Graphical Information Systems and Ham Radio

(The future of A.P.R.S. technologies)

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G.I.S. is a major buzz-word in the scientific and computer graphics communities. GE, or G raphical Information Systems (also sometimes called Geographical InformationSystems) is the displayof significant amounts of data on a graphical system, usually a map of some kind,

GIS programs have historically been run on large systems, usually UNIX based systems due to the large amounts of computer horse power required. Over the last couple of years, this type of program has started to appear on desktop computers as these computers have grown in power and capabilities.

Typical applications of GIS programs have been to display data any where from the placement of telephone poles, to the habitat of animals, to highway and urban planning to pollution problems. This type of program typically sells for anywhere from $500 to $10,000.

Within the ham radio community, we have all seen the many different satellite tracking programs that are out there, and of course simple DX logging type applications that use maps. Although map-based, these programs don't really fall into the category of GIS applications.

Over the last several years, other GIS-like programs have started to be introduced into the amateur radio community.

. 1992 **APRS** [l] Automatic Packet Reporting System.

.1993 **Mail Tracker [2]** a program that displayed where Packet BBS messages went as they traversed the country, displayed on a map overlay.

. 1993 **Packet Tracker [3]** Although not map based, Packet Tracker showed the logical connections between packet stations. This program was really more like a network analysis tool, but the graphics, the logical connections displayed and the large amounts of data collected made it have some of the features of GIS applications.

• 1994 **MacAPRS** [4] the Macintosh version of APRS. This version of APRS has a lot more databases built into the program and uses maps with much more data points..

When **APRS** was introduced in 1992, it was a low-end GIS application. When the Mac version came out a year and a half later, **APRS** had evolved quite a bit from its original implementation, and now, a year later, **APRS** and **MacAPRS** have continued to evolve rapidly. **APRS** was originally developed to track the ships from the Naval Academy while on summer maneuvers. Since that time, it has evolved into a program to track weather, hurricanes, balloons, bicycles, and many other applications.

Maps

APRS depends on maps made either by hand, or more recently, maps made from USGS (United States Geological Survey) data. Early this year, a lot of the USGS data has become available for free on the Internet. This readily available data has created a surge in the interest in making maps for localized areas, and maps for special events.

A problem with the large amounts of map data now readily available is that the data is rapidly exceeding the capabilities of some of the lower-end computers found in ham-radio shacks. This is very evident in that the PC version of APRS which can only handle maps up to 3,000 points. The Mac version can literally handle maps of upwards of 1 million points.. although 10 to 30 thousand points is more typical of what is being used. The trade-off of this is that more points slows map redrawing down. With the newer desktop computers now available, this becomes less of a problem and people want better and better maps.

Databases

Other things that have been integrated into this type of programs is the ability to look up different pieces of information that is relevant to what you are working on. For example, the Macintosh version has the following databases built into the program:

ZIP CODE LOCATION Every zipcode in the country can be located.

AIR PORT LOCATION 18,000 US airports and 4,000 foreign airports are included. All of the US airports have altitude in addition to the lat/lon.

DXCC Database (See the discussion below).

Call Sign Databases MacAPRS supports the following call sign databases.

Buckmaster (all versions, this has the most extensive database)
Percon
QRZ
Amsoft

FCC Recently, the FCC has made a database that is updated weekly available on Internet. This database is a 30meg ZIP file that decompresses to a 13Omeg file. It is free to anyone that wants to take the time to download it.

All of these databases and others that are being worked on continue to take more and more memory and/or hard drive space. People are even copying the callsign databases to their hard drives for connivance and speed.

Specialized Features

APRS and **MacAPRS** lends itself quite readily to a wide variety of specialized applications. The authors of both programs have started to add many specialized features for different applications. Many people have used these programs for purposes that the authors never even thought of in the early days. Several of these are discussed below.

