



Automatic Position Reporting System (APRS) in South Africa

By Dick ZS6RO

27 May 2007



- The *Automatic Packet Reporting System* devised by **WB4APR**, initially transmitted the position or location of mobile stations by piggybacking a burst of packet radio data onto the end of a standard voice transmission.
- As the APRS protocol was extended, it allowed other information to be transmitted eventually requiring its own frequency.



What is APRS ?

- **APRS**, stands for "Automatic Packet Reporting System". Some incorrectly say "*Automatic 'Position' Reporting System*".
- Amongst many other things it is a means of automatically reporting the position of mobile amateur radio stations in real-time using the AX25 packet radio protocol.



So what else can APRS do ?

Short Text Messages

- One can send short messages to an individual callsign using keyboard to keyboard, send short one-line general bulletins or announcements. Even one-line email messages can be sent! Everyone worldwide can read these messages.

Weather information

- Automated weather stations, typically reporting local temperature, barometric pressure, wind speed and direction to interested viewers.



DX-Clusters

- APRS was utilised a lot by the DX-Cluster user. He was able to see all the DX spots on the map instead of seeing them in long lists.
- But recently it was decided that the sheer volume of DX-Spots (especially at contest time) was congesting the APRS network and has since been discontinued.



Callbook server

- I have a **Callbook server** on APRS which may be used to obtain any local or dx callsigns from *anywhere* in the APRS international network.
- Using UI-View, open the window to send a message and in the 'TO callsign' field, type **ZS6RO-WI** ('-WI' stands for '*Who Is*').
- In the 'Message' area, type '**F Callsign**' Return or Enter (**Callsign** being *any* Callsign you wish to look up). '**F**' stands for '*Full Callsign*'. One can type just a '**Callsign**' and a one-line summary line of information on that Callsign will be received.



Objects

- Objects are just blue 'labels' that show up in UI-View maps and are not actually APRS stations. They 'belong' to the user who created them.
- 'Objects' of interest may be defined by any user on the network, These can be anything from the location of a police station, hospitals, local clubs, the location of voice repeaters, to real-time weather events such as storms and tornados.



What do you need to get onto APRS ?

If you are active on *packet radio*, then you probably have all the equipment needed in your shack to set up a **fixed** APRS station!

The minimal APRS requirements for a **fixed** station could consist of the following:-

- A **PC** – any personal computer from a 486 or better, Windows and some form of serial port.



- A **TNC** – virtually any TNC or soundcard will work.
- A **VHF radio** tuned to 144.800 MHz.
- **APRS Software** – Typically **UI-View** for Windows (95/98/XP). APRS software for Linux is also available. This software is free for Ham use.
- A **GPS** receiver is **not** required for **fixed** station use.



APRS program

- **UI-View** uses *bitmap* images for its maps.
- **UI-View** supports TNC's in *KISS mode*, in *AGWPE host mode* and in *terminal mode*.
- **UI-View** has a full-featured intelligent digipeater.
- **UI-View** has full support for connecting to *APRS servers* on the internet.
- **UI-View** is open architecture. A number of other software developers have written some add-on applications providing additional functionality.



The minimal APRS requirements for a **mobile** station could consist of :-

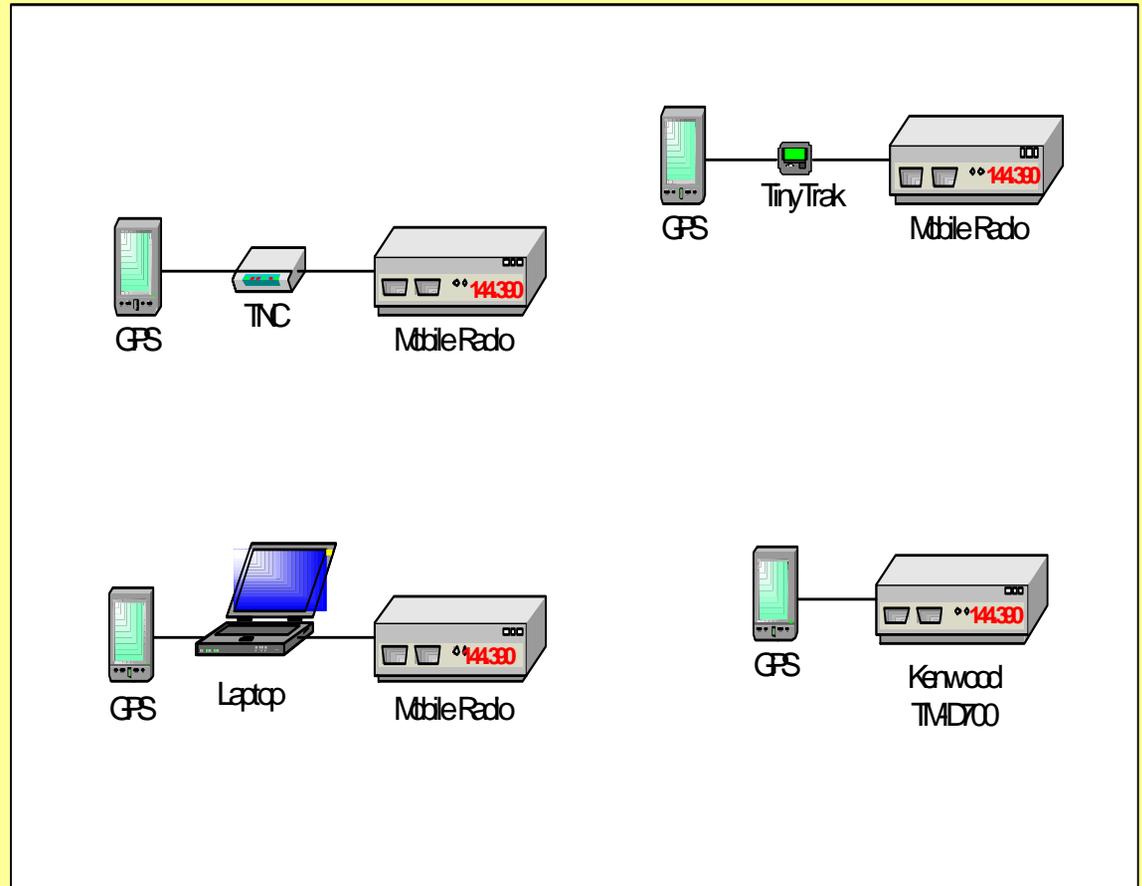
- A suitable **GPS** receiver capable of connecting to a computer serial port.
- A **laptop** computer with the UI-View program installed and some serial ports.
- A **TNC** and **VHF radio** similar to the fixed station installation, and a mobile antenna.



