SCCo ARES/RACES
Data Network

Santa Clara County ARES/RACES/ACS

Revised: 27-Dec-2017 by Michael Fox, N6MEF

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Agenda

• Overview, Charter, Philosophy
• Services
  • Packet BBS Service
    • Plain-text Filter for Packet
  • E-mail Service
  • Intra/Internet Access Service
• Network Infrastructure
  • Architecture, External Networks, Backbone Sites, Security, Access
• Access Options
• Next Steps
Overview, Charter, Philosophy

Who We Are, What We Do, Why We Do It
Overview

• The Santa Clara County RACES data network provides emergency communications responders with a reliable, efficient and effective digital network environment that meets the needs of our served agencies.
  • Emergency communications responders: usually amateur radio operators, but could also include CERT personnel and others
  • Primary need: message traffic
  • Reliability: No service outage in over 7 years!

• Until recently, the network provided one service: packet
  • Accessed using VHF amateur radio for maximum county-wide coverage
  • Provides plain text “e-mail” messages plus bulletins, HTML versions of county EOC and hospital forms, 2-way Internet e-mail gateway

• Recent enhancements to the network allow more services
  • The result is a major step forward in amateur radio EmComm
Served Agencies (i.e. Who’s Asking?)

• The county ARES/RACES/ACS team works for County OES
• We provide services to:
  • County and city OES (including other agencies: NASA, Stanford, ...)
  • County Fire, CAL FIRE
  • Hospitals, Water districts, Red Cross, and other private agencies
  • CERT and other volunteer organizations
  • City/agency ARES/RACES teams supporting all of the above
• Purpose
  • Auxiliary communications for some (county/city agencies, ...)
  • Primary communications for others (CERT, other volunteer orgs)
  • And available anytime for use by any SCCo amateur radio operator
• Requirements
  • High availability, county-wide accessibility, EmComm-effective, information services (predominantly message and status traffic)
What We **Don’t Do**

• **Compete with public safety communications networks**
  • But we do provide an auxiliary/alternate means for EOCs, fire stations or other key locations to communicate
    • Example: 2009 South County fiber cable cut

• **Compete with public carrier networks**
  • But we do provide a means for the public to communicate when public carrier networks are down or do not cover a particular area
    • Example: 2009 South County fiber cable cut
    • Example: Alt-911 for cities with no PSAPs

• **Compete with commercial Internet service providers**
  • But we do provide alternate connectivity to the Internet for emergency use when commercial service is down (e.g. EOC Logistics placing a web order for supplies). It is not intended for general purpose Internet access
    • Example: 2016 Loma fire
Similarities to Commercial Practices

• Site selection:
  • Restricted access, physical security, generator power

• Design:
  • Signal strength, Longley-Rice, Fresnel zones, structural calculations, minimize single points of failure

• Installation practices:
  • Grounding, bonding, surge suppression, UPS, standard site hardware

• Operations:
  • Security: multiple firewall levels, intrusion monitoring
  • Documentation: physical, power, network, logical, security, procedures
  • Status monitoring: system scripts; network interface monitoring; sensors (temperature; humidity; smoke; input and UPS AC volts, amps, frequency; various DC volts, amps)
  • Maintenance: pre-announced maintenance windows

• Result: No service outage in over seven years!
Example: 2016 Loma Fire

• When all else failed ...
  • Commercial power failed
  • Generator at radio site failed
  • Internet service provider networks failed
  • Most private communications systems failed
  • After fire had passed, couldn’t restart generator remotely
  • Roads closed; no access to site to bring backup generator

• Santa Clara County ARES/RACES network continued to run
  • Provided temp, humidity, smoke sensor info to other site tenants
  • Operators transitioned to backup sites, as practiced weekly
  • Used to send/receive Internet email while ISP networks were down
Services

Moving, sharing information
Packet BBS Service

BBS = Bulletin Board System (mail server for packet messages)
Packet BBS Service

- E-mail-like service with automated workflow and documentation

- Capabilities:
  - Simple, e-mail-like client
  - Plain text e-mail-like messages
  - Optimized HTML EOC forms
  - Multi-user notices/bulletins
  - Message numbering & tracking
  - Automatic acknowledgement
  - ICS-309 Comm Log generation
  - Internet e-mail gateway
    - But Internet is not required
  - Optimized for low bandwidth
  - VHF/UHF radio access

