# Integrated Map Data
# for real time use

By
Mark Sproul – KB2ICI

ABSTRACT:

APRS has been around for over 10 years; there are many versions of software that support the on-air protocol. The primary difference between the various programs besides user interface style is the mapping. Map detail and map information is a very important part of the APRS environment. Early on, computer capabilities were the limiting factor for good maps. Data was available, but it was very large and the computers did not have the memory or the speed to deal with it directly. Therefore short cuts had to be taken. Now the speed and memory of even today's laptops can handle very large amounts of data, download it in near real time and display very detailed information.

With the speed and capacity of current desktop and laptop computers, not only can we handle very detailed maps, but we can simultaneously display data from multiple sources such as roads, elevation, and imagery, all integrated seamlessly.

HISTORY:

When APRS first started[1], (Bob Bruniga's DOS version), maps were limited to 2000 points and were made by hand. Mac/WinAPRS[2] came out a couple of years later and increased to 20,000 points as standard, but still the user had to select between different fixed maps. Mac/WinAPRS now uses TIGER data from the US Census Bureau. TIGER data is the basis for most if not all of the commercial mapping systems. The average US county has 75,000 points and in normal use, at least 4 counties are loaded and displayed at a time. This makes a typical in-memory map in the range of 300,000 points, 2 orders of magnitude greater than the original dosAPRS maps.

TYPES OF DATA

There are many types of data utilized by APRS. We will define two primary types as STATIC and DYNAMIC. Static data is the map data representing the physical world such as roads, water bodies, and political boundaries. This data can be considered constant in that it changes very slowly and we can consider it fixed. Dynamic data is what we are interested in, vehicles, people, weather, etc. This data can change from minute to minute and in some cases from second to second. This data is "real time". It is important to have a LOCATION and a TIME for this data; one without the other is normally useless. The amount of data for both of these types can be huge depending on the required level of detail.

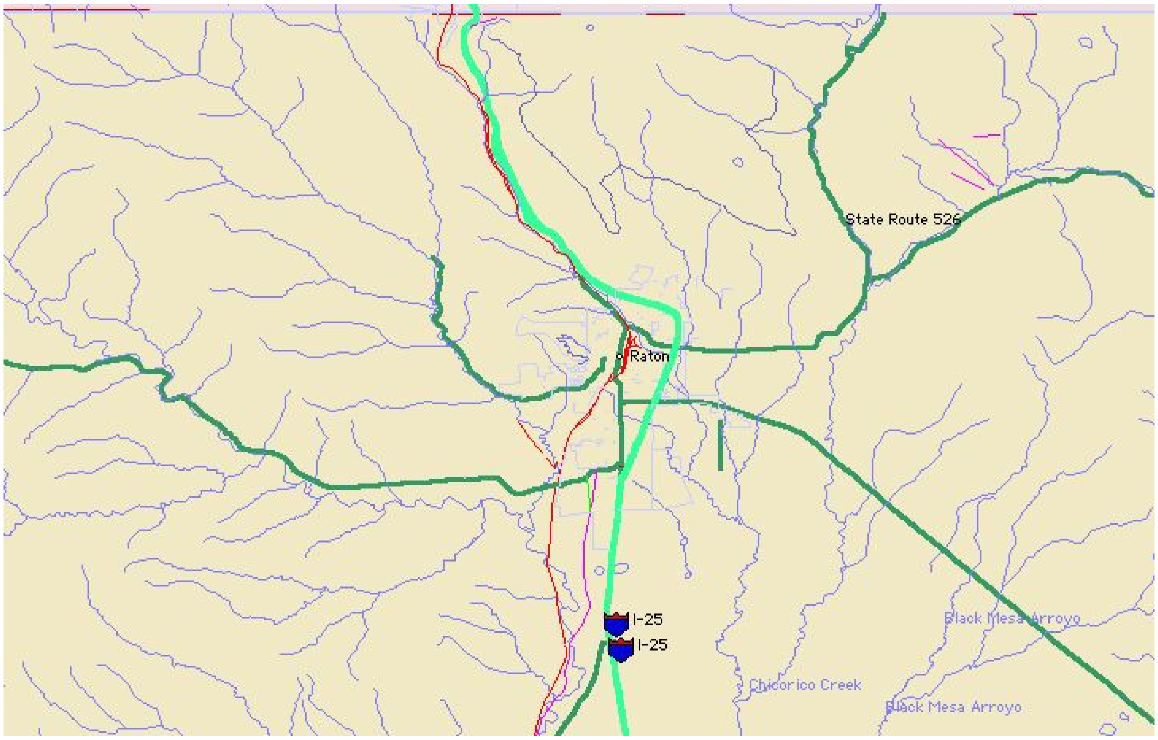
Static map data is the most diverse as it comes from many sources. There are 2 primary types of data, vector and raster. Vector data contains end points of lines and sometimes descriptions of what the line is. Raster data is an image of either a paper map or a photo. The problem with raster data is that it does not scale well and cannot be searched. Integration of raster and vector data can be very useful.