- A few Hams have made available some reasonably priced APRS mobile kits which consist basically of a **GPS** module with GPS antenna, a **TNC** and a **processor unit**, the size of a 20 pack of cigarettes!
- To install into the mobile, one needs to hide the kit in the car and then add a VHF radio (144.800 MHz) and of course a suitable VHF antenna.
- No laptop required!



- Mobile tracking installations can utilise a GPS RX connected to the radio through a TNC interface
- The new “*APRS Ready*” rigs like Kenwood’s TM-D700 have their own built in TNC. Just add a GPS.





- When operating APRS on VHF, use **1200 baud** **1000Hz shift** and a frequency of **144.800 MHz**.
- On APRS HF SSB use **LSB** at **300 baud** and **200Hz shift**. Use xtal ovens to reduce drift.
- **10 MHz** is a good band for mobile APRS in most of South Africa and it's neighbouring countries.
- The international APRS frequency to use is **10.150 MHz LSB**. This is at the top edge of the band. Using LSB the signal will be legally inside the band, assuming the transmission is clean!



Global Positioning System

- The **Global Positioning System (GPS)** is a satellite-based radio location system operated by the USA Department of Defence.
- 24 widely spaced satellites orbit the earth twice a day, continuously transmitting a timing signal, which allows any user with a low cost GPS receiver to determine their latitude and, longitude to better than 10 metre accuracy.

