TBARC Programs
Introduction to APRS

Israel - AD7ND

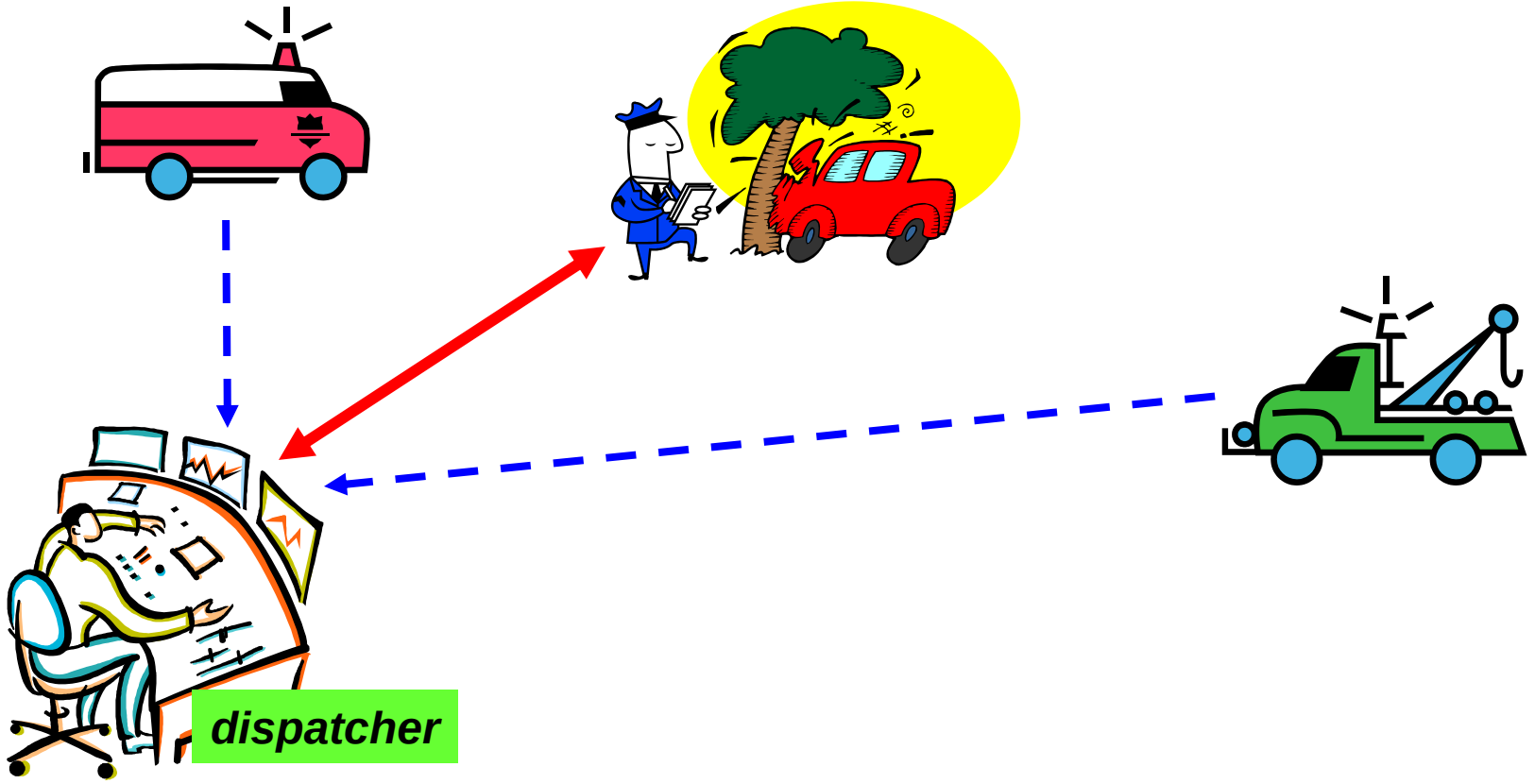
21 Jul 2011

Introduction To APRS

1. **What is it?**
2. **What is it good for?**
3. **Who operates it?**
4. **What do I need to operate it?**
5. **How does it interface with my station?**

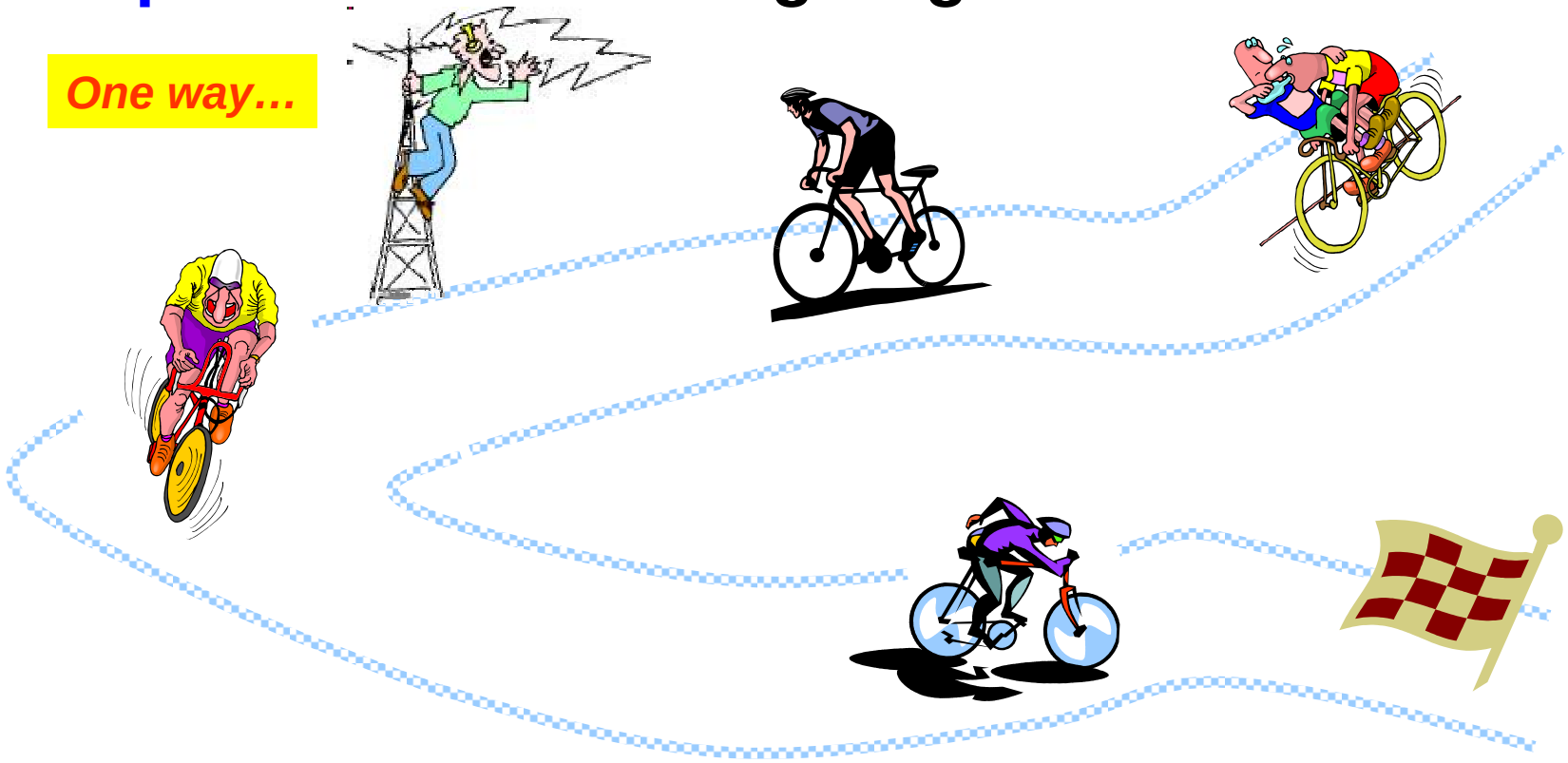
Scenario # 1

- **How can you receive real time status report updates from moving targets over local area ?**



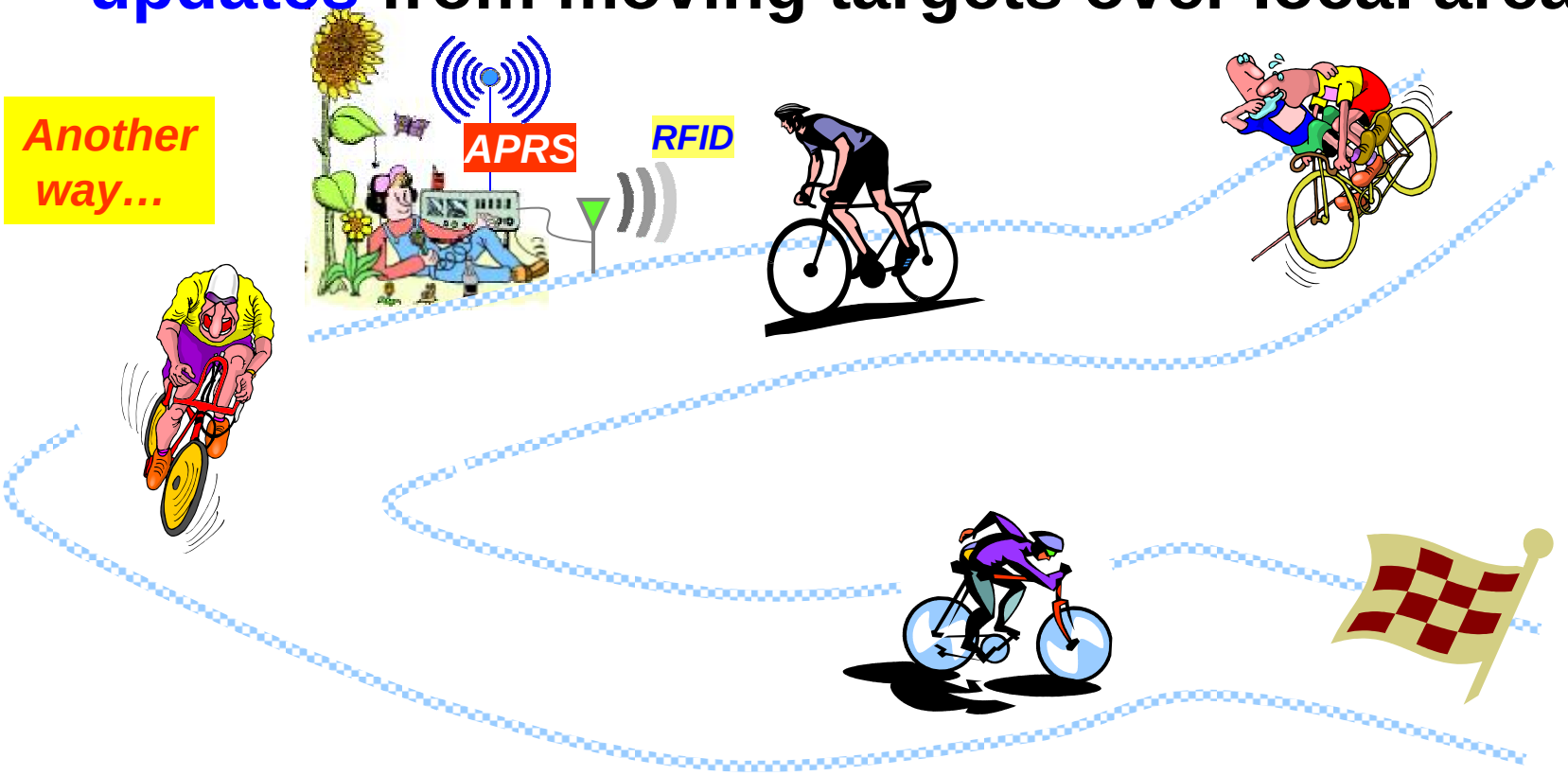
Scenario # 2A

- **How can you send real time status report updates from moving targets over local area ?**



