MacAPRS™

Mac Automatic Packet Reporting System
A Macintosh Version of APRS™

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ABSTRACT

MacAPRS is a Macintosh version of the popular *APRS*, Automatic Packet Reporting System, by Bob Bruninga, WB4APR, [1]. Bob introduced his APRS program at the ARRL CNC in 1992. APRS is a system that uses Packet Radio to track objects, using maps on computer screens. His version runs on Intel-based computers running DOS.

Since the introduction in 1992, this program has gained widespread popularity and has had many uses. The most obvious of these uses has been in public service events such as bike-a-thons and other public events covering large areas. It has also been used for such things as tracking amateur balloon launches and tracking the space shuttle.

This paper discusses both the improvements/enhancements to the APRS system and also the introduction of the Macintosh version. It also discusses many of the real-world applications of this system and future possibilities.

INTRODUCTION

Bob Bruninga, WB4APR, has developed a system for tracking objects using Packet Radio. His system uses unconnected packets (UI frames) for transmitting the position and other information about each station or object. He has been working on different aspects of this system since 1984. In 1992 Bob presented a paper at the ARRL Computer Networking Conference that introduced the PC program now called *APRS* (Automatic Packet Reporting System). *APRS* is a program that sends and receives these packets and displays the objects

on a map on your computer screen. Over the last two years, APRS has become quite popular on Packet Radio and is gaining new users daily.

Bob Bruninga wrote his APRS program in QuickBasic to run on Intel-based DOS computers. Since many Hams have Intel-based computers, this program started to gain popularity rapidly. However, Hams that had other computers could not participate.

Mark and I have been writing software for Ham radio for the Macintosh over the last several years We started with an experiment with a graphical user interface on the air in 1991,[2]. We proceeded with better ways to receive Packet Mail in 1992, [3], and in 1993, we presented two papers. One was on Packet Tracker, [4] a program that displays a real-time logical map of packet connections and the other was Mail Tracker, [5] which used maps to show where mail had been as it traveled across the country. We have also written map software back in the early 80's while in college. We wanted to get *APRS* running on the Macintosh so we decided to write the Macintosh version of this program.

MacAPRS is a Macintosh implementation of WB4APR's APRS protocols. *MacAPRS* is written in Think-C and was done as a completely separate program without using any of the code from Bob's original QuickBasic program. *MacAPRS* is designed to be fully compatible with the protocols developed by Bob Bruninga.

We have worked with Bob on formalizing the protocols used in these programs. We have agreed to keep our protocols in sync with each other and to not implement new variations without checking with each other and to try to release new features at or near the same time. We have also discussed several new features that we plan on implementing over the next year or so.

APRS SYSTEM OVERVIEW

The APRS programs, both Mac & PC, use Packet Radio to send and receive station position reports from a variety of different types of stations. The information contained in these reports vary with the type of station, but in general, they all have at least the Latitude, Longitude and station type of the sending station. These packets are sent as unconnected packets <UI Frames>. The APRS programs receive these packets and display an appropriate symbol on a map showing where the station is located.

In addition to being able to able to transmit your own station location, you can also send information about objects. For example, you can send out the position of a hurricane out in the ocean, giving its Latitude/Longitude and station type (Hurricane). Then everybody else listening will know where the hurricane is. This feature makes APRS very useful for many different applications.