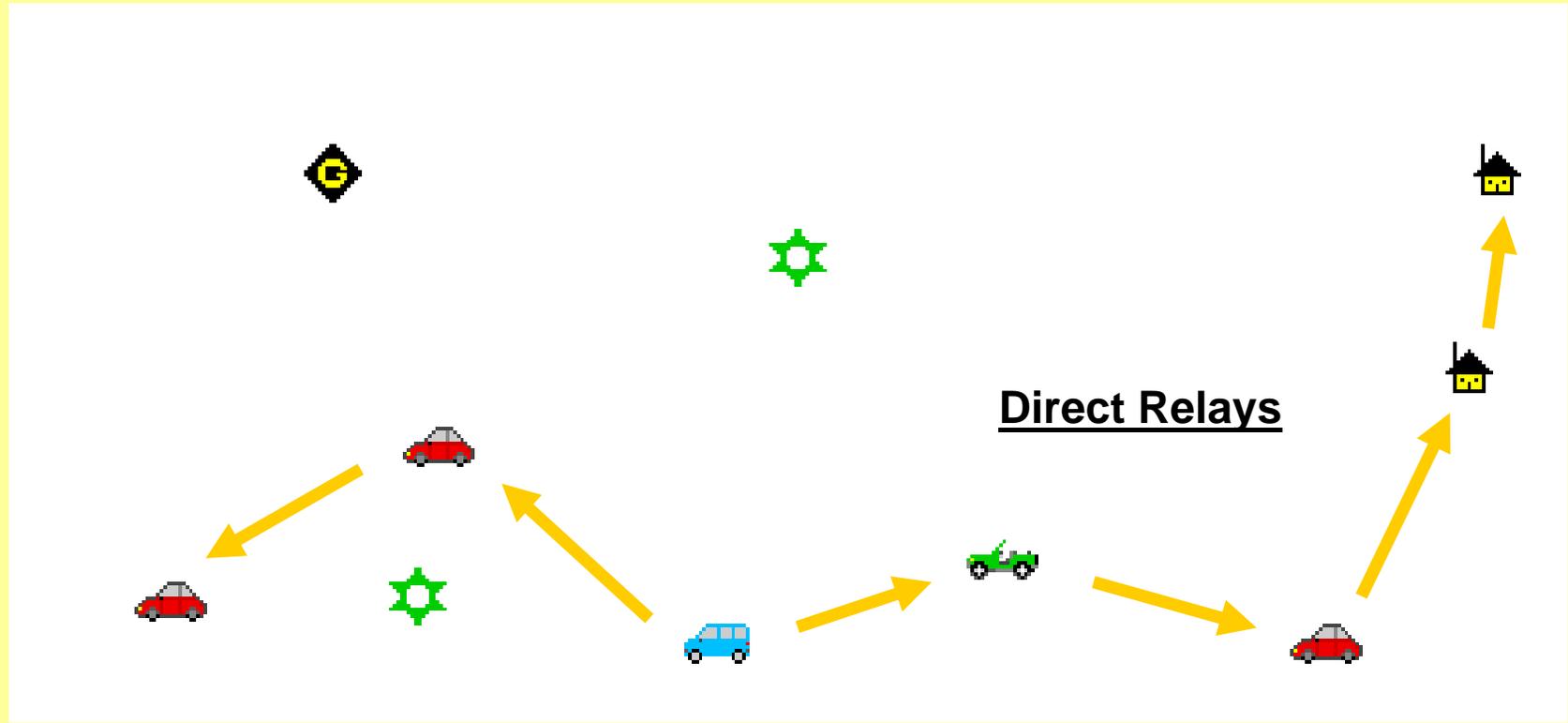


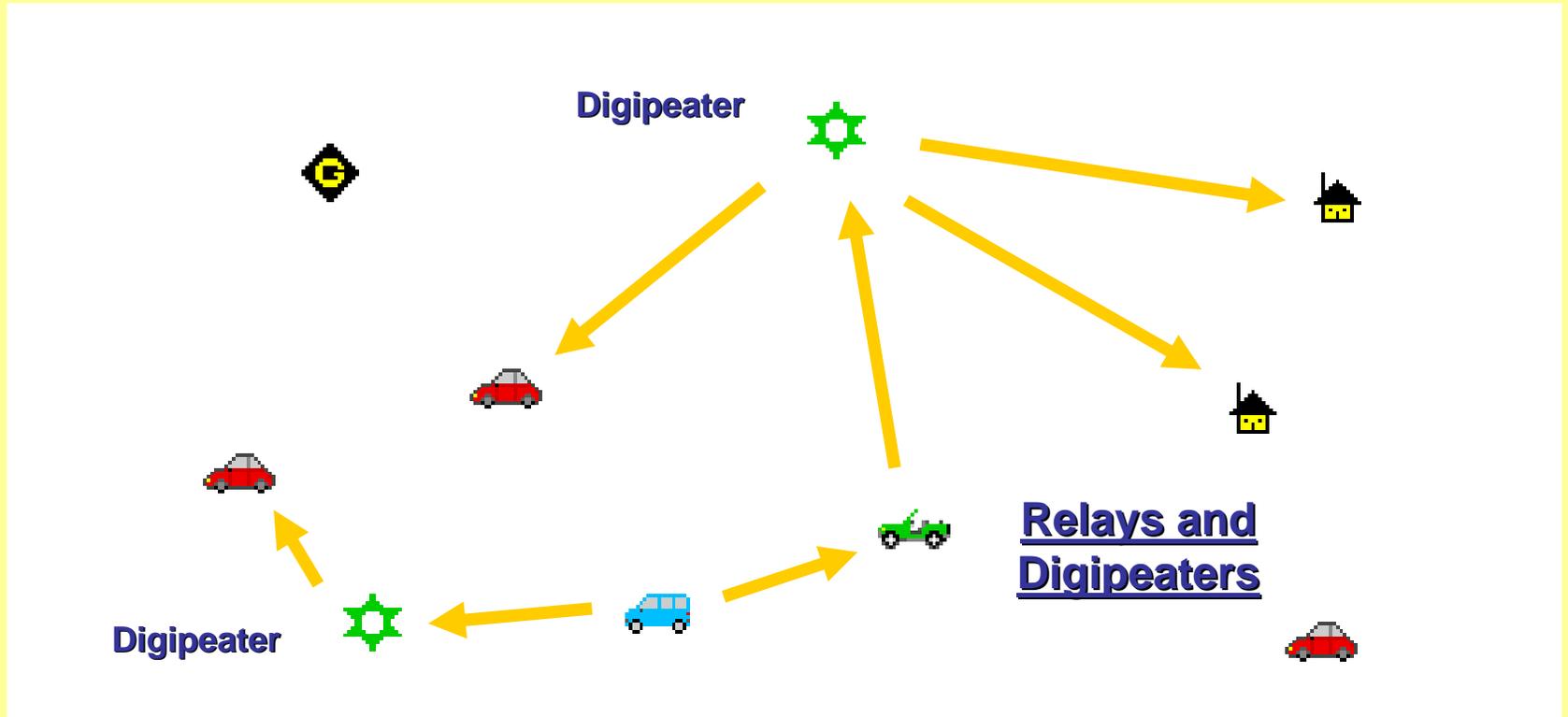
How does it all work ?

- Typically, an APRS station would transmit its geographic location in a specific format using *AX25 UI frames* - (**U**nnumbered **I**nformation) and beacon at roughly 20 - 30 minute intervals.
- *UI frames* do not require any form of acknowledgement from the receiving station.