Scenario # 2B

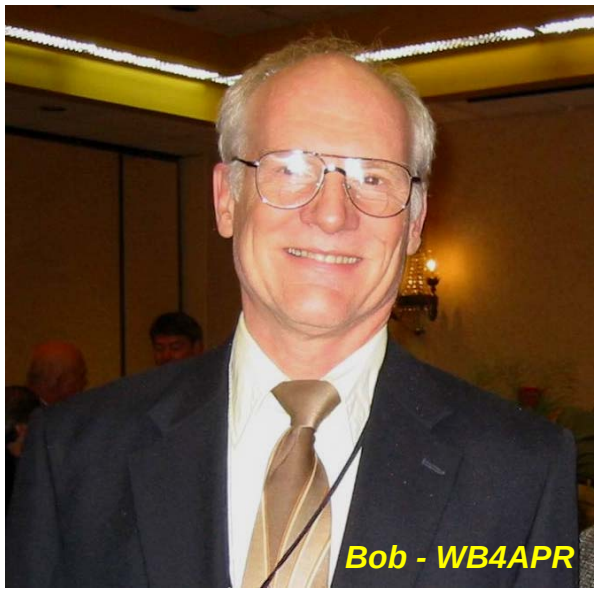
- **How can you send real time status report updates from moving targets over local area ?**



What is APRS?

- **APRS:**
  - **Automatic Packet Reporting System**
  - **Automatic Position Reporting System**

- APRS is a registered trademark of Bob Bruninga, WB4APR



- APRS was developed in the early 1990's for:
  - **Local tactical digital communications**
  - **Situational awareness**
  - **2-Way information exchange using Ham Radio (texting…)**

Automatic Packet Reporting System

APRS for Local Tactical Communications ...!

What is APRS?

What is APRS?

- **APRS** = Automatic Packet Reporting System (not position tracking!)
- **APRS** since late 1980's was for local tactical digital communications, situational awareness and TWO-WAY information exchange
- Messages + maps for OBJECTS – everyone sees the same situation and Network Connectivity
- A single Reference Resource for all HAM activities
- Not just GPS Vehicle Tracking!

APRS is a registered trademark Bob Bruninga, WB4APR

Credit: Bob Bruninga WB4APR website

Bob: "Automatic Packet Reporting System"

What is APRS? cont…

- **Is a real-time tactical digital communications protocol for exchanging information between a large number of stations covering a large (local) area**
- **Multi-User Data Network Protocol**
- **Can be used over any 2-way Radio System including HAM, Marine Band, Cellular and even CB**
- **APRS packets must be received perfectly in order to be recovered**

It Is Not Just For Vehicle Tracking ...!

AX.25 Protocol (VHF and HF)

AX.25 Protocol http://www.tapr.org/pub_ax25.html

U and S frame construction

First Bit Sent				
Flag	**Address**	**Control**	**FCS**	**Flag**
01111110	112/560 Bits	8 Bits	16 Bits	01111110

Information frame construction

First Bit Sent						
Flag	**Address**	**Control**	**PID**	**Info.**	**FCS**	**Flag**
01111110	112/560 Bits	8 Bits	8 Bits	N*8 Bits	16 Bits	01111110

AX.25 Amateur Packet-Radio Link-Layer Protocol

HF APRS Using PSK63

- **APRS Messenger Application for HF APRS:**
  - **Developed by Chris Moulding G4HYG**
  - **Sends and Receives APRS messages using PSK63**
  - **Freeware program can downloaded from the link below**

- **Features:**
  - **Typical PSK soundcard with waterfall tuning display**
  - **APRS messaging send/receive client**
  - **Position beaconing capability for a mobile station**
  - **TCP/IP interface for Receive-Only IGate**
  - **Blocks corrupted packets**

Download: APRS Messenger for HF APRS Using PSK63

Setup Info: http://wa8lmf.net/APRS_PSK63/

Sends and Receives APRS Messages Using PSK63

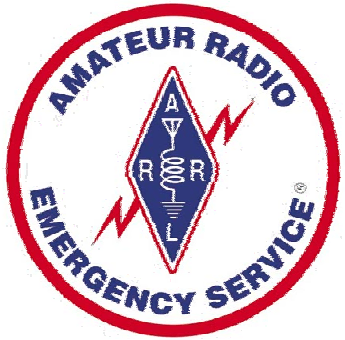
APRS Is Not Packet…

- APRS is different than Packet Radio because:
  - **Integrates maps with other displays**
  - **Real time updates**
  - **Does not require prior knowledge of the network**
  - **Protocol designed to optimize short distance real-time emergency operations**
  - **Can handle very short lived events that need to be updated in nearly real time to many users**

APRS Allows for Nearly Real Time Updates…

What Is APRS Good For?

- Emergency Organizations (ARES/RACES)
- Automatic Vehicle Location & Tracking
- Status Reporting
- Search & Rescue
- Parade Organizers
- Fox Hunting, etc.



LOJACK

What Do I Need to Operate APRS?

- To setup a full APRS station, you need:
  - ✓**Transceiver (VHF or HF)**
  - ✓**TNC (Terminal Node Controller)**
  - ✓**APRS Node coverage (Digipeater)**
  - ✓**GPS, Wx-Station, etc (Optional)**
  - ✓**PC/Laptop (for TNC set up)**

- APRS Frequencies are:
  - **North America = 144.390 MHz**
  - **Europe = 144.800 MHz**
  - **Other Countries often use other frequencies**

TNC + Radio (144.390 MHz) + PC + GPS

APRS Overview

- Mode
  - **Rx Only**
  - **Tx Only**
  - **Tx and Rx**
- TNC
  - **Software**
  - **Sound Card + Sw**
  - **Encoder**
  - **Full Encoder/Decoder**
- Protocol
  - **AX.25**
  - **PSK63**
- Band
  - **HF**
  - **VHF**
  - **UHF**
- Configuration via
  - **Dedicated Apps**
  - **Hipper Terminal**
  - **Putty**
- Path
  - **WIDE1**
  - **WIDE2**
  - **I-Gate**
  - **Interstate**

Mode, TNC, Protocol, Band, Config and Path…

APRS Modes of Operation

- **Fixed**
  - **Tx Only (Position, Weather/Telemetry)**
  - **Rx Only (Home, I-Gate)**
  - **Tx & Rx (Home, Relay, Digipeater, I-Gate)**
- **Mobile**
  - **Car, Truck, RV**
  - **Marine (Boat, Ship, etc)**
  - **Air (Airplanes, Gliders, Balloons, etc)**
  - **Railroad Trains**
  - **Walkers, Runners and Hikers**
  - **ISS**
  - **Satellites**
- **Portable/Stationary**

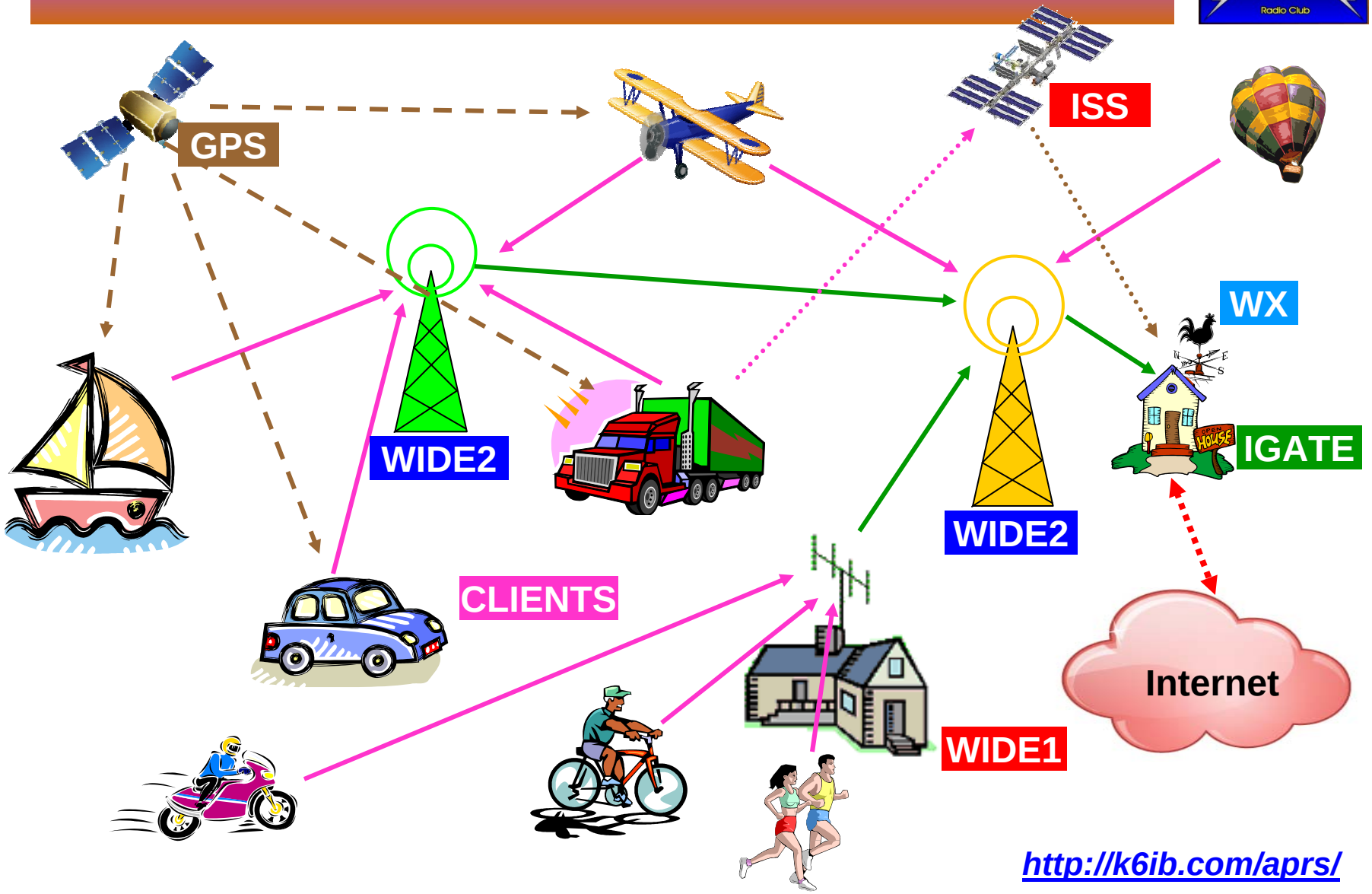
Fixed, Portable or Mobile

APRS Interfaces

- **TNC**
  - **Full (Tx and Rx)**
  - **Encoder (Tx Only)**
  - **Decoder (Rx Only)**
- **Sound Card + Software**
  - **Tx and Rx**
  - **Tx Only**
  - **Rx Only**
- **Software**
  - **UI-View** (**http://www.ui-view.org/**)
  - **PC/FlexNet** (**http://www.afthd.tu-darmstadt.de/~flexnet/**)

