Amateur Packet Radio

Michael E. Fox, N6MEF
Assistant District Emergency Coordinator, ARES®
Deputy Chief Radio Officer, RACES
Santa Clara County ARES®/RACES

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Agenda

- What is packet radio?
- Why use packet radio?
- Building your personal packet station
- A packet station for a city
- A packet network for a county
- Connectivity beyond the county boundaries ...
What is Packet Radio?

• An amateur mode for sending data over radio
• Uses the AX.25 protocol
  – Similar to X.25 standard; callsigns for addresses
• Sends a packet (envelope + payload) at a time
  – Envelope contains header at beginning and checksum at end
  – Header contains addressing information (to, from)
  – Checksum determines if packet received error-free
  – Payload contains the data to be sent
  – Differs from character-at-a-time, like RTTY, CW, etc.
• Can operate as connection-oriented (reliable) or connection-less (unreliable – use higher-level protocol)
• Typically operates at 1200 or 9600 baud
Why Use Packet Radio?

- **Long messages**
  - We know to keep it under 25 words; served agencies often don’t/won’t

- **Complex messages**
  - “Need to swap 22 20-gallon drums of acetalethelhexabadstuff for 4 4-gallon drums of phenylbromotetragoodstuff”
  - Lists of names, addresses, phone numbers, call signs, ...

- **High volume messages**
  - Messages can be transmitted, logged, and printed (multiple copies) much faster than by voice

- **Store and forward**
  - Recipient does not have to be available at the same time as the sender

- **Multiple recipients with acknowledgements**
  - “cc:” with auto-acknowledgement, instead of polling each station

- **Networking**
  - Multiple stations can be networked together for wider coverage – literally, around the world
BUILDING A PACKET STATION
Santa Clara County Station Requirements

• Laptop, network or other portable, battery operated style of PC capable of running Outpost and PacFORMS (Windows 2000 or later rec’d)

• Outpost and PacFORMS installed and properly configured according to county standard settings

• Sufficient battery power to operate entire packet station (including PC and printer) continuously for at least one hour on battery)

• USB flash drive (i.e. “USB Key” or “thumbdrive”)

• Configured and working 1200 baud TNC

• All appropriate radio, audio and data cables

• Printer for printing messages (rec’d, not req’d)
Packet Radio Components

- BBS
- Simplex Simplex
- TNC (Terminal Node Controller)
- City or County
- RS-232 Cable
- Radio-specific Cable
- Radio (HT, Mobile, Base)
- TNC (Terminal Node Controller)
- RS-232 Cable
- PC Running Outpost and PacForms
Computer

- **Portability**
  - Size, weight

- **Readability**
  - Screen Size, non-glare

- **Power efficient**
  - Wattage used, extended battery, 12V power adapter, inverter

- **Types**
  - Windows (for Outpost)
  - Netbook (ideal)
  - Laptop (better screen & keyboard; uses more power; less portable,)
  - Slate (Windows based for Outpost; lack of keyboard, screen real estate will reduce operator efficiency; not recommended for anything other than personal use)
Other Computer Considerations

• External Storage for backup, file transfer
  – Hard Drive (power)
  – USB Memory (required)
  – Memory Card

• Printer
  – Power is key! (no laser printers!)
  – Portability
  – Fresh ink cartridges
  – Power
  – Interface
Software - Outpost

- Easy to use, e-mail like interface
- Folders: Inbox, Outbox, Sent, Archive, Draft, Deleted
- Address book; various automation options
- Automates comms with TNC/BBS – just press Send/Receive
- Produces ICS-309 Communications log
Software - PacFORMS

- HTML representation of standard forms
- “Submit” button creates text message in Outpost
- Only data is sent; no formatting
- Upon receipt, form is recreated and displayed, printed, logged
TNC = Terminal Node Controller

• Implements AX.25 protocol
  – Manages AX.25 connections
  – Assembles / disassembles AX.25 packets

• Keys radio PTT

• May include additional functions
  – Personal BBS (PBBS)
  – Node or digi-peater
  – Keyboard-to-keyboard functions

• May be implemented in hardware or software
Hardware TNCs

- **Recommended for EmComm work**
  - “Out of the box” readiness
- **Built-in Personal BBS for backup/emergency BBS**
- **Full command set includes monitoring, other features**
- **Typical:** DB-25 (or DB-9) serial interface to computer
- **Typical:** DB-9 (or DIN) audio/PTT interface to radio
- **Examples**
  - SCCo packet network: Kantronics KPC-3+, Timewave PK-96
  - Other popular options: Kantronics KPC-9612, radios with built-in TNCs
## Comparison of two popular TNCs