- Availability:
  - RF throughout county
  - Also useful at higher speeds
  - TCP/IP access
Packet BBS Service Connectivity

- Five networked Packet BBSs
  - Four 7x24x365; redundant backbone
  - One roaming: training, drills, disasters
  - Connected to but not reliant on Internet

- Worldwide connectivity
  - BBS Network
  - AMPRnet
  - Winlink (via Internet)
  - Internet E-mail (two-way gateway)

- Multiple access methods
  - AX.25 (packet) over VHF (2 m, 1.25 m)
  - AX.25 (packet) over IP or UDP tunnels
  - TCP/IP over UHF (70 cm)
  - TCP/IP over WiFi (mesh or P-2-P or P-2-MP)
New for 2018
Plain Text Filter for Packet
Let’s Packet Users Read Encoded Messages
E-mail to Packet: Conversion to Plain Text

- Most E-mail uses MIME (Multipurpose Internet Mail Extensions) format
  - Packet BBS doesn’t understand MIME
- Most E-mail is sent as HTML; packet is plain text
  - Most e-mail senders don’t know they need to set plain text mode
  - Even if they do, they may not know how to do it, or they may forget
- Some service providers automatically encode; no choice!
  - Example: Mobile phone text message > HTML > Base64 (ugh!)
- Solution: MIME conversion to plain text in mail gateway
New

Decode / Notify Conversion Filter

• Try (very hard) to get a usable message through
  • Decode to plain text where possible
    • “VGVzdA==” in Base64 becomes “Test” (readable!)
  • Non-text content left encoded for possible manual decoding
    • Recipient sees that “something” is there; can manually decode if needed
  • Notify recipient of other necessary changes
    • Attachments removed
    • Redundant HTML removed

• Only reject messages that we can’t handle at all
  • Currently, only MIME-type message/partial (rarely, if ever, used)

• Result: most likely, a usable message
  • If necessary, recipient can perform further decoding or ask sender for additional clarification
Example: HTML E-mail w/attachments to Packet

Original E-Mail

Packet: Old Behavior

Packet: New Behavior

Before: VERY long and mostly unreadable message
After: Text portion is readable, printable; recipient can decide on rest
Example: Text Message w/ Emojis to Packet

Original Text Message

Packet: Old Behavior

Packet: New Behavior

Before: A completely unreadable message
After: Text portion is readable, printable; recipient can decide on rest
And, in case you were wondering ... Yes, you can recover the graphics!
New

Status: Plain Text Conversion Service

• Basic functionality working on development server
• Need to add
  • Error-handling
  • Case of blank body w/ text attachment
• Lots more testing needed; move to test server
• Expect deployment to productions servers: Spring 2018
New for 2018
Standard E-mail Service
... no Internet required!
New E-mail Service

- Standard e-mail service
- Capabilities:
  - Standard server software
  - Standard e-mail client software
    - Rich text formatting, attachments
  - Standard e-mail protocols
    - POP3, SMTP, TLS, SPF, DKIM, ...
  - Anti-X measures
  - Internet gateway
    - But Internet is not required
  - Automated account mgmt (soon)
- Needs more bandwidth than packet
  - n* Mbps (WiFi)
  - TCP/IP at 56+ Kbps (UHF) ... soon
- Availability:
  - WiFi: Where line of sight exists
  - UHF: Throughout most of county (soon)
E-mail and BBS Servers are Co-Located

- Multiple servers, just like with packet
- Numbered 1-5, just like with packet
- Each city has primary and secondary, just like with packet
- Failure of one doesn’t affect the others, just like with packet

<table>
<thead>
<tr>
<th>E-mail Domain</th>
<th>Location</th>
<th>Co-located Packet BBS</th>
</tr>
</thead>
<tbody>
<tr>
<td>email1.scc-ares-races.org</td>
<td>San Jose (Santa Clara Co office bldg)</td>
<td>W1XSC</td>
</tr>
<tr>
<td>email2.scc-ares-races.org</td>
<td>Crystal Peak (South County)</td>
<td>W2XSC</td>
</tr>
<tr>
<td>email3.scc-ares-races.org</td>
<td>Palo Alto</td>
<td>W3XSC</td>
</tr>
<tr>
<td>email4.scc-ares-races.org</td>
<td>Frazier Peak (above Milpitas)</td>
<td>W4XSC</td>
</tr>
<tr>
<td>email5.scc-ares-races.org</td>
<td>varies (drills, events, incidents)</td>
<td>W5XSC</td>
</tr>
</tbody>
</table>
# Account Details