TNCs, Sound Cards and Software

APRS Network



APRS Software May Provide…

- Station Status
- Station Positions
- Messages
- Bulletins
- Stations Heard
- Station Tracking
- APRS Satellites
- Fox Hunting and Direction Finding
- Weather Station Reporting
- DX Clusters
- Internet and IGATES
- Frequency Coordination

Google Maps APRS http://aprs.fi/

APRS for Weather Station…

- Hardware requirements for a typical Weather Station:
  - **Weather Reporting Unit (i.e. Peet Bros, Davis etc.)**
  - **2-Meter Transceiver**
  - **TNC (Terminal Node Controller) able to support connecting to a weather unit**
  - **PC or Laptop**
  - **APRS software**

APRS North America Frequency is 144.390 MHz

Digipeater

- **Digipeater is short for "Digital Repeater“**
- **Is a repeater for packet data rather than voice**
- **Digipeater is a single frequency device:**
  - **Receives a packet of data, stores it in internal memory and then a moment later retransmits the data on the SAME frequency (144.39 MHz)**
  - **Digipeater is sequential, not simultaneous like voice repeaters**
  - **Using just one digipeater cuts the channel capacity by 50%**
  - **Indiscriminate use of 3, 4 or more digipeater hops can reduce channel capacity by 75% or more**

Unlike voice Repeaters, Digipeater is sequential…

APRS Paths – Legacy

- **RELAY**
  - **Was simple digipeating but NO dupe checking**
- **WIDE**
  - **Was simple digipeating but NO dupe checking***
- **TRACE**
  - **Simple digipeating but with call substitution & no dupe check**
- **WIDEn-N**
  - **Was N flooding with DUPE-CHECKING, but no traceability**
- **TRACEn-N**
  - **Was N TRACEing with DUPE-CHECKING and with TRACEABLITY**

APRS Needs: n-N Hopping + Dupe Checking + Path Tracing

APRS Paths – New Paradigm

- **New-N Paradigm in the USA achieved:**
  - 2 to 4-fold reduction in dupes
  - QRM reduction in regions that had been heavily using the old RELAY and WIDE parameters

- **WIDEn-N has**
  - Full dupe-checking
  - Traceability

WIDEn-N

- **IGATE**
  - Major contributors to the health of the APRS network
  - Should set their path to their local area only (WIDE1-1)
  - Should NOT flood their area with unwanted QRM

WIDEn-N has reduced dupes by up to 4x in USA

APRS Paths – New Paradigm

- **Recommended Paths:**
  - **WIDE1-1,WIDE2-1**
    - **Recommended for the majority of mobile operations!**
    - Produces 2 hops
    - Takes advantage of home fill-in digipeaters
    - Good in busy urban and suburban areas (i.e Phoenix)
  - **WIDE1-1,WIDE2-2**
    - Produces 3 hops
    - Takes advantage of home fill-in digipeaters
    - Good for mobile operation in rural areas with low APRS activity only
  - **WIDE2-2**
    - Shortest path string
    - Produces 2 hops by directly using 2 high-level digipeaters
    - Works almost anywhere, recommended where high-level digipeaters are on mountain tops thousands of feet above users
  - **WIDE2-1**
    - Used by fixed stations
    - Produces only one digipeater hop
    - Fixed stations have advantages over mobile (better antenna and elevation) and are able to reach a true wide-area digipeater without the aid of another home station

WIDEn-N

For Mobile Operation Use WIDE1-1, WIDE2-1

APRS Paths – New Paradigm

- **For more details, visit Steve's web-site at:**
  http://wa8lmf.net/DigiPaths/

- **NEVER put WIDE1-1 anywhere except the first position path otherwise, dozens of home stations within the range of one or more WIDEs will clog the channel retransmitting the WIDE's packets for no reason**

WIDE2-1,WIDE1-1 ✗

WIDE1-1,WIDE2-1 ✓

WIDE1-1 Should Always be First

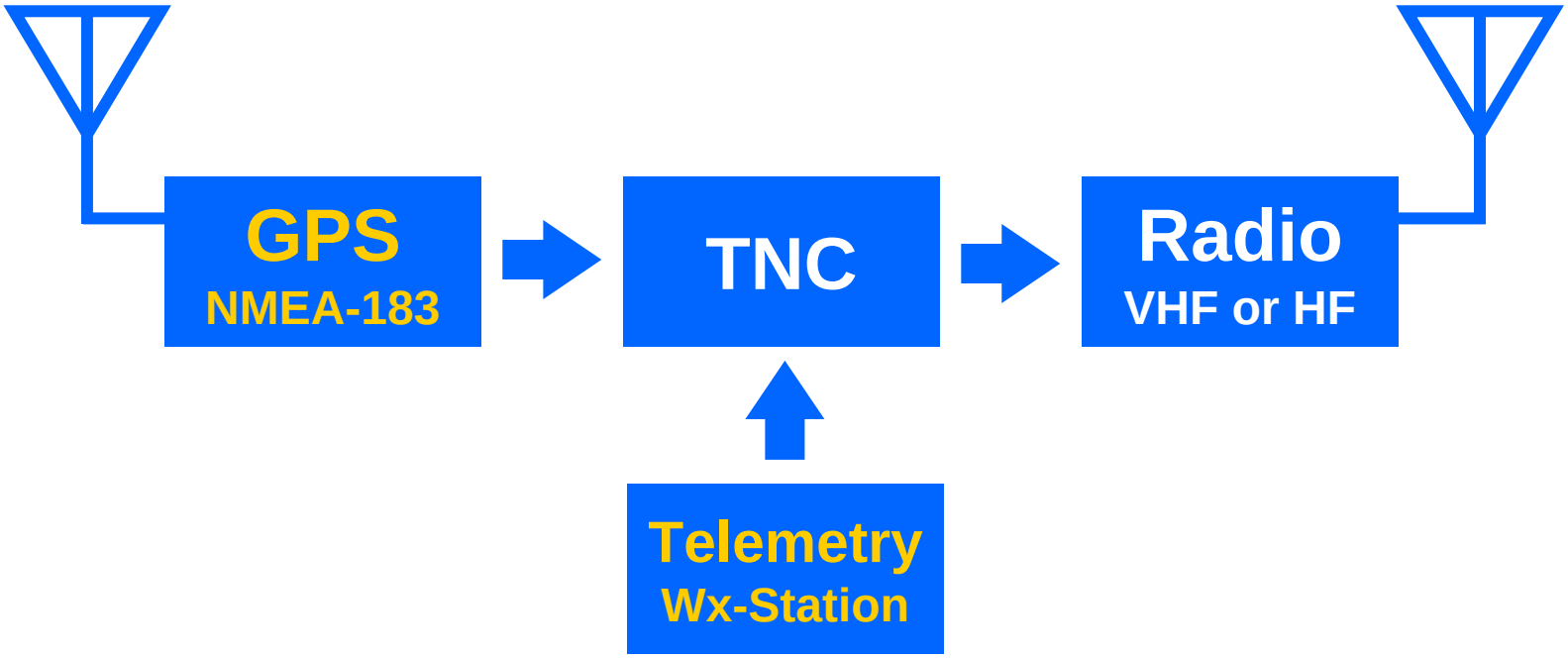
APRS Path Facts

- **Paths longer than about WIDE3-3 are almost totally useless**
- **Probability of success decreases exponentially as the area covered by the transmission expands outward**
- **Packets are exposed to more random collisions in long paths**
- **One can create thousands of useless packets when long paths are being used**
- **Intelligent digipeaters can automatically reformat excessively long or abusive paths or even ignore anything over WIDE2-2**

http://wa8lmf.net/DigiPaths/NNNN-Digi-Demo.htm

Even WIDE3-3 Paths Should be Avoided…

APRS Basic Configurations

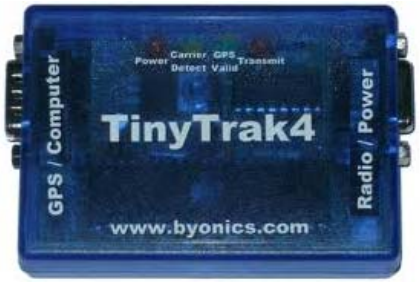


- **Broadcasting Mode Only**
- **VHF = 1200 bauds and HF = 300 bauds**
- **NMEA = National Marine Electronics Association electrical & data specs for marine electronics**

