Amateur Radio Data Networking in Event/Incident Communications

SPECS Annual Meeting
Jan 31, 2015

Revised: 31-Jan-2015

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Why Do We Care About Data Networking?

• Whether it’s audio from a microphone or data from a PC going in ...

• ... and whether it’s analog modulation or digital modulation coming out ...

• ... and whether we track it manually on a pad of paper ...

• ... or automatically via a network of computers ...

• It’s all amateur radio
Why Do We Care About Data Networking?

• In SPECS, we focus on providing communications services during a disaster or other communications emergency

• What services?

• The ones that people depend on

• So how important are data services?
Data Eclipsed Voice Traffic 15 Years Ago
## U.S. Service Penetration

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<tr>
<th>Year</th>
<th>Fixed Tel Line</th>
<th>Mobile Line</th>
<th>Internet User</th>
<th>Source</th>
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Mobile Lines Are Not Just For Voice ...

- 4G LTE mobile data communications
- Multi-Mbps up/download
- Personal WiFi hotspot
Now, > 60% of U.S. Adults Have Smart Phones

Source: Pew Research Center’s Internet & American Life Project April 26-May 22, 2011, January 20-February 19, 2012, and April 17-May 19, 2013 tracking surveys. For 2013 data, n=2,252 adults and survey includes 1,127 cell phone interviews. All surveys include Spanish-language interviews.
Mobile Data Surpassed Voice in 2009

Source: Akamai & Ericsson
And Data Applications Continue to Grow

>50% of mobile data traffic will come from video in 2019

i.e. Phone Calls
WiFi is Very Popular

- WiFi routers in homes, offices, coffee shops, ...
- 100+ Mbps over limited range
- 2012: 61% of U.S. homes have WiFi (Strategy Analytics)
In Other Words, the General Public ...

- Is a heavy user of Internet connectivity

- Is accustomed to WiFi at home, at coffee houses, on planes, trains, automobiles, ...

- Is accustomed to MOBILE Internet connectivity

- Uses MUCH more data than voice, even on their phones!

- So, overall, the demand for data services is very high
But, the General Public ...

• Are **consumers** of Internet services

• They are **dependent on the public network infrastructure**
  – The telephone, cable, or WiFi network service provider

• They are **dependent on the application service provider**
  – The PBX or repeater operator or the web site/app provider

• So, when data services break, there’s not much they can do
So, What Can Amateur Radio Do?

- We build communications networks and applications

- We make them work “When All Else Fails”

- We’ve got voice covered pretty well
  - Lots of repeaters; ubiquitous HTs; message passing procedures

- But demand for data services today far exceeds the demand for voice services
  - And yet the number of hams prepared to provide data services is much lower than for voice services
So, What Can Amateur Radio Do?

1. We can make more hams data capable
   – Equipment, training, practice, ...

2. We can build new, more advanced data solutions
   – ... for use “When All Else Fails” (no dependence on public Internet)
   – ... but also for public service events (great for practice)

3. We can recruit new, younger hams
   – It’s hi-tech, it’s exciting, it’s aligned with their interests
So what data services can we offer?
Examples: Races/Marathons; Mountain View CERT Damage Assessment

NARROWBAND DATA
STATISTICS COLLECTION / DISPLAY
Neighborhood Information Gathering

| Incident # | Time | By | Location | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W | X | Y | Z | Comments |
| 1          | 1801 | 2  | 825 Pan | 10 | 10 | 000 | 01 | 6802 |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | Apart, Wing collapsed |
| 2          | 1803 | 6  | 25v Dona | 000 | 000 | 000 | 330 | 2660301 |        |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | Tree across Church |
| 3          | 1804 | 9  | 125 Church | 01000001 | 30 | 26080210 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | Powel line down |
| 4          | 1805 | 4  | 125 Mercy | 10000001490210 | 0 | 0 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    | Thick smoke |
| 5          | 1807 | 2  | 152 Bush | 0012800101 | 0 | 0 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |  |
| 6          | 1809 | 6  | 272 Bush | 10100001149101 | 0 | 0 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |  |
| 7          | 1810 | 4  | 372 Bryant | 10000102611210 | 0 | 0 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |  Chimney Fell |
| 8          | 1811 | 5  | 631 Oak | 10000101251010 | 0 | 0 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |  |
| 9          | 1813 | 9  | 238 Villa | 00030220 | 0 | 0 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |  |
| 10         | 1815 | 1  | 118 Ellora | 10000102340100 | 0 | 0 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |  |

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Field Data Station

Wes Freeman, KG6POV
Amateur Radio Application: PacFORMS
Amateur Radio Application: Outpost
### Amateur Radio Application: MTV DA Summary

![DA Summary Table]

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**Projected onto a screen in the Mountain View EOC**

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Examples: Bike Race; Los Altos Festival of Lights Parade

NARROWBAND DATA
MOBILE ASSET TRACKING
Typical APRS Connectivity to the Internet

Tracker

GPS Receiver → TNC → Radio

APRS iGate

Radio

Internet

General Public Access
http://aprs.fi

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Integrated APRS Trackers

• Integrated: Radio / GPS / APRS TNC

• Portable: for individuals
  – Yaesu VX-8DR
  – Byonics Micro-Track All-In-One
  – Others ...