The US Census Bureau provides TIGER (Topologically Integrated Geographic Encoding and Referencing) data for all of the US and its possessions free of charge. This data contains lat/lon vectors of all roads, water bodies, and political boundaries in the US. It is very detailed and is the basis for most of the commercial mapping software available. The data is very verbose and hard to decipher but is very complete and allows generation of very detailed maps.

DOS-APRS maps and earlier versions of Mac/WinAPRS maps were all or nothing. That is when a map was selected; all of the lines for that map were displayed regardless of zoom level. This meant if a high detail maps was selected and you zoomed out, the map became a blob of lines. This was because the line type data, if available, was forgotten in favor of memory conservation and speed.

When Mike Musick implemented PocketAPRS he took the Mac/WinAPRS map format and expanded it to include line type, this allowed map levels or sometimes referred to as layers. This was an excellent step in the right direction and Mac/WinAPRS quickly expanded to support these PocketAPRS maps as well.

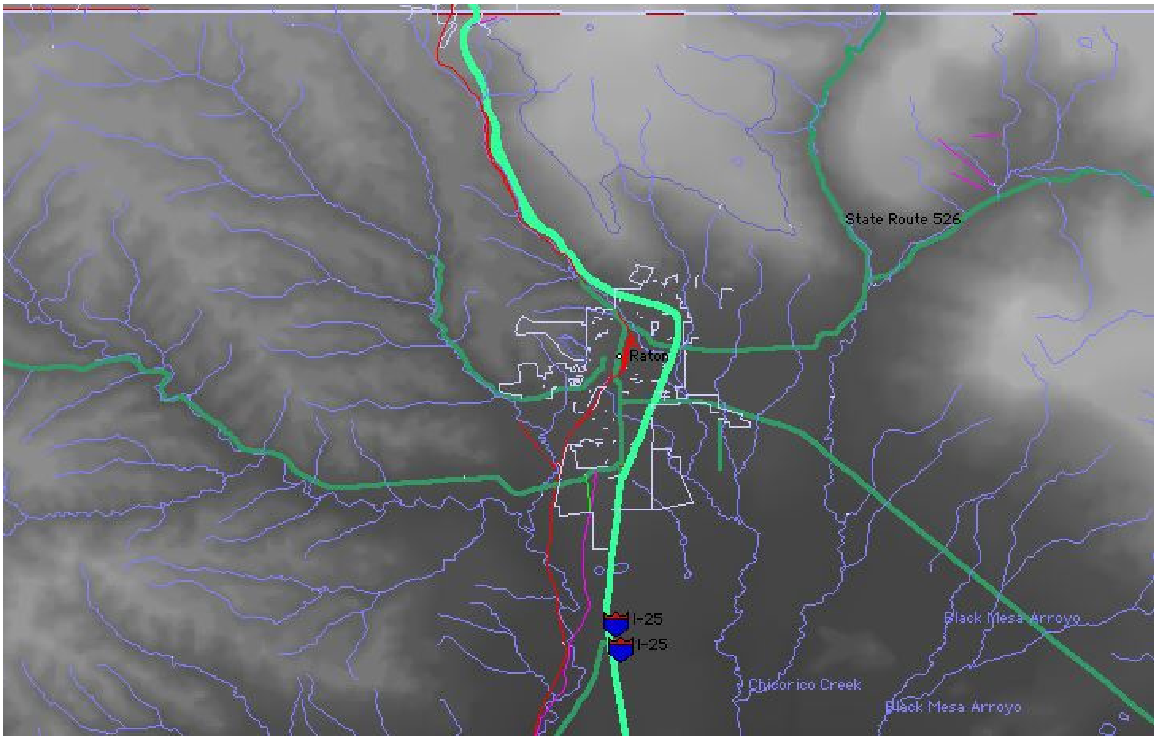
When Mac/WinAPRS was expanded to utilize TIGER data directly, the line data type was maintained. Every line segment in TIGER has a classification know as Census Feature Class Codes (CFCC). Mac/WinAPRS allows the user to enable/disable, specify the color, and specify at what range (zoom level) for each CFCC code separately. For example you could disable all railroads or display only water. Mac/WinAPRS also uses this information to extract interstates for all maps to be displayed at all zoom levels even when individual maps are not loaded. No commercial mapping program has this ability to control each and every line type.