Weather Tracking One of the early uses of APRS has been to track weather. This use has been growing quite rapidly, especially in areas prone to experience bad weather. Both APRS and MacAPRS have added many features just for weather, and have added a lot of alarm capabilities to satisfy the Skywarn people. Both programs interface with weather recording equipment so that they can report the weather in real-time. The programs even support stand-alone weather stations for remote weather sensing.

DX Cluster For the person that wants to use a DX Cluster, APRS and MacAPRS will listen to the 'DX SPOTS' issued by a DX-Cluster System and plot the stations on a world map in the correct area. This is done by looking up the call-sign prefix in a database that says were they are located. The 'station' is then plotted on a map showing you where that station is. This brings an entirely different way of viewing this data, and you can tell graphically where the propagation is currently the best just by looking at a map.

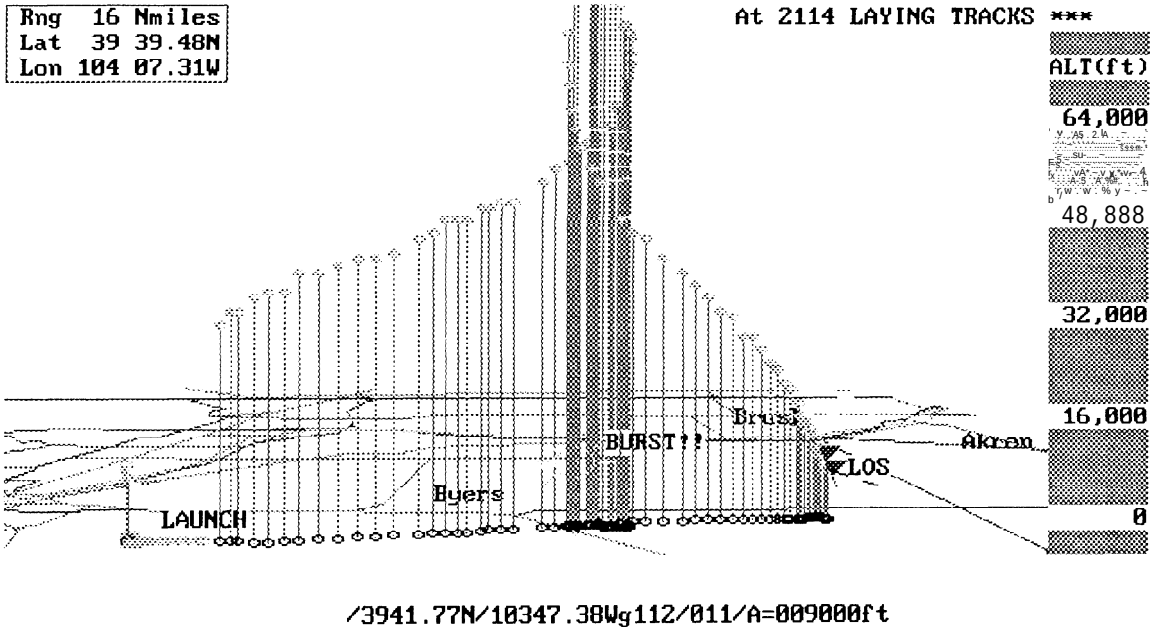
Direction Finding There is a lot of interest in Radio Direction Finding. There are two main groups of people that want this type of capability. The first group is people involved in search-and-rescue type operations, and the second group is people that want to track down repeater jammers or other types of illegal radio interference. The APRS programs work with automatic direction finding equipment and display the results on a map. They can also send the information to other APRS stations, and therefore allowing instantaneous triangulation showing where the radio signal is coming from. In near future, the Macintosh version will even be able to then give a list of all hams living within a specified radius of that point. This feature is just now starting to grow, especially since there is some low-cost Automatic RDF equipment starting to become available.

Meteor Scatter Recently, we have started to work on features to enable meteor-scatter communications via APRS. It would be very interesting to see where this type of communications actually will work, and APRS has proven to be a very good method for this type of research. It has many advantages in that it can be fully automatic, it uses very short packets, and it shows instantly where the communications are on a map. Some other people are also working on using APRS for E-Skip propagation testing.

