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4/15/08
NET-215
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Automatic Position Reporting System

There is sometimes the urge to find out where someone actually is. Wouldn't it be great to be able to make this happen? Absolutely! Automatic Position Reporting System, from now on referred to as APRS, is a system that is self-explanatory in the title by itself. This system reports where someone is automatically, wow what a concept!

For this short little excerpt which can be mistaken for a research paper, a few important aspects will have to be covered to explain how APRS actually works specifically in the Amateur Radio or HAM world, as well as how it relates to the TCIP/IP world. To get the eager readers ready for stimulating learning, get ready for learning the backgrounds of where APRS came from, the key elements from the APRS Protocol, what digipeaters actually do, the AX.25 Link Access Protocol, and finally the best part, APRS in action.

APRS was designed by Bob Bruninga, WB4APR. His first presence in telling the public about this new system was at a digital communications conference hosted by The Amateur Radio Relay League, ARRL. Although APRS is creating by an Amateur Radio operator, APRS can be used by any individual or company that is permitted to transmit on their own radio frequencies. APRS is considered to be a live type of transmission as it takes a matter of milliseconds to just a few seconds for a location to be displayed on a GPS or possibly the internet (G3NRW 7).

APRS systems transmit specific types of information depending on what the user intends to do. Many radio operators use APRS as a learning experience of a fun project, but if an emergency situation arises, radio operators can easily find out where other radio operators are. This will provide better information on how to relay information to the desired destination. The most data that is sent through APRS is to report just the location of where a user is by sending off GPS coordinates to a digipeater, which will be covered later. Other applications of APRS include weather information, messaging to other APRS users like we can text message people with cell phones today, and even transmit information about whether someone is "in-service" "in-route", etc. (G3NRW 8).

Let's explore digipeaters to better understand the AX.25 protocol. Digipeaters actually have a more proper name known as digital repeaters. To learn more about digipeaters, let's explore what regular repeaters do. There are two major types of repeaters, simplex repeaters and duplex repeaters. Simplex repeaters only use one frequency. It listens for a signal and once it receives it, the repeater will start digitally recording the audio on the frequency. After the audio stops transmitting or for a more technical term, the carrier drops, the recording will stop, the repeater will key the transmitter and the audio will be played back on the same frequency. For a more sophisticated way to repeat information, duplex repeaters are used. In duplex repeating, the repeater station will key the transmitter once it receives a signal on the receive frequency. This does not cause double messages as it will rebroadcast what it received on a different frequency.

For the user application, the radio will be programmed to transmit on the repeater receive frequency and receive on the repeater transmit frequency.

Digipeaters in APRS applications use simplex repeating for a few very important reasons in the HAM world. In amateur radio, the universal frequency for APRS in the USA is 144.39 MHz and the default data rate is 9600 baud. When a location wants to be transmitted, the user or device does not have to have a huge list of frequencies to better ensure a repeater can receive the signal. This universal frequency ensures the correct frequency is actually used.

Since digipeaters are digital, it of course has a set of protocols to transfer information that comes in back out or to drop the packets into the "bit-bucket", simply discard the packets. The protocol being used is AX.25. This transfer was actually adapted from the X.25 type of transporting. On the OSI model, the AX.25 uses the physical and data link layers (NJ7P 2). The frame structure has three different types, but the most common for APRS is the Unnumbered frame known as the U frame. For this type of frame, there are 6 fields.

1. Flag – The flag bit is always set to Ox 7E or 01111110 (NJ7P 6).
2. Address – The source and destination of the packet are identified (NJ7P 6).
3. Control – This is the type of frame that is being transferred (NJ7P 7).
4. Info – This is the big field which actually supplies the data such as location (NJ7P 8).
5. FCS – This frame is the frame check sequence tries to provide error correction to better detect corrupt data transmissions (NJ7P 8).
6. Flag – The flag bit is always set to Ox 7E or 01111110 (NJ7P 8).

