Newcomers and Elmers Net: APRS in Space 08.23.15
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As noted last time, many amateur radio operators are familiar with APRS as a means of sending position reports, beacons, weather information and emergency messages while traveling or from fixed locations. APRS was developed by Bob Bruninga (WB4APR), and for those unfamiliar with APRS a lot of information can be found here. APRS is showing up in more and more radios, both handheld and mobile rigs. Another great use of APRS is in space—I am referring to APRS on the International Space Station, as well as other orbiting satellites which regularly transmit APRS information.

Why Space?
One might wonder why satellites and the ISS would have APRS capabilities, especially since ground-based APRS is used mostly for position reports and local information gathering/sharing. Well, the simplest explanation might be that a satellite or the space station represents the tallest line-of-sight antenna we are able to access from earth.

When we think about typical VHF/UHF transmissions, when our signals are limited to within our atmosphere, the most distance we might be able to expect is a few hundred miles under the best of circumstances, and maybe out to 1200 or so miles during rare skip or ducting opportunities. Signals can be sent much farther when the antenna is in space!

One of the main reasons the ISS put APRS and Packet capabilities in place is for the ability to communicate with schools across the world, as simple status reports and messages could be contained in a single packet. This allows for many different users to connect with the ISS during its passes, and the hope is that this will encourage an interest in both amateur radio and in space.

For the typical user at home or at a remote location, there is no doubt a certain thrill to both receiving and being heard by an object in space.

Equipment
APRS from space is in one sense just like APRS from terrestrial sources. A TNC (Terminal Node Controller) or its software equivalent is needed, along with software to configure the TNC and to log and send messages. There are several radios which come with the TNC built-in, including the TS-2000 by Kenwood, along with the TM-D710G mobile or the TH-D72/D7AG handhelds by Kenwood, and the Yaesu 8DR handhelds and its predecessors. Oddly enough TNCs are not very common even though they are easier than ever to incorporate into a radio these days.

The other alternative for a hardware TNC is to have an external unit, and these are plentiful both new and used. Just make sure to get the cables which work properly with the specific radio as different radios have different pin-outs and the drivers for communicating with the TNC and the radio (or computer) can be a bit tricky. A simple terminal program like Hyperterminal (Windows) or similar program works for sending commands through a TNC in KISS mode, as well as for logging purposes.

If you are using Windows 7 or above and want to use Hyperterminal you will need to get a copy of two files from a previous version of Windows (e.g. XP) and copy over hypertrm.exe and hypertrm.dll into the Program files and System32 files directories respectively. There are also other free alternatives available on the web, some designed specifically with APRS in mind, or as a suite of other modes such as with Multipsk.

In fact, TNCs are not really needed at all if access to a computer is possible. There are a number of software packages which will emulate a TNC in software, using the sound cards much like typical digital modes.

Conversely, if the TNC is already built into the radio there may be no need to connect to a computer or use software; simply use the radio's built-in TNC functions to send status reports or respond to messages. An advantage of this type of setup is that if the radio is a dual-bander, one side of the radio can be used for normal repeater work while the other side monitors APRS signals. For satellite and ISS work the standard APRS uplink/downlink frequency is 145.825 MHz.

Antennas

More significant for satellite work is the antenna(s) in use, since there will be a need to track the desired satellite as it moves across the sky, or use a base antenna pointed toward a portion of the sky which crosses the satellite field of view for a time. Tracking may be done manually (as in a hand-held directional antenna tracking across the sky) or from a base antenna with a rotor. However, if the antenna is fixed without the ability to rotate, satellite reception is still quite possible, as I will explain below. I will cover several options which do not require expensive Azimuth/Elevation tracking rotors, as well as fixed antennas.

One of the main advantages of low-earth orbiting (LEO) satellites is that they can be tracked relatively easily with a simple handheld Yagi or log periodic antenna. There are various methods for doing so, but I have found I like to have my radio(s) mounted on a support system such as a tripod, while freeing me up to move the antenna as needed. An advantage to APRS work is that it is simplex in nature, unlike traditional satellite work which has separate uplink and downlink frequencies.

For a more controlled field operation the a tracking telescope mount could be used in conjunction with satellite tracking software to follow the birds, or more simply just using the remote control for the mount to track the satellite or ISS should be sufficient with some practice. Both Orion and Meade make such devices, and they may work perfectly well for portable use.

For fixed antennas there are several options. The simplest option is to have a fixed vertical antenna which, if mounted more or less in the clear of local obstructions, will have a good view of the sky at elevations up to 45° or more, and this will cover a surprising number of passes.

Two main limitations of this type of setup is lower gain than a directional antenna and more susceptibility to fading as the satellite rotates in orbit along its path. Having said this, I have received a number of good satellite signals with nothing more than a vertical antenna which serves double duty as my regular repeater UHF/VHF antenna. If a rubber duck can be used on a handheld both to receive and sent satellite communications (and it can!), a base vertical can certainly bring in those signals far better.