Balloon Tracking. We have been doing work for balloon tracking. The PC version added a feature where it would show a pseudo 3-D display showing where the balloon was in relation to the ground. See Figure 1.

The Macintosh version has also added a several features to aid the balloon tracker to predict where the balloon will go BEFORE it gets there. This is based on some work done by Bill Brown, WB8ELK and several other people including some work by NASA and the military. The Macintosh version has added a separate graph to show altitude, ascent, and descent rates. See Figure 2. The numbers on the right hand side of the graph are the wind reports from the FAA. This data is used to predict where the balloon will land, based on how high it is expected to go, and how fast it rises. See Fiaure 3. The upper line is the PREDICTED path, and the lower line is the actual data. The predicted path shows the balloon landing only about 10 miles from where it actually landed. Unfortunately, the data from the FAA only goes to about 50 or 60 thousand feet, and therefore, the winds above that altitude are not known. In this particular balloon launch, some of the balloon chasers actually got to see the balloon come down!

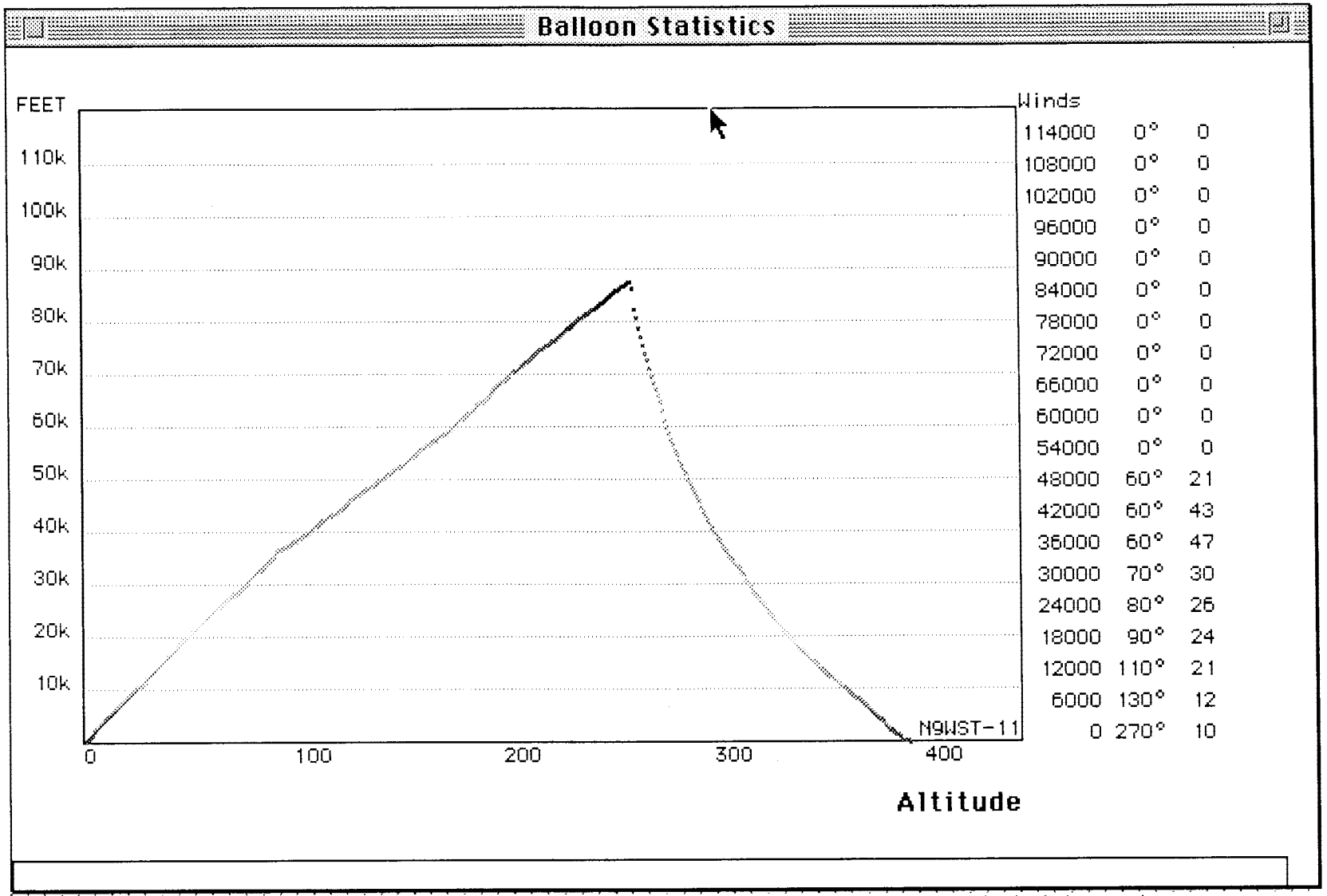
Figure 1



Pseudo 3-D display in PC APRS

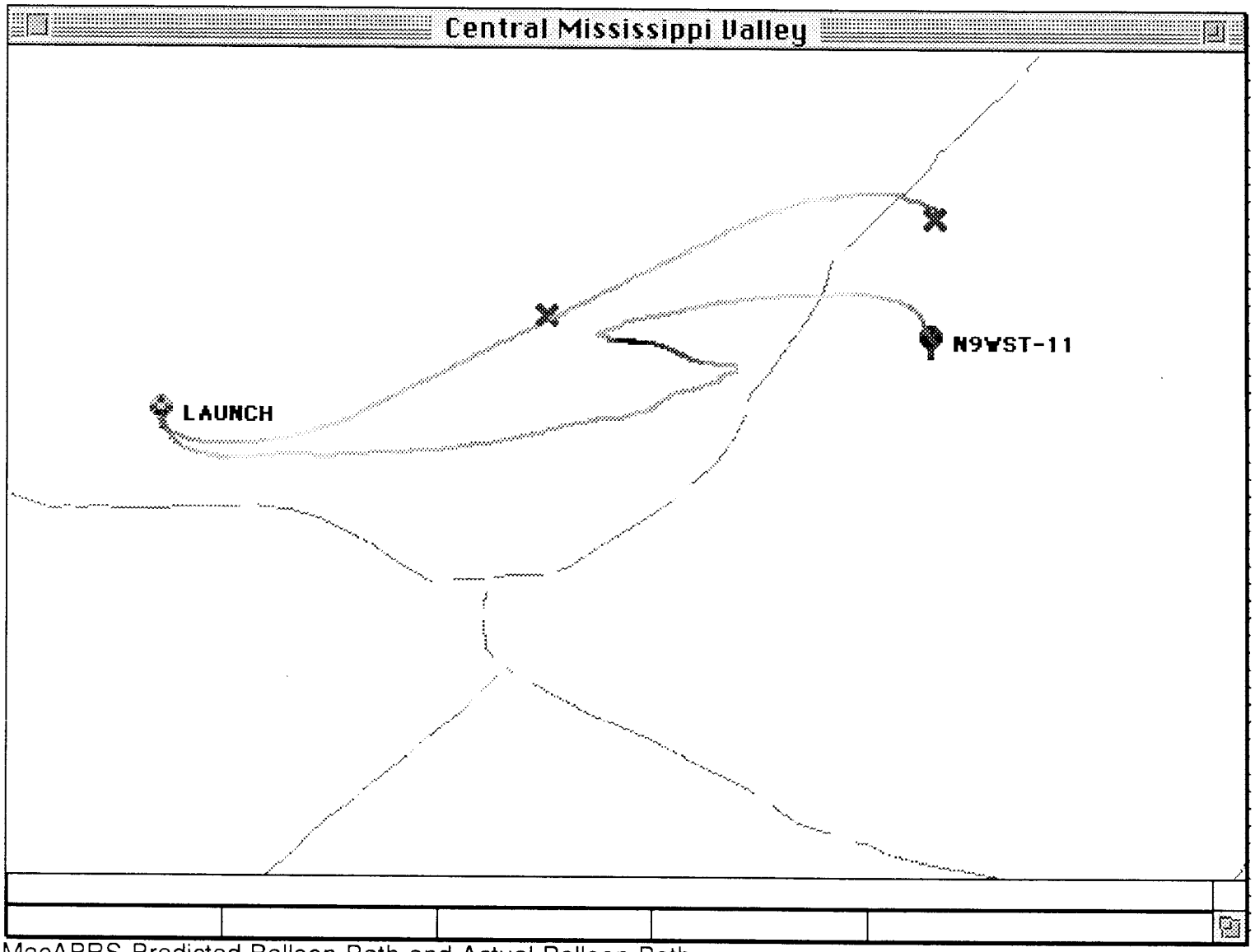
Model **Rocketry** Hams have been putting electronics up in model rockets for a long time. The most popular thing to do with model rockets is ATV. There are now groups of people doing high-powered model rockets going up 10,000 - 20,000 feet and even higher. With rockets going this high, it becomes desirable to track them too. Most of the software and features of the balloon tracking described above are used identically for rocket tracking, however, there are some minor differences used in the prediction of where the rocket will land. Also, due to the much shorter duration, the