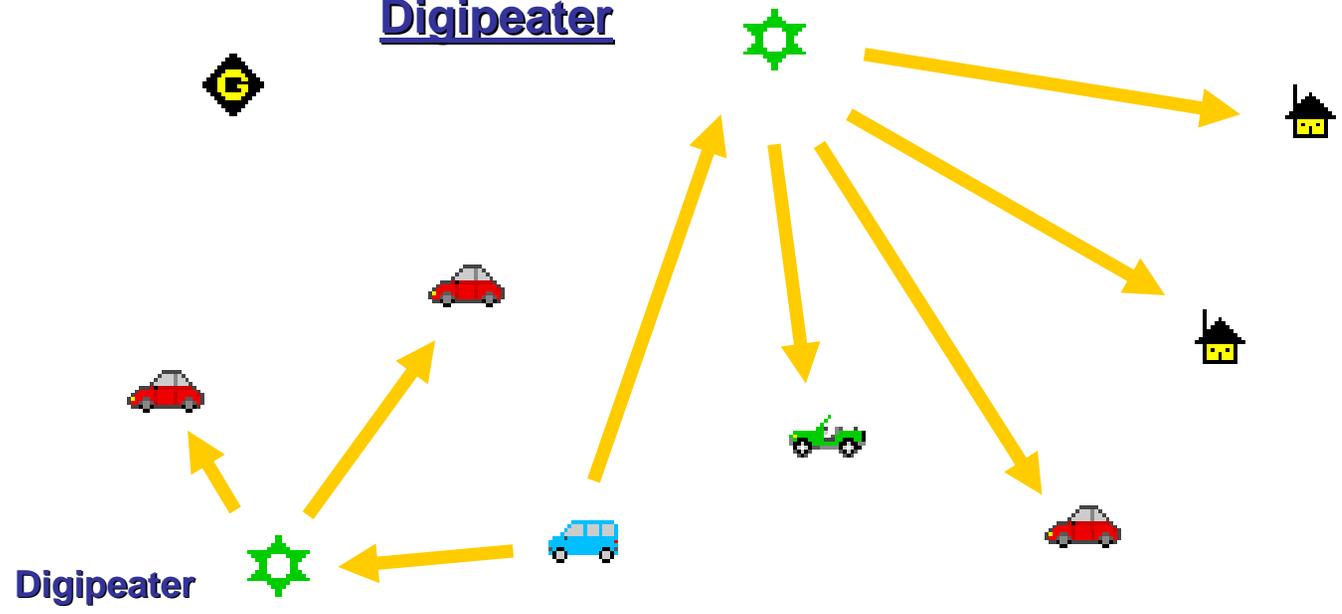
- When a mobile APRS station is moving and depending upon it's speed, it will beacon it's position, direction and speed more frequently, sometimes every minute!
- This enables the viewer to see a 'smooth' display on his map as the mobile is being tracked.

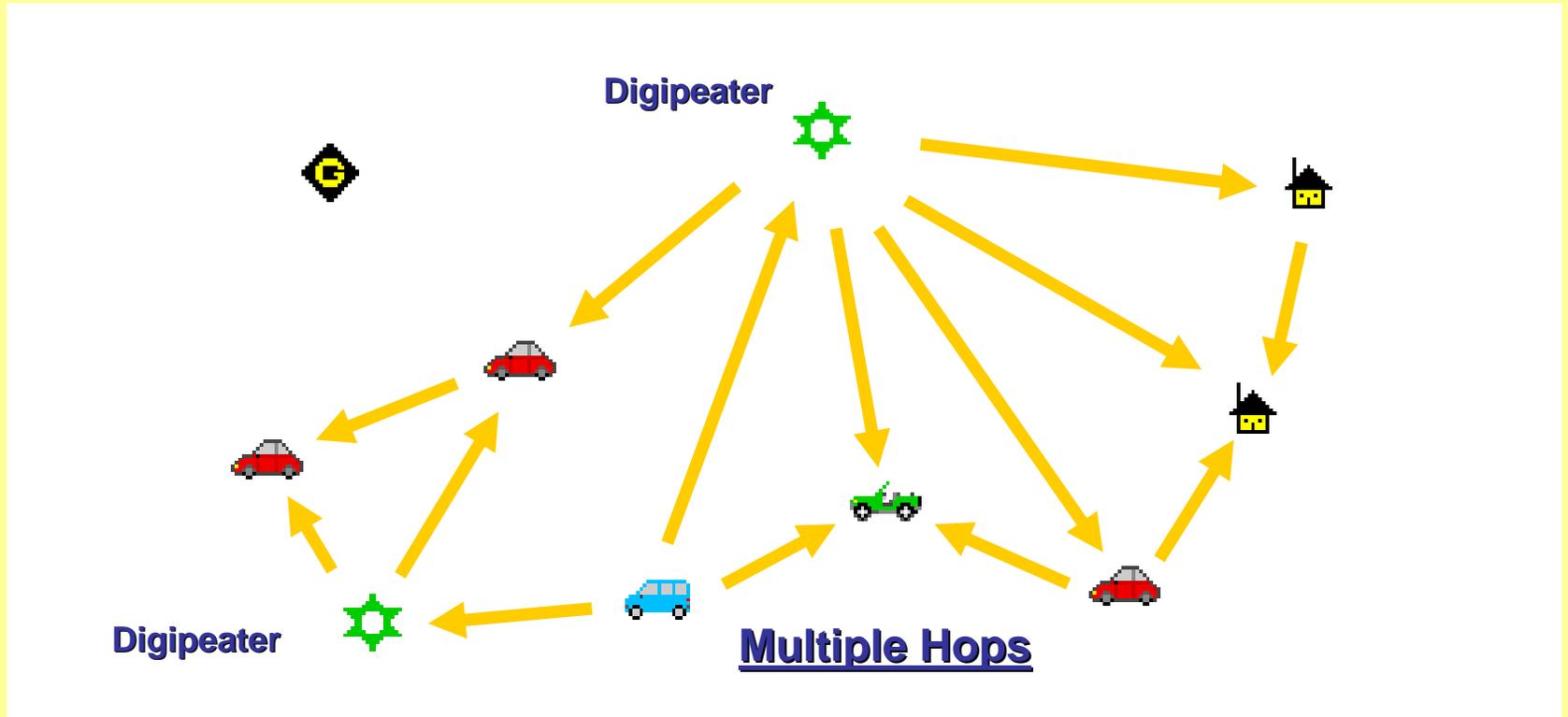






Straight through the Digipeater







- The Automatic Packet Reporting System is designed to support rapid, reliable exchange of information for local, tactical real-time information, events or nets.
- All relevant information is transmitted immediately to everyone in the network and every APRS station in range captures that information for display to all participants.