APRS Basic Configuration

Position

TNC

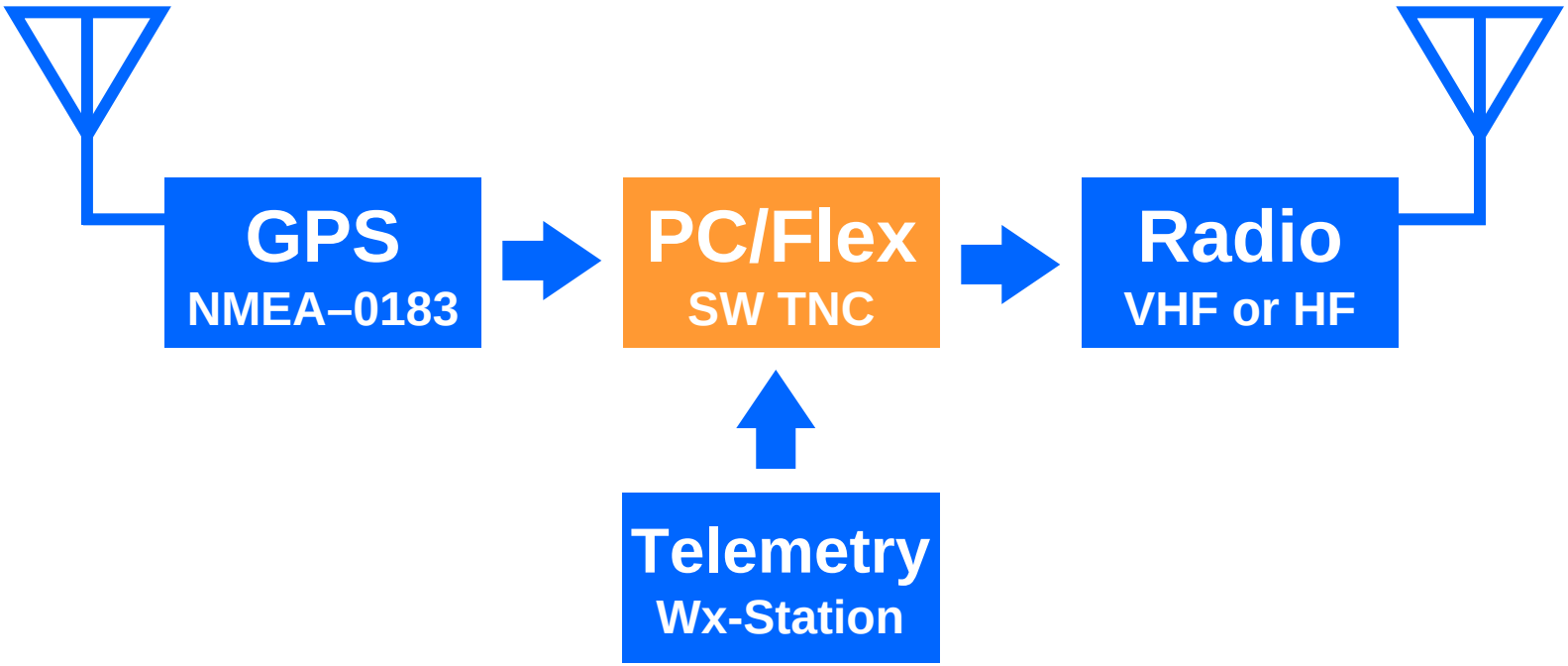


Radio

Telemetry

By I.Vicente AD7ND - Updated on 7/10/2011 Rev-4

APRS Alternate Configuration



- **PC/FlexNet is a free software package that uses PC sound card to emulate a TNC**

APRS Alternate Configuration

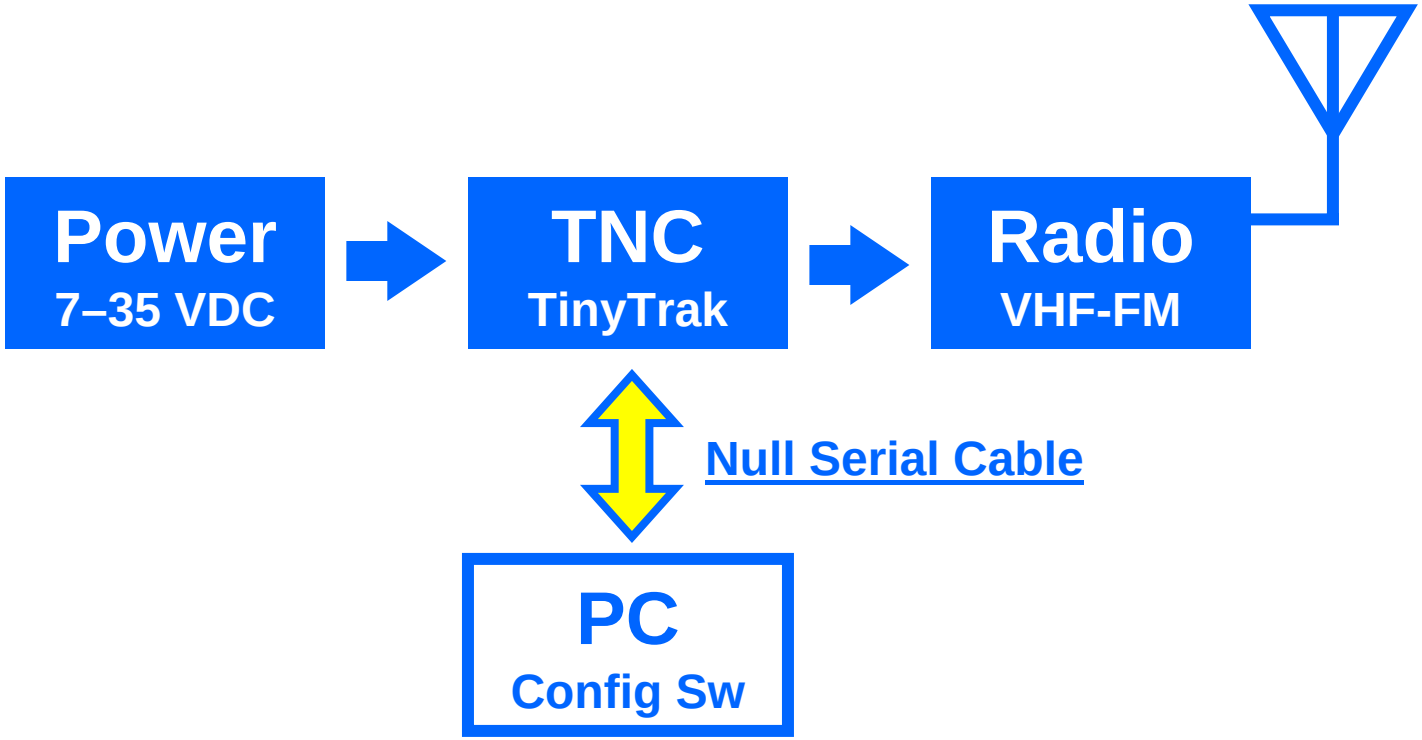
Position

PC-Flex

Radio

Telemetry

Programming Byonics TNC



- This config is for Byonics TinyTrak TNCs
- PC is used for programming TNC during setup

Programming TNC

Power Supply

TNC

PC + Config Sw

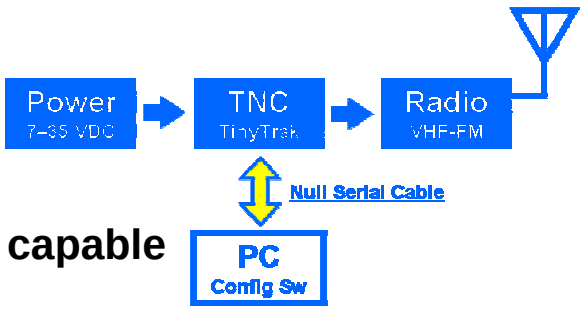
F-F Null Cable

To Program TinyTrak you will need:

- External power supply
- Female-Female Null cable or Null Adapter

Recommended SSIDs

SSIDs = Secondary Station Identifiers



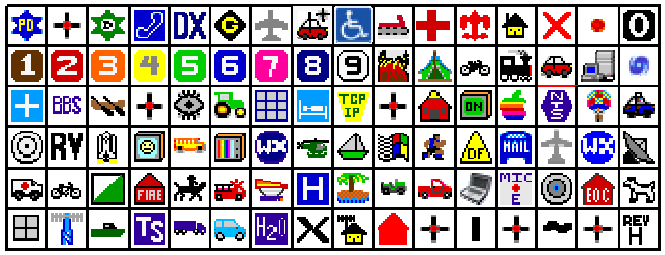
- -0 Your primary station usually fixed and message capable
- -1 generic additional station, digi, mobile, wx, etc
- -2 generic additional station, digi, mobile, wx, etc
- -3 generic additional station, digi, mobile, wx, etc
- -4 generic additional station, digi, mobile, wx, etc
- -5 Other network sources (Dstar, Iphones, Blackberry's etc)
- -6 Special activity, Satellite ops, camping or 6 meters, etc
- -7 Walkie-talkies, HTs or other human portable
- -8 boats, sailboats, RV's or second main mobile
- -9 Primary Mobile (usually message capable)
- -10 internet, Igates, echolink, winlink, AVRS, APRN, etc
- -11 balloons, aircraft, spacecraft, etc
- -12 APRStt, DTMF, RFID, devices, one-way trackers*, etc
- -13 Weather stations
- -14 Truckers or generally full time drivers
- -15 generic additional station, digi, mobile, wx, etc

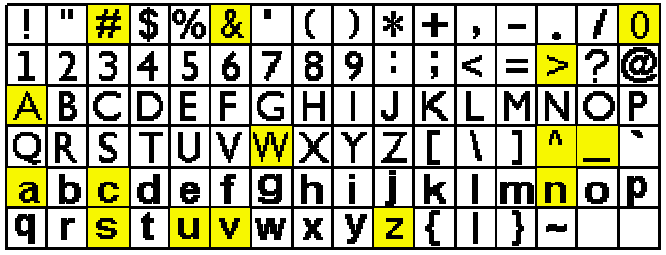
APRS SSID Standard Applications at http://www.aprs.org/aprs11/SSIDs.txt