Figure 2



MacAPRS Balloon Altitude vs Time Graph. The numbers on the right are FAA reported wind data values. (Actual altiude data for balloon in Figure 2)

Figure 3



MacAPRS Predicted Balloon Path and Actual Balloon Path
(Upper line is predicted path, lower line is actual.path)

data is generally transmitted much more often when tracking a rocket vs. tracking a balloon.

Three-D Graphics

With the introduction of the RISC PowerPC from IBM/Motorola/Apple, we now have a lot more power available to the desktop than was available even as little as a year ago. PowerPC computers are now being sold by Apple, IBM, Motorola, and several Clone manufactures. Along with this new CPU architecture, Apple has introduced a new set of graphics routines that run on the PowerPC Macintoshes called **QuickDraw-3D.** This set of routines allows programmers to 3-D graphics relatively easily.

As stated above, earlier this year, the USGS released a lot of their data on the Internet. Digital Elevation Data is one of the data sets available..

With the combination of these two items, we can now develop sophisticated 3-D graphics systems and can start to do many new things for Amateur Radio and map software.

The first application that comes to mind is a TRUE 3-D APRS system. See Fiaure 4. As you can see, with Quick-Draw 3D from Apple and the Digital Elevation Data from the USGS, we can do a quite sophisticated 3D system relatively easily. This type of system has its applications, especially if you live in a mountainous area. Although interesting and neat to look at, a 3-D system isn't always better than a 2-D system. The reason for this is that most people are used to looking at 2-D maps and adding the 3-D information would just lead to confusion.

We are developing a 3-D program that will do real-time 3-D visualization and allow 'tracking' through 3-D worlds from either live Packet data from the air, directly from a GPS unit while driving in your car, or from recorded data. (Check out the Web sites listed in at the end of this paper). An interesting application for this type of program will be to visualize what a balloon would see as it comes back to earth. There are some Quick-Time Movies up on the Internet showing this. These 'movies' can be downloaded and displayed on either Macintosh or Windows computers.