- Information is refreshed redundantly but at a decaying rate so that old information is updated less frequently than new info.
- After the first transmission, there is say, a delay of 60 seconds, then a 2nd repeat transmission, then a further delay of 120 seconds before a 3rd transmission would be sent. Then a 240 seconds delay and so on. (The delay time is doubled each time.)
- Note that APRS is *not* a vehicle tracking system per se. APRS is much more!



- APRS can provide awareness to all operators of everything that is going on in his local area, whether it be Weather reporting, traveler info, car rallies, races, the Comrades in KZN, parades, direction finding, objects pointing to ECHOLink and IRLP, or traffic reporting and emergency response.
- In fact think of APRS as a signaling channel to reveal all amateur radio resources and live activities that are in range of the operator at any instant in time. That's awesome !



- Although APRS is a local, tactical real-time two-way communications system, the Internet allows global monitoring of all real-time data from *all local communities around the world*.
- Everything on any APRS frequency in the World is being monitored locally and fed globally into the APRS internet network by hundreds of **iGates**. That's even more awesome !



- This allows for worldwide monitoring of any local activity, and it also allows two-way point-to-point messaging between any two APRS users anywhere in the World that has an APRS infrastructure.
- Think of it as everything ‘*goes in*’ so it is available to everyone, but the only thing that comes back from the internet to the local RF channel are messages and *selected* position data requested locally.



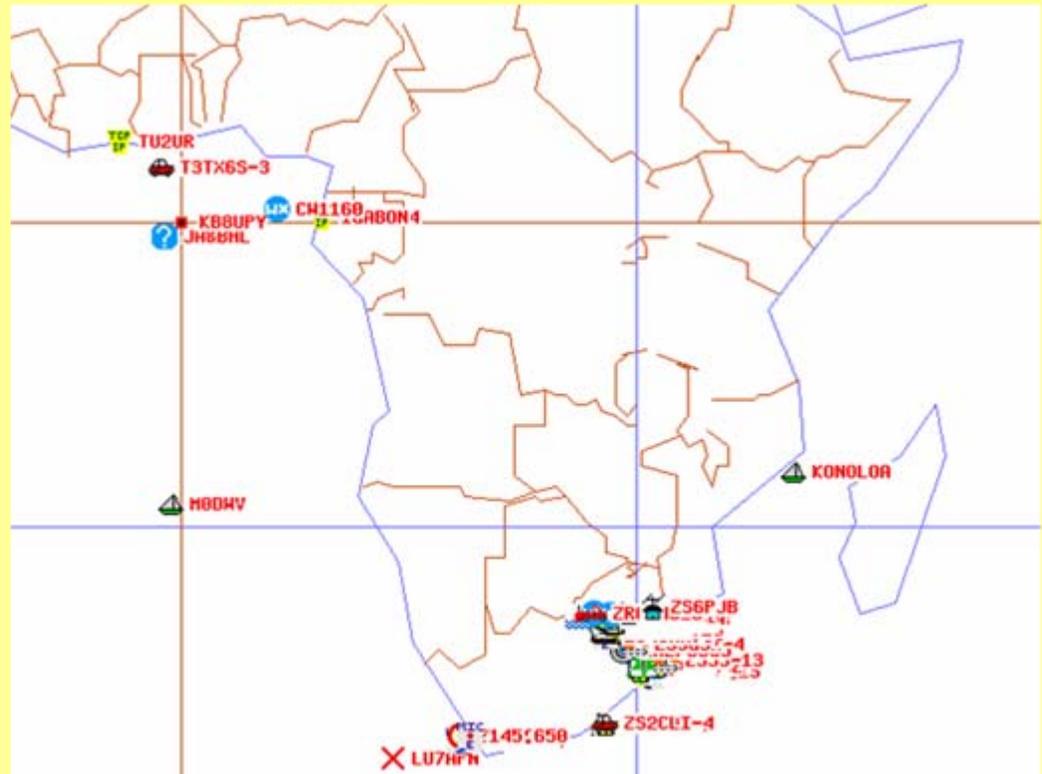
SSID Conventions (Guidelines)

- Many operators have multiple APRS stations on the air, such as their *HOME*, *CAR*, *BOAT*, and *HT*. It is very convenient to be able to recognize these typical applications at a glance. Here are those common ‘**Service Set Identifier**’ (*SSID*) defaults:
 - **0** is for home stations. **ZS6XXX**
 - **1**, **-2**, **-3**, **-4** are for digipeaters. **ZS0DXT-1**, **ZS0DXT-2**, **ZS0DXT-3**
 - **5** is ?
 - **6** is for operations via satellite.
 - **7** is for TH-D7 walkie talkies. **ZS6XXX-7**
 - **8** is for boats, sailboats and ships (maybe 802.11 (WiFi) in the future).
 - **9** is for mobiles. **ZS6XXX-9**
 - **10** is for operation via the internet only.
 - **11** is for APRS touch-tone users (and the occasional balloon activity).
 - **12**, **-13** is ?
 - **14** is for truckers, bakkies, vans.
 - **15** is for HF. **ZS6XXX-15**



An example of APRS activity in **South Africa**, mainly Gauteng, Kwa Zulu Natal, East London and Cape Town, and a few stations up north.

