APRtrak provides a mechanism for plotting the positions of stations and objects world wide based on both lat/long and grid square. It evolved from the APRS (Automatic Packet Reporting System) software which is a packet program for tracking mobiles using GPS units interfaced to standard AX.25 packet radios. The objective of APRtrak is to provide this same tracking and plotting capability for Spacecraft and satellite ground stations. Not only does APRtrak satisfy the inherrent curiosity that all amateur radio operators have about the locations of other stations, but it also helps newcomers to radio visualize the three dimensional and geographic aspects of satellite communications.

APRtrak is designed to extract the most useful information for the largest number of users from the minimum number of packets. In this respects, it is unlike other packet programs, because it does not concentrate on the exchange of message text, but on position data. APRtrak avoids the overhead and complexity of a connected link by using the AX.25 unnumbered information (UI) packets. This mode is called UNPROTO for un-protocol packets. These packets are like beacons to everyone on frequency, instead of being addressed to individual stations. APRS scans these UI packets looking for position data or other useful information in every packet, and only needs one valid packet to plot a position.

THE SHUTTLE AMATEUR RADIO EXPERIMENT (SAREX):

The oginal SAREX packet robot was designed in the mid 1980's when most stations were still using dumb terminals with their TNC's. The robot provided unique serial numbers to each station that connected with the shuttle, but five successful and successive packets were required for success. Although hundreds of stations were successful, more than three times as many showed up in the HEARD log as having at least gotten one CONNECT-REQUEST packet through. Thousands more had probably tried.

APRtrak was designed to take advantage of single packets to not only permit a greater success rate, but also to provide a more visually rewarding image of the spacecraft, orbit, and ground station geometry. Since shorter packets result in success of more stations, the complete position report is compressed into the TO address of all uplinked packets using the Maidenhead Grid Square system. These grid squares are only 6 characters but provide a location anywhere on earth to about the nearest 2 miles. These position reports then are just as short as a CONNECT-REQUESTs, provide much more information, and only required one packet for success!

To demonstrate the effect of having SAREX relay these position reports, use the FILE-REPLAY command to replay the SHUTTLE.HST file and watch the contacts appear as the shuttle moves across the country. You may enhance

the demonstration by selecting to see only the Shuttle, STS-99, or by turning off CALLS to reduce the clutter of callsigns on the display. Obviously, in this SHUTTLE.hst file, I assumed that the Shuttle had its TNC connected to a GPS navigation receiver so that it was also beaconing its position once per minute.

APRtrak DISPLAYS:

Obviously the map is the most important display screen, but APRtrak has several other screens for presenting other information about all packets that it hears as follows:

LATEST - This display maintains a copy of the latest UI frame received from each station.

POSITIONS - This display maintains a separate list of the positions of each station often including a brief comment.

MESSAGES - Single packets can be addressed to other stations, but the fact that these messages require a second acknowledgment packet gives them an order of magnitude lower success rate.

BULLETINS - This screen captures all BULLETINS.

TRAFFIC - This screen shows the last 23 lines of messages heard.

ALL LOG - This display is a time sequenced log of every new beacon or message heard.

HEARD LOG - This display shows the total number of packets heard from each station per hour.

DIGIPEATER LIST - This displays the raw packet header so that users can see what digipeater paths are being used by other stations.

STATION TRACKING. Although APRtrak was designed to track spacecraft and ground station position reports, it can also track any station, fixed or mobile that is transmitting its position via packet using the APRS protocols. Further provision is made for transmitting the location of objects on one station's screen to every one else's screen. This feature can be used by one station to uplink the position of an artic polar expedition, or ships at sea for example.

GRID SQUARES: Because of the ambiguity of a grid-square position report, APRS will not display a 4 or 6 digit gridsquare report on map ranges less than 128 and 8 miles respectively. Stations reported in the same grid square are

randomly offset to avoid cluttering of callsigns on top of each other in the same grid square. The P-list is annotated to indicate that the position is approximate. The big advantage of grid squares is their short length of 6 characters vice seventeen for lat/long.

PROTOCOL - Since the objective of the APRS protocols are the rapid dissemination of real-time information using packet UI frames, a fundamental precept is that old information is less important than new information. All NEW beacons, position reports, messages and display graphics are redundantly transmitted but at a longer and longer repition rate. Each new beacon is transmitted immediately, then 20 seconds later. After every transmission, the period is doubled. After ten minutes only six packets have been transmitted. From then on, only 1 packet every 10 minutes is transmitted. All transmissions can
be turned off using the CONTROLS-XMT command. But a transmission can be forced at any time by hitting the X key. For details on the APRS raw packet formats see the PROTOCOL.txt file.