2-D maps are all that is required for most APRS use. However, in many of the most important uses, elevation can be very important as well. The most obvious example of this is in Search And Rescue (SAR). It doesn't matter if the search is for a plane in a mountain region or for a child that wondered off into the woods, knowing the terrain makes the search a lot easier. The ability to merge traditional map data with terrain elevation makes this possible.

Elevation data is available for the entire world from the Shuttle Radar Topography Mission (SRTM). Elevation data for the US is also available from the U.S. Geological Survey (USGS). This data gives elevation values in meters for points either 3 arc-seconds apart or for the US, 1 arc-second apart.
`

We now have a lot of data, displaying this to the user in a meaningful manor that does not overwhelm is more important than having the data at all. Below are examples of integrated TIGER and USGS elevation data in the same map. The first example uses the elevation to select a gray scale value for each pixel. This is referred to as an X-RAY view.

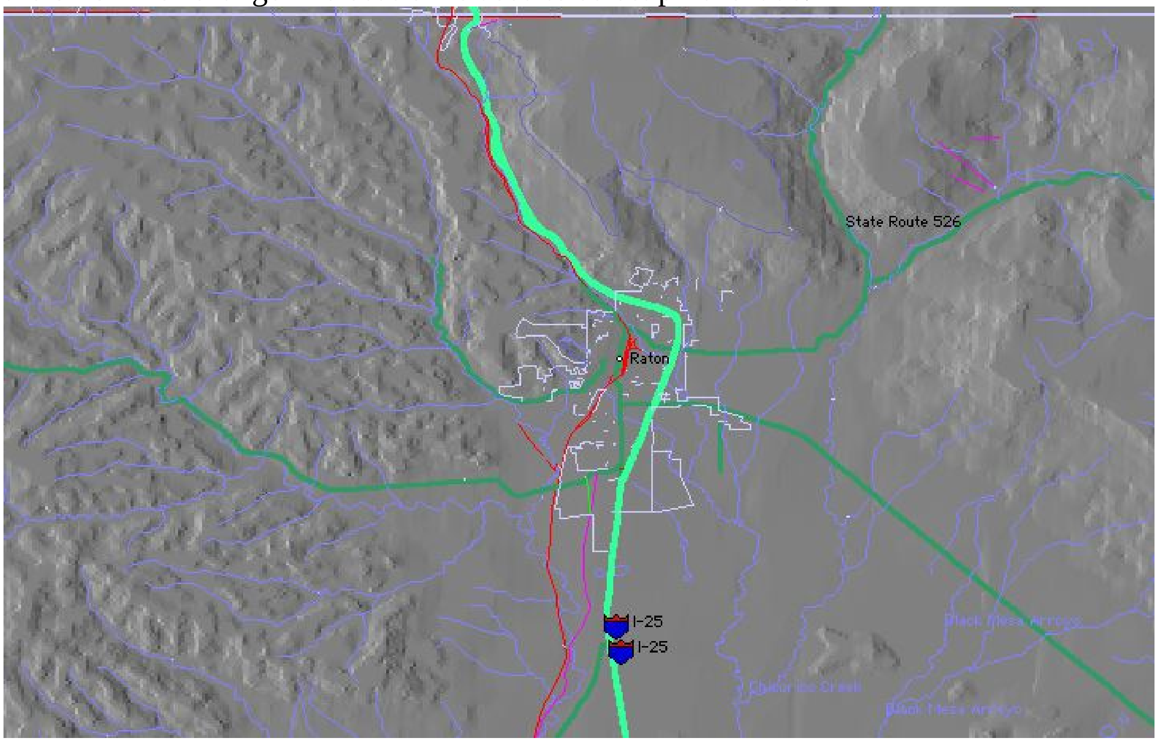



Raton, NM
X-RAY elevation

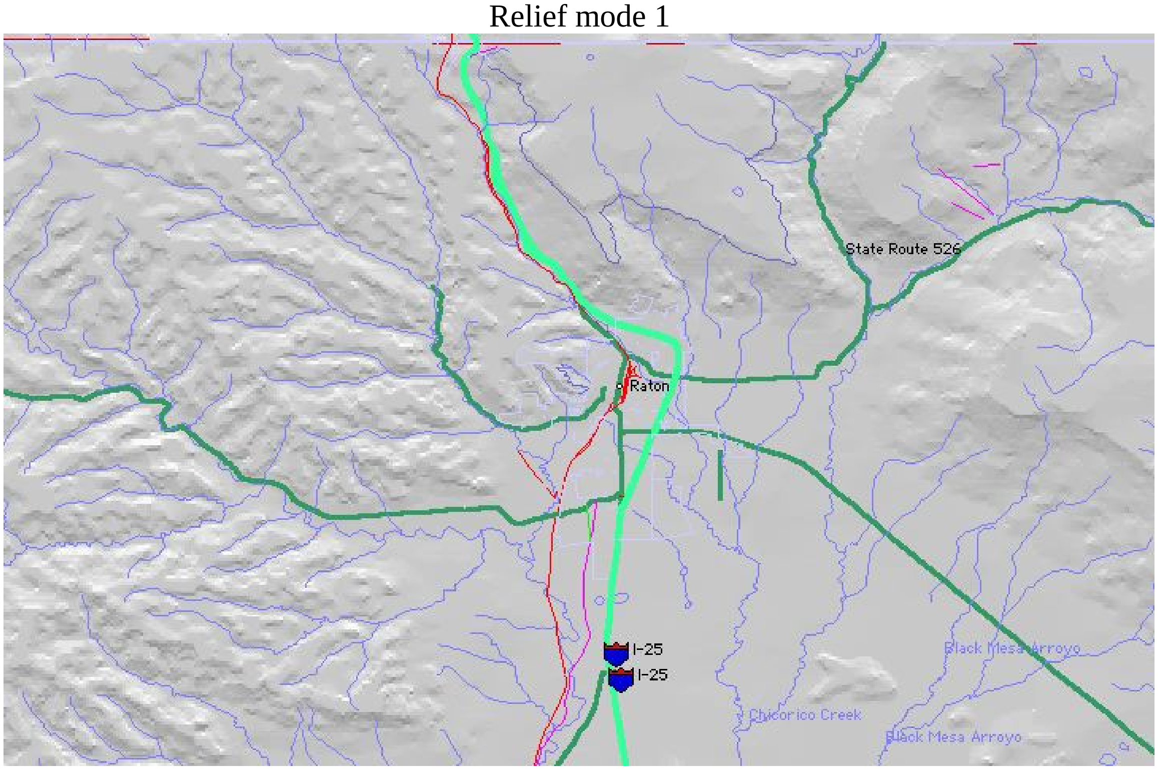
NOTE: Color versions of all of the images in this paper can be found at

http://www.winaprs.org/dcc2005

The next 2 examples show relief view with different relief algorithms. In the relief mode, the SLOPE or change in elevation is used to select pixel shade.