• Mobile: for vehicles
  – Kenwood TM-D710G
  – Byonics Micro-Trak Ready-To-Go
  – Others ...
Portable APRS Tracking Solution for Events

Net Control Station, Info Booth, etc.

Radio & TNC
APRSISCE
Hotspot

Trackers On Vehicles
Trackers On Rovers

Roll-Up J-Pole & Mast

APRSdroid For Hams

Public and/or Event Officials Use:
http://aprs.fi

Internet

If Available

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FASTER NARROWBAND DATA
56KBPS – 100KBPS RADIO
Wide Area Coverage Plus (not vs.) Speed

• County-wide coverage is critical for disasters
  – Need to operate from anywhere
  – Line of site issues in cities without tall buildings, trees
• 1200 baud packet provides coverage but limits functionality
  – 100 kB files not really practical to send (it would take too long)
• Broadband WiFi provides functionality but has coverage limits
  – Line of site issues, power limitations, ...
• New radio options are on the horizon (56kbps+ ... 100kbps+)
• Would allow
  – County-wide access; no line of site issues (440 MHz)
  – Simple antennas (role-up J-pole)
  – Standard applications (e-mail clients, web pages, ...)
2014 Backbone Connectivity

Next steps:
1. Move to high speed backbone as main BBS-to-BBS transport; 70cm network as backup
2. Add links to high-speed backbone to become fully redundant; 70cm can be repurposed
High Speed 440 Access in the Future?

- BBS Network
- AMPRnet
- Internet E-mail

70 cm Backbone

2m Access 1200 baud
1.25m Access 1200 baud

High Speed Backbone

56kbps+ FEC Radios
Redundancy

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Example: NW Digital Radio UDRX-440

- 25W, 70 cm Transceiver
- Linux platform
- Browser interface
- 1 Ethernet
- 4 USB
Example: Art & Wine Festival; SCCo County-wide Drill

BROADBAND MESH EVENT CONNECTIVITY
Voice/Video Solution for Public Service Event

- Provide easy-to-use services to public and event workers
  - Info booths, start/finish line, press office, first aid station, ...
- Monitor conditions at entrance, start/finish line, ...
- Independent of commercial power or network
Mesh Networking Experimentation

• 2014 SCCo ARES/RACES County-wide Exercise
Example: WB6ECE voted/simulcast system

BROADBAND VOIP
REPEATER LINKING
Analog Voice Repeater Linking Options

• Typical Analog Link

• Digital Link (example: WB6ECE voted/simulcast system)
802.11 (WiFi): Part 15 vs. Part 97

- **2.4 GHz**
  - **2390 – 2450 MHz** Part 97
  - **2412 – 2472 MHz (Centers)** Part 15

- **5 GHz**
  - **5650 – 5925 MHz** Part 97
  - **5180 – 5825 MHz (Centers)** Part 15

• Off-the-shelf 802.11 gear is readily available and can be used under Part 97 (higher power, no encryption, no 3rd party)
• Or, the same gear can be used under Part 15 rules (encryption, 3rd party, but lower power)
Example: Cupertino ARKnet

BROADBAND FIXED SITE CONNECTIVITY
Cupertino ARKnet Purpose

- Connect ARKs, key city locations and served agencies via a broadband data network

- Key applications:
  - Local hot spot for data exchange
  - Telephones (VoIP) at ARKs for ARK staff, possibly elsewhere for public
  - Status and information dissemination (web access)
  - Inventory management (shared file access)
  - Video surveillance

- Low cost vs. commercial service provider solutions
  - Off-the-shelf WiFi components
  - Volunteer labor
Pilot Coverage

Sector 14

Montebello
EOC
Hyde

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Montebello Site

Hyde ARK site
Demo... live, from Hyde Ark!
Future Sites... ARKs, City Sites, Served Agencies
Broadband Line of Sight Issues

- Line of sight can be a real problem for 802.11 networks
  - Example: Cupertino ARK Project
- Even more of a problem with ad hoc, temporary nets
Cupertino ARKnet Status

• Three site pilot was successful
  – Established connectivity
  – Showed examples of likely applications

• Approved for next phase (analysis)
  – Analyze and plan how they will cover the other sites
  – Some sites are much further away than the pilot locations
  – Some sites have line-of-site issues
  – Power/margin/coverage investigation
Demo Diagram and Explanation
ARKnet Demo

ARK Location

5.8 GHz

Directional Antenna

5.8 GHz

Sector Antenna (demo=Omni)

Central Location

Demo Applications:

Streaming Video

Telephone (VoIP)

File Sharing/Live Update

Client PC

File Server

Phone Server

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Conclusions

• Public has a huge appetite for data
• Technology is affordable and available
• Lots of solutions ideal for amateur radio deployment
• Lots to learn / experiment / develop / spur interest
  – Applications: information collection, presentation, ...
  – New traffic types: VoIP, message traffic, telemetry, statistics, video, ...
  – IP Networking: addressing, switching, routing, security, ...
  – MHz and GHz radio: antennas, power, propagation, ...
• Recruiting tool for younger, hi-tech hams
Where Can You Contribute?

- What do you (want to) know?
- Applications
  - User software
  - Operating system, management
- Access
  - Client equipment
  - Training, demo, user mentor, docs
- Infrastructure
  - Site work (rack, tower, ...)
  - Design, implementation, monitoring of: RF TX/RX, antenna, IP network, power: design, implementation, monitoring
Thank You