COMMANDS: In most cases the keyboard is always active awaiting any of the many single key commands. Many commands bring up additional menus on the bottom of the screen. Note that APRS processing of packets on the air is continuous EXCEPT while waiting for the user response to a BOXED prompt. Commands fall in to 3 categories:

SCREENS:

Space Key - Display map and all station locations L -Latest beacons - Displays the latest STATUS BEACON from each station P - Positions - Displays a list of all stations reporting positions A - ALL packet log - Keeps a chronological log of all beacons and messages B - BULLETINS - Keeps a list of all BULLETINS heard R - Read Messages - Displays the status of your in and out messages T - Traffic - Displays the last 23 lines of messages between stns D - Digis Used - Displays the digipeater paths being used by others H - Heard Log - Displays packets per hour per station for 24 hours V - VIEW - Displays all packets on a scrolling screen

SUB-MENUS:

F1- Help - Select from a MENU of HELP commands C -Controls - Display a one line status of all control states F -FILES Menu - For Loading/Saving files, or Replaying tracks I -Input commands - Used to input posits, DF info or add OBJects to map O - OPERATIONS - Several commands for normal operations M - MAP Functions - Functions dealing with maps
W - Weather Menu - Displays the number of beacons per hour per station

MESSAGES:

R - READ - Displays your incomming and outgoing messages S - Send - Sends traffic to a station
E - Erase - Erases outgoing traffic lines
K - Kill - Kills incomming traffic lines
T - Traffic - Displays message traffic between other stations

DEMONSTRATION FILE: To see how APRtrak can display meaningful packet position reports in a number of different applications,
use FILES-LOAD to load the file called 2METERS.BK. This file contains all the local stations on the local APRS frequency in the Washington DC area. To see the tracking of
the GPS equiped Army/Navy game football run, load the file named FBALL.BK and replay the file named FBALL.HST and select to see only FBALL, or CHASE1. To see the Marine Corps marathon event, load MARATHON.BK and replay the MARTHON.HST file. See Details in README.1st.

HOOKING STATIONS: The cursor can be moved to select any station on the map screens using the arrow keys. When near any station symbol, the ENTER key
will "hook" the station. Detail information on that station will be displayed on the bottom of the screen. Alternatively, use the + and -keys to step through each station one by one. You may also use the cursor on the P or L-list to hook a station or object. Once hooked, several functions may be performed:

1. ALL BEACONS - The A key will list all beacons from that station.

2. MOVE - Move the cursor to a new location and press the Insert key. You are then prompted to enter in a new info as needed.

3. DELETE - performed by hitting the D key.

4. UPLINK - transmit the object to all other stations on the net

5. QUIT - quit uplinking the object to the net.

6. KILL - kill the object from all displays in the network

7. ALARM - You will be alerted if that station ever moves.

8. TRACK - APRS will always center display on selected station

9. #MARK - Mark special stations so that only these stations will be

shown on the map when # is used instead of SPACE BAR for drawing a map. If the * key is pressed, all symbols will be shown on the map, but only the marked symbols (#) will show callsigns.

The hook function also works on the LATEST and POSITION display lists by using the up/down arrow keys. If a position exists, hitting the HOME key will display the map screen with that station centered on the display.

REPLAY: The positions of any moving station can be replayed either from memory or from a file. Tracks are kept in on-line memory until 150 have been saved, and then are saved to a HISTORY file. During REPLAY, use the Calls command to toggle on and off the display of callsigns, and use the HOME and page keys to center and zoom the map display if the mobile station moves off the screen. During replay, use these commands:

C - CALLsigns on/off
HOME - Homes map to presently displayed station
SPACE- Redraws the present map to remove track clutter F -Faster. Speeds up playback
G - Overlays the Civil Air Patrol Search and Rescue grids M - Medium replay speed
P - Pause
S - Slow. Slows down playback
Q - Quit playback.
PgUp/PgDn - Zoom in and out

FILES: All APRtrak files are retained in five different sub-directories of BAKS, LOGS, HSTS, SYSTEM and README. There are several other files used by the system:

MAPLIST.sat - The directory of all map files. APRS uses this file to find out what map to use for a given cursor location. Many other MAPLIST.xxx files are now available. BACKUP .BK - Automatic backup of system every time program is quit. This file is overwritten every time the program is quit. It can be reloaded by simply indicating the letter B for a filename. MAPFIXer.BAS - The Qbasic program I use to fix, draw, and modify APRS maps! SYSTEM (DIR) - Contains the following required files IintTAPR.TNC - Setup parameters for your TNC (InitAEA.TNC for AEA) RESTORE.TNC - TNC commands used to restore your TNC after quitting APRS. NWSDATA.DAT - A sample file used to load National Weather Service data NWSPOSNS.DAT - A file of the locations of all NWS sites CAPGRIDS.DAT - A file of the Civil Air Patrol Sectional Aeronautical charts DXCALLS.DAT - Callsign prefix-to-LAT/LONG database for DX spots XXXX.SYS - Numerous brief files for APRS internal screens

APRtrak OPERATIONS:

There are two operating modes for APRtrack. The first mode, or passive mode only transmits your position about once every 10 minutes. This position report is your exact LAT/LONG location and posiiton comments. It allows all stations on frequency within range of each other, to see who else is nearby. The other mode is SPACE mode specifically designed to transmit a minimum length grid-square report via a spacecraft transponder.

In space mode, APRtrak places your GridSquare in the TO address of your TNC by using the UNPROTO command of UNPROTO ATRAK via XXXXX. Where XXXXX is the callsign of the satellite or spacecraft digipeater. If APRtrak sees your packet digipeated by the spacecraft, it will beep several times and display a CONGRATULATIONS message. To imporve your chances for getting a packet through the spacecraft, you may force a transmission of your GridSquare BEACON each time your press the XMT-BEACON command. A timer prevents you from sending an more than one packet every 8 seconds. Also in SPACE mode, APRtrak will automatically increase its beacon rate when ever it hears packets from the designated spacecraft digipeater. It does this by resetting the normal decaying BEACON period timers to minimum. This results in several packets over the next few minutes, but, as usual, the period between each packet doubles.

To minimize QRM, any APRtrak station that sees itw own BEACON digipeated by the spacecraft will immediately reset its beacon timer to 4 minutes, since there is no need for that station to continue to transmit again until later in the pass to cover a different geographical footprint.

OPERATING TIPS VIA DIGIPEATING SPACECRAFT:

First, be sure that APRS position reporting is being authorized via the particular spacecraft. To have a good chance of being seen via the SPACE digipeater and to minimize unnecessary QRM, use the following procedures. Even under worst case scenarios, APRS stations will still generate fewer packets than other stations attempting to CONNECT to the spacecraft!

* Use UNPROTO to set your VIA path to the Space DIgipeater (R0MIR or W5RRR) * Use alt-SETUP-MODES-SPACE to make your posit as short as possible. This command also opens up APRS to parse all OTHER packets instead of just APRS packets. This way, your L-List will show all stations. * Make your BCN text as short as possible, or none at all. * X command to force a transmission as desired - OR -

* Use alt-SETUP-POSRATE to reset your POSIT period decay timer. APRS will send an immediate packet and then double the period to the next one and so forth. This prevents unattended stations from accidentally cluttering the freq.
* Use the APRS VIEW screen so you can VIEW all packets on a full screen * Use your lowest 2m antenna (preferably on the ground). This minimizes any QRM to your receiver from other local uplink stations, and also minimizes your QRM to them. A ground level antenna should work perfectly well, since it can still see the sky, and the SPACECRAFT is so far away on the horizon and has such high doppler that you will NOT make it anyway at elevations below 20 degrees or so.

UNATTENDED OPERATION: If you use a low antenna as described above and leave APRS unattended, you will be transmitting only one BCN and POSIT about once every 15 minutes. This is less than one-half of one percent (0.5%) of the number of packets generated by other stations trying to connect to the spacecraft. Of course your chances are similarly diminished, but its only fair for unattended stations not to QRM manned stations. If this idea catches on, then maybe all of those other stations will STOP trying to CONNECT to the spacecraft and join us! That would be a net REDUCTION in MIR/SAREX QRM!

Imagine the fun that the cosmonauts and astronauts will have if they carry a lap-top computer so they can see everyone on their maps!

NOTE: Even if you only see a GRIDSQUARE from a station, you can tell if he is running APRS by the @ vice [at the start of the report. APRS uses this distinction so it can tell who is an on-line APRS station and one which is only comming from a passive TNC BText.