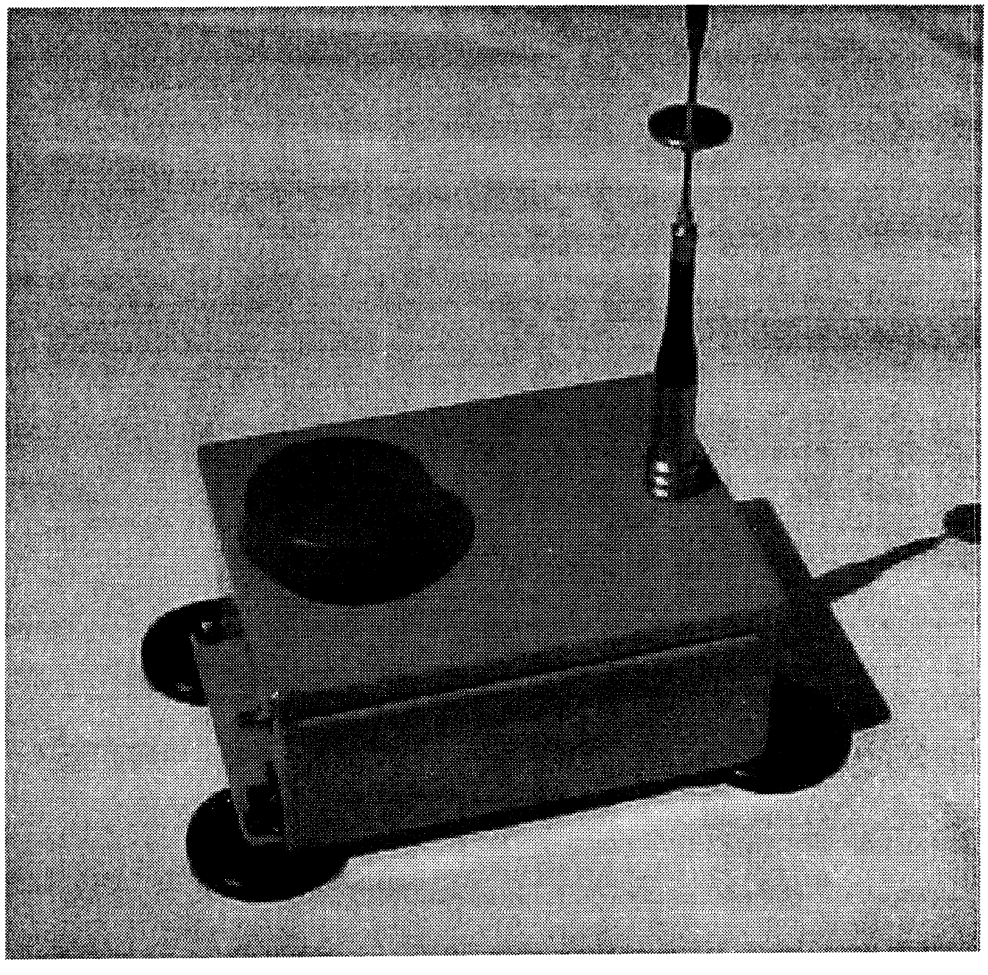
APRS has evolved over the last year or so and is being used in more and more applications. Many of the improvements have been enhancements of the user interface and the types of information that can be displayed. There have been many additions to the data and station types to handle the many different situations encountered in public events. There have also been lots of improvements in the quality and types of maps available. The early maps were created by hand, now we have the ability to use map data from the USGS (United States Geological Survey).

GPS and TNCs

PacComm has developed a new version of software in their TNC to support hooking up a TNC directly to a GPS unit. The commands are listed in the table below. This set of commands allows a TNC to send out a 'Beacon' containing the current position of the unit. As the unit moves, the GPS sends out updated position reports to the TNC. This data typically gets updated every second. Since we don't want the TNCs sending out the data that often, the PacComm commands make it so that the TNC sends this data out only as often as needed. Usually once a minute, or once every 5 minutes.

Using PacComm TNCs, we have made several self-contained units that have a GPS receiver, a TNC, and a radio. We installed the GPS, TNC, and Radio into a watertight box, and then put magnets on it so that it can easily be installed on a car. There are external connectors for power, antennas, and computer connections for both the TNC and GPS. These computer connections are for configuration only and are not used while the vehicle is in motion.

Figure 1: GPS - TNC - RADIO All-In-One Unit



PacComm GPS Related Commands: (Version 3.2 and later)

GPS	on/off	
GPSITEXT	<string to send to GPS on startup>	
GPSTEXT	$GPGGA	The default string to look for coming from the GPS
LOC	every x	How often to send out the GPS location
LPATH	call-string	Same as UNPROTO command, but for GPS data only
LTEXT		The string accepted from the GPS that will get sent.

To use this feature of PacComm TNCs you need to do the following:

- Set the UNPROTO path for the LOCATION with the LPATH command:
  LPATH APRS via **GATE,GATE,WIDE**
- Set the string to look for from the GPS unit (usually the default):
  GPSTEXT $GPGGA
- Set how often the location information gets sent out:
  LOC every 30
- Set GPS mode on:
  GPS ON

Now, every time the TNC gets turned on, it starts looking for the string entered with the GPSTEXT command. Each time it sees a line that starts with this text, it sticks that line into the LTEXT buffer. It then sends that text out via UI frames via the path specified in the LPATH command. It does this at the time interval specified by the LOC command.

If the GPS requires some special command to get it started, this can be set with the GPSITEXT command. If this is done, that command will be sent to the GPS every time the TNC is turned on. This makes this system very flexible.

Once all of this is done, you have a stand-alone system that will transmit its position using a GPS receiver, a TNC and a radio. No computer is required. See Figure 1 for one of the units we have built.

In addition to the commands above, you can also set the normal TNC Beacon Text and the normal Beacon rate etc. Be aware that when in GPS mode, the unit will NOT function as a Digi-peater. If you want to further identify what type of station the unit is, you can specify it's station type in the normal beacon text by putting the station-type character identifier in braces as the first three characters of the Beacon Text. i.e.:

- BTEXT {O} KA9NHL Balloon Launch

However, you must also set the beacon text rate and the UNPROTO path for this. The UNPROTO path SHOULD be the same as the LPATH, and the beacon rate should be much less often than the LOCation rate.