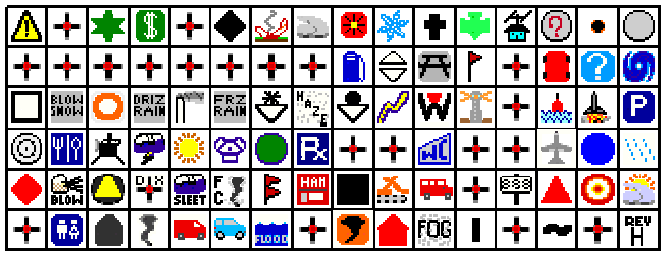
Programming TNC - Basic Symbols

Basic Symbols & Table Overlay

Symbol	Table/Overlay	Icon
>	/	
j	/	
<	/	
[	/	
k	/	
S	\	







More APRS Symbols at http://www.aprs.org/symbols.html

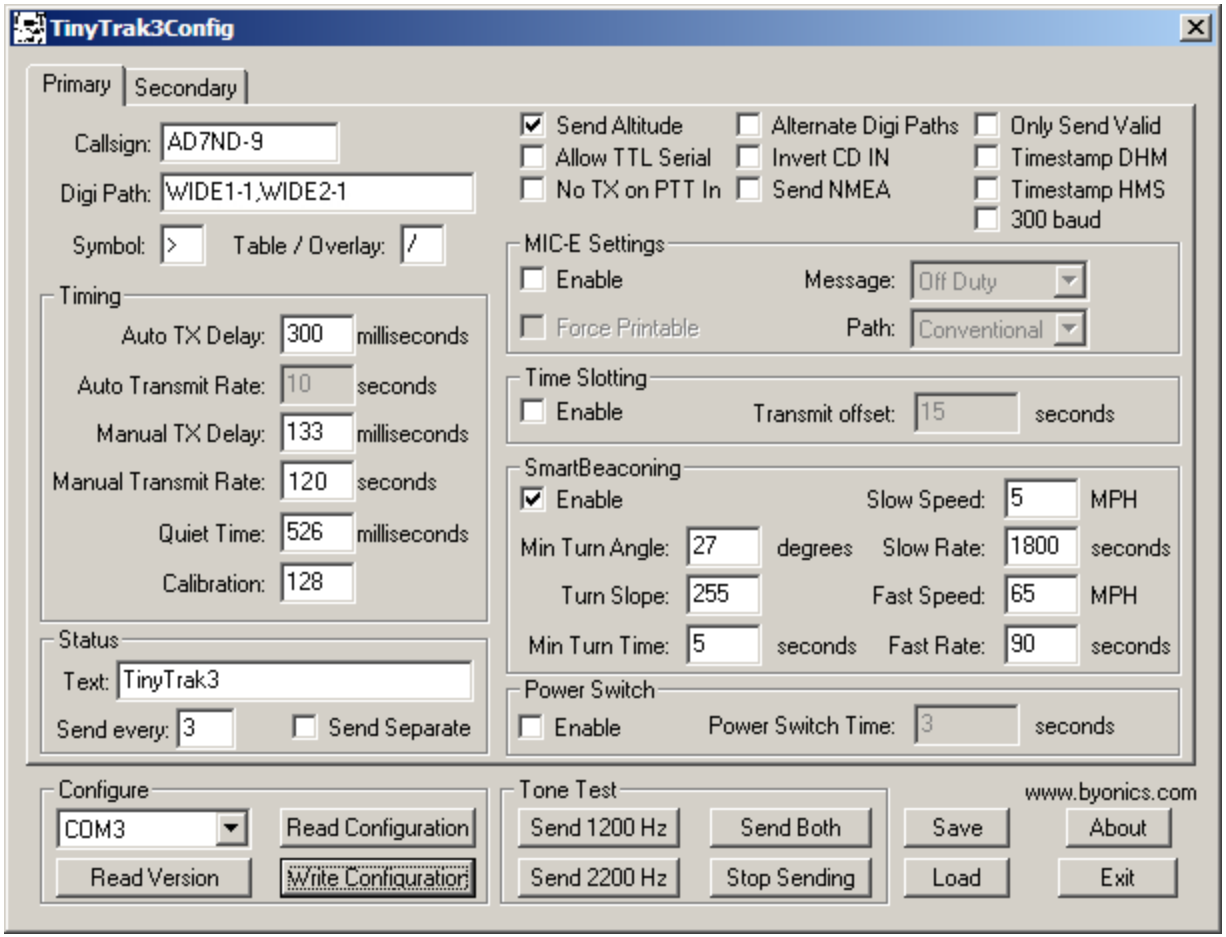
Byonics TinyTrak 3 and 4

- TNC (Tx and Rx)
- Smart Digipeater
- KISS TNC
- APRS tracker plots compatible with GPS
- Weather station support
- Telemetry
- Remote control

- Encoder/Tracker (Tx Only)
- Smart Digipeater
- Telemetry

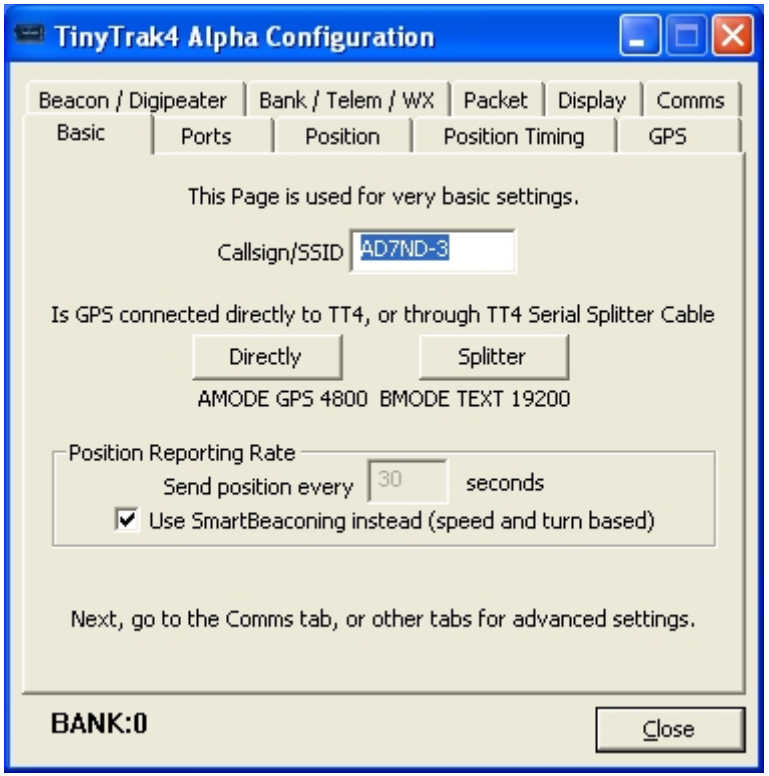
APRS Pre-Assembled Kits

Configuring TNC – TinyTrak3



Using the TinyTrak3Config Tool

Configuring TNC – TinyTrak4

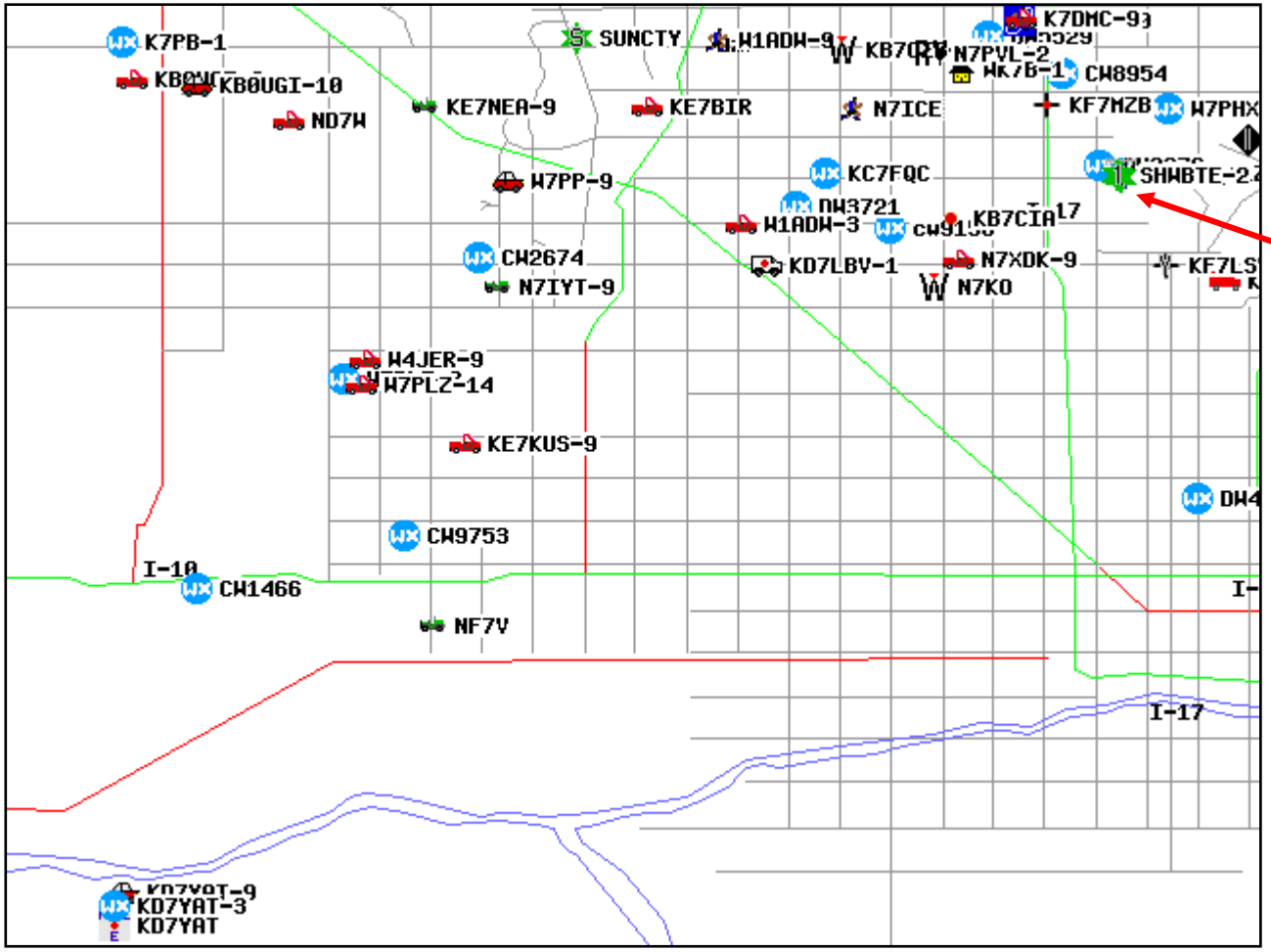



```
BANK 0                          SBSPERIOD 1800
AMODE GPS                       SBFSPEED 60
ABAUD 4800                      SBFPERIOD 90
BMODE TEXT                      ENTS FALSE
BBAUD 19200                     TSOFFSET 17
PKTICOM TRUE                    GWAYMODE NMEA
PKTOCOM FALSE                   GWAYLEN 9
HEADERLN FALSE                  TSWPT TRUE
SOFTRST FALSE                   WYPTXT FALSE
TPROTOCOL MIC-E                 PAVPEN FALSE
TIMESTAMP TRUE                  TPSWITCH 0
TIMEHMS TRUE                    GRELAYBITS 1
TDAO 0                          GRELAYRATE 0
TSYMCODE >                      BPERIOD 0
TSYMTABLE /                     BTEXT >/TinyTrak4 Alpha
MMSG 0                          ALIAS1 WIDE1-1
MICETMV FALSE                   ALIAS2
TOSV FALSE                      ALIAS3
TSPEED TRUE                     PREEMPT FALSE
TALT TRUE                       DIGIID TRUE
MSGCAP FALSE                    DUPETIME 30
LOCATION 33.2351N 111.7918W     TPERIOD 0
GALT 451                        TELHIRES FALSE
TSTAT /TinyTrak4 Alpha          TELVOLT TRUE
STATUSRATE 1                    TELTEMP TRUE
PPERIOD 120                     TVOLTTWK 128
SBEN TRUE                       TTEMPTWK 128
SBTANGLE 27                     TELREAD TRUE
SBTSLOPE 255                    WPERIOD 0
SBTTIME 5                       WXPOS TRUE
SBSSPEED 5
```