The address field is used to specify who the message came from and who the message is going to. In HAM radio, the source field is the amateur call sign plus a number to specify in detail what type of station it is. The number 9 specifies a mobile station, 11 will specify a station at a house and there are even more designators for trucks, ATVs and so on. The destination address can use a few different methods. The first method is to use a relay station. In this scenario, every station that is in range of the signal will have the ability to receive the APRS data. This is great for just transmitting information locally. The next type of field which is widely used in APRS is known as WIDE destination. For a WIDE scenario, a digipeater will be used to retransmit the location. By using a repeater, more APRS uses will be able to capture the APRS data. The next type of destination is WIDEn-N. For this type of destination, each APRS use can determine how many times the APRS packet will attempt to transmit. For instance, if WIDE2-2 is used, the first WIDE digipeater will retransmit the message with the destination being WIDE2-1. Due to the fact that digipeaters are usually found in high locations, digipeaters are often in range of other digipeaters. The next digipeater in range will then take the packet and retransmit it again. The destination will then be WIDE2-0. At this point, the user specified to only transmit up to two hops. The next digipeater or the third digipeater to receive the signal will simply discard the packet (G3NRW 11).

Up until now, the APRS data can only be viewed by users who receive the data via the airwaves. Another type of station came into play to provide similar information to be viewed across the internet. These digital stations that link the APRS frequency to the internet are called IGATES. Due to the fact that there are not enough IGATES for all APRS information to be posted online, IGATES are effective with use of WIDE type of routing. Typically, APRS traffic will flow through two WIDE digipeaters to finally reach an IGATE (K4HG).

Since APRS is an interesting topic, the author of this paper decided to create a simple APRS station in a Ford Escape. For this project which was put into service on December 31, 2007, research on the basics operations of APRS was conducted to be better suited to purchase equipment.

The first item which is important is having a simple GPS and encoder chip to convert GPS data into APRS packets. Byonics has a product called *TinyTrak 3*. This unit in addition to the GPS antenna cost $112. This unit provides this capability with the use of a PIC12F675 microprocessor. This unit is easily programmable and provides many options as well as features to make APRS legal. The few features to make APRS legal is having a source address which will match the creators callsign. For this use the callsign KC2LPU-9 was used. The second feature to make APRS legal is to listen to the frequency first. If busy, then wait, else transmit data. This unit also has LEDs which provide information on simple information such as if the frequency is in use, if there is a GPS signal, and when the unit actually transmits.

The second item to purchase was a radio that could transmit on 144.390 MHz as well as having easy access to the transmit lead, busy lead (COS), audio in lead, and ground. A commercial Motorola SM50 radio was found on ebay for a price of $85. This 40Watt VHF radio easily transmits on the 2meter band (144 MHz – 148 MHz) after a few modifications during programming the radio via computer. In addition, this radio has a 16 PIN interface on the back to provide many different features including what is required for APRS.

The next item to acquire is an antenna tuned to transmit on 144.390 MHz. This item was around the house and is perfect for this type of application. Various wires and connecters were necessary to provide a physical connection to all of the various components. After the physical connections were created, it is time to play with settings. The first time the TinyTrak 3 transmitted, it did not show up on the internet. After some research, a resistor on the board was shorted to provide a stronger audio signal. Afterwards, the APRS station automatically appeared on http://gaprs.net under the station KC2LPU-9.

Some tweaks were necessary to provide more accurate information on the location. The GUI program from Byonics has many features such as destination, which is now set to WIDE2-2, a feature to only transmit a valid GPS signal, and smart beaconing feature. The smart beaconing feature allows the user to specify how often the station transmits APRS data based on speed, and variation in the course. After these few tweaks, the APRS data better mapped out a track especially around turns.

To finally conclude this research, APRS is a really cool system. History related to where a vehicle or person has been is a chill feature. To create such a system, it doesn't hit the wallet hard and it is an easy project to perform. A special thanks goes out to Bob Bruninga for creating such an amazing system.

Works Cited

G3NRW, Ian Wade. (2000). *Automatic Position Reporting System APRS Protocol Referece Protocol Version 1.0.* APRS Working Group.

K4HG, Steve Dimse. (n.d.). *Setting Up an APRS/Internet Gateway*. Retrieved 4 15, 2008, from http://www.aprs.net/vm/DCC97/internet/index.htm

NJ7P, William A. Beech, N7LEM, Douglas E. Nielson, N7OO, Jack Taylorl (1998). *AX.25 Link Access Protocol for Amateur Packet Radio.* Tucson Amatateur Packet Radio Corporation.