This set of commands makes PacComm TNCs very useful for GPS applications and allows them to be used with a wide variety of GPS units. If you already have a PacComm TNC, you can simply upgrade to Version 3.2 ROMS and get these features.

APRS for Public Events

APRS has been used in many public events. The most common places have been bike-a-thons, marathons, etc. Both the PC and Mac versions were used in the spring Multiple Sclerosis Bike-A-Thons this spring. We used the GPS-TNC boxes described above, putting one of these on the head vehicle and each of the tail vehicle(s). In the future, as we get more of the GPS-TNC units, we also plan on putting one on each of the emergency vehicles.

By having instant knowledge of where the people are, it is much easier to plan and be prepared for the many things that go on during these events. We have also found that when we have a lack of volunteers for 'shadows' to the race officials, it is quite often good enough to simply know where they, so if we are short handed, we can either assign a 'shadow' to someone, or put a GPS/TNC/Transmitter on their car. Later on, if that person is needed, we know exactly where they are.

APRS for Weather Monitoring

Many people, especially several groups in Florida, are using APRS for tracking weather. Many features have been added for this purpose. There are many station types specific to weather, such as Hurricane, Thunderstorm, Flood, Small Craft Advisory, Gale, etc. (See Table 2) In addition to being able to display simple weather information,' both the PC and Mac versions of APRS can be hooked up to a Peet Brothers Ultimeter II weather station. With this hookup, the programs will then send out the appropriate weather information automatically. The system can send out the windspeed and direction, rainfall, and temperature,. The wind direction and speed get displayed as a vector on the screen showing the relative speed and direction of the wind at that location.

APRS for Direction-finding

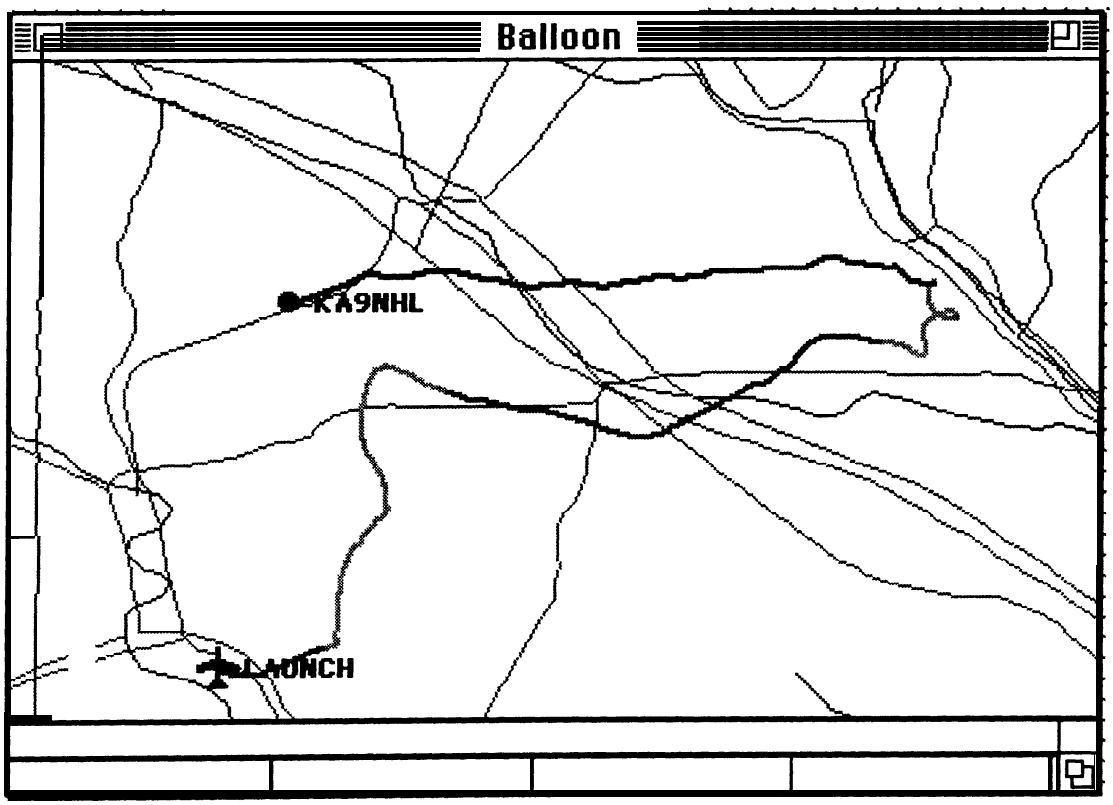
The APRS system can be used for Direction-Finding too. If a station has a direction-finding capability, or even a manual beam heading, it can send out that information as a bearing similarly to the wind information mentioned above. The programs will then display the station on the map with a line coming out at the appropriate angle. This line extends to the end of the map. If you have more than one station reporting this type of information, you can get an immediate graphical location of where the transmitting station is. There have been a couple interfaces developed to hook the Doppler direction-finding units directly into the computer to automate some of this procedure.