Parameters can be saved in text format, edited and reloaded later

Using the TinyTrak Alpha Configuration Tool

APRS Plots…

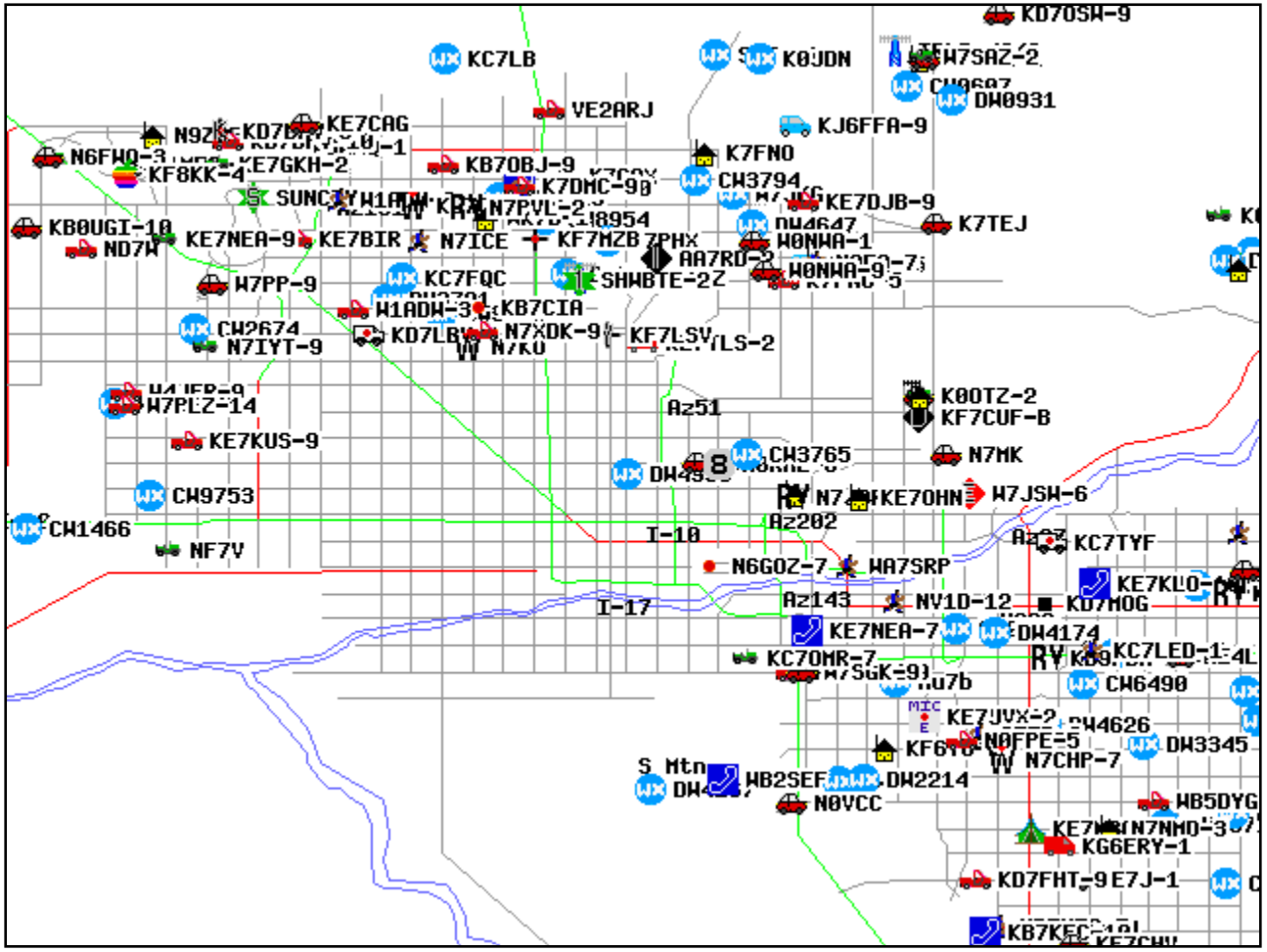


Digipeater

Centered in Glendale AZ

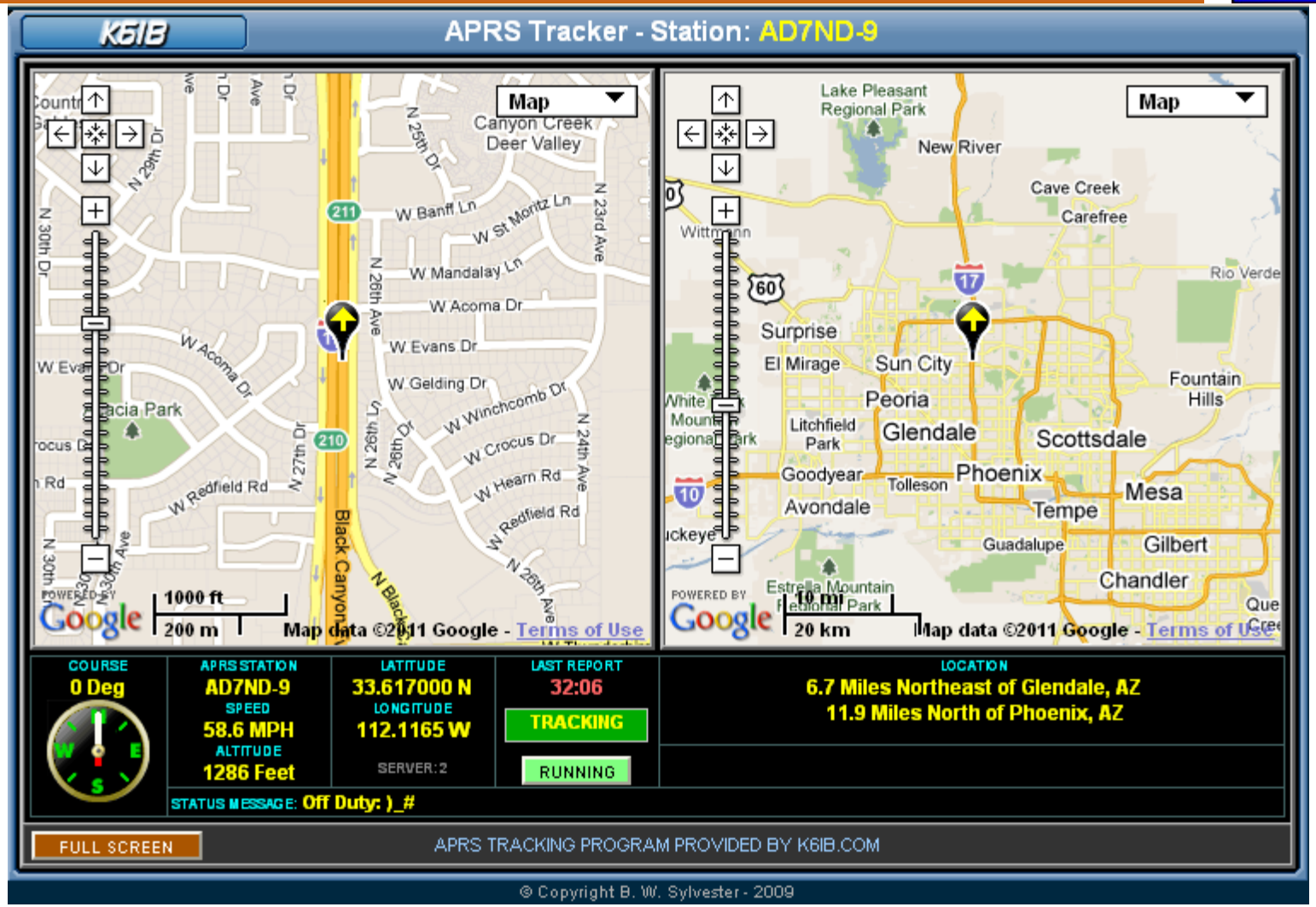
By I.Vicente AD7ND - Updated on 7/10/2011 Rev-4

