operation on 14.1 MHz with the call sign WB6ZNL/B (with the /B indicating a beacon transmitter). The transmitter was heavy and it came to be known among the workers as the "guy-wire anchor," but it did its job as planned, transmitting for 75 seconds every 15 minutes for over a year. It featured Mike's idea of decreasing the power in 10-dB steps by transmitting a long dash at each of four power levels: 100, 10, 1 and 0.1 W.

The power stepping was a completely new idea for Amateur Radio beacon technology. It is much more useful to know what power level can be heard than to merely know the signal strength of the received signal. The knowledge that a certain power level can be

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Dave Rosen, K2GM, chief operator at the 4U1UN/B beacon, on the roof of the United Nations building. The 14.1-MHz beacon antenna is a dipole at the far end of the roof.

Table 1
Present 14.1-MHz Beacon Network Transmitting Sequence

Time	*Station*	*Location*
00:00	4U1UN/B	United Nations, New York
00:01	W6WX/B	Stanford University, California
00:02	KH6O/B	Kaneohe, Hawaii
00:03	JA2IGY	JARL, Tokyo, Japan
00:04	4X6TU	Tel Aviv University, Israel
00:05	OH2B	Helsinki Technical University, Finland
00:06	CT3B	AARM, Madeira Island
00:07	ZS6DN/B	Transvaal, South Africa
00:08	LU4AA	RCA, Buenos Aires, Argentina

The same sequence repeats every 10 minutes. W6WX/B also transmits for 10 seconds every two minutes at 21.150 MHz followed immediately on 28.200 MHz; the call sign and one dash at each of four power levels are transmitted.

Table 2
Transmissions by Each Beacon in the Present Network

Power Level (W)	*CW Message*
100	QST de (call sign)
100	. _____ (9-second dash)
10	. . _____ (9-second dash)
1	. . . _____ (9-second dash)
0.1	. . . . _____ (9-second dash)
100	SK (call sign)

Total transmission time: 57 seconds
Speed: 22 wpm

heard compares the signal to the background noise. Sometimes an S3 signal is perfectly usable; sometimes it is totally useless. The power levels give the listener a better feeling for the quality of the propagation. If you heard only one power level yesterday but hear all four today, then the band is in better condition today. Anyway, it's more fun to tell a friend that you heard the South African beacon at 0.1 W than to report that a 100-W signal was S5.

Phase II, Worldwide Expansion

The horrible prospect of reproducing eight or more of these beacon behemoths for a worldwide network stirred the creative juices of Dave Leeson, W6QHS. Dave designed a beacon that consists of a small controller box to work in conjunction with the Kenwood TS-120S transceiver. The controller used the Intel 8748 computer-on-a-chip to adjust the power output of the transceiver directly via the transceiver's ALC input. This chip combines an eight-bit microprocessor with a 1024-byte EPROM. Jack Curtis, K6KU, wrote the assembly language program for the microprocessor firmware. Jack had used a similar chip for his popular Curtis Keyers.

The late Cam Pierce, K6RU, engineered this prototype beacon into production with the help of Merle Parten, K6DC, and between 1982 and 1985 nine beacons were built and distributed worldwide.[2,3] During this expansion period, the call WB6ZNL/B was changed to W6WX/B.

The time slots during which the various Phase II beacons transmit on 14.1 MHz is given in Table 1, and the format for each transmission is shown in Table 2. Listeners who are not able to copy code at 22 wpm can figure out which beacons they are listening to according to the time that they hear each beacon. Table 1 provides the necessary information.

International Amateur Radio Union

In 1984, Alberto Shaio, HK3DEU, then Secretary of Region 2 of the International Amateur Radio Union (IARU), proposed that the IARU beacon program follow the general NCDXF frequency-sharing plan used by the 14.1-MHz network. Later, that proposal became the basis for NCDXF and IARU cooperation, and in recent years the two groups began planning together to expand the network and to develop a prototype multiband beacon. NCDXF provided the engineering, and IARU offered the international associations to help obtain locations for an expanded network and to disseminate beacon information worldwide to all 140 IARU member societies. Much of the funding will also be provided through the IARU.

After many years of operation it is apparent that the Phase II beacon network should be expanded to cover more of the world. The format of the transmissions should be changed to reduce the time it takes to listen for all beacons. And the beacon network should be expanded to cover more bands.

14.100 MHz Guarded Frequency

Almost from the beginning of the 14.1-MHz beacon network, the IARU drew up a band plan that suggested a 1-kHz "guarded" beacon frequency at 14.1 MHz. This guarded frequency was reaffirmed at the Region 2 IARU meeting in Curacao in 1992 and also has been adopted by IARU Regions 1 and 3. Recently, however, digital stations have swamped this frequency. It would be quite helpful to their fellow amateurs, and a courteous thing to do, for the operators of those digital stations to move either up and down in frequency and to avoid transmitting on exactly 14.1 MHz.

Expansion

The Phase II beacon network does not provide adequate worldwide coverage. With IARU assistance, we contacted five national societies and asked them to accept beacons and join the network. The societies that accepted are Radio Club Peruano, Radio Club Venezolano, New Zealand Association of Radio Transmitters, and Radio Society of Sri Lanka. The Wireless Institute of Australia and the Radio Society of Kenya have been invited, but they have not replied at the time this is being written. We hope to find one or more locations in Central Asia and to add other beacons later.

Transmission Format

Many people find the 10-minute cycle of the beacons too slow. As more beacons are added, the cycle would get even longer if we maintain the one-minute format for each beacon transmission.