If you are having problems with jammers on your repeater, you could hook up two or three stations with the APRS system and Doppler antenna systems. Then every time someone transmits, your computer screen will automatically show what direction the signal is coming from, and if someone else has the same setup a reasonable distance away, they too will have a fix. Their APRS system will then transmit the position and bearing of the signal that they receive and you will now have a triangulated fix of the transmitting station. Since everything can be saved to log files, you now have graphical records of everything transmitting on the input of your repeater over an extended period of time.

APRS for Amateur Radio Balloon Launches

David Chesser, KA9NHL, was involved in a balloon launch this past June where they put a PacComm payload of a balloon. On the ground, they had computers receiving the APRS information, thus allowing full map tracking during the entire flight of the balloon. David used the Macintosh version of APRS for this project We added some additional support to *MacAPRS* just for balloons to allow for altitude tracking. The position and altitude information was quite impressive to see. See figures below. From the data transmitted by the GPS-TNC unit, they were able to determine the maximum altitude of the balloon, which was 86,000 feet. They also got full altitude tracking within the MacAPRS program. Although it is hard to tell in black and white, the balloon track in Figure 2 shows the relative height by the color of the line. The group that David is involved with plans on doing several more balloon launches this summer with GPSs in all or most of them.

Figure 2: KA9NHL Balloon Track



APRS MAPS

When Bob Bruninga first released his *APRS* program, all of the maps were done by hand. He had developed a simple and efficient method for creating map files. Since that time, there has been a high demand for better and better quality maps. All of *MacAPRS* maps were created from data from the USGS (United States Geological Survey). The PC version now also has the ability to create maps using this USGS data. This has allowed for the creation of much better maps. We are continuing to improve the types of maps used and look forward to significant improvements over the next year.

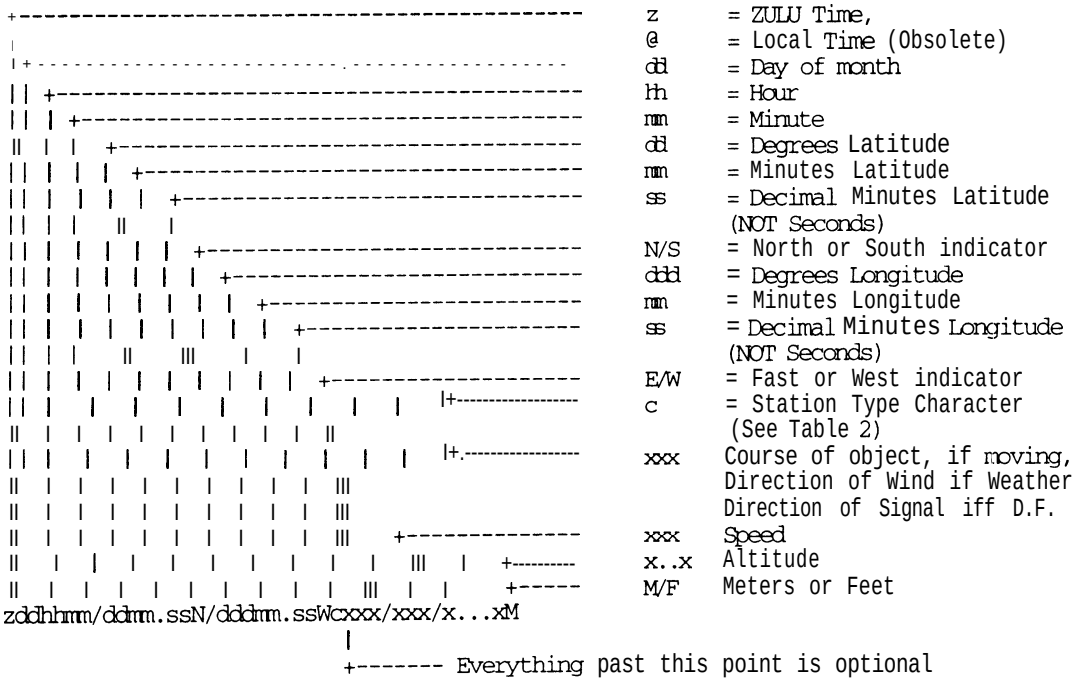
In addition to the USGS Map files, *MacAPRS* can import all of the map files used in the PC version. This allows for the exchange of map files between the two systems.

APRS PROTOCOLS

The APRS programs transmit data using AX.25 UI frames, i.e. Unconnected Packets. The information sent in these packets includes many different aspects of what is needed to track stations. The amount and types of data vary widely with the types of stations being tracked. The following discussions explain the basic information contained in these packets and some of the many different variations.

Most of the packets used in APRS include the position information,, This is explained in the table below. In addition to the position information, there is a STATION TYPE identifier. The current list of recognized station types is given in Table 2.