APRS Plots…



Plots can become cluttered…

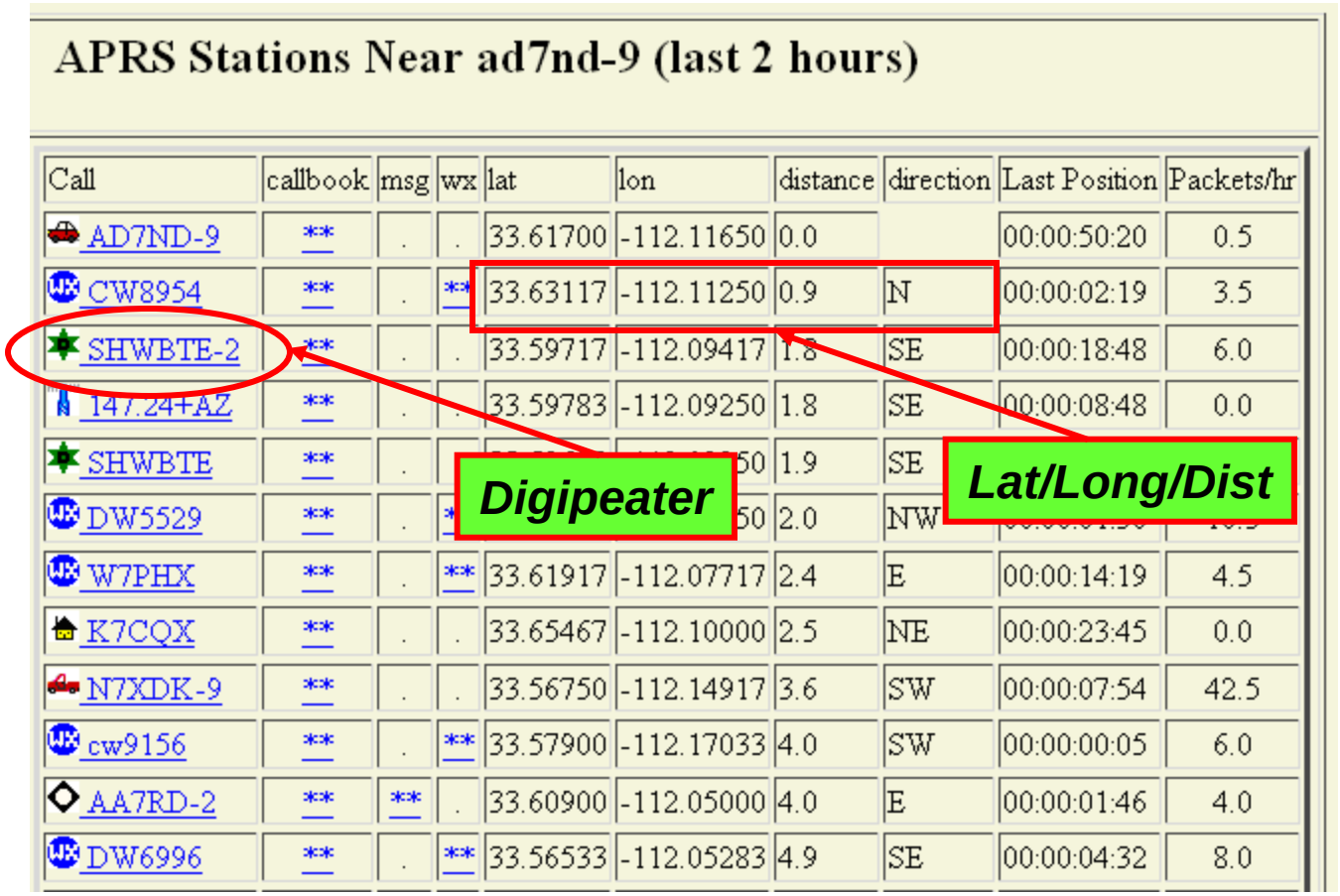
APRS Tracker -- AD7ND-9…



Lat, Long, Altitude, Course, Speed and Distances…

By I.Vicente AD7ND - Updated on 7/10/2011 Rev-4

APRS Tracker…

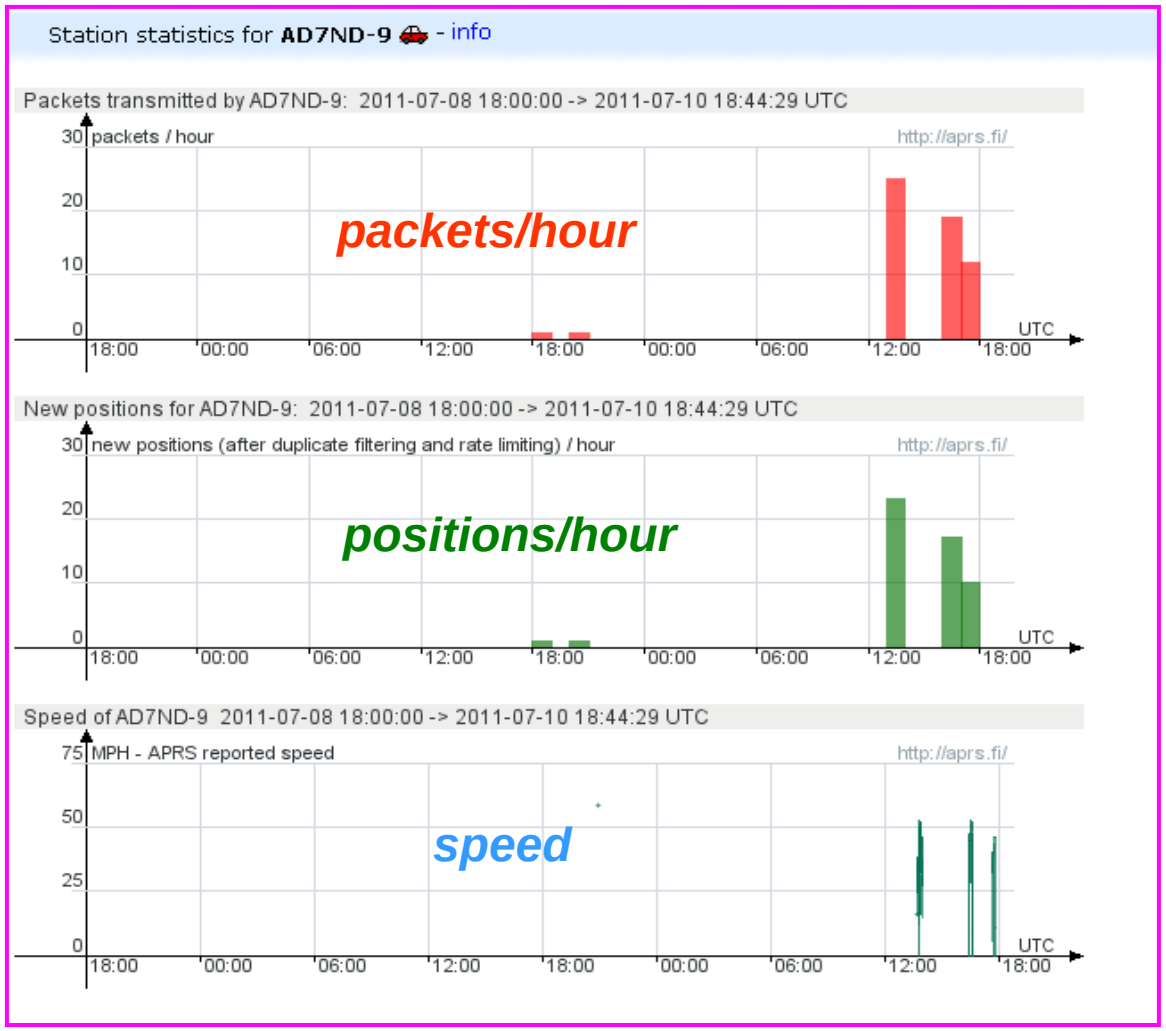


APRS Stations Near ad7nd-9 (last 2 hours)

Call	callbook	msg	wx	lat	lon	distance	direction	Last Position	Packets/hr
AD7ND-9	**	.	.	33.61700	-112.11650	0.0		00:00:50:20	0.5
CW8954	**	.	**	33.63117	-112.11250	0.9	N	00:00:02:19	3.5
SHWBTE-2	**	.	.	33.59717	-112.09417	1.8	SE	00:00:18:48	6.0
147.24+AZ	**	.	.	33.59783	-112.09250	1.8	SE	00:00:08:48	0.0
SHWBTE	**	.			50	1.9	SE		
DW5529	**	.	*		50	2.0	NW		
W7PHX	**	.	**	33.61917	-112.07717	2.4	E	00:00:14:19	4.5
K7CQX	**	.	.	33.65467	-112.10000	2.5	NE	00:00:23:45	0.0
N7XDK-9	**	.	.	33.56750	-112.14917	3.6	SW	00:00:07:54	42.5
cw9156	**	.	**	33.57900	-112.17033	4.0	SW	00:00:00:05	6.0
AA7RD-2	**	**	.	33.60900	-112.05000	4.0	E	00:00:01:46	4.0
DW6996	**	.	**	33.56533	-112.05283	4.9	SE	00:00:04:32	8.0

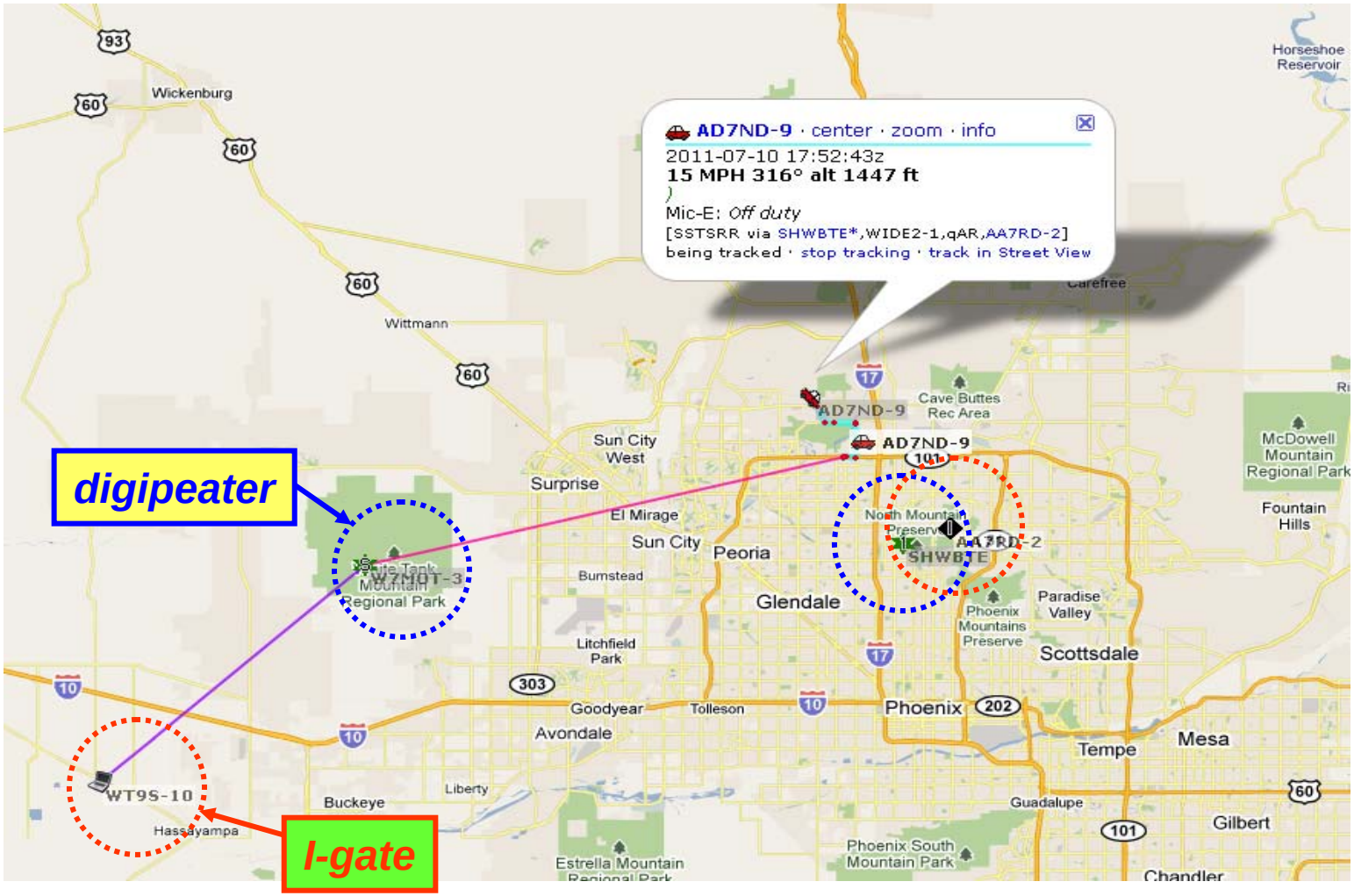
Lat, Long, Rate, Direction and Relative Distance…