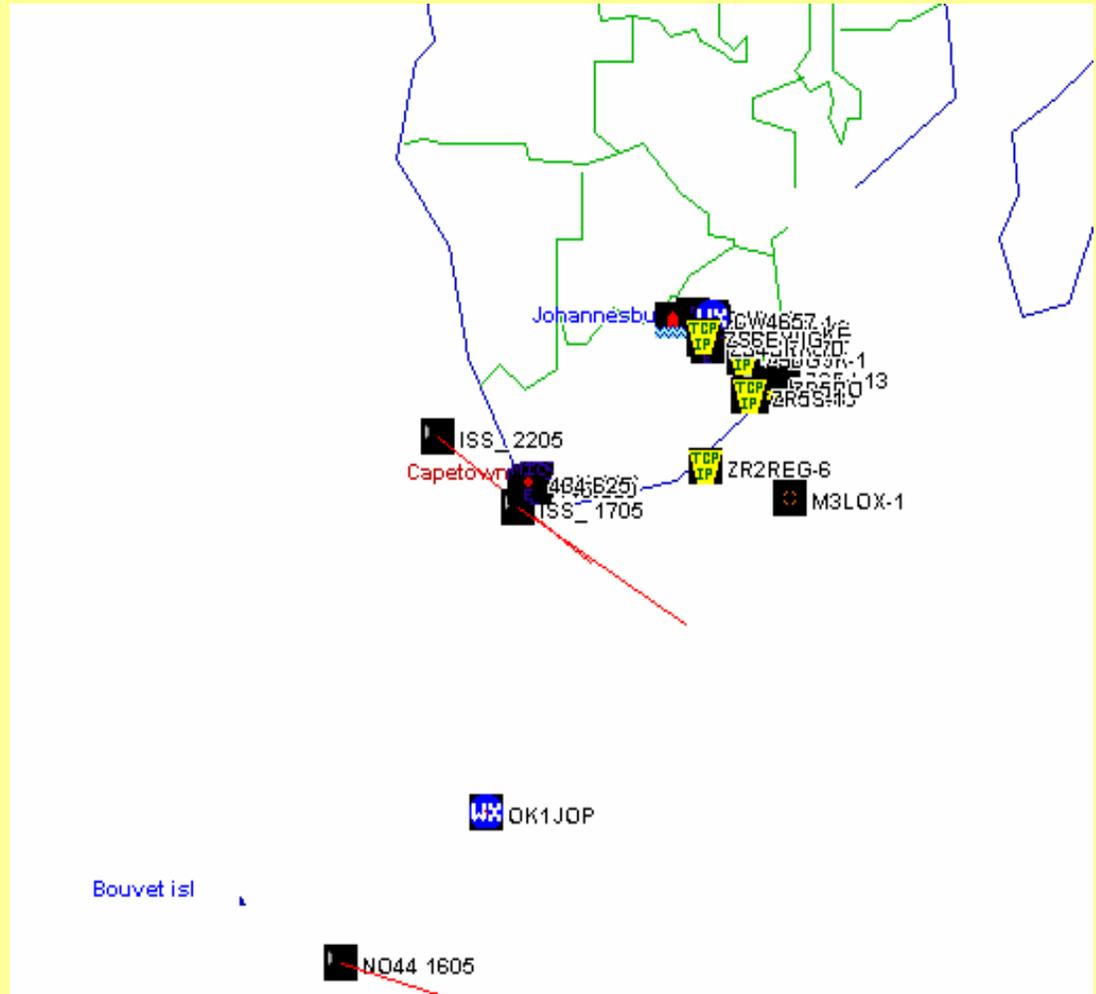
[taken on 20th May 2007]





The bottom of this map shows the **NO44 1605** satellite. Its course is 135 degrees and speed is 1850 kph. The red line indicates the direction it's travelling.

[taken on 23rd May 2007]





SUCCESSFUL APRS

- The success of your local APRS is not how many stations you see on your maps, nor how far away, but how reliably your mobile or handheld or portable station can communicate with others in the local area.
- There is a big difference.
- This fundamental principal should drive everything we do with APRS in our local areas.



RELIABLE APRS

- Said another way, the more stations you see on a radio channel above, say, 60 to 100 or so in typical areas, the more packets you don't see due to collisions and the less reliable your network will be for '**local**' real-time APRS use.



iGate

- An ***iGate*** is an APRS radio station capable of receiving APRS data from a radio channel and sending it to an '*APRS Server*' on the Internet.
- An ***iGate*** is also capable of taking *selected* APRS traffic from the Internet '*APRS Server*' and transmitting it onto the radio channel.
- The UI-View program can be used as an *iGate*.