<table>
<thead>
<tr>
<th>Maximum Message Size</th>
<th>10 MB</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mailbox quota</td>
<td>50 MB</td>
</tr>
<tr>
<td>• Warnings at 75% and 90%</td>
<td></td>
</tr>
<tr>
<td>Old message expiry and removal</td>
<td>92 days</td>
</tr>
<tr>
<td>• Warnings at 7 days</td>
<td></td>
</tr>
</tbody>
</table>
Example Mailbox Quota Warning

From postmaster@

Subject Quota Warning

X-Account-Key account16

X-UIDL 1512540327.M672899P10036.

X-Mozilla-Status 0001

Warning: Your mailbox is over 75% full.

For more information, visit:

http://www.scc-ares-races.org/email/email-quota.html
Example Expiry Notice

---

Summary of expiry activity for SCCo ARES/RACES mailbox: [Redacted]

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**DELETED**

The following messages were older than the maximum age of 4 days. They have been deleted.

<table>
<thead>
<tr>
<th>Date</th>
<th>From</th>
<th>Subject</th>
<th>Mailbox</th>
</tr>
</thead>
<tbody>
<tr>
<td>05-Oct-2017</td>
<td>[Redacted]</td>
<td>Re: testing for spam</td>
<td>INBOX</td>
</tr>
</tbody>
</table>

To prevent expiry (and warnings):

-- Check your mailbox on a regular basis
-- Make sure your e-mail client is NOT set to leave messages on the server

For more information, visit:


End of report

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### & E-mail vs. Packet - Summary

<table>
<thead>
<tr>
<th>E-mail</th>
<th>Packet</th>
</tr>
</thead>
<tbody>
<tr>
<td>GUI Interface</td>
<td>GUI Interface</td>
</tr>
<tr>
<td>Supports rich text</td>
<td>Plain text</td>
</tr>
<tr>
<td>Supports attachments</td>
<td>No attachments</td>
</tr>
<tr>
<td>Requires higher bandwidth</td>
<td>Only needs small amount of bandwidth</td>
</tr>
<tr>
<td>Reduced RF coverage</td>
<td>County-wide coverage</td>
</tr>
<tr>
<td>No workflow</td>
<td>Rich EmComm workflow (message numbering, delivery receipts, logging, ...)</td>
</tr>
</tbody>
</table>

• Packet – still best for EmComm
  • Best RF coverage; best EmComm workflow

• E-mail – can help with some 3\textsuperscript{rd} party communications
  • Complex encoding, attachments; but requires more BW; less coverage
New for 2018
Intra/Internet Access Service
SCCo ARES/RACES Backbone provides robust connectivity within the county. When completed, no site or link or Internet outage can interrupt the network.
New
Intra/Internet Service

- High-speed, redundant backbone
  - Four Internet connections
  - Any hub site or link can fail; no effect on rest of net
- Standard TCP/IP connectivity
- Capabilities, usage examples
  - Connect isolated radio room PCs that may not have other network access
  - Connect to internal servers (as developed)
  - Emergency backup Internet access
  - NOT a replacement for commercial ISP access
Future Service Strategy

• Initial services have been focused on message traffic
  • It’s the bulk of EOC communications needs
  • Even at packet speeds, it’s ~15 time faster than voice!
  • And it’s now much, much faster!

• Future services depend on needs of served agencies and/or amateur radio operator responders
  • Cities/agencies can use the network to develop their own services
    • Example: city-wide damage assessment forms with roll-up display in EOC
  • County network provides access/transport to those services
  • County network could host most popular / widest used services
    • Let’s see what develops ...
Network Infrastructure Overview

The pipes that deliver the services
High Level Network Architecture

External Networks: Internet, Amateur Radio Nets, ...