Table 1: Position Protocol Definition



The following are some examples:

```
WU2Z*>GATE>GATE>WIDE>APRSM:z272146/4026.98N/07428.70WM MacAPRS
VE2JOR>GATE*>WIDE>APRS:@271912/4535.04N/07333.33W_090/000/T065/U-II (auto)
N4PUQ*>GATE>WIDE>APRS:@270602/3602.04N/08418.69W-Oliver Springs,Tn.
```

Table 2: Station Type Character Definitions

Dec	Hex	Char	Description	Dec	Hex	Char	Description
33	21	!	Emergency	80	50	P	Police Car
34	22	"	Rain	81	51	Q	Earthquake
35	23	#	Digipeater	82	52	R	RV - Recreational Vehicle
36	24	$	Sunny	83	53	S	Space
37	25	%	DX Cluster	84	54	T	Thunderstorm
38	26	&	HF/VHF Gateway	85	55	U	Bus
39	27	'	Air Plane	86	56	V	Unused
40	28	(	Cloudy	87	57	W	Unused
41	29	)	Hump	88	58	X	Helicopter
42	2a	*	Snowflake	89	59	Y	Yacht
43	2b	+	Red Cross	90	5a	Z	Unused
44	2c	,	Jay	91	5b	[	BBS
45	2d		QTH/House	92	5c	\	Direction Finding
46	2e	.	Small Dot	93	5d	]	Mailbox, PBBS, etc
47	2f	/	Default Symbol	94	5e	^	Unused
48	30	0	Black Square	95	5f		Weather Report
49	31	1	Brown Square	96	60	`	Thunderstorm
50	32	2	Red Square	97	61	a	Ambulance
51	33	3	Orange Square	98	62	b	Bicycle
52	34	4	Yellow Square	99	63	c	Unused
53	35	5	Green Square	100	64	d	Fire Department
54	36	6	Blue Square	101	65	e	Sleet
55	37	7	Violet Square	102	66	f	Fire Truck
56	38	8	Gray Square	103	67	g	Gale Warning
57	39	9	White Square	104	68	h	Hospital
58	3a	:	Fire	105	69	i	Unused
59	3b	;	Portable (Tent)	106	6a	j	Jeep
60	3c	<	Small Craft Advisory	107	6b	k	Truck
61	3d		Trains	108	6c	l	Unused
62	3e	>	Vehicle	109	6d	m	Color Apple Logo (Reserved)
63	3f	?	Unused	110	6e	n	Unused
64	40	@	Hurricane	111	6f	o	Circle/Default
65	41	A	Brown Circle	112	70	p	Partly Cloudy/Partly Sunny
66	42	B	Red Circle	113	71	q	Unused
67	43	C	Orange Circle	114	72	r	Radio Antenna
68	44	D	Yellow Circle	115	73	s	Ship
69	45	E	Green Circle	116	74	t	Tornado
70	46	F	Blue Circle	117	75	u	U shape (Submarine)
71	47	G	Violet Circle	118	76	v	Van
72	48	H	Gray Circle	119	77	w	Flooding
73	49	I	White Circle	120	78	x	Nodes
74	4a	J	Black Circle	121	79	y	Unused
75	4b	K	School	122	7a	z	Three Horizontal Bars
76	4c	L	Unused	123	7b	{	Fog
77	4d	M	Color Apple Logo	124	7c	|	Don't Use (TNC Switch Char)
78	4e	N	Unused	125	7d	}	TCP/IP
79	4f	O	Balloon	126	7e	~	Don't Use (TNC Switch Char)

This list of station types has evolved over the last couple of years. Many of the items have been added to facilitate public events and emergencies. Prime examples of this are the bicycle that was added for MS bike-a-thons and the Fire that was added for the California Fires The balloon was added because Hams doing balloon launches have started to put APRS transmitters into their balloon systems. The series of colored circles and squares were added for public events where you need to know which station was which, but they were so close together that the call signs would overlap and become unreadable.

Macintosh version of APRS, MacAPRS

The Macintosh version of APRS was released at Dayton Hamvention this past April. This version has all of the functionality of the PC version of APRS and has many new features specific to the Mac and its environment. The Macintosh version is fully compatible with the PC version of APRS and has many enhancements not possible in a non-windowing environment.

The first and most obvious difference is the capability to have multiple map windows open at the same time. The advantages of this are many. The most common configuration is to have a wide area map and one or two local area maps open at the same time. (See Figure 3) You also have full mouse support, which is a requirement in any Mac application, and you have the ability to simply click on a station to get basic information about that station, or to double-click on it to get full information on it. Double-clicking on a station icon brings up an Information-Window with all of the statistics known about that station. In addition to the APRS information about a station, if the user has the Buckmaster CD-ROM, the program will do an automatic lookup of the call sign and display the full name and address of the person selected. This feature has proved extremely useful. (See Figure 5) You can also bring up several other windows such as a Station List, (Figure 4), and Message List, (Figure 6).