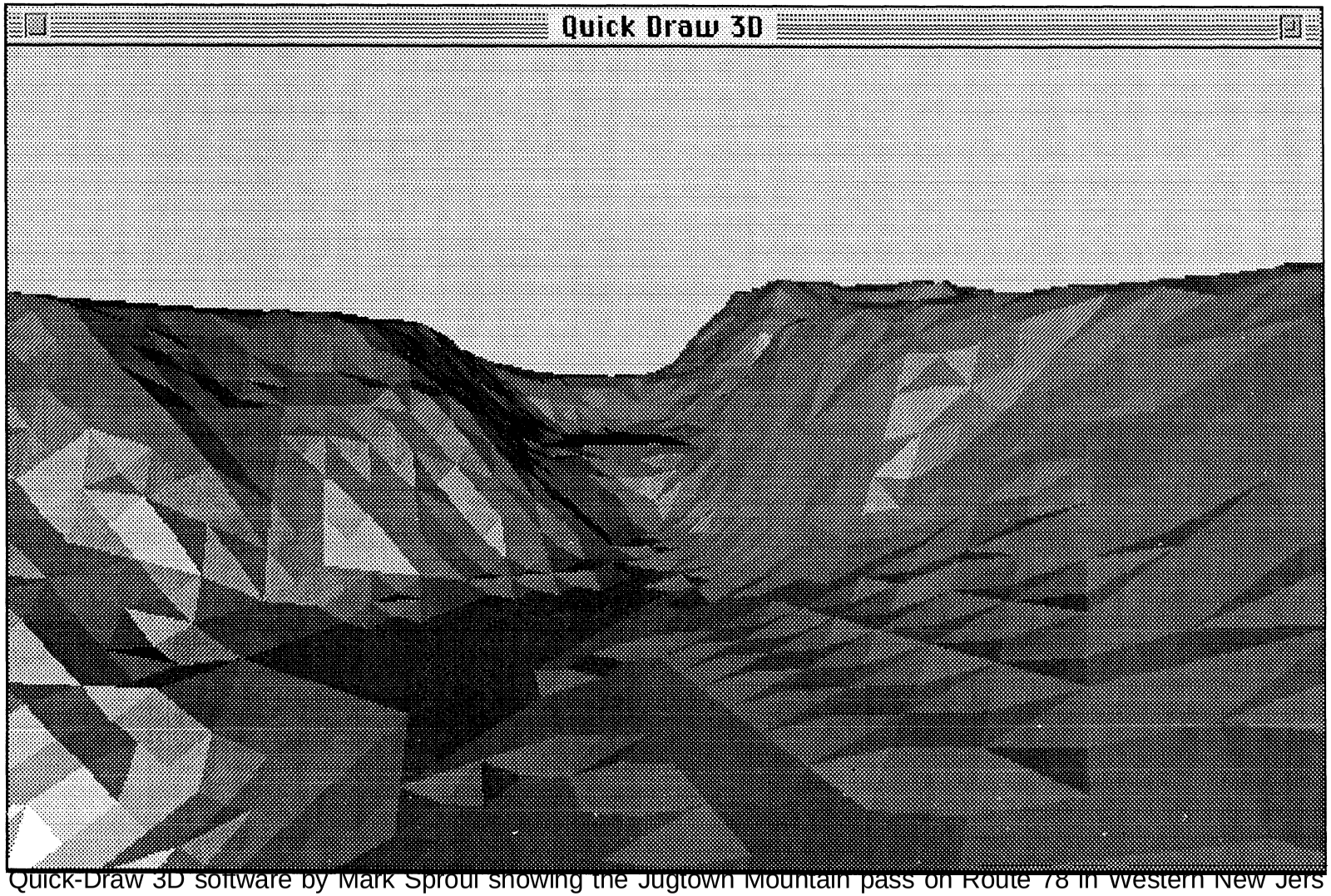
Another application that comes to mind is that you can now have a much better system for estimating repeater coverage. Yes, this type of software has been available for a long time, but in the past, it was very expensive, and also very slow, and generally only available to the 'commercial' radio people.

Large Databases

There are now large databases available, either public, or for low cost that contain HUGE amounts of data. A couple examples are

A named-geographic-location database from the USGS that contains 2 million named locations within the US.

Figure 4



Quick-Draw 3D software by Mark Sproul showing the Jugtown Mountain pass on Route 78 in Western New Jers eY*

Percon's Spectrum database with all of the FCC licensed commercial broadcasting stations. Information like this is highly desirable for use in a ham radio related graphical information system.

These types of databases will become more and more readily available to the ham community and we will want to take advantage of the data available to us. We need software that can handle them efficiently and customized for our needs.