APRS Tracker…



Stats, Bar Charts for Packets, Positions and Speed…

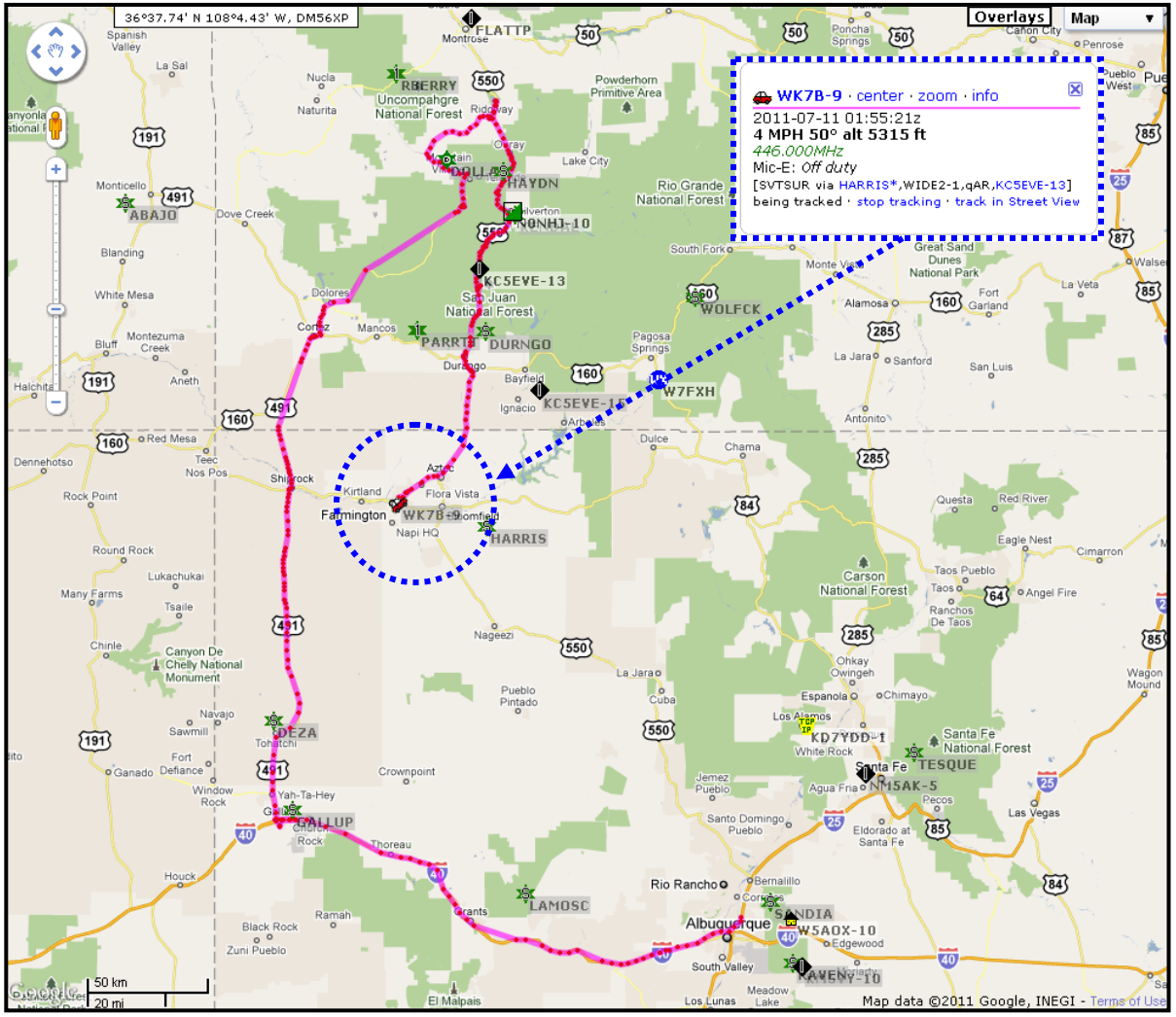
APRS Trackers…



Path to Digipeaters and I-Gates…

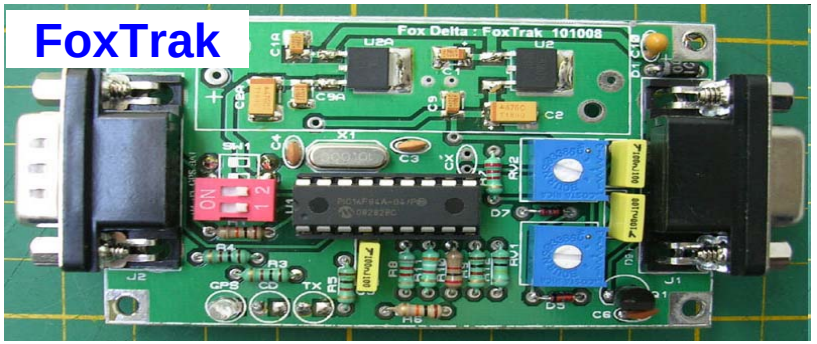
By I.Vicente AD7ND - Updated on 7/10/2011 Rev-4

APRS Traks for WK7B-9…

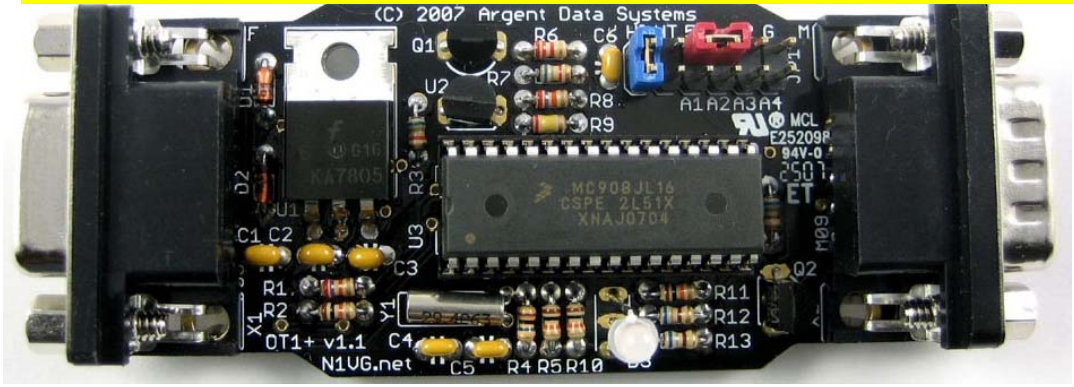


Gary's Traks in New Mexico and Colorado…

APRS Kits…



Argent Data Systems OpenTracker+ (OT1+)

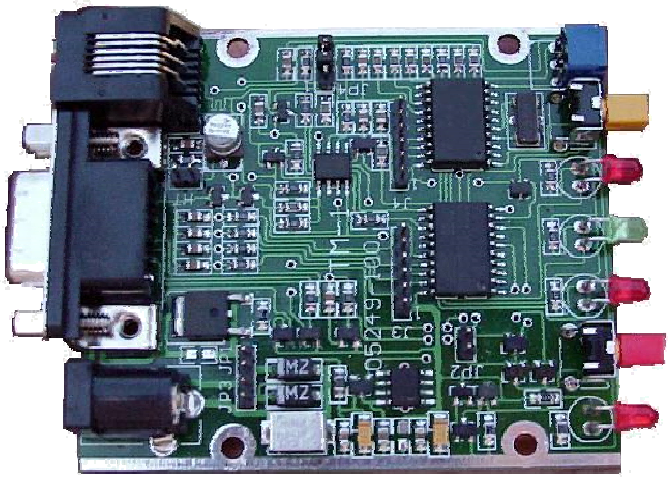


Byonics, Argent and Fox APRS Kits

Tigertronics TNC TigerTrack

FEATURES:

- **APRS**
- **GPS NMEA strings**
- **Supports HF (300 baud) and VHF (1200 baud)**
- **Selectable Baud Rates (1200/2400/4800/9600)**
- **Programmable digipeater paths up to 4 vias**



APRS Pre-Assembled Kits

APRS Frequencies

- **Primary VHF Networks**
  - **North America: 144.390 MHz**
  - **Europe: 144.800 MHz**
  - **Russia: 144.800 MHz**
  - **Australia: 145.175 MHz**
  - **New Zealand: 144.575 MHz**
  - **Argentina: 144.930 MHz**
  - **Uruguay: 144.930 MHz (145.010 MHz also)**
  - **Japan: 144.640 MHz 9600 baud / 144.660MHz 1200 baud**
  - **South Africa: 144.800 MHz**

- **For HF and Satellite Frequencies check this link:**
  http://info.aprs.net/index.php?title=Frequencies

APRS North America Frequency is 144.390 MHz

APRS-Ready Radios

Kenwood RC-D710

Kenwood TM-D700A

(Replaced by RC-D710)

Kenwood TH-D72A

Yaesu VX-8GR

Yaesu FTM-350AR

(With Bluetooth)

Links

Automatic Packet Reporting System
http://www.aprs.org/

APRS TRACKER
http://www.qsl.net/ct1efl/aprs_tracker.htm

OpenTracker+ (OT1+)
http://www.argentdata.com/products/otplus.html

N1BQ's page
http://www.wulfden.org/APRSQuery.shtml

Amateur Radio Stations Via ISS
http://www.ariss.net/

Links

Receiving APRS Data via Radio
http://www.depiction.com/node/148

APRS - Automatic Position Reporting System
http://www.jancorver.org/en/info/aprs/index.htm

Introduction to APRS by Paul Toth K2SEC
http://www.aprs.net/florida/intro.html

K6IB APRS Station Auto Update Tracking Program
http://k6ib.com/aprs/

APRS Additional Resources

- http://www.aprs.org/aprs-messaging.html
- http://wa8lmf.net/aprs/index.htm
- http://www.amsat.org/amsat-new/information/faqs/aprs.php
- http://www.byonics.com/
- http://www.tigertronics.com/tm1.htm
- http://dk5ec.de/APRS-HTML/APRS_DK5EC_english.htm
- http://www.nwaprs.info/aprsinfo.htm
- http://www.ui-view.org/
- http://www.n5oom.org/aprs/
- http://info.aprs.net/index.php?title=Frequencies
- http://www.beals5.com/wx/description.htm
- http://info.aprs.net/index.php?title=Hardware
- http://www.gpsinformation.org/dale/nmea.htm#nmea
- http://vancouver-webpages.com/peter/nmeafaq.txt
- http://info.aprs.net/index.php?title=SymbolsAndSSIDs
- http://www.aprs.net.au/general/what-aprs

Thank you !