<table>
<thead>
<tr>
<th>Feature</th>
<th>KPC-3+</th>
<th>PK-96</th>
</tr>
</thead>
<tbody>
<tr>
<td>User Manual</td>
<td>Poorly formatted, hard to use</td>
<td>Well formatted, easy to use</td>
</tr>
<tr>
<td>Online Help</td>
<td>Yes</td>
<td>No (keep PDF manual on PC)</td>
</tr>
<tr>
<td>9600 Baud (not used very much)</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Audio Level Adjustment</td>
<td>XMITLVL command</td>
<td>Manual, via potentiometers</td>
</tr>
<tr>
<td>Carrier Detect via Software</td>
<td>Settable via command</td>
<td>Default mode</td>
</tr>
<tr>
<td>Command Options</td>
<td>Complete</td>
<td>More levels available; nice, but not really needed</td>
</tr>
<tr>
<td>Real Time Clock Chip</td>
<td>Yes (plug-in option)</td>
<td>Yes (plug-in option)</td>
</tr>
</tbody>
</table>

Note: For information only, no endorsement is expressed or implied. The above two TNCs are successfully being used in the SCCo network on a regular basis. Other TNCs may work equally well. Specifications and prices subject to change without notice.
Software TNC Options

- AGWPE = software TNC (www.sv2agw.com)
  - SV2AGW Packet Engine
- Performs many of the TNC functions available in a hardware TNC using software on the PC
- Out of pocket cost: cheap, but offset by lots of tinkering
- Does not have Personal BBS
- Must be manually configured with SCCo settings
- Requires tweaking many settings to make it work and keep it working
- Not ideal for EmComm – not “out of the box” ready
- Connect to radio via:
  - KISS-mode TNC
  - Soundcard (internal or add-on)
AGWPE Radio Interface Options

• KISS mode TNC
  – No built in command set
  – No Personal BBS
  – Simple Data In, Data Out interface
    • May have problems with high traffic situations
  – Requires driver software – AGWPE – for Outpost
  – Examples: TNC-X, MFJ 1270

• Soundcard
  – Requires driver software – AGWPE – for Outpost
  – PC’s internal soundcard – subject to levels changes by other applications; audio quality varies in older PCs
  – External USB sound card – can “set and forget” for packet
    • Examples: SignaLink, Buxcomm
  – Needs “tweaking” for proper operation
Selecting a Radio for use with Packet

- 5W HTs work fine for personal use
- For best performance, you need a mobile
  - 25W or more and TALL antenna STRONGLY recommended
    - “Hidden transmitter problem”
      - Can’t hear others/others can’t hear you -> DOUBLES!
    - Use 25W or more; use as high an antenna as possible
  - Dual receive nice to monitor command channel
    - Or single band radio and use HT
  - Data Connector preferred
    - Consistent transmit/receive audio levels
    - Simultaneously monitor packet traffic on speaker
    - Audio to TNC not affected by squelch
- Dual-band, dual-receive allows monitoring voice channel at the same time
Radios with Built-In TNCs

• Compact – one less component, one less cable
• All in one solution / single point of failure
• Audio levels usually pre-set for optimum performance
• May have complicated menus
• May have operating restrictions/limited functions
  – Example: limited mailbox features, no transmit w/ open squelch, limited simultaneous connections,
  ... 
• Good for personal stations; not so good for BBS
• More expensive
Antenna Considerations

• Probably the most important component
• Packet networks are simplex
• You must be able to hear EVERYONE else on the channel AND they must ALL be able to hear you
  – If not, you WILL cause doubles.
• Get your antenna up as high as possible
• Santa Clara County standard requirement:
  – Dual-band, portable, such as roll-up J-pole
  – Self-standing tripod or other base
  – Mast to support antenna base at least 10’ above ground
    • Windsock fiberglass poles can extend to 30+ feet, can easily support a roll-up J-pole, and are very portable.
  – Minimum of 25 feet of coax
Power Requirements for Packet

• Devices requiring power:
  – PC
    • Use internal batteries if possible; adapter conversion inefficient
  – Radio (running minimum of 25 Watts)
  – TNC
    • Recommend against using internal battery (different type)
  – Printer

• MAC P2 equipment requirement
  – “Sufficient battery power to operate entire packet station (including PC and printer) continuously for at least one hour on battery (to handle AC power gaps, generator refueling, etc.)”