The Macintosh version requires System 7.0 or later and wants 4meg of memory, however, it will run in less. It will not run on a Map Plus or Mac SE. Like most Macintosh applications, it also supports multiple monitors, this allows you to have several large maps on different computer screens at the same time. This can be quite useful for large spread out events. You can have as many different map windows open at the same time as you have memory.

Like the PC version of APRS, MacAPRS has full GPS support and support for the Peet Brothers Ultimeter-II. With GPS support, you can hook up a GPS unit to your computer and track where you are going while in a vehicle. This works out very well with Macintosh PowerBooks, the portable/notebook Macintosh line of computers.

In addition to the normal Lat/Lon input of the GPS, MacAPRS also supports some statistics and other data that is available from some of the GPS units on the market. This is all done via the NMEA 0183 specification, (NMEA, National Marine Electronics Association). In conjunction with the GPS input, you can automatically set the computer time from the satellites which will give very hi accuracy time once you have locked into a GPS satellite.

Figure 3: Multiple Map Windows

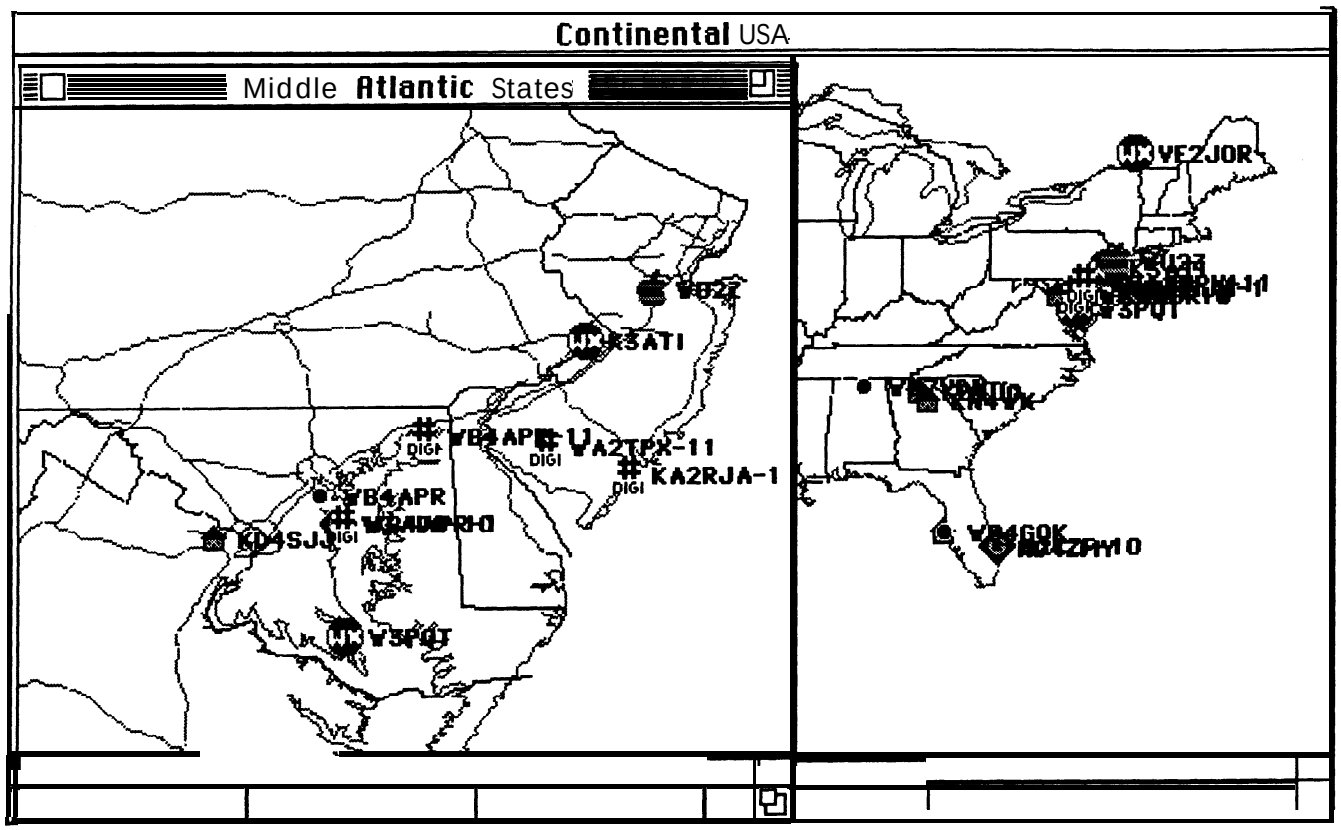


Figure 4: Station List Window

Station List

	Call	C	A	T	O	Count	ID String
	WU2Z	M				257	Keith, North Brunswick, NJ
	N6OAA	;				40	
	VE3TQX					121	
	KN4WK	-				19	KN4WK/R ECHO/D KN4WK-1/B
	N2CZF-10	&				113	ECHO, N2CZF-10 digipeater, GP
	N9GBJ	-				14	
OBJ	N2VEP-4	>			=	0	Station Added Manually
DIGI	KA2RJA-1	#				17	
	K3ATI	-				28	
	N2IPH					21	N2IPH/R
DIGI	WB4APR-11	#				5	
DIGI	WA2JNF-2	#				1	
	N3HTZ	-				4	
DIGI	WB4APR-1	#				6	