Site 1
- Firewall
- Packet Service
- E-Mail Service

Site 2
- Redundant WiFi
- Backbone 10n* Mbps

Site N
- Alternate Connections
- Firewall

Primary Connections
- Firewall
- UHF 56+ Kbps
- VHF 1200 bps

Fixed Locations With Line of Sight

Most places in the county

Anywhere in the county

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External Networks

• Connected to, but not dependent on, external networks
  • Four independent multi-Mbps Internet connections at diverse locations
  • Fully autonomous operation of services without external connectivity

• External network usage:
  • Internet:
    • Health & welfare messages to emergency responder families
    • Communications with external suppliers and agencies
    • Intelligence/situational awareness services (weather, roads, ...)
    • Remote network management, monitoring, alarms
  • Amateur radio nets (AMPRnet, BBS network, WinLink):
    • Request, provide mutual aid
    • Relay to external networks further away, outside of damage area
Backbone Sites

- No one backbone link or site outage can disable the service
  - Each site has at least two connections to other sites; more is better
  - Each site operates fully independent of all other sites
- Backbone sites selected for broad RF coverage
  - Any user location in the county should be able to reach at least two sites
  - Some user locations may need to use lower frequencies/speeds for secondary (or even primary) connectivity
Backbone Sites

• Professional build quality: reliability, ease of maintenance
• Sensors: temp, voltage, current, smoke, IP connectivity, ...
• System scripts monitor server/service status
Backbone Site – High Level Block Diagram

- Commercial Power
- Site Generator
- AC Mains
- AC PDU
- DC UPS
- DC PDU
- Servers
- Ethernet Switch
- Firewall/Router
- Sensor System
- 2m Radio
- Filter
- 1.25m Radio
- Filter
- 70cm Radio
- Filter
- Triplexor
- Soon
- New
- Backbone
- Cities/Agencies
- Internet
- Temp, Humidity, Voltages, Currents, Smoke, ...

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Multi-level Network Security

- Site-level firewall performs overall network protection
  - Protection from external networks
  - Protection from subscriber networks
- Application-level protection for each service
- Per-message Anti-X content inspection and filtering
Access

- Access speed, coverage depends on location, line of sight
  - 1200 bps VHF; covers whole county
  - [Soon] 56+ Kbps on UHF; should cover most of the county
  - [New] n* Mbps WiFi; available where line of sight exists
Summary: Services vs. Access Methods

- Services
  - Internet Access
  - Intranet Services
  - E-mail
  - Packet

- Access Methods
  - TCP/IP over n* Mbps – WiFi
  - TCP/IP over 56+ kbps UHF
  - AX.25 over 1200 bps VHF
Access Options
Access Option: AX.25 Packet over 1200 baud VHF

- Available
  - Anywhere in county
- Services
  - Packet
    - Plain-text, e-mail like service
    - Automated workflow
      - Message numbering, automatic acknowledgements, logging
    - Optimized HTML county forms
      - ICS-213 Message, Resource Request, Hospital, …
    - 2-way Internet e-mail gateway
    - All-user bulletins/notices
    - Global packet BBS connectivity
New Access Option: TCP/IP over 56+ Kbps UHF

- Available
  - Almost anywhere in the county (soon)

- Services
  - Packet (same as option 1)
  - Standard E-mail
    - Adds rich-text/HTML formatting, attachments
    - Does not have automated workflow of packet

- Status
  - 1Q-2018: testing, negotiation
  - 2Q-2018: initial deployments
**New Access Option:**
TCP/IP over n* Mbps WiFi

- **Available**
  - Where line of sight to hub site exists
- **Services**
  - Packet
  - Standard e-mail
  - Intranet access
  - Internet access
- **Status**
  - 1Q-2018: initial deployments

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Next Steps

• County ARES/RACES Network Team
  • Finalize backbone links
  • 56+ kbps UHF radio testing, selection, purchase, deployment
  • WiFi access link deployment
  • General services upgrades, improvements
  • Documentation improvements
  • Initial training courses on new services, access technologies

• Cities/agencies
  • Access planning (site evaluation; access type selection)
  • Initial 56+ kbps UHF access connections
  • Initial WiFi access connections
  • Initial E-mail, Intranet access, Internet access service subscribers
End

For more information:
http://www.scc-ares-races.org