• Recommended
  – Charger to restore battery charge when power comes back
  – Keeps station ready for the next power disruption
Battery Power for One Hour Ops

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Current Needed</th>
<th>Duty Cycle</th>
<th>Amp Hours</th>
</tr>
</thead>
<tbody>
<tr>
<td>Radio RCV</td>
<td>1.2 Amp</td>
<td>50%</td>
<td>0.6</td>
</tr>
<tr>
<td>Radio XMT (50W)</td>
<td>10</td>
<td>50%</td>
<td>5.0</td>
</tr>
<tr>
<td>TNC</td>
<td>.2</td>
<td>100%</td>
<td>0.2</td>
</tr>
<tr>
<td>Laptop (90W)</td>
<td>7.5</td>
<td>100%</td>
<td>7.5</td>
</tr>
<tr>
<td>Printer</td>
<td>.5</td>
<td>100%</td>
<td>0.5</td>
</tr>
<tr>
<td><strong>Total AH for 1 Hr</strong></td>
<td></td>
<td></td>
<td><strong>13.8 AH</strong></td>
</tr>
</tbody>
</table>

- Capacity needed = 13.8AH
- Battery needed
  - 18 Ah minimum (1/3 de-rating)
  - 26 Ah recommended (1/2 de-rating)
  - **Note:** 24-26AH already recommended in SCCo Go Kit
How to get started

A PACKET STATION FOR A CITY OR CLUB
A Packet Station for a City or Club

- Can be as simple as a single TNC with built-in PBBS
  - Users can connect and leave messages for single call sign
  - Current models typically limited to 10 concurrent connections (older = 1)
  - Example: City of Los Altos had single TNC solution for years – K6LOS

- Move up to a full PBBS – single frequency
  - Users can connect and leave messages for each other
  - Example: City of San Jose has their own PBBS
  - Popular BBS software:
    - FBB (Jean-Paul Roubelat, F6FBB)
      - http://www.f6fbb.org/
    - BPQ (John Wiseman, G8BPQ)
      - http://www.cantab.net/users/john.wiseman/Documents/
    - JNOS 2.0 (Maiko Langelaar, VE4KLM)
      - http://www.langelaar.net/projects/jnos2/
    - WinLink 2000
      - http://www.winlink.org/
  - JNOS and WinLink can gateway to e-mail

- Network with other BBSs
How to process high volume traffic efficiently

COUNTY PACKET NETWORK OPERATIONS
Santa Clara County BBS Network

No Internet required to reach anywhere in the county!
BBS Physical Installation

Ground Buss

Filters
(2m/1.25m in rear, behind monitor;
70cm in front, above monitor)

Monitor, Keyboard, Mouse
Power Strip

Radios & TNCs

Computer, Network Switch
PG40S, RigRunner

Battery
12VDC Supply

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Block Diagram: Typical SCCo BBS

[Diagram with labels: AC Mains, UPS, DC Supply, Battery, Charger (PG40S), DC Dist Fuse Panel, Linux & JNOS, 2m Radio, 220 Radio, 440 Radio, Filter, TNC, Triplexor, Tri-band Antenna, Outpost PC, Firewall Router, Internet, Ethernet Switch]
### Agency Assignments to Primary/Secondary BBSs

**Santa Clara County Backbone BBS Nodes**

<table>
<thead>
<tr>
<th>Call Sign</th>
<th>Host-Domain</th>
<th>2m Access</th>
<th>1.25m Access</th>
<th>Location</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>W6XSC-1</td>
<td>w6xsc-1 amp org</td>
<td>144.990</td>
<td>223.620</td>
<td>Santa Clara Co Office Bldg (San Jose)</td>
<td>JNOS; 24/7 UPS</td>
</tr>
<tr>
<td>W6XSC-2</td>
<td>w6xsc-2 amp org</td>
<td>145.730</td>
<td>-none-</td>
<td>Crystal Peak (South County)</td>
<td>JNOS; 24/7 UPS</td>
</tr>
<tr>
<td>W6XSC-3</td>
<td>w6xsc-3 amp org</td>
<td>144.310</td>
<td>223.540</td>
<td>Mountain View</td>
<td>JNOS; 24/7 UPS</td>
</tr>
<tr>
<td>W6XSC-4</td>
<td>w6xsc-4 amp org</td>
<td>145.590</td>
<td>223.580</td>
<td>Frazier Peak (above Milpitas)</td>
<td>JNOS; 24/7 UPS</td>
</tr>
<tr>
<td>W6XSC-5</td>
<td>w6xsc-5 amp org</td>
<td>varies</td>
<td>varies</td>
<td>Extra - for training, back-up, etc.</td>
<td>JNOS</td>
</tr>
</tbody>
</table>

Contact: The Santa Clara County ARES®/RACES Packet Committee manages the county packet backbone nodes. Send e-mail to: packet@scarc.com. Click on links to scc-ares-races dot org.

### BBS Assignments

Connect/Login Instructions:
- **All users**: Connect to the primary BBS for your agency. If the primary is down, connect to the secondary.
- **Individual ARES/RACES users**: Log in with your FCC call sign.
- **Cities and agencies**: Log in with your designated tactical call. Consult your EC if you do not know your tactical call. Agencies within the county may define additional tactical calls beginning with their assigned prefix.

