SA radio amateurs embark on a next gen beacon programme

Current beacon in Bethlehem — antenna structure

VHF and UHF radio propagation remains a mystery; even tropospheric and sporadic-E propagation are not fully understood, with new long-distance communication distance records being broken. The enquiring nature of radio amateurs has over many years resulted in informal research with setting up beacons and monitoring signals. But this hand-to-mouth way of doing this has not really delivered the kind of data to make meaningful and scientific findings. All it's really is showing is that long distance communication of frequencies above 30 MHz is possible and does regularly occur. The answer to the conundrum is to set up a reverse beacon network to monitor beacons.

Reverse beacon monitoring has always been a major requirement for monitoring a beacon and has been discussed over the past two-plus years at various workshops arranged by the SARL and AMSATSA. The initial outcome of these deliberations was to monitor CW beacons using software like CW skimmer, but experience gained through actual testing has shown a number of flaws with this approach. The major flaw is that CW skimmer software is not 100% reliable when it comes to decoding. It requires a fairly strong signal before the software actually begins decoding the received CW signal. Aural reception of a weak CW signal can already take place way before the skimmer software starts to decode the signal.

These findings encouraged members of the SARL VHF work group to start experimenting with digital modes like FT8 and JS8Call on VHF and UHF, and they found that the reception and reporting of the signals heard could take place at very low levels. This therefore seems to be a much better solution for a beacon than continuing with a traditional CW beacon.

Next generation beacons

Drawing on experience from international amateur radio groups with similar objectives, the work group found that the PI4 mode would meet the requirements and the journey to next generation beacons.

Next generation beacons generate a machine generated message (MGM) similar to WSJT-X and other digital modes. There are already numerous digital modes available, however testing and experience has shown that the various digital modes have been developed with specific types of propagation in mind and do not all work equally well for different propagation types.

Pi4 has been developed specifically by the next generation beacon project team in Denmark for VHF propagation and above. Pi4 is short for PharusIgnis4. The name PharusIgnis4 comes from the ancient words for beacon, lighthouse and fire - Pharos (from Greek to Latin Pharus and coming from the lighthouse of Alexandria), Ignis (Latin: fire) and 4 for the four FSK tones.

Pi4 is also compliant with the International Amateur Radio Union (IARU) Region 1 VHF Committee, which accepted one minute mixed-mode beacon sequence.

Pi4 makes use of four tones, as does JT4 and WSPR, however there is a difference in the spacing of the tones and on which tones syncing takes place.

Pi4 is free, allowing any radio amateur who is set up for digital modes to easily receive, decode and report on the signal received. It is available as a standalone package called PI-RX and has been incorporated in the MSHV software package also used by a number of VHF and above enthusiasts.

Extra bonus

The MGM signal generated by the next generation beacon does not only generate a Pi4 sequence, it also generates the beacon ID in CW and sends out a frequency accurate tone. The beacon therefore caters for automated reception of the Pi4 digital sequence, aural reception of the CW ID and a frequency accurate signal that can be used to check the accuracy of the receiver.

The amateur radio license requirements are to have frequency measurement equipment, but the quality and accuracy of the frequency measurement equipment is not specified. Most affordable frequency checking equipment is fine for HF frequencies, however as one moves up to the higher VHF, UHF and microwave bands, frequency accuracy and stability becomes critical and can be the difference between making a contact or not. Most operators have no idea how far off-frequency their radios actually are, and having a method to check their equipment against a frequency accurate signal is an added bonus.