APRS Servers

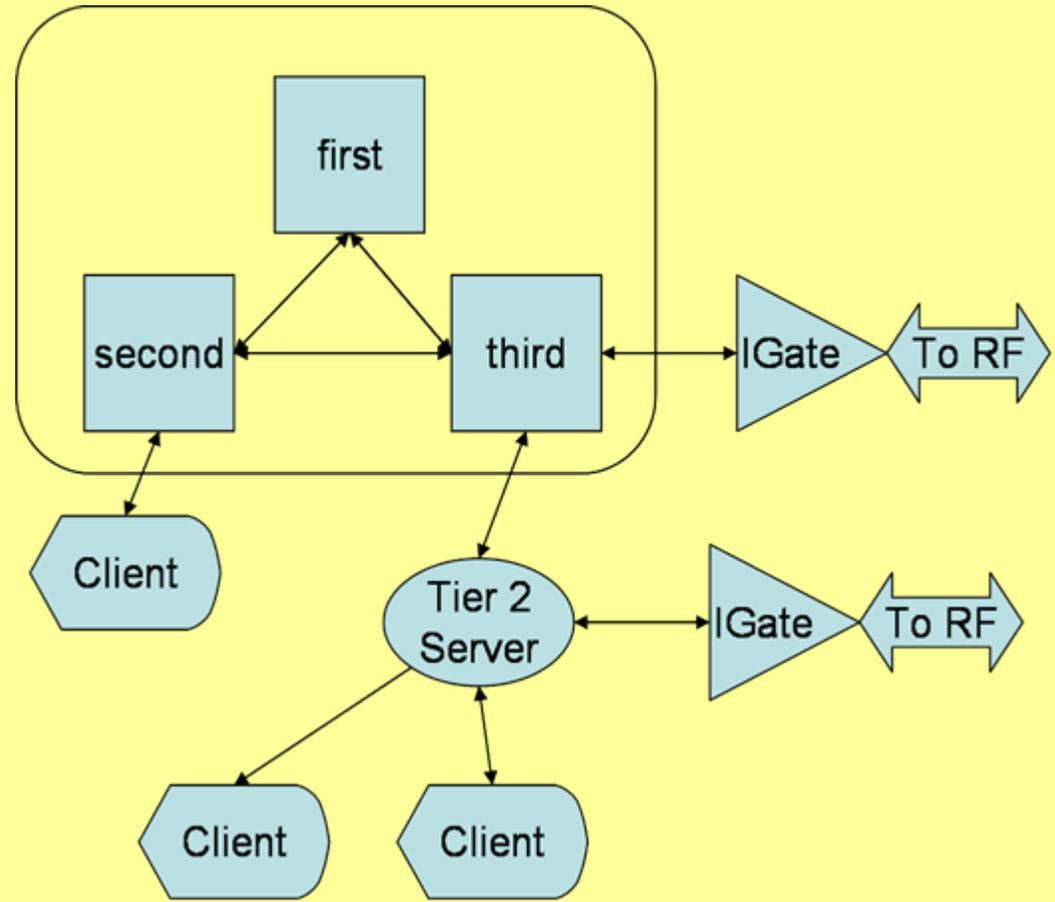
- A transparent Internet backbone of *APRS Servers* exists worldwide.
- An **APRS Server** acts as a central site for hams (*clients*) to access packets being seen throughout the world.
- There are **three main core servers**.
- Other '*APRS Servers*' around the world 'interface', either directly or indirectly to one of the three main core servers.



The current architecture of APRS is shown here.

It consists of three core servers with a number of second tier servers.

There are also lower tier servers that assist in sharing the load.





APRS digipeater

- In order to extend the range of data transmissions, APRS and UI-View use a facility known as digipeating ('*digi tally re peating*').
- This facility operates like a voice repeater albeit digitally.



- Any packet that is received by a station which contains either its own *callsign*, or an *alternative callsign* (known as an '**alias**') within a part of the packet known as the '*Digipeater Path*', is automatically re-transmitted.
- Each packet has the provision for up to seven digipeater callsigns within the '*Digipeater Path*' and therefore the packet can be repeated up to a maximum of seven times.



RELAY, WIDE and TRACE

- APRS, UI-View and other APRS programs make use of generic aliases of '**RELAY**', '**WIDE**' and '**TRACE**'.
- The reason for using generic aliases is because the network is then accessible to any station within range of any digipeater.
- RELAY digipeaters are intended to increase the range of low-power mobile stations, and are relatively closely spaced.



- WIDE digipeaters, are intended to cover large areas and ideally are placed on high ground to provide maximum coverage in a similar manner to existing voice repeaters - typically 80 to 100 kilometres apart.
- TRACE - as the name suggests, allows the route to be traced.



Duplicate packets

- If the same packet is re-transmitted by a digipeater, it is a duplicate packet. Often called a 'Ping Pong'.
- Another possible cause are bugs in the TNC's firmware. Instead of simply adding the '*' to the last alias as the packet is digipeated, they also remove all the preceding '*'s allowing the packet to be digipeated back along the path it came.



- Recognising duplicate packets can prevent this problem.
- To do this the system protocol looks for packets with identical content which occur within a predetermined time-frame and when found, selectively ignores the packets that occur within it.
- This must be short enough to allow for retries.
- Time-frames are usually around 30 seconds.



- Another way of resolving the duplicate problem is to automatically replace the generic callsigns '*RELAY*' and '*WIDE*' with the callsign of the digipeater as the packet is repeated, i.e:

ZS6XXX>CQ,RELAY,WIDE

- The nearest APRS station will digipeat the packet because it contains '*RELAY*' (This is replaced with its own callsign '*ZS0DXT-1**').

ZS6XXX>CQ,ZS0DXT-1*,WIDE



- Next the packet is received by the nearest 'WIDE' station ('ZS0AAA-1'), and once again its digipeated after replacing *WIDE* with ZS0AAA-1.
ZS6XXX>CQ,ZS0DXT-1*,ZS0AAA-1*
- Note the '*' after each digipeater. This means that this packet has been digipeated through these digipeaters.
- The APRS protocol will not allow this packet to '*Ping Pong*' and be duplicated.