Figure 5: Station Information Window with CD-ROM lookup

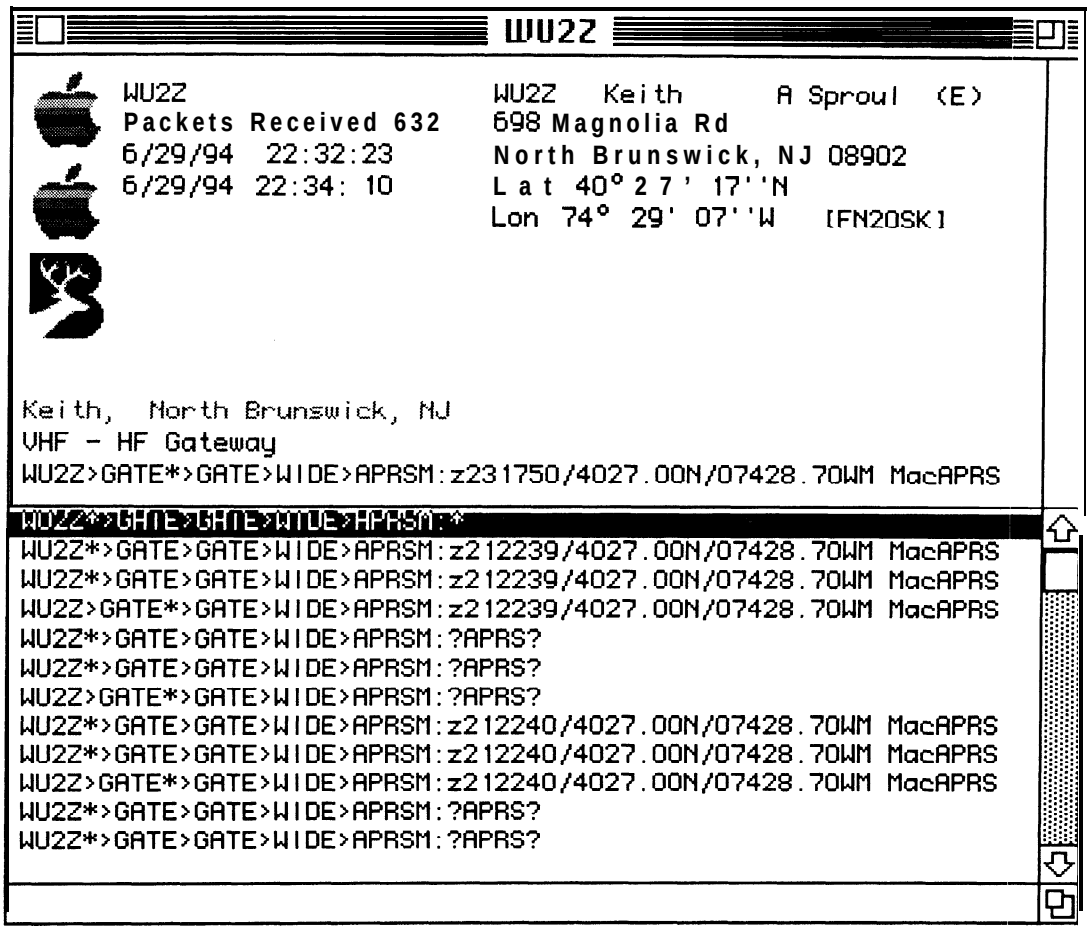
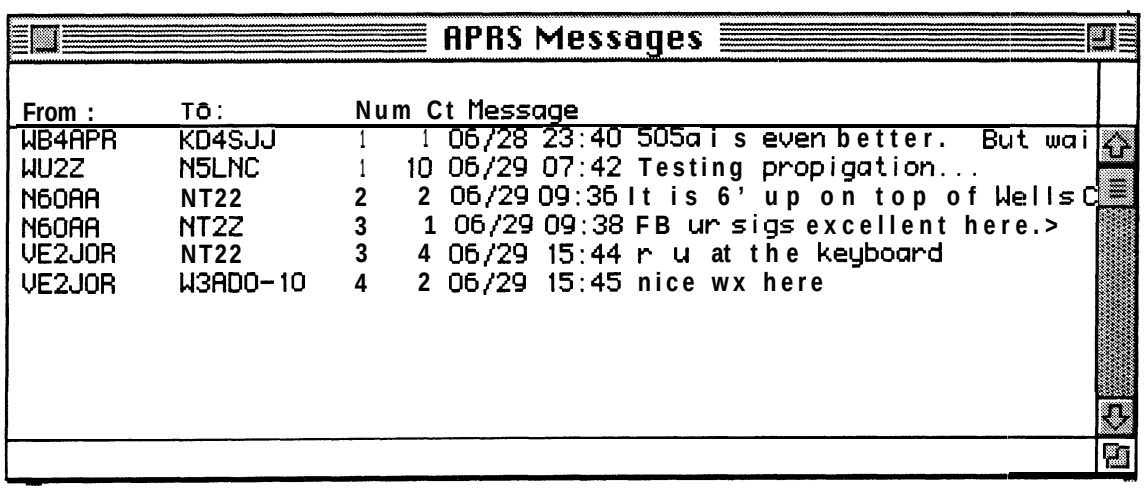