Ideally the next generation beacon programme requires that beacons are set up in many locations. The SARL decided that the priorities are Cape Town, Northern Karoo and Bethlehem as this would provide the best opportunity to study the north south propagation path. Bethlehem has been chosen as a test site by the VHF work group for the following reasons:

- It is a reasonable distance away from the centre of VHF/UHF activity in Gauteng. This is important as VHF active radio amateurs constantly monitor the beacon to determine when suitable propagation is available to make long distance VHF contacts.
- The site is owned and controlled by radio amateurs.
- The custodian of the site, Rickus de Lange ZS4A, is a VHF and above enthusiast and an active member of the VHF work group.
- There is already an established CW beacon located on the site with antennas pointing towards Gauteng and KZN.
- The current CW beacon in Bethlehem has been used for all the current testing that has taken place since it went live almost a year ago.
- The current CW beacon has also provided propagation reports from some unexpected areas and this has also helped with the decision to change the direction of the KZN antenna to point towards the SW, where there is more VHF and above active amateurs who can monitor the beacon and provide much needed reception reports.

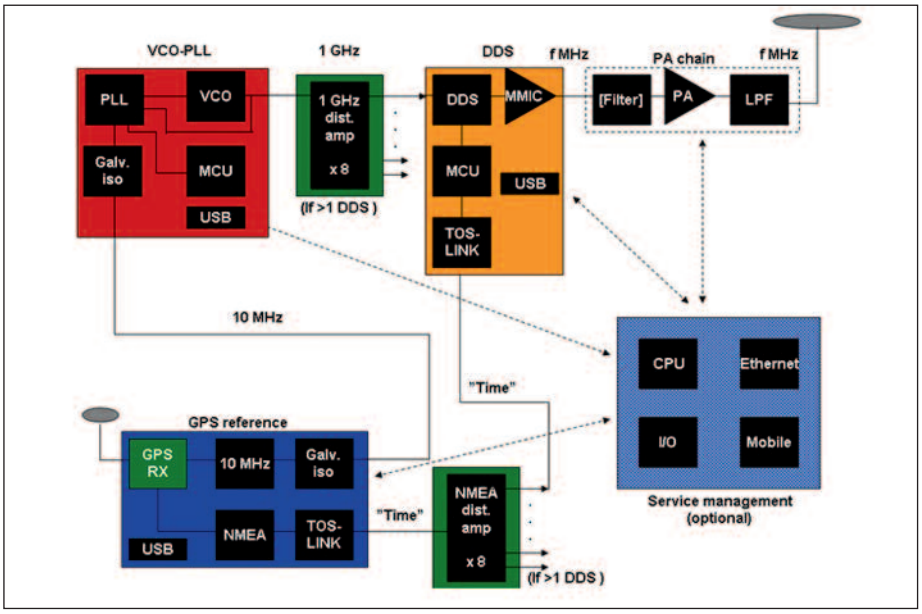
Reverse beacon monitoring network

Once the first next generation beacon network is operational, work can start on the development of a reverse beacon network. This will require developing an inexpensive receive dongle Raspberry Pi driven receiver with an internet connection to a central server where the information can be stored. Software development will be required to set up an alert system to generate SMS or telegram messages.

Student research

Weather and tropospheric propagation are closely related and the collected data will offer many research opportunities for high school learners and students who are looking for interesting science projects.

Next generation beacon hardware



The NGNB platform consists of the following functional blocks:

- VCO-PLL which provides a stable GPS disciplined frequency reference to the DDS.
- The DDS (direct digital synthesizer) generates the modulated signal at the desired frequency.
- GPS is used to provide a reference frequency to the VCO-PLL, as well as timing for the DDS to ensure accurate timing of the message being generated by the DDS.
- RF amplifier to amplify the DDS output, along with the necessary RF filtering as required in any RF power chain.

Crowd funding

The SARL has provided funding for the first beacon. However, the project will have to rely on crowd funding to accelerate the project. AMSAT SA has launched a crowd funding project on behalf of the SARL VHF work group. Contributions can be made from www.amsatsa.org.za/nextgenbeacon by clicking on the pay button for R50, R250 or R1000. Your contribution is appreciated and will be acknowledged. ■

For more information email vhfnews@sarl.org.za

FT8: http://physics.princeton.edu/pulsar/K1JT/wsjtx.html
PIA: http://rudius.net/oz2m/ngnb/
Reverse Beacon network: http://www.reversebeacon.net/
JS8call: http://js8call.com/
After CW (Morse code)