WIDEn-N

- Another solution to the duplicate problem is *WIDEn-N* digipeating. Say a packet enters the network with the '*Digipeater Path*' of '**WIDE7-7**'.
- Each time the packet is digipeated, the SSID (the number after the '-') is decremented until it reaches '0', then the packet is ignored:-

ZS6XXX>CQ,WIDE7-7

ZS6XXX>CQ,WIDE7-6

ZS6XXX>CQ,WIDE7-5

until finally **ZS6XXX>CQ,WIDE7** is reached.



- The problem with this is that the path or route taken to get to the destination is lost and the only way that an APRS station can acknowledge this packet is to also use '*WIDE7-7*' and hope that the packet will eventually get there.
- This packet will unfortunately also be broadcast everywhere else on the network!



TRACEn-N

- As the name implies, this feature allows the route to be traced through the network.
- For example, a packet entering the network with the '*Digipeater Path*' of '*TRACE7-7*' would be propagated as:-

ZS6XXX>CQ,TRACE7-7

ZS6XXX>CQ,ZS0DXT-1*,TRACE7-6

ZS6XXX>CQ, ZS0DXT-1*,ZS0AB-1*,TRACE7-5

until:-

ZS6XXX>CQ,ZS0DXT-1*,ZS0AB-1*, ZS0CD-1*, ZS0EF-1*, ZS0GH-1*, ZS0IJ-1*, ZS0YZ-1*



- The disadvantage of this method is that packets get progressively longer as they are repeated and is not ideal for DX (long distance).
- Because the packet is longer, there is more chance of errors or collisions occurring during the time taken to transmit it.
- Fortunately UI-View reduces unwanted traffic, as acknowledgements are sent using UI-View by reversing the order of the received callsigns.



Now we reach the cross-roads !!

- In my opinion APRS in South Africa is still very much in the infant stage.
- APRS in the USA and Europe has matured and we can learn a lot from their experiences.
- Their APRS networks are more heavily utilised when compared to our network in South Africa.
- APRS networks in the USA and Europe differ in their approach to what generic aliases to use.



USA

- Bob, WB4APR, stated in a bulletin (2 April 2005) that *RELAY*, *WIDE*, *TRACE* and *TRACEn-N* are all obsolete in the USA.
- Using *RELAY* caused 2 to 5 times as many duplicated packets as was deemed tolerable.
- He suggested the following:-
 - WIDE1-1* One HOP works everywhere and via HOME stations.
 - WIDE2-2* General mobile recommendation and metro areas.
 - WIDE3-3* Rural areas with no mountains for hundreds of kilometres.
- Note the low SSID numbers used here.



- But for mobiles that live in an area where ‘*fill-in*’ digipeaters are common, (these used to be called *RELAY* digipeaters in the USA), there are two new paths that will work the way the old ‘*RELAY,WIDE2-2*’ paths used to work:

RELAY,WIDE2-2 The **OBSOLETE** way which causes dupes and 3 hops.

WIDE1-1,WIDE2-1 New **TWO hop** path which is safe to use everywhere.

WIDE1-1,WIDE2-2 New **3 hop** path that may be used in remote areas.

- This solution apparently eliminates the bad duplication problem caused by the old *RELAY,WIDE* ... paths. All it really does is substitute the ‘*WIDE1-1*’ path for ‘*RELAY*’.



- Digipeaters including the *fill-in* home digipeaters will respond to *WIDE1-1*, but only for **one hop**.
- This is just like *RELAY* used to be.
- But the real advantage is that once it is digipeated by any digipeater, even through a home APRS station, that same digipeater will never digipeat it again, because it always looks like a *WIDEn-N* packet and the *WIDEn-N* system has the perfect *DUPE-ELIMINATION* algorithm.



- For the USA method I would imagine that all digipeaters in the network would have *generic aliases* as shown below:

WIDE1,WIDE2,WIDE3

- The digipeaters would then be able to recognise and digi the various packets that contained these aliases.



European APRS Guidelines

- Apparently states that *WIDE* and *WIDEn-N* are no longer required on the APRS network and should be removed from all digi *generic aliases* routes !
- The *generic aliases* should now be set so all:-
 - Home Stations use '**TRACE3-3**', all
 - Mobiles use '**RELAY,TRACE2-2**' and all
 - iGates should use '**TRACE1-1**'



- For the European method I would imagine that all digipeaters in the network would have *generic aliases* as shown below:

RELAY,TRACE1,TRACE2,TRACE3

- The digipeaters would then be able to recognise and digi the various packets that contained these aliases.



Where does this leave us?

- OK, which guideline is better ?
- Which guideline should South Africa use ?
- Why does each guideline appear to contradict each other ?
- At this point I don't really know all the answers !!!
- I do feel however that we should experiment and try both methods of generic aliases mentioned and then opt for the one that works for us.
- Cape Town Hams are experimenting with these guidelines and I should hear from them soon.



- I hope that there is enough useful information in this presentation to whet your appetite and motivate you to set up some form of APRS station and swell the APRS network ranks.
- Hopefully more APRS stations should show up on various APRS maps after this presentation.
- If you require maps for UI-View, get them at:

http://www.zs6ro.co.za/zs6ro_home/zs6ro_pages/maps/index.htm



I'd like to now invite further discussion and ideas from the floor.

If you are able, please share your experiences with regard to the APRS network in your area.

What you share now could help another area.

Thank you for listening.

Not 'THE END' but rather the Beginning!