Figure 6: Message List



MacAPRS Databases

In addition the information received over the air, there are other databases built into the program as well. You can locate several different things that are of interest to Hams. If you have the Buckmaster CD-ROM, you can do a FIND and type in a call sign, it will show you on the map where that person lives and tell you their name. You can also locate any zip code in the US, and any airport, simply by typing in the appropriate item you want to find. All of these searches show the appropriate location on the map. The Grid Square option shows either 2-letter Grids or 4-letter Grids. (See Figure 7).

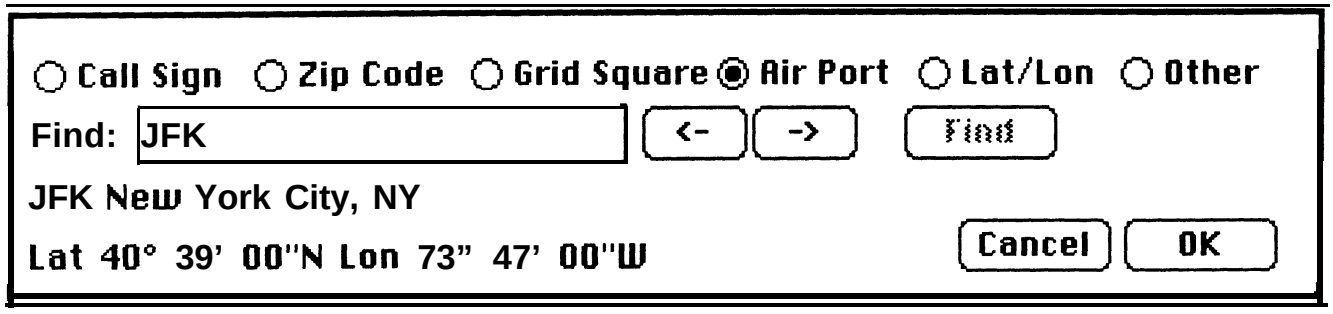
As you type in what you are looking for, the program automatically figures out which type of information you are entering and selects the appropriate category. The categories supported in the FIND function are:

- Call Sign (If you have the Buckmaster CD-ROM)
- Zip Code
- Grid Squares, both 2-letter and 4-letter
- Airports (Search by 3-letter or 4-letter Airport Code)
- Latitude/longitude

For Zip Code and Airport data, it will automatically fill in the Lat/Lon as soon as it recognizes what you have typed. Once it recognizes the data as an Airport or Zip Code, you can then push the arrow keys to scroll through to the next or previous airport or zip code.. After you have what you want, hitting okay will show were it is on the map. The airport database includes over 3000 foreign airports and 18,000 US airports. It also has altitude for the US airports. The zip code database has all of the valid Zip Codes in the US.

For call sign, you type in a call, you then can push the FIND button and it will do the look up. After you have what you want, you hit OK and it will show you that location on the map. If you just hit OK, it will simply go look it up and show you the location. The find button actually brings up the name etc. within the dialog box before it shows you the location on the map.

Figure 7: Find Airport



APRS FUTURES

I am trying to get better map data for other parts of the world. This project is already in progress, and proceeding nicely. I would also like to get a database of the postal codes of Canada with latitude and longitude, but so far, have not been able to locate this data. I have the US zip code database, and would like to be able to extend this capability to Canada.

One thing that the APRS community needs is for someone to come out with an inexpensive, data only (SSB) 30 meter radio. There are several companies that have nice radios that are CW only, but we need a small, crystal-controlled radio that we can run on 30 meters for transmitting APRS data from the car on HF. This radio does not have to be fancy, just small, inexpensive, and able to output at least 25 watts.

We are working with Peet Brothers to further enhance the weather capabilities of the system and we are working with the people making the interfaces to the Doppler antennas to enhance that capability also.

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