The second option is to use a directional antenna in either a fixed position or with a simple TV-type Azimuth-only rotor attached. When a directional antenna is left in a fixed position obviously reception will be best when the satellite crosses the field of view of the antenna where it has the most gain. This is a limited field of view, and therefore the reception/transmission time will be limited as well. However, this type of setup can allow sufficient time for several contacts with each eligible pass, and therefore should be considered a viable alternative. I have used this arrangement many times to receive signals, and it has the advantage of being rather simple to set up.

One useful option is to angle the fixed directional antenna at about 30-45° instead of the traditional vertical orientation used for repeater work. While this may limit some reception of more distant repeaters (I have not found this to be the case in my setup but every station is different), I have found it particularly useful for satellite and ISS reception. It helps both with tracking and with signal fade since the elements are not fully vertical.

The simple Azimuth-only tracking option takes advantage of the geometry of low earth orbiting satellites which are within view of a 15 degree fixed elevation beam over 90% of passes. This means a simple Azimuth-only rotation can keep a majority of satellite passes in view for most of the pass.

A nominal 4 to 6 element beam will allow for very usable amount of relative gain whenever it is in view. The satellites are rarely completely overhead (also useful when using a vertical antenna) and spend most of their passes well below 30 degrees. At higher elevations signal strength is 6 to 10 dB greater. Thus the maximum amount of gain is needed on the horizon, while less is needed as elevation increases. The angled orientation I mentioned above is therefore also very useful with an Azimuth-only rotation.

With some practice using a good satellite tracking program one can quickly learn how to follow the satellites with just a simple TV-style rotor. The one I use has a digital readout, but the old style analog rotors will work fine as long as they are reasonably accurate. The hardest part is learning the timing of the rotation.

Messaging and Status Reporting
The two main transmissions from satellite APRS are messages and status reports. The ISS will send periodic status reports which can be easily received during good passes, and only one packet is needed to receive the information. The APRS messaging function allows for contacts to be made through the ISS between two stations, as well as allowing the message to be sent through an APRS-IS gateway. When the message is picked up by a gateway the contact can be identified on several online maps like the one below which show recent activity.

Since each program or radio is different in terms of setup I will not attempt to give specifics for messaging or status reports, but simply cover the basic concepts. Just like with terrestrial APRS, messages are designed to be brief communications between contacts, while status messages are basically a beacon output signal.

Using aprs.fi online map and raw data display shows the basic contact information:

2015-06-18 22:06:24 EDT: W0JW-6>APEG02,RS0ISS*,qAR,KD8THX-6:=4111.15N/09347.30W`73 via PSAT 73 {UISS53}

The first line shows date and time, call sign and then original source and subsequent wide-1 hops through gateways, followed by longitude/latitude and some brief text.

An example of a message text from the same site looks like this:

2015-06-15 18:18:52 EDT: WB3FKP>CQ,RS0ISS*,qAR,N9ZTS:
=4110.64N/07601.26W-de WB3FKP @gmail.com   Mark in Alden Station, PA FN11XE
2015-06-15 18:19:03 EDT: WB3FKP>CQ,RS0ISS*,qAR,N9ZTS:
:ISS-5:82F in Alden , PA - UR 599 today via ISS !

The same basic format is followed but notice the second listing where Mark (WB3FKP) has responded to a signal "UR 599 today via ISS!" indicating an actual contact rather than just a beacon message.

Available Satellites

The number of available satellites changes depending on the operational status of previously launched satellites, as well as the new "birds" being sent up. In addition to the ISS there are several older PCSat stations and the newly launched PSAT stations launched in May 2015:

Details:
Developer: U.S. Naval Academy
Configuration: One 1.5U CubeSat
Mission: Psat stands for Parkinson Sat and its primary mission is a communications payload with two transponders operating in the Amateur Satellite Service. One enables handheld texting and position/data reporting between handheld radios almost anywhere on Earth and/or to the internet. The second can support up to 30 simultaneous text users from laptop type portable ground stations.
Frequency and Modulation: 145.825 1200bps AFSK APRS
Frequency and Modulation: 435.350 PSK31

NO-84 PSAT, a student satellite project named in honor of USNA alum Bradford Parkinson, of GPS fame, contains an APRS transponder for relaying remote telemetry, sensor, and user data from remote users and Amateur Radio environmental experiments or other data sources back to Amateur Radio experimenters via a global network of Internet-linked ground stations.

PSAT is another APRS satellite that can digipeat user packets just like the original PCSAT (NO44) and the packet system on the ISS. PSAT also supports the same digipeating alias of ARISS so that users do not have to change any parameters when using any of these three APRS transponders. As a side note, the Psat (or NO-84) can also send and receive PSK31 using standard PSK31 software such as fldigi. More useful info can be found at the AMSAT-UK site.

There are more satellite launch plans coming up in 2015 and 2016, as well as future plans for a number of cubesats which will give even more opportunities to reach out to the heavens with our radio signals. The future of satellite radio communications seems to be small, privately funded satellites or university projects, and that is just fine. The more birds up there the more fun we can have down here!

Give satellite APRS reception a try—I think you will find it to be very exciting as I have. I have been keeping one side of my Kenwood radio tuned just to the 145.825 frequencies so that I can hear those elusive data tones several times a day. With all the online resources for satellite pass predictions and my own aural alert system, there are many chances each day to catch something interesting! 73, Robert