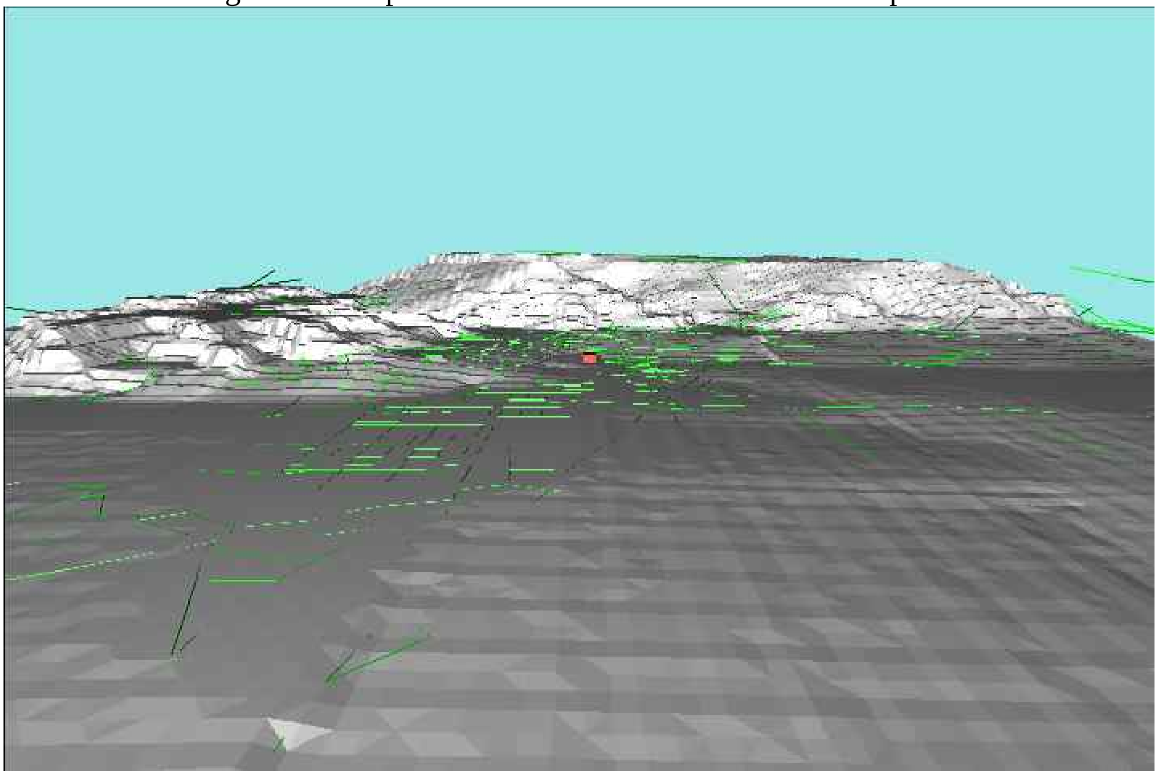



Raton, NM
Relief mode 1




Raton, NM
Relief mode 2

The image below is the same data displayed in 3-D using Macintosh Quick Draw 3D which is similar to OpenGL. This shows the terrain, roads, and APRS stations in 3-D. This will be changed to use OpenGL and thus allow it to work on all platforms.



Raton, NM
3-D
Red block is center of Raton

## IMAGE RASTER DATA

Data for Canada has been slow in becoming freely available. This past year a WinAPRS user from Canada told me about Toporama image files. This data is free, easy to download, and covers 100% of Canada. The images are available in 2 different modes, scanned maps and satellite photos. These files are organized almost identical to normal Ham Radio Grid Squares. That is with numbers, letters and increasing degrees of detail as you add more numbers/letters. The size of the images even corresponding to grid squares. Why they had to come up with their own numbering system instead of using the grid square numbering system is unknown. Mac/WinAPRS now fully integrates these map images into the TIGER map window. Additionally, the downloading of these files is fully integrated into Mac/WinAPRS so the user does not have to deal with complicated downloading. The user can tell the program to get ALL of it, or just individual areas. CAUTION, this data is VERY LARGE. The lower resolution files for all of Canada occupy 390 megabytes

## ACCESS TO DATA:

Data such as US Census Bureau TIGER data was available in the early 90s, but you had to pay for CDs. The primary issue was the data was so large, few computers could handle it. This prompted the early simpler data formats for dosAPRS and Mac/WinAPRS, which of course lost much of the original subtle details in favor of reduced size and faster drawing. Significant effort was spent making sure the maps drew fast even on slower computers.

Now days most people have fast enough access to the internet to be able to download an entire state of TIGER data in a reasonable amount of time.

Access to the Internet from your car is not very far off. When we get this kind of universal access, you will be able to have your data when and where you want it, not mater what. This will further this type of seamless integration, so the user doesn't have to worry about downloading what he needs before he leaves his house.

## INTEGRATION:

As you can see from the images presented, various data types from various sources can be combined to produce maps far superior to each map separately. By working with data from many different sources the map user gains tremendous insight to the area in 2-D and 3-D form.

## AUTOMATIC DOWLOADING

The every increasing amount of data that a program uses requires more sophisticated management of that data. In the early days of APRS, it was simple to tell the user to download a few files. When we are dealing with latterly 1000’s of files, this is not practical or at the very least, it is unfair to the user. We have made lots of advances in WinAPRS to automatically download files from both the WinAPRS web site and from the actual source of the data.

## DATA SOURCES

TIGER MAP DATA

http://www.census.gov/
http://www.census.gov/geo/www/tiger/tiger2004fe/tgr2004fe.html

USGS Digital Elevation Model

http://edcsgs9bb.cr.usgs.gov/glis/hyper/guide/1_dgr_demfig/states.html

[1] Automatic AX.25 Position and Status Reporting by Bob Bruninga, WB4APR "ARRL 11th Computer Networking Conference 1992"

[2] MacAPRS: Mac Automatic Packet Reporting System-A Macintosh Version of APRS by Keith Sproul, WU2Z, and Mark Sproul, KB2ICI, "ARRL 13th Digital Communications Conference Proceedings 1994"