### Santa Clara County Cities and Agencies

<table>
<thead>
<tr>
<th>#</th>
<th>Agency</th>
<th>Prefix</th>
<th>Primary BBS (2.1)</th>
<th>Secondary BBS (2.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CalFire MIPs - Santa Clara Unit</td>
<td>SCU</td>
<td>WX6SC-2</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>2</td>
<td>Campbell, City of</td>
<td>CBL</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>3</td>
<td>County Communications Center</td>
<td>CCC</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>4</td>
<td>Cupertino, City of</td>
<td>CUP</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>5</td>
<td>Gilroy, City of</td>
<td>GIL</td>
<td>WX6SC-2</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>6</td>
<td>Hospitals (all SCCo &amp; DEOC)</td>
<td>HOS</td>
<td>WX6SC-2</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>7</td>
<td>Loma Prieta Region</td>
<td>LMP</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>8</td>
<td>Los Altos, City of</td>
<td>LOS</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td></td>
<td><strong>Los Altos Hills, Town of</strong></td>
<td>LAH</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>10</td>
<td>Los Gatos, City of</td>
<td>LGT</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>11</td>
<td>Los Gatos Red Cross</td>
<td>LGR</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>12</td>
<td>Milpitas, City of</td>
<td>MLP</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>13</td>
<td>Monte Sereno, City of</td>
<td>MSO</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>14</td>
<td>Morgan Hill, City of</td>
<td>MRG</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>15</td>
<td>Mountain View, City of</td>
<td>MTV</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>16</td>
<td>NASA Ames</td>
<td>NAM</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>17</td>
<td>Palo Alto, City of</td>
<td>PAF</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>18</td>
<td>Palo Alto Red Cross</td>
<td>PAR</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>19</td>
<td>San Jose, City of</td>
<td>SJC</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>20</td>
<td>San Jose Red Cross</td>
<td>SJR</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>21</td>
<td>San Jose Water Co</td>
<td>SJW</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>22</td>
<td>Santa Clara, City of</td>
<td>SNC</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>23</td>
<td>Santa Clara County</td>
<td>XSC</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>24</td>
<td>Santa Clara Valley Water District</td>
<td>VWD</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>26</td>
<td>Saratoga, City of</td>
<td>SAR</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>27</td>
<td>Stanford University</td>
<td>STU</td>
<td>WX6SC-1</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>28</td>
<td>Sunnyvale, City of</td>
<td>SNY</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
</tbody>
</table>

### Other Agencies

<table>
<thead>
<tr>
<th>#</th>
<th>Agency</th>
<th>Prefix</th>
<th>Primary BBS (2.1)</th>
<th>Secondary BBS (2.2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>29</td>
<td>CalEMA - Coastal Region</td>
<td>COS</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>30</td>
<td>Alameda County</td>
<td>XAL</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>31</td>
<td>Contra Costa County</td>
<td>XCC</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>32</td>
<td>Marin County</td>
<td>XMR</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>33</td>
<td>Monterey County</td>
<td>XMY</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>34</td>
<td>San Benito County</td>
<td>XBE</td>
<td>WX6SC-2</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>35</td>
<td>San Francisco County</td>
<td>XSF</td>
<td>WX6SC-1</td>
<td>WX6SC-3</td>
</tr>
<tr>
<td>35</td>
<td>San Mateo County</td>
<td>XSM</td>
<td>WX6SC-3</td>
<td>WX6SC-1</td>
</tr>
<tr>
<td>36</td>
<td>Santa Cruz County</td>
<td>XCZ</td>
<td>WX6SC-2</td>
<td>WX6SC-1</td>
</tr>
</tbody>
</table>

Secondary BBS assignments used if Primary BBS fails

http://www.scc-ares-races.org/packet.html > Packet Frequency and BBS Listings

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BEYOND COUNTY BORDERS
Connectivity Beyond County Borders

• Bay Area
  – All surrounding counties and Coastal Region EOC can reach at least one Santa Clara County BBS – no Internet required!
    • Anticipated use: mutual aid; connectivity to CalEMA Coastal Region
  – Tactical calls already installed in all SCCo BBSs

• Wide Area
  – AMPRnet gateway
    • Connectivity between amateur packet stations around the world
    • Uses 44/8 IP addresses; connectivity via IP/IP tunnels
  – E-Mail gateway
    • JNOS already uses SMTP for mail transport
    • E-mail gateway installed for security
  – Traditional BBS network connection via RF
Thank You!

Questions, comments, suggestions?
Michael Fox – n6mef@arrl.net