We experimented with shortening the transmissions. We assumed that each beacon would send its call followed by four equal-length long dashes, one at each power level. We recorded simulations of a network of beacons with 15 seconds per beacon, then with 10 seconds, then with 7.5 seconds. We played these recordings for the NCDXF Board and they recommended the 10-second format. The same recording format was

DAVID V. LARSEN, ZS6DN

The 14.1-MHz beacon at ZS6DN/B, with the controller sitting on top of the transceiver.

JOHN G. TROSTER, W6ISQ

Lance Ginner, K6GSJ, secures the vertical antenna for the W6WX/B beacon, as Bob Fabry, N6EK, watches, atop Mt Umunum, overlooking San Jose, California.

Kenwood TS-140S Transceiver Donation

Bob Ferrero, W6RJ, of Ham Radio Outlet, and former president of the NCDXF, contacted Kenwood Communications Corporation about a possible discount on the Kenwood TS-140S transceivers that are the heart of the beacon system. Paul Middleton of Kenwood responded with the donation of 16 TS-140S transceivers to the network. We are deeply grateful to Kenwood for their generous endorsement of the beacon project. This magnificent gift was presented by Kenwood in memory of Jim Rafferty, N6RJ, the former Vice President of Ham Radio Outlet. A small plaque will be attached to each transceiver with this inscription: "This Kenwood TS-140S transceiver was donated to the NCDXF/IARU International Beacon Project by Kenwood Communications Corporation and Ham Radio Outlet in memory of Jim Rafferty, N6RJ."

AHARON SLONIM, 4X4FQ

The antenna for the 4X6TU/B beacon, mounted on the physics and astronomy building of Tel Aviv University.

played for the delegates of IARU Region 2 at a meeting in Curacao in September 1992. The delegates concurred that 10 seconds sounded about right. This timing allows 18 beacons to transmit in sequence around the world in three minutes.

Multiple Bands

Expanding the beacon network to cover additional bands will provide valuable additional propagation information. The Phase III network will transmit on the 14, 18, 21, 24 and 28-MHz bands. (The 10-MHz band is not included because the band is still shared with other services, but it could be added later.) In addition to the listener being able to detect band openings on an individual band, he will also be able to quickly check all five bands to see which band has the best propagation to a particular part of the world.

To select frequencies for five-band operation, Bob Knowles, ZL1BAD, International Coordinator of the IARU Monitoring Service was asked to study the bands from 14 to 28 MHz. His report, based on the work of the IARU worldwide volunteer monitoring system, was instrumental in developing the tentative primary frequencies: 14.100, 18.110, 21.150, 24.930, and 28.200 MHz. Alternate frequencies at the high and low ends of each band also are being considered, but at the time of ZL1BAD's report there was interference from commercial stations outside the high end of some bands that could be copied inside the amateur bands. We are continuing to study the situation and will be able to re-program these frequencies if necessary by issuing a firmware upgrade.

Phase III, the W6WX/B Prototype

A new control unit has been built that can key a Kenwood TS-140S on five bands. This unit is now in operation at W6WX/B, but is restricted to operation on 14.100, 21.150, and 28.200 MHz because those are the frequencies for which it is licensed by the Federal Communications Commission. The technical aspects of this new beacon design will be described in Part 2 of this article.

New Format

W6WX/B transmits its regular one-minute message in its turn on the 14.1-MHz network at 0001Z, and every 10 minutes thereafter, just as it has for 15 years. When it has completed its 14.1-MHz one-minute message, it switches to 21.150 MHz and transmits for 10 seconds in the new format, "W6WX/B, dah-dah-dah-dah." It then immediately switches to 28.200 MHz and sends the new-format message. The 21 and 28-MHz message is repeated every two minutes. The other seven beacons will continue to transmit their one-minute message on 14.1 MHz only until they are replaced by multi-band equipment.

When the new beacons are in place, each will be able to transmit its call sign and four dashes on each of five bands. Ultimately, we hope all beacons will be licensed by their governments for five-band operation.

Financing

The three IARU Regional Executive Committees were solicited for funds to build and distribute the beacons in their respective Regions. Region 2 (North and South America) responded with a pledge to fund one beacon, at an estimated cost of $2500 per beacon, plus $1000 for continuing support. Region 1 (Europe, CIS and Africa) did the same. The ARRL Foundation generously contributed $5000. We hope that other major national amateur organizations will also become sponsors. John Downing, K6YRU, of the Downing Foundation, which has funded NCDXF with several grants, provided funds for prototype Phase III beacon construction.

Conclusion

The present 14.1-MHz beacon network is for everyone, whether you are a DXer looking for general band-opening information, or a contester looking for spot-opening information, or perhaps a high school or college student working on your science project, or a laboratory researcher, or SWL, or just a rag chewer who would like to find out what's new. Get the 14.1-MHz habit now. Flip in your CW filter and listen along.

DXpeditions even find the beacons useful. Bill Schmieder, KK6EK, in his recently published book *3YØPI, Peter I Island Antarctica* remarked that conditions at one point were very poor. So just to make sure conditions were as bad as they sounded, he "listened on 14.1 for the beacons, but…heard nothing."[4]

In part 2 of this article, we will discuss the implementation of the beacons for Phase III, including the use of a GPS satellite receiver to provide timing.

Notes

[1]J. G. Troster, W6ISQ; O.G.Villard Jr, W6QYT; J. K.Ouimet, K6OPO; C. G. Pierce, K6RU; "The WB6ZNL Beacon," *QST*, Jan 1980, p 57.

[2]J. G. Troster, W6ISQ, and C. G. Pierce, K6RU, "World-Wide Beacon Net: The Possibilities Abound," *QST*, Jun 1983, p 27.

[3]J. S. Stover, W5AE, "20-Meter Beacons Revisited," *QST*, Dec 1988, p 60.

[4]R. Schmieder, KK6EK, *3YØPI, Peter Island Antarctica* (Walnut Creek CA: Cordell Expeditions, 1994).

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