Future of GE software

A common comment within the education and programming communities is:

"Don't let lack of computer power stop you from writing something because by the time you get it written, there will be computers with enough power to do it".

With the introduction of RISC technology, and the PowerPC, and to some degree the Pentium, people are getting lots more powerful computers at home and in their ham shacks.

The following was taken from the Internet newsgroup **comD.infosvstems.gis**

Subject: Re: G/S around the year 2000
Ne wsgroups: camp. in fosys terns. gis

Question
So, does anyone want to get out on a limb and suggest what sort of hardware and software used in G/S will be common in the year ZOOO?

Answer
Well, I've been around long enough to remember the same history. I think people tend to overestimate the speed things will happen, but here's my best shot at what I think I'll be doing 5 years from now.
On broad themes, integrated raster/vector databases will be common. Databases will range in the 100s of GB in size for the mid-to-high end users. Terabyte databases will be common at the highest end, with hyper-spectral remote sensing data being the biggest resource hog. Hardware will have a hard time keeping up with the data volumes. Real-time differential GPS will be ubiquitous, and the spatial accuracy/resolution requirements for GIS databases will tend toward the sub-meter and centimeter level, because the technology will allow it. (Most current applications I deal with don't need that kind of spatial detail, but as soon as it's available, people will decide it's necessary.) The fields of surveying and GIS will be difficult to differentiate, too, as a result of the increasing spatial accuracy requirements. Professionals in both fields have a lot of learning to do in the next five years, to be able the master these currently very different fields. Projections, datums, geoids, and network adjustments will become considerations for every project. People will start worrying about the affects of tectonic movement on the quality of their databases.
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(Note: This is his personal opinion and not that of the USG.S)

What gets interesting and exciting about this type of capabilities is where will it lead and what will be available to the ham radio operator as the power of the our computers increases and as the software gets better.

Conclusions

GIS technologies are changing rapidly. They are pooping up in more and more applications in our day-to-day life. Faster and bigger desk-top computers are allowing this type of applications to migrate to the individual user. This type of software has many applications within the ham radio community. We need to be aware of this type of software system and take advantage of it. We also need to realize that we can't continue to support the lowest common computer around for ever, i.e. 8088 or even 80286, and 80386.

The capabilities available to us are growing faster than we can keep up with. The only real limitation is our imagination and occasionally our pocket-book, but the possibilities are limitless, and the future, even the very near future looks very exciting!

References

[1] ***Automatic AX.25 Position and Status Reporting,*** Bob Bruninga, WB4APR, ARRL 1 lth, Computer Networking Conferences, Teaneck, New Jersey, November 1992, pp 13-18.

[2] ***Mail Tracker, A Graphical Mail Tracking Program,*** Keith Sproul, WU2Z, ARRL 12th Digital Communications Conference, Tampa, Florida, September 1993, pp 83-96.

[3] ***Packet Tracker, A Graphical Packet Tracking Program,*** Mark Sproul, KB2lCl, ARRL 12th Digital Communications Conference, Tampa, Florida, September 1993, pp 77-82.

[4] ***MacAPRS: Mac Automatic Packet Reporting System, a Macintosh Version*** of ***APRS,*** Keith Sproul, WU2Z and Mark Sproul, KB2lCI, ARRL 13th Digital Communications Conference, Bloomington, Minnesota, August 1994, pp 133-l 45.

Internet Sources of Information

APRS and MacAPRS can be downloaded from:

ftp.tapr.org in the directory /tapr/SIG/aprs/uploads/

WWW Sites of interestes

APRS info

http://www-ns.rutgers.edu/-ksprouI/MacAPRS

http://www.ccnet.com/-rwilkins/aprs.htmI

http://www.mindspring.com/-rwf/aprs. html

Apple Quick-Draw-3D info

http://www.info.apple.com/qd3d/QD3D. HTML

http://www.njin.net/-msprouI/macintosh/QD3Dhml

USGS Data

http://info.er.usgs.gov/data/index. html